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Program, Abstracts and Field Trip Guide

JURASSIC 2022

Budapest

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PROGRAM, ABSTRACTS AND FIELD TRIP GUIDE

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WELCOME MESSAGE

Dear Colleagues,
Dear members of the Jurassic family!

It is a great pleasure to welcome all of you to Budapest, Hungary at the 11th International Congress on the Jurassic System. We are pleased that there will be about 110 researchers from 31 countries gathering to present their new research results, meeting old friends and making new ones, forging new scientific collaborations, ready to move forward our quest to understand more than 55 million years of Earth history.

The scientific program is organized into 12 thematic sessions with 88 oral and 20 poster presentations. Four lectures in the first morning on Monday will set the scene by highlighting key topics in current Jurassic research and giving you an overview of the Jurassic geology and paleontology of Hungary as the host country.

Traditionally, Jurassic conferences in the past were dominated by biostratigraphic research, first and foremost featuring ammonite studies. Whereas ammonoid taxonomists and biostratigraphers are still core members of the Jurassic community and present a rich session here, they are joined by many who apply integrated methods, carry a geochemistry toolbox, and focus on events on biotic and environmental change. The very start of the Jurassic follows one such event, the end-Triassic extinction that will receive attention here, but now undeniably the most popular research theme is the Toarcian, with its much studied anoxic event and other changes. Clearly, unravelling greenhouse warming-related events is the topic where Jurassic research becomes most relevant in today's world of accelerating climate change, biodiversity loss, ocean acidification, and spreading dead zones. Jurassic climate, marine and terrestrial life, sedimentary basins, tectonic evolution, and geoheritage complement the spectrum of exciting topics to make this conference a stimulating event. As all good things must end, the Jurassic is no exception – but we still have to decide when the Jurassic ended, so watch out for the session on the Jurassic-Cretaceous boundary. In addition, we invite you to a public panel discussion on Jurassic topics, a presentation of a newly published book, visits to museums, and a mid-conference field excursion to give you a glimpse of the Tethyan Jurassic stratigraphy in the Geological Garden at Tata.

We have been through turbulent years since the last congress in Mexico in 2018. The pandemic hit, war broke out as our neighbour Ukraine was invaded, an energy crisis is looming, and climate change came home with a record hot and dry summer this year. Yet science always offers hope and we are glad that the conference will happen as planned. Beyond the science, we wish that you enjoy your stay in Budapest, a city with a rich architectural heritage and cultural scene.

Welcome to the conference, welcome to our Jurassic family reunion!

József Pálfy and István Főzy
Chairpersons

PROGRAM

MONDAY, 29 AUGUST

9.00	OPENING - WELCOME ADDRESS 1 – Tivadar M. Tóth, President of the Hungarian Geological Society	
9.10	WELCOME ADDRESS 2 – László Túri, Vice Dean of Scientific Affairs, Eötvös Loránd University, Faculty of Sciences	
9.20	WELCOME ADDRESS 3 – Angela L. Coe, Chair of the International Subcommission on Jurassic Stratigraphy	
9.30	PLENARY SESSION, LECTURE 1 TOWARDS AN INTEGRATED STRATIGRAPHY, TIMESCALE, AND EARTH SYSTEM UNDERSTANDING FOR THE LOWER JURASSIC (INITIAL RESULTS OF THE JET PROJECT) - Stephen Hesselbo	
10.10	COFFEE BREAK	
10.30	PLENARY SESSION, LECTURE 2 THE EARLY TOARCIAN GLOBAL CHANGE: IMPACT ON ECOSYSTEMS - Matías Reolid	
11.10	PLENARY SESSION, LECTURE 3 THE HISTORY OF JURASSIC STUDIES IN HUNGARY - András Galácz, Attila Vörös	
11.50	PLENARY SESSION, LECTURE 4 MESOZOIC EVOLUTION OF THE PANNONIAN REGION - László Fodor, János Haas	
12.30	LUNCH	
	THE TOARCIAN OAE A.K.A. JENKYNS EVENT (IGCP 655) – *PANORAMA* Chairpersons: Matías Reolid, Viktória Baranyi, Luís Duarte, Angela Coe	JURASSIC SEDIMENTARY BASINS AND GEODYNAMICS – *MERCURE* Chairpersons: Hans-Jürgen Gawlick, Boštjan Rožič
14.00	ASSESSING THE EFFECT OF HIATAL SURFACES ON OUR UNDERSTANDING OF THE PLIENSBACHIAN/TOARCIAN BOUNDARY EVENT - Stéphane Bodin, Alicia Fantasia, Bjarke Nebsbjerg, Lasse Christiansen, Francois Nicolas Krencker	ADRIA PLATE MIDDLE-LATE JURASSIC RECONSTRUCTION THROUGH BALANCED AND RESTORED CRUSTAL CROSS-SECTIONS - Estefanía Bravo-Gutiérrez, Jaume Vergés, Ivone Jiménez-Munt, Montserrat Torne, Wentao Zhang, Daniel García-Castellanos, Ana Negredo, Eugenio Carminati
14.20	STRATIGRAPHIC CHANGES IN SHELL SIZE OF THE BIVALVE *HARPAX SPINOSUS* DURING THE LATE PLIENSBACHIAN AND EARLY TOARCIAN - Adam Tomašových, Luís Vítor Duarte, Tamás Müller, Ján Schlögl	THE FIRST STAGE FROM THE GULF OF MEXICO EVOLUTION WAS A PROTO-HISPANIC CORRIDOR (LATE TRIASSIC-PLIENSBACHIAN) AS A PRODUCT OF A HOT SPOT WITH TRIPLE JUNCTION - Jaime Rueda-Gaxiola
14.40	STRATIGRAPHIC CONSTRAINTS ON THE LOWER TOARCIAN STRATA OF THE LAS OVERAS SECTION, NORTHERN NEUQUÉN BASIN, ARGENTINA - Marisa S. Storm, Stephen P. Hesselbo, Hugh C. Jenkyns, Micha Ruhl, Aisha H. Al-suwaidi, Daniel J. Condon, Lawrence M.E. Percival Susana E. Damborenea, Miguel O. Manceñido, Alberto C. Riccardi	THE SECOND STAGE FROM THE GULF OF MEXICO EVOLUTION WAS THE HISPANIC CORRIDOR (BAJOCIAN-TITHONIAN) AS A PRODUCT OF THE HOT SPOT WITH TRIPLE JUNCTION - Jaime Rueda-Gaxiola
15.00	EXTINCTION INDUCED CHANGES TO MOROCCAN REEF ECOLOGY IN THE EARLY JURASSIC - Travis Stone, Rowan Martindale, Tanner Fonville, Raphaël Vasseur, Bernard Lathuiliere	NEW PERSPECTIVES ON OPALINUS CLAY FACIES DESCRIPTIONS BASED ON DRILL CORES FROM CENTRAL NORTHERN SWITZERLAND - Geraldine Zimmerli, Bruno Lauper, Gaudenz Deplazes, David Jaeggi, Stephan Wohlwend, Anneleen Foubert

15.20 COFFEE BREAK

		JURASSIC MARINE LIFE, PALEOECOLOGY AND TAPHONOMY – *MERCURE* Chairpersons: Atsushi Matsuoka, Adam Tomašových
15.50	NEW INSIGHTS INTO CALCAREOUS NANNOPLANKTON RESPONSES TO THE TOARCIAN OCEANIC ANOXIC EVENT - Sam M. Slater, Paul Bown, Richard J. Twitchett, Silvia Danise, Vivi Vajda	BRACHIOPOD GEOCHEMISTRY AND SHELL STRUCTURES HELP CONSTRAIN PALAEOECOLOGY AND PHYLOGENY - Clemens V. Ullmann, Richard Boyle, Luis V. Duarte, Stephen P. Hesselbo, Simone A. Kasemann, Tina Klein, Tim M. Lenton, Veronica Piazza, Martin Aberhan
16.10	LEVEL-BOTTOM MACROFAUNAL COMMUNITY STRUCTURE IN THE EARLY JURASSIC OF MOROCCO - Sinjini Sinha, Rowan C. Martindale, Crispin T.S. Little, Travis N. Stone, Tanner Fonville, Stéphane Bodin, Lahcen Kabiri	PELAGIC VS. NERITIC FORAMINIFERAL FAUNA CHANGE DURING THE UPPER PLIENSBACHIAN – UPPER TOARCIAN, CAUSED BY ENVIRONMENTAL PERTURBATIONS - Gábor Zsiborás, Ágnes Görög
16.30	ASSEMBLAGES OF TRACE FOSSILS DOCUMENTING EARLY RECOVERY AFTER THE TOARCIAN OCEANIC ANOXIC EVENT (WESTERN CARPATHIANS, SLOVAKIA) - Vladimír Šimo, Adam Tomašových, Ján Schlögl	DATING THE COLOMERA SECTION (MEDIAN SUBBETIC, SE SPAIN) USING CALCAREOUS NANNOFOSSILS Angela Fraguas, José Miguel Molina, Luis Nieto, Matías Reolid
16.50	RIFT-ASSOCIATED DEEP-WATER ARCHAEA IN BLACK SHALES OF THE TOARCIAN MANGANESE DEPOSIT AT ÚRKÚT, HUNGARY - Lorenz Schwark, Márta Polgári, Thorsten Bauersachs, Wolfgang Ruebsam	
17.10	VEGETATION RESPONSE TO AN EARLY JURASSIC CLIMATE CHANGE AND ENVIRONMENTAL PERTURBATION - Viktória Baranyi, Xin Jin, Zhiqiang Shi, Binbing Li, David B. Kemp, Jacopo Dal Corso, Nereo Preto	

TUESDAY, 30 AUGUST

	THE TOARCIAN OAE A.K.A. JENKYNS EVENT (IGCP 655) – *PANORAMA* Chairpersons: Matías Reolid, Viktória Baranyi, Angela Coe, Luís Duarte	JURASSIC MARINE LIFE, PALEOECOLOGY AND TAPHONOMY – *MERCURE* Chairpersons: Atsushi Matsuoka, Adam Tomašových
9.00	IMPACT OF THE JENKYNS EVENT (EARLY TOARCIAN) ON DINOSAUR ASSEMBLAGES - Matías Reolid, Wolfgang Ruebsam, Michael Benton	AALENIAN PROTOGLOBIGERINIDS FROM THE AMMONITICO ROSSO FACIES OF GERECSE AND BAKONY MTS., HUNGARY - Ágnes Görög, Gábor Zsiborás
9.20	THE EARLY TOARCIAN CALCIFICATION CRISIS: OUR KNOWLEDGE SO FAR - Tamás Müller	TAXONOMIC AND TAPHONOMIC REMARKS ON THE OXFORDIAN AMMONITES FROM MONTE BARBARO (WESTERN SICILY, ITALY) - Carolina D'Arpa, Pietro Di Stefano
9.40	NEW GEOCHEMICAL RECORDS OF THE PLIENSBACHIAN-TOARCIAN CLIMATE CHANGES NEAR THE NORTH POLE - Thomas Letulle, Guillaume Suan, Mikhail Rogov, Oleg Lutikov, Alexei Ippolitov, Mathieu Daëron, Arnauld Vinçon-Laugier, Christophe Lécuyer	JURASSIC SEALIFE PRESERVED IN THE NUSPLINGEN FOSSIL LAGERSTÄTTE (UPPER KIMMERIDGIAN, SW GERMANY) - Günter Schweigert, Erin Maxwell
		WESTERN TETHYS MEETS EASTERN TETHYS (IGCP 710) – *MERCURE* Chairpersons: Michał Krobicki, Ender Sarifakioglu
10.00	SYNONYMOUS USE OF T-OAE AND T-CIE? SPATIOTEMPORAL VARIABILITY IN ORGANIC CARBON ISOTOPE SIGNATURE AND ORGANIC MATTER ACCUMULATION DURING THE EARLY TOARCIAN - Wolfgang Ruebsam, Lorenz Schwark	SIGNIFICANCE OF THE ANKARA MÉLANGE: AN ANCIENT SUBDUCTION-ACCRETION COMPLEX OF THE NORTHERN NEOTETHYS, TURKEY - Ender Sarifakioglu
10.20	COFFEE BREAK	
10.50	LIP VOLCANISM AS A DRIVER OF THE TOARCIAN OCEANIC ANOXIC EVENT (T-OAE) - Thomas Gibson, Sev Kender, Stephen Hesselbo	ULTRASTRUCTURE AND COMPOSITION OF CALPIONELLIDS IN THE UPPER JURASSIC AND LOWER CRETACEOUS PELAGIC DEPOSITS - Diana Ölveczká, Adam Tomašových
11.10	FOSSIL LEAF MERCURY (HG) ANALYSES PROVIDES INSIGHT ON EARLY JURASSIC ATMOSPHERIC CONCENTRATIONS AND LIP VOLCANISM - Emma Blanka Kovács, Micha Ruhl, Jennifer McElwain	SYN-RIFT ORIGIN OF THE BAJOCIAN SUBMARINE SWELL (CZORSZTYN RIDGE) WITHIN CARPATHIAN BASINS - Michał Krobicki
11.30	REDUCED PLATE MOTION CONTROLLED TIMING OF EARLY JURASSIC KAROO-FERRAR LARGE IGNEOUS PROVINCE VOLCANISM - Micha Ruhl, Stephen P. Hesselbo, Hugh C. Jenkyns, Weimu Xu, Ricardo L. Silva, Kara J. Matthews, Tamsin A. Mather, Conall Mac Niocaill, James B. Riding	HOW FAR TO THE WEST WAS THE SLOVENIAN BASIN EXTENDING? - Boštjan Rožič, Jan Udovè, Petra Žvab Rožiè, Luka Gale, David Gerèar
11.50	EARLY JURASSIC LIP MAGMATISM AND ENVIRONMENTAL CHANGE - Isabel M. Fendley, Joost Frieling, Oliver Neilson, Micha Ruhl, Tamsin A. Mather, Stuart A. Robinson, Hugh C. Jenkyns	MIDDLE-LATE JURASSIC GEODYNAMIC EVOLUTION OF THE WESTERN TETHYS REALM AS DEDUCED FROM SEDIMENTARY MÉLANGE ANALYSIS IN TRENCH-LIKE BASINS FORMED IN FRONT OF OBDUCTING OPHIOLITES - Hans-Jürgen Gawlick

12.10	APPLICATIONS OF LARGE MULTI-PROXY DATA SETS TO ASSESS THE TEMPORAL RELATIONSHIP BETWEEN KAROO AND FERRAR LARGE IGNEOUS PROVINCE ACTIVITY AND LOWER JURASSIC (TOARCIAN) ENVIRONMENTAL PERTURBATIONS - Aisha Al Suwaidi, Micha Ruhl, Cameron Mercer	MANGROVES KILLED BY STORMS – PLIENSBACHIAN/EARLY TOARCIAN RECORD OF NEARSHORE TETHYAN PALAEOENVIRONMENTS IN THE ALBANIAN ALPS - Michał Krobicki, Jolanta Iwańczuk, Maria Barbacka, Bardhyl Muceku
12.30	LUNCH	
14.00	CARBON-ISOTOPES AND CALCAREOUS NANNOFOSSILS, CLUES FOR EARLY JURASSIC MARINE PALAEOENVIRONMENTS IN THE NEUQUÉN BASIN - Micaela Chaumeil-Rodríguez, Juan Pablo Pérez-Panera, Jorge E. Spangenberg, Alejandro R. Gómez-Dacal, Guillaume Suan, Emanuela Mattioli	LATE JURASSIC FORAMINIFERAL PLANKTON IN THE NORTHERN TETHYS: NEW DATA FROM THE POLISH OUTER CARPATHIANS - Andrzej Szydło
14.20	TOARCIAN OCEANIC ANOXIC EVENT IN WESTERN TETHYS: THE SOGNO CORE PELAGIC RECORD (LOMBARDY BASIN, NORTHERN ITALY) - Gabriele Gambacorta, Hans Juergen Brumsack, Bernhard Schnetger, Elisabetta Erba	NEW EVIDENCES FROM MIDDLE JURASSIC CONTINENTAL STRATA OF TUNISIA, FRANCE AND MOROCCO CHALLENGE PREVIOUS PALAEOBIOGEOGRAPHIC THOUGH RELATED TO THE PANGEA BREAKUP - Khaled Trabelsi, Benjamin Sames, Michael Wagreich
		JURASSIC CLIMATE AND SEA LEVEL – *MERCURE* Chairpersons: Grzegorz Pieńkowski, Gregory Price
14.40	TRACING THE AFTERMATH OF THE HYPERTHERMAL TOARCIAN OCEANIC ANOXIC EVENT: A MULTIPROXY STUDY - Alicia Fantasia, Thierry Adatte, Jorge E. Spangenberg, Emanuela Mattioli, Romain Millot, Jérémie Melleton, Christian Salazar, Stéphane Bodin, Guillaume Suan	AALENIAN–BAJOCIAN EUSTATIC SEA-LEVEL FLUCTUATIONS: NEW INSIGHT FROM THE CENTRAL HIGH ATLAS BASIN, MOROCCO - Stéphane Bodin, Julien Talon, Simon Andrieu, Malte Mau, Jan Danisch, Francois-Nicolas Krencker, Lahcen Kabiri
15.00	THE EFFECTS OF EARLY JURASSIC (PLIENSBACHIAN–TOARCIAN) WARMING EPISODES ON THE COMPOSITION AND THERMAL STRUCTURE OF BENTHIC MARINE MACROINVERTEBRATE COMMUNITIES - Carl Reddin, Jan Landwehrs, Georg Feulner, Erin Saupe, Clemens Ullmann, Martin Aberhan	SEQUENCE STRATIGRAPHIC ARCHITECTURE OF THE MIDDLE AND UPPER JURASSIC OF THE ARABIAN PLATE - Frans van Buchem, Chris Gravestock, Mike Simmons, Roger Davies
15.20	COFFEE BREAK	
15.50	POSTER SESSIONS	
17.00	TRANSFER TO ELTE CAMPUS	
17.30	VISIT OF UNIVERSITY MUSEUM'S GEO EXHIBITS	
18.00	PUBLIC PANEL DISCUSSION *EVERYTHING YOU ALWAYS WANTED TO KNOW ABOUT THE JURASSIC BUT WERE AFRAID TO ASK*	

WEDNESDAY, 31 AUGUST

MID-CONFERENCE FIELD TRIP TO TATA AND VÉRTESSZŐLŐS

THURSDAY, 1 SEPTEMBER

	THE TOARCIAN OAE A.K.A. JENKYNS EVENT (IGCP 655) – *PANORAMA* Chairpersons: Matías Reolid, Viktória Baranyi, Angela Coe, Luís Duarte	INTEGRATED STRATIGRAPHY OF THE JURASSIC – *MERCURE* Chairpersons: Angela Coe, David Kemp
9.00	EARLY-STAGE ORE FORMING PROCESS OF THE ÚRKÚT AND EPLÉNY MANGANESE ORE DEPOSITS (HUNGARY) - Máté Zs. Leskó, Boglárka A. Topa, Richárd Z. Papp, Ferenc Kristály, Ferenc Móricz, Tamás G. Weiszburg, József Pálfy, Norbert Zajzon	RE-OS DATING OF JURASSIC STRATA: ACHIEVEMENTS, CHALLENGES AND FUTURE DIRECTIONS - Svetoslav V. Georgiev, Holly J. Stein, Judith L. Hannah
9.20	ORE-FORMING PROCESSES ON MICROMETRE-SCALE IN THE ÚRKÚT MANGANESE ORE DEPOSIT, HUNGARY - Boglárka Anna Topa, Norbert Zajzon, Máté Zs. Leskó, Tamás G. Weiszburg	CYCLOSTRATIGRAPHY AND ASTROCHRONOLOGY OF THE LACUSTRINE TO PARALIC MECSEK COAL FORMATION (SOUTHWEST HUNGARY) - Zsolt Vallner, József Pálfy
	THE TRIASSIC-JURASSIC BOUNDARY AND OTHER EVENTS IN THE JURASSIC – *PANORAMA* Chairpersons: Pierre Pellenard, Micha Ruhl	
9.40	MAJOR VEGETATION TURNOVER ACROSS THE TRIASSIC-JURASSIC BOUNDARY OF SWEDEN - Vivi Vajda, Sam Slater, Jungang Peng, Ashley Kruger	INTEGRATED STRATIGRAPHY OF THE HETTANGIAN-SINEMURIAN (LOWER JURASSIC) IN THE TATA GEOLOGICAL GARDEN (TRANSDANUBIAN RANGE, HUNGARY) - Dorottya Dénes, Zsolt Vallner, Attila Demény, Zsófia Kovács, József Pálfy
10.00	GEOCHEMICAL EVIDENCE FROM THE MT. SPARAGIO SECTION, SICILY, ITALY: A CONTINOUS PERITIDAL SUCCESSION ACROSS THE TRIASSIC/JURASSIC BOUNDARY - Simona Todaro, Manuel Rigo, Pietro Di Stefano	THE SINEMURIAN SHALLOW-WATER CARBONATES IN THE LUSITANIAN BASIN (PORTUGAL): AN INTEGRATED STRATIGRAPHIC ANALYSIS - Luís V. Duarte, Ricardo L. Silva, Ana C. Azerêdo, María J. Comas-Rengifo, João G. Mendonça Filho
10.20	COFFEE BREAK	
10.50	MULTIPROXY CYCLOSTRATIGRAPHY AND ASTROCHRONOLOGY OF A TRIASSIC-JURASSIC BOUNDARY SECTION FROM CSÕVÁR, HUNGARY - Zsolt Vallner, Emma Blanka Kovács, Attila Demény, Ferenc Móricz, Norbert Zajzon, József Pálfy	THE INTEGRATED UPPERMOST TORCIAN BIOSTRATIGRAPHIC SECTION IN THE MINETT BIOSPHERE UNESCO, SOUTHWESTERN LUXEMBOURG - Andrea Di Cencio, Robert Weis
11.10	EXTENSIVE ANOXIA AFTER THE END-TRIASSIC MASS EXTINCTION: URANIUM ISOTOPE EVIDENCE FROM THE TRIASSIC-JURASSIC BOUNDARY SECTION AT CSÕVÁR - Anna Somlyay, László Palcsu, Gabriella Ilona Kiss, Matthew O. Clarkson, Emma Blanka Kovács, Zsolt Vallner, Norbert Zajzon, József Pálfy	A NEW COMBINED HIGH-RESOLUTION JURASSIC C-ISOTOPE CHEMO- AND BIOSTRATOGRAPHIC CORRELATION FROM NORTHERN SWITZERLAND - Stephan Wohlwend, Susanne Feist-Burkhardt, Bernhard Hostettler, Ursula Menkveld-Gfeller, Hansruedi Bläsi, Stefano M. Bernasconi, Gaudenz Deplazes

11.30	MULTIPROXY EVIDENCE FOR UNSTEADY PALAEOENVIRONMENTAL CONDITIONS DURING THE AALENIAN - Alicia Fantasia, Emanuela Mattioli, Thierry Adatte, Jorge E. Spangenberg, Enrique Bernárdez, Jorge Ferreira, Nicolas Thibault, François Nicolas Krencker, Stéphane Bodin	BELEMNITES AND CALCAREOUS NANNOFOSSILS FROM THE NORTH BOHEMIA REVEAL PROLONGED JURASSIC SEDIMENTATION IN CENTRAL EUROPE - Jan Geist, Katarina Holcová, Lucie Vaňková, Martin Mazuch, Martin Košťák
		JURASSIC AMMONITES AND BIOSTRATIGRAPHY - (BARNABÁS GÉCZY MEMORIAL SESSION) – *MERCURE* Chairpersons: András Galácz, Andrzej Wierzbowski
11.50	CARBON CYCLE RECORD AT THE EARLY–MIDDLE OXFORDIAN TRANSITION: NEW INSIGHT FROM THE PARIS BASINP - ierre Pellenard, Justine Blondet, Chloé Morales, Philippe Landrein, Johann Schnyder, François Baudin, Anne-lise Santoni, Ludovic Bruneau	AMMONOID BIOSTRATIGRAPHY OF A NEW LOWER JURASSIC LOCALITY FROM THE DEATH VALLEY NATIONAL PARK (CALIFORNIA, USA) - Zsófia Horváth-Kostka, Matthew Ferlicchi, Vincent Santucci, József Pálfy
12.10	OXYGEN AND CARBON ISOTOPE VARIATION IN THE EARLY JURASSIC OCEAN - Gregory Price	NEW RESULTS ON THE STRATIGRAPHY OF THE ARIETENKALK FORMATION (SINEMURIAN, SW GERMANY) - Armin Scherzinger, Günter Schweigert
12.30	LUNCH	
	SCIENCE OUTCOMES OF THE JET PROJECT – *PANORAMA* Chairpersons: Steve Hesselbo, Kevin Page, Micha Ruhl	
14.00	ENHANCED GLOBAL WEATHERING IN RESPONSE TO CENTRAL ATLANTIC MAGMATIC PROVINCE ACROSS THE TRIASSIC–JURASSIC TRANSITION - Weimu Xu, Giorgia Ballabio, Danny Hnatyshin, David van Acken	OXYNOTUM ZONE (UPPER SINEMURIAN) OF ASTURIAN AND LUSITANIAN BASINS, IBERIAN PENINSULA: AMMONOID SUCCESSION AND CORRELATION - Íñigo Vitón, María J. Comas-Rengifo, Luís V. Duarte, Antonio Goy
14.20	TOWARDS A HIGH RESOLUTION AND GENUINELY 'STANDARD' CHRONOZONATION FOR THE HETTANGIAN STAGE - Kevin N. Page	PLIENSBACHIAN (EARLY JURASSIC) AMMONOIDS FROM THE KURUMA GROUP AROUND MT. KIKUISHI IN ITOIGAWA, NIIGATA, CENTRAL JAPAN - Atsushi Matsuoka, Kentaro Nakada
14.40	SEAWATER RE-OS OSCILATTIONS DURING THE EARLY JURASSIC SINEMURIAN-PLIENSBACHIAN BOUNDARY - Giorgia Ballabio, Weimu Xu, Danny Hnatyshin, David van Acken	TOARCIAN AMMONITES FROM THE CENTRAL HIGH ATLAS (MOROCCO) - Mohamed Benzaggagh, Hanane Khaffou, Mariusz A. Salamon, Touria Hssaida, Mohamed El Ouali, Badre Essafraoui

15.00	INSIGHTS INTO THE EARLY JURASSIC CARBON-CYCLE, PALEOENVIRONMENT AND CLIMATE USING ALGAL-DERIVED BIOMARKER *P*CO_2 RECONSTRUCTIONS - Marisa S. Storm, Luís V. Duarte, Stuart A. Robinson, Stephen P. Hesselbo, Stefan Schouten, Marcel T.J. van der Meer	CHRONOSTRATIGRAPHIC OVERVIEW OF THE TOARCIAN (EARLY JURASSIC) AMMONITE FAUNA FROM THE MECSEK MTS (SW HUNGARY) - Zoltán Kovács, Zsófia Horváth-Kostka, Tamás Müller, József Pálfy
15.20	COFFEE BREAK	
15.50	THE RECORD OF EARLY JURASSIC ORGANIC MATTER PRESERVATION INTERVALS (OMPI) IN THE CENTRAL AND NORTH ATLANTIC CONJUGATE MARGINS - Ricardo L. Silva, Luís V. Duarte, Grant D. Wach, Micha Ruhl, Bruno Rodrigues, Driss Sadki, Juan J. Gómez, Stephen P. Hesselbo, Weimu Xu, João G. Mendonça Filho	BOREAL AND TETHYAN CEPHALOPOD FAUNAS AT THE AALENIAN/BAJOCIAN BOUNDARY (MIDDLE JURASSIC): EXAMPLES FROM SOUTHERN LUXEMBOURG AND THE ATLAS MOUNTAINS, MOROCCO - Driss Sadki, Robert Weis
16.10	ICHNOLOGY, SEDIMENTOLOGY, AND ORBITAL CYCLES IN THE HEMIPELAGIC EARLY JURASSIC LAURASIAN SEAWAY (TOARCIAN, CARDIGAN BAY BASIN, UK) - Grzegorz Pieńkowski, Alfred Uchman, Krzysztof Ninard, Stephen P. Hesselbo	THE AMMONITES OF THE KEPPLERI HORIZON (BASAL CALLOVIAN, MIDDLE JURASSIC) OF ALBSTADT-PFEFFINGEN (SWABIAN ALB, GERMANY) - Gerd Dietl, Eckhard Mönnig, Günter Schweigert
16.30	GRAIN SIZE AS A KEY TO UNDERSTANDING PALAEOENVIRONMENTAL PARAMETERS IN JURASSIC SEDIMENTARY ROCKS - Mengjie Jiang, Stephen P. Hesselbo, Clemens V. Ullmann, Kate Littler	WORLDWIDE CORRELATION OF THE BASE OF THE OXFORDIAN STAGE AND UPPER JURASSIC USING AMMONOIDEA - Kevin N. Page, John K. Wright
16.50		SEA LEVEL CHANGES AND PALAEOGEOGRAPHICAL CONTROLS ON THE EVOLUTIONARY DEVELOPMENT OF AULACOSTEPHANID AMMONITES - Andrzej Wierzbowski
17.10		NEW TITHONIAN BIOSTRATIGRAPHIC DATA FROM THE NEUQUÉN BASIN, ARGENTINE ANDES: A CONTRIBUTION FROM THE SOUTHERN HEMISPHERE - Marina Lescano, Verónica Vennari, Rafael López-Martínez, Andrea Concheyro, Beatriz Aguirre-Urreta, Pierre Pellenard, Mathieu Martinez
17.30		PRESENTATION OF THE NEWLY PUBLISHED MONOGRAPH "FAUNA, BIOSTRATIGRAPHY, FACIES AND PALEOTECTONIC EVOLUTION OF THE LATE JURASSIC-EARLY CRETACEOUS FORMATIONS IN THE BAKONY MOUNTAINS (TRANSDANUBIAN RANGE, HUNGARY) - István Főzy
	RIVER CRUISE & BANQUET	

FRIDAY, 2 SEPTEMBER

9:00	ISJS BUSINESS MEETING - PANORAMA	
	THE JURASSIC-CRETACEOUS BOUNDARY – *PANORAMA* Chairpersons: Jacek Grabowski, Ottilia Szives	JURASSIC GEOHERITAGE – *MERCURE* Chairpersons: Kevin Page, Günter Schweigert
9.40	WHERE SHOULD THE JURASSIC SYSTEM END? - Jacek Grabowski, B. Aguirre-Urreta, J.-F. Deconinck, E. Erba, C. Frau, G. Li, M. Martinez, A. Matsuoka, J. Michalik, J. Mutterlose, G. Price, D. Reháková, M. D. Schmitz, P. Schnabl, O. Szives, A. Wierzbowski	CONTRASTING APPROACHES TO THE CONSERVATION OF JURASSIC PALAEONTOLOGICAL HERITAGE AND SITES AND ITS CONSEQUENCES FOR JURASSIC SCIENCE - Kevin N. Page
10.00	THE JURASSIC/CRETACEOUS TRANSITION: NEW AMMONITE DATA FROM AMMONITICO ROSSO/BIANCONE SECTIONS OF THE BAKONY MOUNTAINS (TRANSDANUBIAN RANGE, HUNGARY) AND A PROPOSAL FOR THE MEDITERRANEAN AMMONITE ZONAL SCHEME - Ottilia Szives, István Főzy	GEOHERITAGE IN THE MINETT UNESCO BIOSPHERE (SOUTHERN LUXEMBOURG): INVENTORY, EVALUATION, AND CONSERVATION ASPECTS OF REPRESENTATIVE GEOSITES - Robert Weis
10.20	COFFEE BREAK	
10.50	THE JURASSIC/CRETACEOUS BOUNDARY IN TERMS OF RADIOLARIANS FROM THE SÜMEG AREA (TRANSDANUBIAN RANGE, HUNGARY) - Péter Ozsvárt, János Haas, László Makádi	HOW TO USE SOCIAL MEDIA TO PROMOTE GEOSCIENCE AND CONSERVATION - Emma M. Cieslak-Jones, Kevin N. Page
		TERRESTRIAL LIFE IN THE JURASSIC – *MERCURE* Chairpersons: Grzegorz Pieńkowski, Vivi Vajda
11.10	PALEOENVIRONMENTAL STUDY OF THE JURASSIC–CRETACEOUS BOUNDARY INTERVAL IN THE TRANSDANUBIAN RANGE (HUNGARY) - Damian Gerard Lodowski, Ottilia Szives, Attila Virág, István Főzy, Jacek Grabowski	PLANTS FROM JURASSIC DINOSAURS' COPROLITES FROM THE HOLY CROSS MOUNTAINS, POLAND - Maria Barbacka, Grzegorz Pacyna, Jadwiga Ziaja
11.30	A REVIEW OF JURASSIC-CRETACEOUS TRANSITION SEQUENCES IN JAPAN - Atsushi Matsuoka, Shin-Ichi Sano	A WORLD-CLASS HETTANGIAN TRACKSITE FROM POLAND – A NEW LIGHT ON THE EARLY EVOLUTION OF DINOSAURS - Grzegorz Pieńkowski, Grzegorz Niedźwiedzki
11.50	CARBON CYCLE, CYCLOSTRATIGRAPHY AND U-PB AGES OF THE TITHONIAN FROM THE NEUQUEN BASIN, ARGENTINA - Pierre Pellenard, M. Martinez, Aurelia Londero, Dylan Colon, Beatriz Aguirre-Urreta, Verónica Vennari, Marina Lescano, Rafael López Martínez, Johann Schnyder, Urs Schaltegger	TAXONOMY OF THE TOARCIAN PALAEOENTOMOFAUNA ASSEMBLAGE OF ALDERTON HILL, GLOUCESTERSHIRE (UK) - Emily J. Swaby, Angela L. Coe, Jörg Ansorge, Bryony Caswell, Scott Hayward, Luke Mander, Liadan Stevens, Aimee Mcardle
12.10	ULTRASTRUCTURE OF CALPIONELLID LORICAE FROM THE JURASSIC/CRETACEOUS BOUNDARY - Jozef Michalík, Silviya Petrova, Jolanta Iwañczuk	X-RAY IMAGING OF BEETLE BORINGS *(DEKOSICHNUS MENISCATUS)* IN MIDDLE–LATE JURASSIC ARAUCARIAN CONIFER WOOD FROM ARGENTINA - Stephen McLoughlin, Chris Mays
12.30	CLOSING CEREMONY	
12.50	LUNCH	
14.45	VISIT OF THE GEOLOGICAL MUSEUM IN THE HUNGARIAN MINING AND GEOLOGICAL SURVEY	

LIST OF POSTERS

Presenting author	*Title of poster*
Błażej Błażejowski	A NEW ATOPOSAURID CROCODYLIFORM FROM THE LATE JURASSIC OF POLAND
Carmela Chateau-Smith	REEXAMINING THE POSITION OF THE WOODHAMENSE HORIZON IN EUROPEAN BASINS: WHAT CONSEQUENCES FOR THE OXFORDIAN GSSP?
Antonello D'Alessandro	NEW FINDINGS OF GRAMMOCERATINAE (AMMONITINA: HILDOCERATIDAE) FROM THE TOARCIAN OF THE CENTRAL APENNINES (CENTRAL ITALY)
Calum P. Fox	UTILIZING PALEOBOTANICAL AND WHOLE ROCK SAMPLES TO EXPLORE THE RECORD OF FERRAR LARGE IGNEOUS PROVINCE ACTIVITY IN THE ANTARCTIC
Christina Ifrim	NANNOFACIES ANALYSIS IN SOLNHOFEN AND OTHER MESOZOIC PLATY LIMESTONE
Emma Blanka Kovács	DEPOSITIONAL CONTROLS ON TOARCIAN MERCURY SEQUESTRATION (RÉKA VALLEY SECTION, MECSEK, SW HUNGARY)
Zuzana Kozlová	CORALS FROM THE ŠTRAMBERK CARBONATE PLATFORM (TITHONIAN–BERRIASIAN, CZECH REPUBLIC, POLAND, CARPATHIANS): AN OVERVIEW
Zoltán Lantos	THE OBSCURE LIFE OF LIASSIC NEPTUNIAN DYKES IN THE GEOLOGICAL GARDEN AT TATA (NW HUNGARY)
Katharina Leu	CYCLOSTRATIGRAPHY OF THE OPALINUSTON FORMATION IN THE SWABIAN ALB DEDUCED FROM X-RAY FLUORESCENCE DATA
Thomas Mann	SEDIMENTOLOGY AND SEQUENCE STRATIGRAPHY OF THE AALENIAN FROM SOUTHERN GERMANY
Mengjie Jiang	MAGNETOSTRATIGRAPHY OF EARLY JURASSIC SEDIMENTS: TOWARDS A GLOBAL STANDARD MAGNETOCHRONOLOGICAL TIMESCALE
Anna Merkel	STRATIGRAPHY VS. DIAGENESIS: HOW USEFUL ARE Δ13C ANALYSES OF BULK ROCK SAMPLES? – NEW DATA FROM THE LOWER TOARCIAN OF S' GERMANY
Tamás Müller	TRACING PALEOENVIRONMENTAL CHANGES DURING THE JENKYNS EVENT IN THE NORTHWESTERN TETHYAN MARGIN (SACHRANG, EASTERN ALPS)
Junhee Park	A NEW PROXY FOR PALEOENVIRONMENT USING ZIRCONIUM AND HAFNIUM
Daniela Rehakova	REVISED CALPIONELLID STRATIGRAPHY AND MICROFACIES OF THE TORRE DE´ BUSI SECTION (LOMBARDY BASIN, J/K BOUNDARY)
Matias Reolid	GIANT TRACE FOSSILS FROM THE KIMMERIDGIAN (UPPER JURASSIC) OF THE IBERIAN CHAIN (SPAIN)
Manuel Rigo	CONODONTS FROM THE NORIAN/RHEATIAN BOUNDARY TO THE HETTANGIAN: HOW LONG DID THEY SURVIVE IN THE JURASSIC FOR?
Andrzej Szydlo	MICROFOSSILS RELATED TO THE ROPICE HORIZON (CZECH AND POLISH OUTER CARPATHIANS): CHANGES IN TETHYAN BASINS AT THE J/K BOUNDARY
Clemens V. Ullmann	GEOCHEMISTRY OF MACROFOSSILS, BULK ROCK AND SECONDARY CALCITE IN THE MOCHRAS CORE
Deyan Zhang	FIRST RECORD OF THE MIDDLE OXFORDIAN POSITIVE CARBON ISOTOPE EXCURSION WITHIN THE KORALLENOOLITH FORMATION, LOWER SAXONY BASIN, GERMANY

LIST OF ABSTRACTS

ABSTRACTS

Abstracts of all papers to be presented either as oral or poster presentations at the 11th International Congress on the Jurassic System are included here in alphabetical order of their first author. Presenting authors are indicated by an asterisk.

APPLICATIONS OF LARGE MULTI-PROXY DATA SETS TO ASSESS THE TEMPORAL RELATIONSHIP BETWEEN KAROO AND FERRAR LARGE IGNEOUS PROVINCE ACTIVITY AND LOWER JURASSIC (TOARCIAN) ENVIRONMENTAL PERTURBATIONS

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Volcanism of the Karoo (southern Africa) and Ferrar (Antarctica) Large Igneous Provinces (LIPs) is often considered to be the trigger for major environmental changes in the Lower Jurassic associated with the Toarcian Oceanic Anoxic Event and carbon isotope excursion (CIE), as well as the Pliensbachian–Toarcian Event and CIE. This environmental change is linked to carbon cycle perturbations that affected the whole ocean-atmosphere system, as well as multi-phased minor extinction events in the marine realm, significant disruption of the global osmium and strontium cycles, an increase in atmospheric mercury, which resulted in increased burial concentrations, and disruptions of a number of other biogeochemical cycles (eg. Li, Zn, Mo). Significant work has been undertaken to understand the association, impact, absolute age and duration of these environmental perturbations in relation to LIP activity. However, despite the plethora of vintage and recent geochronological datasets that have been generated from Karoo and Ferrar magmatic rocks, no rigorous statistical analyses of all the published data have been undertaken to assess the temporal relationship between igneous province activity and environmental changes. Here we provide a statistical analysis of ~400 radiometric ages for both the intrusive and extrusive phases of both Karoo and Ferrar Large Igneous Province emplacement. With this, we assess its timing and duration and the relationship to the Lower Jurassic Events. These analyses demonstrate the value of re-calculation of vintage geochronology, and the potential application of large, integrated, multi-proxy data sets to improve our understanding of durations and impacts of these events as well as to identify potential gaps in our knowledge of these igneous events.

SEAWATER RE-OS OSCILLATIONS DURING THE EARLY JURASSIC SINEMURIAN-PLIENSBACHIAN BOUNDARY

GIORGIA BALLABIO*, WEIMU XU, DANNY HNATYSHIN, DAVID VAN ACKEN

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The Sinemurian-Pliensbachian boundary (~193 Ma) in the Early Jurassic is characterised by a ~2–5‰ negative carbon-isotope excursion in organic and inorganic carbon substrates from different marine basins, likely representing a global carbon cycle perturbation. This carbon cycle perturbation has been suggested to be linked to a late phase of the Central Atlantic Magmatic Province (CAMP). It has also been suggested that the Hispanic Corridor was established at this time during the breakup of Pangaea.

Here we reconstruct the seawater Os isotope signal as recorded in organic-rich mudrocks, which reflects the relative contribution of the unradiogenic mantle input ($^{187}Os/^{188}Os$ ~0.13) and the radiogenic continental crust weathering input ($^{187}Os/^{188}Os$ ~1.4). We present preliminary results of the high-resolution Os isotope stratigraphy study spanning the upper Sinemurian–lower Pliensbachian, including the Sinemurian-Pliensbachian boundary event from mudrocks of the Prees Borehole, Cheshire Basin, Shropshire, England. The Prees Borehole, drilled recently by the International Continental Scientific Drilling Program (ICDP), is stratigraphically well constrained with ammonite biostratigraphy and high-resolution carbon isotope stratigraphy (JET project initial data from Hesselbo et al.). Our results show a distinct shift in the Os isotope values around the Sinemurian-Pliensbachian boundary towards unradiogenic mantle signals. Our data also provide a Re-Os isochron age right below the Sinemurian-Pliensbachian boundary. Together with high-resolution carbon-isotope stratigraphy and future astrochronological study, the new Re-Os age from the Prees Borehole provides the opportunity to refine the Early Jurassic timescale. By investigating mudrocks from an open marine setting, it is possible to better understand the causal and feedback mechanisms associated with the Sinemurian-Pliensbachian boundary event and placing the event in a more defined/robust temporal framework.

VEGETATION RESPONSE TO AN EARLY JURASSIC CLIMATE CHANGE AND ENVIRONMENTAL PERTURBATION

VIKTÓRIA BARANYI*[1], XIN JIN[2], ZHIQIANG SHI[3], BINBING LI[4], DAVID B. KEMP[5], JACOPO DAL CORSO[6], NEREO PRETO[7]

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The Toarcian oceanic anoxic event (T-OAE, ~183 Ma) was marked by a rapid global warming, pronounced negative carbon-isotope excursion, ocean deoxygenation, volcanic activity and turnover of marine and terrestrial biota. This warming world affected global weather patterns leading to increased seasonality and storminess, with erratic precipitation patterns, climatic extremities, enhanced hydrological cycle and runoff. The biotic feedbacks during these Mesozoic hyperthermals are important archives of how the Earth's ecosystems respond to severe environmental crisis.

We have investigated the link between geochemical climate proxies Sr/Cu, Rb/Sr and the vegetation composition from the palynological dataset (fossil spore and pollen) in the lacustrine Anya section, from the Ordos Basin, North China. The Ordos Basin was situated at low-middle latitudes during the Mesozoic and spread across the warm-temperate to subtropical climate belts. The rise in the thermophilic drought-adapted Cheirolepidiaceae conifer and cycad pollen during the T-OAE negative carbon excursion is paralleled by the decrease in more water-dependent ferns and seed ferns simultaneously with a shift to a more seasonal semihumid–semiarid climate indicated by the Sr/Cu, Rb/Sr ratios. The vegetation experienced only temporal biodiversity losses but the decrease of mainly mid-canopy and understory elements indicates loss on functionality in the terrestrial ecosystem. This shift to a more open landscape reduced the slope stabilization function of the vegetation that increased the run-off rate from the hinterland during high rain periods. In addition, the proliferation of Cheirolepidiaceae conifers with low stomatal density and lower transpiration rate may have enhanced the weathering and transport of sediments and nutrients into the lake.

The T-OAE scenario resonates well with climate model projections that suggests an increase in the number of extreme precipitation events, and longer and more frequent droughts for the future of forest ecosystems. The results even suggest that changes in vegetation composition may increase the severity and consequences of the ongoing climate change.

This work was supported by the National Natural Science Foundation of China grants (41902106, 41888101); the Youth Innovation Promotion Association of CAS (E029070299); the 2nd Tibetan Plateau Scientific Expedition and Research (2019QZKK0707); and State Key Laboratory of Loess and Quaternary Geology (Y452002299, SKLLQGZR2005). V. Baranyi was supported by the Croatian Geological Survey through programme funding provided by the Croatian Ministry of Science and Education.

PLANTS FROM JURASSIC DINOSAURS' COPROLITES FROM THE HOLY CROSS MOUNTAINS, POLAND

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Analyses of coprolites depend strongly on good material, in which remains of food are preserved. Such excellently preserved coprolites were collected in the early Hettangian deposits at Sołtyków in the Holy Cross Mountains, Poland. These fossil excrements probably originated from herbivorous sauropodomorphs, ornithischians and large carnivorous theropods, from which tracks are known from the site.

We provide the first description of plant remains, cuticles of which were extracted from coprolites. Thanks to this record we can conclude on animal feeding behaviour and provide new data about the composition of the flora within the feeding territory. Herbivorous coprolite producers fed on the plants growing on a fluvial plain, mainly from crowns of gymnospermous trees or shrubs. Coprolites assigned to large predators contained more diverse plant remains, also gymnosperms. These were probably ingested together with the stomachs and intestines of prey animals.

The plant cuticles originated from seed ferns (incuding *Komlopteris distinctiva* Barbacka sp. nov.), cycadophytes, ginkgophytes and conifers. For the first time, a fragment of a needle-leaved conifer was found (*Aciphyllum triangulatum* Barbacka & Górecki gen. et sp. nov.) which shows features corresponding with those of modern *Pinus*. This is the oldest example of such a leaf.

TOARCIAN AMMONITES FROM THE CENTRAL HIGH ATLAS (MOROCCO)

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In the central High Atlas, southeastern Morocco, the Toarcian Stage is represented by a marl and marly limestone series of variable thickness. Two sections have been studied: the Amellago section (500 m thick) located 40 km north of Goulmima city, and the Aït Athmane section (100 m thick) located 20 km north of Errachidia city. Ammonites from the two sections allowed to characterize the Polymorphum and Levisoni zones of the lower Toarcian, the Bifrons and Gradata zones of the middle Toarcian and the Speciosum Zone of the upper Toarcian. The Polymorphum Zone provided in the Amellago section several ammonite specimens dominated by the genus *Dactylioceras,* including: *Dactylioceras (Eodactylites) mirabile*, *Dactylioceras (Eodactylites)* aff. *mirabile, Dactylioceras (Eodactylites) pseudocommune, Dactylioceras (Eodactylites) simplex, Dactylioceras (Orthodactylites)* aff. *crosbeyi,* and contains *Canavaria rosenbergi*, *Canavaria* aff. *zancleana, Lytoceras* aff. *Lytoceras* gr. *villae, Neolioceratoides* aff. *hoffmanni* and *Praepolyplectus* sp.; the Levisoni Zone provided in the same section a rich ammonite fauna dominated by the genera *Harpoceras* and *Hildaites,* with: *Harpoceras falciferum*, *Harpoceras pseudoserpentinum*, *Harpoceras. serpentinum*, *Harpoceras subplanatum*, *Hildaites* cf. *forte*, *Hildaites levisoni*, *Hildaites* cf. *serpentiniformis*, *Hildaites* cf. *subserpentinus*, *Hildaites striatus, Hildaites wrighti,* and contains *Calliphylloceras nilssoni*, *Dactylioceras* (*Orthodactylites*) cf. *semiannulatum*, *Eleganticeras exaratum*, *Lytocers siemensi, Lytoceras* sp., *Maconiceras soloniacense*, *Phylloceras* sp., *Polyplectus pluricostatum* and *Polyplectus* sp.; the Bifrons Zone was characterized in the two sections and provided: *Eleganticeras* sp., *Harpoceras subplanatum*?, *Hildoceras bifrons*, *Hildoceras lusitanicum, Hildoceras semipolitum, Hildoceras sublevisoni, Hildoceras* sp., *Porpoceras* gr. *vortex – verticosum*; the Gradata and Speciosum zones were characterized in the Aït Athmane section. The first zone yielded *Pseudocrassiceras bayani, Pseudocrassiceras frantzi, Pseudocrassiceras*. sp., *Pseudocrassiceras* sp. indet.; the second zone provided one specimen of *Hammatoceras* aff. *insigne*.

Most of the listed species are reported for the first time for the central High Atlas and are common to other Moroccan Jurassic basins (folded Middle Atlas, South Riffian Ridges, Beni Snassen), and western Algeria and to several basins of northern Tethyan margin (SE France, Italy, Hungary, Bulgaria, Greece) and the Subboreal Domain of North-West Europe (SE England, NW France and SW Germany).

This work was partly funded by the National Science Center, Poland, grant no. 2020/39/B/ST10/00006.

A NEW ATOPOSAURID CROCODYLIFORM FROM THE LATE JURASSIC OF POLAND

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The Owadów-Brzezinki palaeontological site located in the near Sławno in NW margin of the Holy Cross Mts is one of the most important palaeontological discoveries described recently from Poland. Unusually well-preserved fossils of marine and terrestrial organisms of the Late Jurassic (Tithonian) age, many of them new to science, provide a very good opportunity for studying the taphonomy of the ecosystem, evolution and migration of taxa, and palaeoenvironmental changes. The Owadów-Brzezinki section provides important clues for correlation between the NW Europe, Russian and Tethyan domains in the Tithonian, linking calpionellid occurrences (as a typical Tethyan stratigraphic proxy) with well-established ammonite zonation correlable with British and Russian zonal schemes.

The aim of this study is to report the discovery of new, well-preserved atoposaurid crocodyliform, which add significantly to our knowledge of a group. Atoposaurids are small-sized Mesozoic crocodyliforms of mainly European distribution, which are considered to be phylogenetically close to the origin of Eusuchia. The atoposaurid reptile articulated skeleton from the Owadów-Brzezinki quarry is the easternmost discovery of the Late Jurassic Atoposauridae. Preliminary studies of the atoposaurid reptile from the Owadów-Brzezinki site indicate its similarity to the specimens described from the "Portlandian" of England.

The palaeontological sites of Owadów-Brzezinki is referred to as a new "taphonomic window" of Late Jurassic, providing insights on evolution of life on Earth in the palaeogeographical and palaeoenvironmental context.

Study was financed by Polish National Science Centre (grant no. 2020/39/B/ST10/01489).

AALENIAN–BAJOCIAN EUSTATIC SEA-LEVEL FLUCTUATIONS: NEW INSIGHT FROM THE CENTRAL HIGH ATLAS BASIN, MOROCCO

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The Aalenian–Bajocian is a time interval marked by important changes in carbon cycle and climate, as well as by biological turnovers. However, it remains uncertain if these changes were tuned to global eustatic fluctuations and potentially linked to the transient growth of polar ice caps. To address this issue, we have undertaken a high-resolution sequence stratigraphy analysis of the expanded Middle Jurassic marine sedimentary record from the central High Atlas Basin in Morocco. The sequence stratigraphic interpretation of several sections distributed along two proximal–distal transects within this basin allows us to untangle different orders of relative sea-level fluctuations within this basin. Thanks to high-resolution biostratigraphic and carbon-isotope chemostratigraphic calibration of the studied sections, a comparison with other high-resolution sequence stratigraphy analyses from other basins can be established, revealing a clear imprint of eustatic sea-level fluctuations. A direct correlation between the observed sea-level fluctuations and environmental changes can also be established. Hence, this study confirms the existence of a long-term eustatic sea-level lowstand during the Aalenian–earliest Bajocian, followed by a long-term eustatic sea-level rise starting in the middle early Bajocian. During this time interval, several short-term sea-level swings of amplitude that can reach up to 40 m are occurring. This suggests the transient development of polar ice caps, in line with previously published studies advocating for an overall cold climate during the late early Bajocian.

This research was financed by the Independent Research Fund Denmark (DFF, grant n° 9040-00188B)

ASSESSING THE EFFECT OF HIATAL SURFACES ON OUR UNDERSTANDING OF THE PLIENSBACHIAN/TOARCIAN BOUNDARY EVENT

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The Pliensbachian/Toarcian boundary (Pl/To) event is the first manifestation of the protracted early Toarcian environmental perturbations that reached a climax during the T-OAE. Compared to this latter event, the Pl/To boundary is, however, less well-understood. Hence, contradictory evidence has been presented about, for example, change in carbon cycle or sea-level fluctuations during this event. Uncertain is also the relationship of the Pl/To event with the preceding late Pliensbachian Spinatum cold snap. In this study, we will present the results of integrated chemo- and sequence stratigraphy studies from SE France and Morocco that will highlight how the presence of ubiquitous hiatal surfaces in the stratigraphic record has so far blurred our understanding of this event. These hiatal surfaces are linked to the rhythmic sea-level fluctuations spanning the late Pliensbachian–early Toarcian transition as well as to the dramatic change in sediment supply associated with the Pl/To event. Combining the available carbon isotope geochemical dataset from the highly-expanded records of the Dades Valley in Morocco and the Mochras core in Wales, we will propose a new look at the carbon cycle and environmental changes during the Pl/To event, as well as highlight the numerous unknowns that are still left to resolve. In general, our study highlights the valuable contribution of basin proximal–distal transects in order to extract paleo-environmental information during time of climatic upheavals.

ADRIA PLATE MIDDLE-LATE JURASSIC RECONSTRUCTION THROUGH BALANCED AND RESTORED CRUSTAL CROSS-SECTIONS

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Despite the wealth of geological and geophysical reconstructions of the Adria plate and its margins during the Middle-Late Jurassic — prior to the west-directed Vardar Ocean obduction — the quantified width and internal structure of the plate are still a matter of debate. Furthermore, the complex tectonic deformation of the Adria plate margins, developing the opposed Apennines and Dinarides fold belts, hinders the the right definition of its crustal structure.

We aim to constrain a restored length of the Middle-Late Jurassic sedimentary cover and shed light into the width of the Adria plate during this period. To do so, we integrate published geological sections at crustal scale to build balanced and restored geotransects crossing the southern sectors of the Tyrrhenian Sea, the Apennines and the Dinarides up to the Sava Suture Zone. The resulting present-day crustal geotransect up to the Sava Suture Zone is ca. 700 km long whereas the restored section is ca. 1000 km long and thus implying a minimum shortening of 300 km since the obduction of the Vardar Ocean.

With the obtained restored cover length and the balanced basement area we calculated the crustal thickness of the geotransects during the Middle-Late Jurassic applying area conservation of crust through time. The results show an extremely thin crust beneath most of the tectonic domains, indicating an overall lack of crust in the present-day structure. Furthermore, we constrained coherent crustal and lithospheric structures by means of published Middle-Late Jurassic paleobathymetries and assuming Airy isostasy during this period. We propose that part of the missing crust at present may be related to the opposed delamination processes of the NeoTethys slab beneath the Dinarides and the Ligurian-Tethys beneath the Apennines.

CARBON-ISOTOPES AND CALCAREOUS NANNOFOSSILS, CLUES FOR EARLY JURASSIC MARINE PALAEOENVIRONMENTS IN THE NEUQUÉN BASIN

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The study of global climate changes impacting past marine communities is pivotal to model the paleoenvironments and understand the development of present-day ecosystems as well as the possible threats associated with anthropogenic activities. Ocean Anoxic Events (OAEs) are often associated with hyperthermals and are related to rapid perturbations of the carbon cycle impacting the biosphere. The Toarcian Oceanic Anoxic Event (T-OAE) is one of the most important hyperthermal of the Jurassic Period. It has been studied in detail in several European basins and the Maghreb section of North Africa. Comparatively, little is known from localities in the Southern hemisphere.

The Neuquén Basin in Argentina is one of the few places in southwestern Gondwana where the T-OAE has been recorded and has the potential to shed light on its global extent. Los Molles Formation in the Neuquén Basin is the expression of the first marine transgression from the Pacific Ocean in the Early to Middle Jurassic and yields a continuous and rich record of calcareous nannofossils. We present the results of a first multidisciplinary study integrating geochemical ($\delta^{13}C_{carb}$, TOC, major and trace elements) and calcareous nannofossil data from a novel southern section in the Neuquén Basin. The primary aim of the study was to identify marine perturbations with precise biostratigraphic control. The combined data set allowed the identification of the T-OAE besides four additional significant isotope excursions distributed across the Pliensbachian-Bajocian interval. This new geochemical and calcareous nannofossils record is the most time-extended and continuous in the Neuquén Basin and the southwestern Gondwana. Our contribution highlights the global extension of the T-OAE and other Early to Middle Jurassic isotope excursions, and the utility of combining carbon isotopes and calcareous nannofossils for global age correlation and paleoenvironmental reconstructions and evaluation of the marine community response to major long-term environmental changes.

HOW TO USE SOCIAL MEDIA TO PROMOTE GEOSCIENCE AND CONSERVATION

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The use of various forms of social and related media, including YouTube have often been assumed to be effectively ways of engaging a broader, public audience, including to both demonstrate the role of funding bodies, but also to raise support for scientific activities (and it is at least partly for these reasons that publishers now use metrics base on such media when they assess the impact of papers in their journals). But just how effective is the use of such media, and can it really make any difference to public attitudes and, perhaps more fundamentally for many scientists, help satisfy funder's requirements (and not least, a willingness in them to provide additional funding to any research group in the future)?

In addition, for a palaeontological aspects in particular, how can a bone-fide scientific presentation 'compete' with, or distance itself from, a vast amount of media focussed on little more than 'fossil-collecting', often with little reflection on associated ethical and legal, let alone scientific issues? These are often complex issues and careful thought is always required before launching into this arena. YouTube, in particular, however, has great potential for uploading videos as discrete news or educational items with a degree of 'permanency', not unlike a library – and hence can be used as such, both by the content maker and the user. Two examples of such a use are a documentary on an excavation of the Lower Toarcian 'Strawberry Bank' lagestatten in southern England, funded by the Bath Royal Literary and Scientific Institute and Geckoella Ltd

(https://www.youtube.com/watch?v=j7itOJEmpDc&t=34s) and a 'whodunnit' focussed on a unique new specimen of a predated cardioceratid ammonite form the Lower Oxfordian, collected as part of a GSSP project (https://www.youtube.com/watch?v=AY2aiH12SCk&t=868s).

In addition, as the platform provides content makers with a range of tools to analyse the nature of their viewers, which can help indicate how successful any model for raising public awareness has been as well as informing the design of future content to help maximise its effectiveness for whatever purpose it is intended.

Crucially, however, a common misconception about YouTube is that it can provide a source of income for any content producer. The level of commitment required, however, to not only meet the xxxx hours threshold for income from the platform, as well as to produce regular content to maintain such viewing levels, would be a major commitment for any organisation. Hence, the platform is best viewed as one of a range of tools for meeting any requirements for public engagement, and for the more 'casual' user, some collaboration with an appropriate existing channel can perhaps offer opportunities for the greatest success. This presentation will provide an introduction to new-comers on how to establish the YouTube content that best meets their aims and objectives, including through using all the available tools and techniques available – whilst helping ensure that their postings do not get overlooked!

NEW FINDINGS OF GRAMMOCERATINAE (AMMONITINA: HILDOCERATIDAE) FROM THE TOARCIAN OF THE CENTRAL APENNINES (CENTRAL ITALY)

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The discovery of exotic species in a typical Mediterranean Toarcian region is unusual. We report the discovery of two NW European species of Grammoceratinae from the Toarcian Rosso Ammonitico Umbro-Marchigiano Formation: *Pseudolillia donovani* Garcia-Gomez & Rivas, 1980 and *Phlyseogrammoceras* cf. *dispansum* (Lycett, 1860). *P. donovani* was found in the Scoppio section, Martani Mountains, in Umbria, at the base of a slump without accompanying fauna; above, the slump contains reworked specimens of *Geczyceras* cf. *speciosum* (Janensch, 1902). *P. donovani* is one of the earliest species of the genus, having been found in the Fallaciosum Subzone of the Thouarsense Zone (upper Bonarellii Zone of the Mediterranean province), and is widespread from a paleobiogeographical point of view, having been found in South-Eastern France, and the Betic and Iberian Cordilleras. *P.* cf. *dispansum* was discovered at Val Tenetra, Monte Catria group, Marche, as an *ex situ* specimen; *P*. *dispansum* is typical of the Pachu biohorizon of the Dispansum Zone of the NW European province. It is abundant in France, Germany, Luxembourg, and England, and is also recorded from Portugal, Bulgaria, the Caucasus and Iran. It should be noted that in the Thouarsense Zone, Sassaroli & Venturi (2005) reported the new species *Pseudolillia apenninica*, and Venturi et al. (2010) cited *Grammoceras* sp. At the top of the Speciosum Zone, in the Scoppio section, numerous specimens of *Gruneria* cf. *gruneri* (Dumortier, 1874) were found. It seems that in the Thouarsense and Speciosum Chrons, the Grammoceratinae were able to migrate towards the south, with rare, drifted specimens or ephemeral populations, possibly linked to changes in currents, sea level or climate in the Late Toarcian.

TAXONOMIC AND TAPHONOMIC REMARKS ON THE OXFORDIAN AMMONITES FROM MONTE BARBARO (WESTERN SICILY, ITALY)

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The study of the Oxfordian (Upper Jurassic) outcrop from Monte Barbaro has been motivated by the presence of an historical ammonite collection without taxonomic determinations housed at the "Geological Museum G.G. Gemmellaro" since 1939 (i.e., the Floridia collection).

Monte Barbaro, with a relief about 600 m high, is located close to the village of Calatafimi in Western Sicily, that is well known worldwide for the presence of the archaeological site of Segesta. From the geological point of view, it consists of a Mesozoic and Cenozoic sedimentary succession of lowermost Jurassic shallow water carbonates that are overlain by Middle and Upper Jurassic ammonitic limestones with volcanic intercalations. Upward, Cretaceous to Miocene pelagic carbonates follow, with marls and sandy clays.

Around the 1940s Ramiro Fabiani studied the Monte Barbaro outcrop and charged Giovan Battista Floridia with the study of cephalopods collected from this outcrop. In a brief note in 1940 Floridia identified only two taxa that were assigned to the Kimmeridgian. Even if he planned to perform a subsequent and more detailed study, it was never completed because of World War II.

Our re-study of the ammonite bearing outcrop from Monte Barbaro allows us to assess that a large part of the ammonites occur in neptunian dykes that crosscut a thick layer of altered submarine basalts (pillow-lavas) and tuffites that extend about 50 m both horizontally and vertically. The dense network of neptunian dikes, generally a few centimetres wide, are filled with red calcilutites rich in volcanoclastic fragments as well as ammonites. Detailed study of the outcrop coupled with the comparison of the newly sampled ammonites with those kept in the museum collection, allow to assess that the fossils of the Floridia collection come from the neptunian dykes that crosscut the volcanites. The taxonomic and taphonomic study of ammonites allows to refer the fossil association of Monte Barbaro to the lower and middle Oxfordian and the recognition of some taxa has been particularly useful for the paleobiogeographic reconstructions of the Mediterranean Province.

INTEGRATED STRATIGRAPHY OF THE HETTANGIAN-SINEMURIAN (LOWER JURASSIC) IN THE TATA GEOLOGICAL GARDEN (TRANSDANUBIAN RANGE, HUNGARY)

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The Kálvária-domb (Calvary Hill) at Tata is arguably the most important Mesozoic locality in the Transdanubian Range, now a protected site of the Tata Geological Garden to be visited by the participants of the 11th Congress on the Jurassic System. During a long history of research, most studies have been focused primarily on litho- and biostratigraphy of this site, with an aim of reconstructing the sedimentary basin evolution in a western Neotethyan paleogeographic context. Thick Upper Triassic shallow marine carbonate platform deposits (Dachstein Limestone Formation) are overlain by the Lower Jurassic, increasingly open marine and pelagic *ammonitico rosso*-type Pisznice Limestone Formation above a hiatal surface that corresponds to the Triassic-Jurassic boundary (TJB). However, previous biostratigraphic results have been inconclusive about the extent of the TJB gap and the age of the onset and cessation of deposition of the Pisznice Fm. Here we present new results of stable isotope chemostratigraphy and cyclostratigraphy, develop an age model, and establish correlation to constrain the Early Jurassic evolution of the disintegrating former Dachstein platform and its successor carbonate ramp and pelagic basin.

Previously published ammonite biostratigraphy established a Hettangian-Sinemurian age of the Pisznice Formation, although the presence of Middle Hettangian and Upper Sinemurian remained questionable. Besides, a largely untapped resource of published high-resolution (5 cm spacing) microfauna and microfacies data from thin sections are available and used here. In addition, we generated carbon and oxygen stable isotope data from the topmost Dachstein Fm. and the entire Pisznice Fm., and elemental composition data from the Pisznice Fm. (excluding its lowermost part) using a hand-held XRF instrument. These datasets have been used for chemo- and cyclostratigraphy to improve age constraints and correlation.

The TJB gap explains the lack of a negative carbon isotope anomaly observed in numerous other sections worldwide. The demise of the Dachstein platform system was likely related to the end-Triassic extinction that resulted in the collapse of reef ecosystem around the platform. The top of the Dachstein Fm. is best interpreted as a submarine erosion surface. The duration of the hiatus is not likely to exceed a few hundreds of thousands of years, if our new astrochronology, biostratigraphic constraints on the Hettangian-Sinemurian boundary, and the best current estimates for the length of the Hettangian are taken into account. Orbitally controlled cyclicity is present throughout the Pisznice Fm. and is recorded in the fluctuating ratio of various carbonate components, changing elemental abundances, and stable carbon and oxygen isotopic ratios. Cyclostratigraphic analysis allows to assess the duration of deposition of this formation and informs carbon isotope-based chemostratigraphic correlation with coeval sequences from Tethyan and northwest European localities. Utilization of microfacies and geochemical data can contribute to a paleoenvironmental and depositional model that is based on detrital and biogenic elemental proxies and microfossil components. These investigations can validate, complete, and extend the prior results and provide new means of stratigraphic correlation of the Tata section with different other sections in Europe and beyond.

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THE INTEGRATED UPPERMOST TORCIAN BIOSTRATIGRAPHIC SECTION IN THE MINETT BIOSPHERE UNESCO, SOUTHWESTERN LUXEMBOURG

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The southwestern part of Luxembourg, known as Minett in the local language use, exposes an exceptionally high diversity of marine near-shore sediment rocks from the Early to Middle Jurassic, owing to its proximal position at the north-eastern margins of the Paris Basin. The well-known Minette ironstone formation is the worldwide largest oolitic ironstone deposit and the abandoned open cast mines are nowadays protected sites with a high biodiversity, intrinsically linked to geodiversity. During mining activities thousands of fossils have been collected from the several sites in Minett, mainly ammonites and belemnites. Studies about these faunas have stretched their importance for the paleontology and biostratigraphy for the entire European upper Toarcian. Recent studies of ammonite faunas contribute to the taxonomic and biostratigraphic knowledge of upper Toarcian ammonites. In a more detailed study about species of the *Pleydellia* group, the new subfamily Pleydellinae is proposed.

THE AMMONITES OF THE *KEPPLERI* HORIZON (BASAL CALLOVIAN, MIDDLE JURASSIC) OF ALBSTADT-PFEFFINGEN (SWABIAN ALB, GERMANY)

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The aim of this study is to describe the ammonite fauna of the *keppleri* Horizon (Herveyi Zone, basalmost Callovian, Middle Jurassic) of Albstadt-Pfeffingen (Swabian Alb, southwestern Germany) more precisely in order to enable a trans-provincional correlation of the base of the Callovian Stage. The association consists of about 200 specimens comprising eight genera and 20 species. It is predominated by *Homoeoplanulites* (60%), others are *Macrocephalites*, *Bullatimorphites*, *Kepplerites*, *Cadoceras, Choffatia* and several Oppeliidae. The diagnostic specimens will be illustrated and briefly described. Instead of a detailed systematic treatment of each species, we discuss their significance as guide fossils. One important result is that not only *Kepplerites keppleri* alone has a great potential for high-resolution biostratigraphy, but also other taxa such as *Cadoceras quenstedtiforme* or the genus *Homoeoplanulites*, and it is likely that almost everywhere in Europe *Macrocephalites* appears at the beginning of the Callovian, except for Southern Germany, where it already turns up in the Orbis Zone. All other genera are only suitable for coarse correlations in the ranking of subzones or zones *(Bullatimorphites*, *Choffatia*, Oppeliidae). The possibilities of a biostratigraphic correlation rise and fall with bioprovincialism, so we discuss this topic in more detail. Probably the *keppleri* Horizon falls into a sea-level highstand. This enables a cross-regional exchange of ammonite species and a correlation of the Boreal and Tethyan realms. With the horizons above and below, the correlation possibilities are more limited, and especially the correlation of the Discus Zone remains extremely difficult. Furthermore, the *quenstedtiforme* Horizon is limited to Central Europe and Russia, but the occurrences of the genera *Cadomites* and *Phlycticeras* is interesting for long-range correlations in the Tethyan Realm. In conclusion, we can state that the *keppleri* Horizon with its rich and diverse ammonite fauna – supplemented by other stratigraphic methods – is a very good choice to describe the base of the Callovian Stage. Whether this also applies to the location Albstadt-Pfeffingen as a candidate for a GSSP is still controversial. Although its ammonite biostratigraphy is without doubt the worldwide best-known and unlikely to be surpassed, its low thickness of only a few meters was criticized again and again. In this respect, the profile is far from the requirements of the guidelines of the ICS, but as long as no better alternative is presented, it makes sense to press ahead with further investigations, at least to provide an excellent auxiliary stratotype bridging the Tethyan and Boreal zonal schemes.

THE SINEMURIAN SHALLOW-WATER CARBONATES IN THE LUSITANIAN BASIN (PORTUGAL): AN INTEGRATED STRATIGRAPHIC ANALYSIS

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The Lower Jurassic of the Lusitanian Basin (western Portugal) shows a distinctive succession of carbonate deposits that are a stratigraphic reference at a global scale. Much of the research interest arises from the preferred palaeogeographic location of these deposits between the Tethyan and pre-Atlantic realms, thus relevant for regional and global biostratigraphic correlations and palaeogeographic and palaeobiogeographic reconstructions. Except for its base, dated from the Sinemurian, the majority of the Lower Jurassic is composed of hemipelagic marly limestones with abundant benthic and nektonic macrofauna, formally organised in several lithostratigraphic units that are biostratigraphically well constrained and dated from the uppermost Sinemurian to the upper Toarcian. In addition, a set of reference stable carbon isotopic curves, covering the uppermost Sinemurian to middle Toarcian, reinforce detailed regional and global correlation.

In this context, an integrated stratigraphic analysis of the base of the Lower Jurassic carbonate deposits, included in the Coimbra Formation, was developed in the S. Pedro de Moel area, in order to improve the lithostratigraphic and biostratigraphic knowledge of this unit and to perform a chemostratigraphic analysis based on stable carbon isotopes and total organic carbon (TOC). Based on sporadic ammonite occurrences, some with endemic character, this unit is dated from the lower to upper (base of Oxynotum Chronozone) Sinemurian and is subdivided into eight informal subunits. Except for its base, consisting of dolostones and microbialites, much of the succession consists of bioclastic and bioturbated micritic centimetric–decimetric limestone levels (sometimes rich in benthic macrofauna, especially bivalves and gastropods; brachiopods at the top) alternating with millimetric–centimetric marly layers, all deposited in shallow-water carbonate ramp environments. Organic-rich sediments occur in some intervals, with TOC reaching up to 12 wt.%. At a broad scale, the Coimbra Formation is transgressive and part of a long-lasting 2nd-order transgressive–regressive facies cycle ending around the Sinemurian-Pliensbachian boundary. The transgressive phase involved three 3rd-order subordinate flooding episodes, corresponding to the more argillaceous and organic-rich intervals of succession, two of them associated with abundant ammonites. The vertical variation of $\delta^{13}C$ determined in bulk carbonate is characterized by relatively normal marine values (0–2.5‰); however, several negative shifts are observed associated with the organic-rich sediments, with a maximum amplitude reaching 8‰ in the Obtusum Chronozone (the most negative value of -5.8‰). These shifts in bulk carbonate $\delta^{13}C$ are interpreted to be of diagenetic origin and, therefore, of local significance. However, it cannot be discarded that a regional/global signal is imprinted on the observed trends.

MULTIPROXY EVIDENCE FOR UNSTEADY PALAEOENVIRONMENTAL CONDITIONS DURING THE AALENIAN

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The Jurassic was punctuated by several episodes of abrupt environmental changes associated with climatic instabilities, severe biotic crisis, and perturbations of the global carbon cycle. Over the last decades, the Toarcian Oceanic Anoxic Event and the early Bajocian Event have attracted much attention because they represent such episodes of global and severe environmental changes. Bracketed in between these events, the Aalenian (Middle Jurassic, ~174-170 Ma) has been overlooked. This study provides unprecedent multiproxy records of two expanded successions composed of marl/limestone alternations in France (French Subalpine Basin) and Chile (Andean Basin) to constrain the palaeoenvironmental conditions during the Aalenian. The duration of the stage has also been revised using cyclostratigraphy. Our high-resolution carbon isotope records ($\delta^{13}C_{org}$ and $\delta^{13}C_{carb}$) show medium-term $\delta^{13}C$ fluctuations, which are reproducible across different palaeoceanographic settings from both hemispheres and between different organic and inorganic carbon substrates, indicating that the Aalenian was a time marked by recurrent global carbon cycle perturbations. Especially, the middle-late Aalenian was marked by a worldwide-represented positive carbon isotope shift associated with an increase in eutrophic conditions and demise of platform carbonate factories, indicating that climate change and perturbation of the biogeochemical cycles occurred, likely in response to major tectonic rearrangement and volcanic activity. Our results highlight that relatively stable climatic conditions persisted in the afterglow of the Toarcian Oceanic Anoxic Event until the middle-late Aalenian transition, marking a return to unsteady climatic and environmental conditions, which likely catalyzed the Bajocian carbonate crisis.

TRACING THE AFTERMATH OF THE HYPERTHERMAL TOARCIAN OCEANIC ANOXIC EVENT: A MULTIPROXY STUDY

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The Earth system experienced several episodes of global warming, which were superimposed on the natural secular climatic variations. The causes and consequences of these past climate changes are relatively well constrained, but how natural mechanisms help mitigate and adapt to elevated CO_2 levels remain largely underconstrained. The Toarcian in the Early Jurassic is an ideal time interval to understand better the response of Earth system to abrupt climate change. Indeed, it was marked by the Toarcian Oceanic Anoxic Event (T-OAE, ca. 183 Ma), which was certainly one of the most extreme hyperthermal events of the Phanerozoic accompanied by major environmental changes. The triggering mechanisms and the climatic and environmental response to the T-OAE are relatively well constrained, whereas the recovery phase in the aftermath of the event has been less studied. Increased chemical weathering and enhanced marine biological carbon pump are the two primary natural mechanisms generally proposed as negative feedbacks that caused the drawdown of atmospheric CO_2 levels at the T-OAE termination. However, to date, there is still no consensus about the respective importance of both feedback mechanisms. This study aims to tackle this lack of empirical data by providing a multi-proxy dataset combining sedimentological observations, mineralogical and geochemical analyses. Two biostratigraphically well-defined successions composed of lower to upper Toarcian marl/limestone alternations were selected in the northern and southern hemispheres: Fontaneilles (Grand Causses Basin, France) and Agua de la Falda (Andean Basin, Chile) to reconstruct the long-term environmental and climatic evolution in the aftermath of the T-OAE and to constrain the efficiency of the natural biogeochemical mechanisms leading to the recovery of the system. The inorganic ($\delta^{13}C_{carb}$) and organic ($\delta^{13}C_{org}$) carbon isotope records show medium-term fluctuations, with a marked positive excursion in the middle Toarcian. This positive shift is associated with higher total organic carbon contents, an increase in total phosphorus and lower lithium isotope ratios, suggesting an episode of increased primary productivity related to enhanced continental weathering and nutrient inputs. These results indicate that enhanced organic matter burial and silicate weathering could have been efficient negative feedback mechanisms to allow the recovery of the system and a return to cooler climatic conditions after the Toarcian hyperthermal.

EARLY JURASSIC LIP MAGMATISM AND ENVIRONMENTAL CHANGE

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Large Igneous Province (LIP) eruptions have been coeval with severe environmental perturbations throughout Earth history, including climate change, mass extinctions, and oceanic anoxic events. In the Early Jurassic, the Karoo-Ferrar LIP has been linked to the Toarcian Oceanic Anoxic Event (T-OAE) and associated climate warming and extinction. The Early Jurassic was a tumultuous period in Earth history and experienced several perturbations in addition to the T-OAE. Such episodes include the gradual Sinemurian–Pliensbachian (S–P) negative carbon-isotope excursion (CIE), a rapid positive CIE in the late Pliensbachian *margaritatus* biozone, and significant (>1 Myr) periods of relative environmental stability. The Early Jurassic carbon-cycle perturbations were highly diverse with a range of amplitudes and durations.

Since volcanoes are among the main sources of natural mercury (Hg), sedimentary variations in Hg content have been interpreted to reflect volcanic activity. Many of the proposed disruptive effects of LIP eruptions occur on shorter or similar timescales to the highest attainable precision on radiometric dates on LIP lava flows themselves. Thus, the Hg-proxy might fill the gaps left by radiometric LIP dating methods, because Hg concentration data are obtained at the same resolution and from the same sedimentary sections as other palaeoenvironmental proxies.

In this study, we test whether LIP (or other significant magmatism) was coeval with the environmental changes in the Early Jurassic, via the creation of an unprecedently long (~10 Myr) and high-resolution (~5–200 kyr) Hg record from the Mochras Farm (Llanbedr) Borehole, Wales. The Mochras core is geochemically and palaeontologically well studied, and the timing of key events is constrained via ammonite biostratigraphy, astrochronology, and carbon-isotope stratigraphy. We also developed a robust framework to evaluate Hg datasets and use it to quantitatively compare Hg variations across different time intervals within the Mochras core. This framework corrects sedimentary Hg for dilution effects due to $CaCO_3$ content and (non)linear variation in host-phase (e.g., TOC, S) concentration.

We find that periods of environmental stability have no statistically significant peaks in Hg, whereas the T-OAE, *margaritatus*, and S–P CIEs each perturbed the Hg cycle. However, the nature of the perturbations is different in each case. The peaks in Hg during the T-OAE are uniquely large, consistent with significant LIP activity (corroborating earlier studies). The increase in Hg starts earlier, however, during the *margaritatus* ammonite zone (~188 Ma), ~5 Myr before the T-OAE (at ~183 Ma), coinciding with the *margaritatus* zone CIE and the decreases in ammonite diversity. After the T-OAE, Hg returns to background values almost immediately, suggesting that LIP volatile emissions may ramp up slowly but terminate relatively abruptly. By contrast, the S–P CIE has very few low-amplitude Hg peaks and no strong Hg cycle perturbation, suggesting that the greatest part of the volcanism at this stage was submarine and/or smaller-scale. Instead, the S–P CIE is associated with a gradual climate cooling and increase in aridity. Overall, our results provide a unique dataset to understand the relationship between volcanic events and a range of carbon-cycle perturbations.

REEXAMINING THE POSITION OF THE WOODHAMENSE HORIZON IN EUROPEAN BASINS: WHAT CONSEQUENCES FOR THE OXFORDIAN GSSP?

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Before selecting the best GSSP (Global Stratigraphic Section and Point) candidate for the base of the Oxfordian Stage, it is necessary to agree upon the stratigraphic succession at the Callovian-Oxfordian boundary. No consensus has so far been established among the three main candidates, Thuoux (SE France), Redcliff Point (Dorset, UK), and Dubki (Russia), probably due to the lack of consensus regarding the definition of the horizons surrounding the Callovian-Oxfordian boundary. In this context, the differences in interpretation of the Woodhamense Horizon in Western Europe are somewhat problematic.

By compiling data from several sites in Europe, this synthetic review brings to light differences in interpretation for the definition of the Woodhamense Horizon, and its position within the Lower Oxfordian faunal succession. Critical examination of the Cardioceratinae defining the index species, as well as their association with other groups of ammonites in successive assemblages, can serve to refine the position of the Woodhamense Horizon in the Scarburgense Subzone. Identification of the ammonite faunal succession for the base of the Oxfordian in the Subalpine Basin (south-east France), the Boulonnais (northern France), the eastern Paris Basin, the French Jura Mountains, and northern Switzerland reveals a consistent order for the horizons in the Mariae Zone. By contrast, this succession cannot be identified in the reference-section for the base Oxfordian historically defined by Arkell, due to the condensed nature of the series at the base of the Woodham brick pit. This unfortunate hiatus may well have biased later attempts to correlate sites proposed as potential GSSPs for the base of the Oxfordian stage, leading to discrepancies in the identification of horizons between the Redcliff Point section, and the French and Swiss sections. An alternative interpretation of the Redcliff Point section, however, could be compatible with the succession identified in the candidate GSSP of the Subalpine Basin (i.e. Thuoux, with Lazer as an additional section) and with other European sections. Regrettably, the Dubki section cannot be used to confirm the position of the Woodhamense Horizon, as the ammonites initially reported as *C. woodhamense* were later reinterpreted as other species of *Cardioceras*.

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UTILIZING PALEOBOTANICAL AND WHOLE ROCK SAMPLES TO EXPLORE THE RECORD OF FERRAR LARGE IGNEOUS PROVINCE ACTIVITY IN THE ANTARCTIC

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Museums, universities and other publicly funded entities have large repositories of Lower Jurassic Antarctic samples, including whole rock and palaeobotanical samples, that could offer important information about the environmental impact of the Ferrar Large Igneous Province (LIP). Samples from the Polar Rock Repository and University of Kansas Palaeobotanical Collection were selected based on the lithology, formation and presence of fossil wood in the samples. Samples were analyzed for organic carbon isotopes and handheld XRF as well as being examined petrographically. The samples primarily represent rocks from the Central Transantarctic Mountains and South Victoria Land, specifically the Mawson and Kirkpatrick Formations within the Ferrar Group, Lower Jurassic. While the exact stratigraphic relationship between the samples cannot be determined since samples originate from various mountain ranges, palynological assessment of the Mawson Formation suggests a Sinnemurian to Pliensbachian age, while palynological assessment of the Kirkpatrick Basalt suggests a Pliensbachian to Toarcian age. Geochronology of the Kirkpatrick Basalt indicates a similar age, specifically radiometric ages from the Kirkpatrick Basalt range from ~179 to 180 Ma (Toarcian). Samples from the Mawson Formation give a $\delta^{13}C_{TOC}$ signature of -24.3 to -32.9 ‰ while those from the Kirkpatrick are between -24.1 to -28.3 ‰. Given that $\delta^{13}C_{TOC}$ values from stratigraphically lower units (Fremouw Formation and Lashly Formation; Middle to Upper Triassic) are generally more positive values (-24.5 and -24.3 ‰, respectively), it is most likely that $\delta^{13}C_{TOC}$ values from the Mawson Formation and Kirkpatrick Basalts are altered by Ferrar LIP activity. Within the Mawson Formation, $\delta^{13}C_{TOC}$ values generally shift between those of pre-Ferrar and much lower values, likely indicating activity of the Ferrar LIP. Within this formation, samples from various mountain ranges spanning Victoria Land are generally isotopically heavier than samples from Carapace Nunatuk from the mid Central Transantarctic Mountain ranges, suggesting samples from Carapace Nunatuk were influenced by Ferrar LIP activity. Although isotopically heavier, within the Kirkpatrick Basalt that is generally considered time synchronous to Ferrar activity, wood samples show negative isotopic $\delta^{13}C_{TOC}$ signatures of -28.3 and -26.9 ‰, likely related to uptake of isotopically light carbon as a result of Ferrar activity. Together, this data set highlights the possible applications of large, readily available and more accessible data sets, but also highlights the need for more stratigraphically constrained data sets from the Antarctic region that can help more fully resolve carbon cycle perturbations.

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DATING THE COLOMERA SECTION (MEDIAN SUBBETIC, SE SPAIN) USING CALCAREOUS NANNOFOSSILS

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We are using calcareous nannofossils for dating the Colomera section, located at 400 m northeast to the Colomera village (Granada Province, Southern Spain). It belongs to the Median Subbetic (Betic Cordillera), and its Mesozoic materials were deposited in the South Iberian Paleomargin under hemipelagic conditions. This 42-m-thick section is part of the Zegrí Formation and consists of a marl and marly limestone (wackestone-packstone) rhythmite, with abundant radiolarians and filaments. Below this section we find the cherty limestones of the Gavilán Formation. This succession is intensively bioturbated (mainly *Thalassinoides*, *Chondrites*, *Planolites*, *Teichichnus*, *Lamellaeichnus* and *Zoophycos*). Ammonites and belemnites are scarce.

Calcareous nannofossils are the main tool for dating Mesozoic rocks, especially when ammonites are rare. In this work, 21 smear slides were prepared from the marly samples to perform a biostratigraphic study. 2000 fields of view were analyzed per sample, for identifying those species very rare, using a Leica DMLP light microscope, at x1250 magnification. These semiquantitative analysis allowed us to describe the abundance and degree of preservation of calcareous nannofossil assemblages and the relative abundance of each identified species. Calcareous nannofossil assemblages are moderately preserved and relatively abundant and are dominated by the nannolith *Schizosphaerella* spp. and the coccoliths *Calcivascularis jansae*, *Lotharingius hauffii* and *Mitrolithus lenticularis.* Two main events, based on the biozonation schemes of the south-Tethyan region, were identified: the first occurrences of *Lotharingius crucicentralis* and *Zeugrhabdotus erectus*, which mark the base of the NJ5b and NJ5c calcareous nannofossil subzones, respectively. Moreover, the appearance of *Z. erectus* allows to approximate the position of the Emaciatum/Polymorphum ammonite zone boundary, approaching the Pliensbachian/Toarcian boundary.

These biostratigraphic results are consistent with those found at Arroyo Mingarrón section, located 800 m north to the Colomera section, where the Upper Pliensbachian-lowermost Toarcian rhythmite above the Gavilán Formation seems to be three times thinner.

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THE HISTORY OF JURASSIC STUDIES IN HUNGARY

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The beginnings of recognition of Jurassic rocks in Hungary go back to the 18th century. In those times West European gentleman travellers, with interest in geology, when visiting the country, recorded familiar minerals, fossils and rocks, including those of Jurassic. From the middle of the 19th century, geologists from the Geologische Reichsanstalt of Vienna started large-scale mapping in the Austro-Hungarian „Empire", including the territory of this country. Many of the staff members of the Reichsanstalt, who took part in this work, were Hungarian geologists. Jurassic rocks are separately recorded in these maps.

The first systematic research on Jurassic rocks in Hungary was carried out in the 1860's, on the Liassic coal measures of Pécs, Mecsek Mountains, by the Austrian-born Carl Peters, then professor at the Mineralogical Department of the University of Budapest.

For this time the formerly established Hungarian Geological Society (1848), the Hungarian Royal Geological Institute (1869) and the Geological Department, as well as the Institute of Palaeontology (1882) of the University of Budapest created an academic environment for geological researches, presentation of results in words and printing, and possibilities of discussions. From the beginning, Jurassic was one of the topics of general interest.

In Hungarian territory, as it is today, the detailed geological mapping of the mountainous areas began in the 1870's. Miksa (Maximilian) Hantken, the founding director of the Hungarian Geological Institute, commissioned János Böckh to map the Southern Bakony, and Antal Koch to make the map of the northern Bakony. Böckh (1874) presented a milestone monograph on the Jurassic rocks and fossils of the area. Later Károly Hoffman and János Böckh mapped the Mecsek Mountains. This latter work ended in a monograph by J. Böckh about the Middle Jurassic ammonites of the Mecsek (1881). Unfortunately, this work, very early in its category, was published only in Hungarian, thus it remained almost unknown for Jurassic workers (L.F. Spath was one of the few exceptions).

In the early years of the 20th century the first important, internationally significant works on the Hungarian Jurassic were published. These are about the Liassic-Dogger ammonite fauna from Bakonycsernye by Gyula (Julius) Prinz (1906), and on the Callovian ammonites of Villány (South Hungary) by L. Lóczy jun. (1915). Both were heavily based on previous, unfinished work and collected material of M. Hantken.

After the First World War, in the country with her territory reduced to one third, geological activity, including Jurassic studies, were lessened to the minimum. Studies had been restarted only in the 1930's with Gyula Vigh mapping in the Gerecse Hills and K. Telegdi-Roth working in the Bakony. In this latter area he was soon followed by J. Noszky jun. Vigh and Noszky were especially interested in Jurassic, with collecting fossils (mainly ammonites) and publishing papers of stratigraphic relevance for the respective regions.

After the Second World War the whole industrial and institutional background of research and science changed profoundly in Hungary. Geological studies became essential for the heavy industry, and the Jurassic suddenly became as of first importance with manganese ore in the Bakony Mts and coal in the Mecsek (the single black coal occurrence in the country). Detailed mapping began. The activities of contributors and staff from the enlarged Geological Institute, research departments of mining companies, and from newly established university departments resulted in important new data, information and fresh knowledge also about the Jurassic of all regions.

In 1959 the Hungarian Geological Institute organized an international meeting (International Mesozoic Conference) with emphasis on the Jurassic. Hungarian experts introduced their new results on stratigraphy and fossils, mainly ammonites: Gusztáv Vigh (son of Gyula Vigh) on the Gerecse Hills, A. Kaszap on the Middle

Jurassic of Villány, I. Szabó on Tata, and B. Géczy on the Jurassic of Bakonycsernye. This latter contribution was the preliminary information about the gigantic revision what B. Géczy later (in 1966-67) published as his two-part monograph on the ammonites of Csernye.

From the 1970's, a new generation of students started research on the Hungarian Jurassic. A good start was the Mediterranean Jurassic Colloquium in 1969, commemorating the centenary of the founding of the Geological Institute. A large number of colleagues from the Jurassic fraternity turned up, and a wide array of papers was presented on fine biostratigraphy (based on macro- and microfossils), on the new sedimentological approach and on paleogeography. Actually, this Colloquium can be regarded as one of the forrunners of the series of international Jurassic meetings, of which this present Budapest meeting is the 11th.

Around the turn of the 1960's and 1970's Jurassic studies were greatly impacted by the recognition that plate tectonic reconstructions render the Mesozoic sequence of the Transdanubian Range to the southern, Gondwana margin, and that of the Mecsek-Villány to the southern, Eurasian shelf of the Mediterranean Tethys. The first to confirm this concept here in Hungary was B. Géczy (1972, 1973). He demonstrated and explained the contrasting Jurassic faunas and facies of the Transdanubian Range and the Mecsek and Villány Mountains. This new concept opened the door for a new perspective to detect faunal affinities and connections.

In the same time the Geological Institute initiated a new program to help geological mapping with well accessible sections serving as type sections for lithostratigraphic units. In the case of the Jurassic rocks, which are rarely exposed in rock walls or in quarries in the Hungarian mountains, this project resulted in numerous, freshly excavated outcrops. In these excavations the layers were documented bed-by-bed, and all fossils were carefully collected. The Jurassic material from these Bakony, Vértes and Gerecse collections went to experts in the Geological Institute, in the Eötvös Loránd University, and in the Natural History Museum in Budapest.

Long is the list of shorter or longer papers on these fossils and their stratigraphy that published in the 1970's to 1990's. Important monographs appeared: by B. Géczy on the Carixian ammonites of the Bakony (1976), on the Bajocian-Bathonian ammonites of Gyenespuszta (Bakony Mts) by A. Galácz (1980), on the Lower Jurassic brachiopods of the Bakony by A. Vörös (1983-2009), and a monograph-grade series of papers on the Lower and Middle Jurassic gastropods from the Bakony by J. Szabó (1979-1983).

Microfaunal studies were activated also. Tintinnids, the group of microfossils stratigraphically so valuable around the Jurassic/Cretaceous bundary, were studied in the Transdanubian Range and in the Mecsek Mts by J. Knauer and I. Nagy, from the early 1960's. In the 1980's Á. Görög published the results of her pioneering studies on early globigerinid planktonic foraminifers.

A unique element in the Jurassic research was the publication of a monograph on the Mesozic geology of Tata by J. Fülöp (1975). In Tata a small, tectonically uplifted block exposes uppermost Triassic and Lower Cretaceous rocks, with a thin Jurassic sequence in between. These Jurassic rocks and fossils were worked out by sedimentologists and experts of the particular represented faunal groups. The work is a kind of example for a holistic approach to research on a well-outlined topic.

Soon afterwards I. Főzy started his work on Late Jurassic ammonites, what he extended from the Bakony and Gerecse also to he Mecsek. Here, in this latter region a rich Bathonian fauna was worked out in detail (Galácz 1994). I. Szente started his studies on Jurassic molluscs, mainly bivalves also from the Mecsek, and later he treated Bakony and Gerecse material too. As the beginning of the revision of the Jurassic ammonites of Villány, the Liassic, then the Bathonian forms, which were formerly mixed up with the Callovian material, were separately worked out (Géczy 1998, Géczy & Galácz 1998).

Important is the work on the Lower Jurassic plants from the Liassic coal measures around Pécs, in the Mecsek Mts. The first plant fossils were described and figured by C. Peters in the 19th century, then microscopic plant remains (pollen and spores) were successfully used in identifying the Triassic/Jurassic boundary and defining the individual coal seams and beds within the sequence (J. Bóna 1950-1970). The rich macroflora, mainly leaves, is in the hands of eminent experts for investigation (Barbacka 2011). On the surface of some barren sandstone beds, dinosaur footprints were identified in the 1960's. These were the only dinosaur remains in Hungary for long, till the discovery of a rich Late Cretaceous vertebrate fossil assemblage in the Bakony Mts in 2000.

Even in such a small country as Hungary, new occurrences of Jurassic rocks could have been found by investigations in the 1950-1970 interval. It became clear that large masses of Jurassic rocks are embedded deep in the basement of the Great Hungarian Plain, as continuations of sequences exposed in the Mecsek and Villány Mts. In the north-eastern mountains of Hungary, in complicated tectonic position, parts of the former Vardar ocean margin and ophiolitic basement became identified. All show Dinarid affinities. In a small outlier, north-east from the knee-bend of the Danube, uppermost Triassic and basalmost Jurassic beds are exposed. This siliceous-calcareous sequence is one of the few European localities where the Triassic/Jurassic bounday interval is represented with fossiliferous sediments, although the faunal content is rather poor. However, this does not set back the intensive recent studies (Pálfy 1999-2007).

In recent times Jurassic faunal studies are connected to facies and paleogeographic investigations more tightly than before. Most stratigraphic problems seem to be solved, subdivisioning of sequences arrived to the finest possible level of definition. Naturally, a huge amount of fossils are around to describe them properly, but nowadays the main questions are different. Jurassic studies target paleoenvironmental issues: sedimentation responses to changes in paleoclimate, in oceanic water chemistry, anoxia, cabon-cycle elements, etc. This changing approach is best documented by the recently published two great, multi-authored monographic volumes edited by I. Főzy. One is on the Upper Jurassic – Lower Cretaceous of the Gerecse and Pilis Mts (2013), the other on the Upper Jurassic – Lower Cretaceous of the Bakony (in press). Both are based on studies covering all faunal and microfloral groups, but the facies analyses, the paleoenvironmental evaluation and the structural discussions are equally strong parts in the synthesis.

The lavishly executed two books show that Jurassic studies are alive in Hungary. They have the traditional background, the continuous rise of young, interested students, and what is even more important: a scientific audience still open to receiving new results.

TOARCIAN OCEANIC ANOXIC EVENT IN WESTERN TETHYS: THE SOGNO CORE PELAGIC RECORD (LOMBARDY BASIN, NORTHERN ITALY)

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The Sogno Core recovered a complete record of the uppermost Pliensbachian – lower Toarcian interval deposited on the Albenza Plateau (Lombardy Basin) at a paleo-water depth of ca. 1500 m. The section contains a pelagic record of the T-OAE in the Northwestern Tethys. In the early part of the negative carbon-isotopic excursion marking the Jenkyns Event, sedimentation was characterized by the deposition of the so-called Fish Level, a 5 m-thick organic-rich dark grey to black marly claystone. New sedimentological and inorganic geochemical data were used as proxies to reconstruct detrital input, redox and primary productivity conditions. Progressively warmer conditions started to develop prior to the onset of the Jenkyns Event, with an increase in weathering and runoff, accompanied by slightly higher primary productivity, peaking in correspondence of the most negative values of the carbon-isotopic excursion. The establishment of stagnation induced at first a drastic reduction in bioturbation during the early phase of the Jenkyns Event, with a progressive shift to suboxic conditions close to the sediment-water interface in correspondence of the most negative values of the carbon-isotopic excursion. This was followed by the recovery from suboxia, with fully oxic conditions re-established at the end of the deposition of the Fish Level. Runoff intensity started to decline together with primary productivity and detrital input, with pre-perturbation conditions re-established only at the end of the Jenkyns Event. The comparison of the Sogno Core record with other key Western Tethyan sections shows that dominant suboxic conditions were present also at greater depths in the southern margin of the Northwestern Tethys and confirm that anoxic and euxinic conditions were practically confined exclusively to the northwestern shallow water shelf region.

MIDDLE-LATE JURASSIC GEODYNAMIC EVOLUTION OF THE WESTERN TETHYS REALM AS DEDUCED FROM SEDIMENTARY MÉLANGE ANALYSIS IN TRENCH-LIKE BASINS FORMED IN FRONT OF OBDUCTING OPHIOLITES

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Component analyses of ancient Neo-Tethys mélanges along the Eastern Mediterranean mountain ranges allow both a facies reconstruction of the Middle Triassic to Middle Jurassic outer passive margin of the Neo-Tethys and conclusions on the processes and timing of the Jurassic orogenesis. This Middle-Late Jurassic mountain building process in the Western Tethyan realm was triggered by west- to northwestward-directed ophiolite obduction onto the former passive continental margin (wider Adria) of the Neo-Tethys.

Ophiolite obduction onto the former passive continental margin started in the Bajocian and trench-like deep-water basins formed in sequence within the northwest-/westward propagating nappe fronts in the footwall of the obducting ophiolites, i.e. in lower plate position. Deposition in these basins was characterized by coarsening-upward cycles, i.e. forming sedimentary mélanges as synorogenic sediments, in cases tectonically overprinted. In the Middle Jurassic, the oceanic realm and the most distal parts of the former passive margin were incorporated into the nappe stacking. Bajocian-Callovian ophiolitic and Meliata mélanges were formed as most oceanward preserved relics of trench-like basins in front of the propagating ophiolitic nappe stack, often with incorporated components from the continental slope (Meliata facies zone). In the course of ongoing ophiolite obduction, thrusting progressed to the outer shelf region (Hallstatt Limestone facies zone). In Bathonian/Callovian to Early Oxfordian times the Hallstatt nappes with the Hallstatt mélanges were established, expressed by the formation of the up to 900 m thick basin fills comprising its material mainly from the outer shelf region. In Callovian to Middle Oxfordian times the nappe stack reached the former carbonate platform influenced outer shelf region and the reef rim. Newly formed basins received material from this shelf region, occasionally mixed with material from the approaching ophiolite nappes. Ongoing shortening led to the formation of the proximal Hallstatt nappes with concomitant mobilisation of Hallstatt Mélanges. Persistent tectonic convergence caused the partial detachment and northwest- to west-directed transport of the older basin groups and nappes originally formed in a more oceanward position onto the foreland.

Comparison of mélanges identical in age and component spectrum in different mountain belts (Eastern Alps/Western Carpathians/Dinarides/Albanides/Pelso) figured out one Neo-Tethys Ocean in the Western Tethyan realm, instead of multi-ocean and multi-continent scenarios. The evolution of several independent Triassic-Jurassic oceans is unlikely considering the fact that re-sedimentation into newly formed trench-like basins in front of a west- to northwestward propagating nappe stack including ophiolite obduction is nearly contemporaneous along the Neotethyan Belt. The Middle to Late Jurassic basin evolutions with their sedimentary cycles and component spectra are comparable everywhere.

BELEMNITES AND CALCAREOUS NANNOFOSSILS FROM THE NORTH BOHEMIA REVEAL PROLONGED JURASSIC SEDIMENTATION IN CENTRAL EUROPE

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Belemnites from North Bohemia were previously, in most cases, assigned exclusively to the Upper Jurassic (Oxfordian–Kimmeridgian). Tectonically disturbed and fragmentarily preserved Jurassic strata along the Lausitian Fault were divided into the non-fossiliferous Callovian Brtníky Formation and fossiliferous Oxfordian and Kimmeridgian strata (Doubice Formation). We have applied a detailed stratigraphic framework dealing with previously published data, based on the systematic investigation of preserved belemnite rostra and calcareous nannoplankton. Macro- and microfaunal characters point to possible continuous sedimentation with frequent gaps (linked probably to eustatic cycles). Therefore, the historical lithostratigraphic regional division (Brtníky and Doubice formations based on a similar lithological character) is probably not relevant. Belemnites were classified at the generic and species levels (including at least five genera with at least eight species). The stratigraphic distribution of the studied belemnites and calcareous nannofossils surprisingly showed ranges from the Bajocian to Tithonian, based on belemnites, ammonites and calcareous nannoplankton. Megateuthidid belemnites (*Megateuthis suevica* and *Megateuthis* cf. *elliptica*) indicate the earliest known faunal components within the Central European Jurassic (Bohemian Massif). Belemnites clearly show the prevailing Tethyan (*Belemnopsis* fauna) and partly also Boreal (*Cylindroteuthis* cf. *puzosi*) provenances. Our results provided the first comprehensive description of the Jurassic belemnite fauna from Northern Bohemia and Saxony. Sgnificantly, our approach fills a gap in stratigraphical, palaeoenvironmental, and palaeobiogeographical interpretations of Jurassic strata within Central Europe based on belemnites.

RE-OS DATING OF JURASSIC STRATA: ACHIEVEMENTS, CHALLENGES AND FUTURE DIRECTIONS

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Rhenium and osmium are two of the least abundant elements on Earth, rarely reaching single digit ppb-level concentrations in most crustal materials. However, dissolved Re and Os in seawater are reductively accumulated and enriched in organic-rich sediments (ORS) deposited in oxygen-deficient waters, providing sufficient metal contents for precise isotopic analyses. Once organic matter and other authigenic phases in sediments capture ambient Re and Os from seawater, the radioactive decay of ^{187}Re to ^{187}Os with time creates distinct isotopic signatures for geologic materials depending on their depositional age.

Re-Os geochronology was first applied to black shales in the late 1980s by Ravizza and Turekian and technological advances in the following decades enabled widespread application to different ORS. Driven in part by the paucity of precise radiometric ages for the Jurassic and related uncertainties in the Jurassic chronostratigraphic scale, the abundance of Jurassic ORS, and their importance as chemostratigraphic records of oceanic anoxic events and as source rocks for major petroleum accumulations, a sizeable proportion of Re-Os geochronology studies have focused on Jurassic ORS.

Here, we provide an up-to-date synthesis of the available Re-Os geochronology of Jurassic sedimentary rocks. After a brief review of the methodology, we outline the analytical procedures and discuss the strengths and limitations of this method. Highlighting a number of successful applications mostly from the North Sea and Barents Sea, we focus on the implication of Re-Os geochronology for individual sections and discuss the contributions of this chronometer towards refining the Jurassic time scale. In addition, we briefly summarize two other related aspects of Re-Os geochronology of ORS – for characterization of depositional conditions based on Re and Os contents and for tracing the changing sources of Os to the ocean with time based on the initial Os ratios of Jurassic ORS.

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LIP VOLCANISM AS A DRIVER OF THE TOARCIAN OCEANIC ANOXIC EVENT (T-OAE)

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The Toarcian Oceanic Anoxic Event (T-OAE) at ~183 Ma was the most severe environmental perturbation of the Lower Jurassic, characterised by widespread basin anoxia, disruption to the global carbon cycle, significant global warming, and elevated marine extinction rates. The T-OAE onset typically exhibits a series of abrupt steps or pulses of more negative $\delta^{13}C$ values in marine and terrestrial material, separated by minor temporary reversals to more positive values and, as a result, the causes of these excursions are often interpreted as being astronomically driven. Duration estimates for the event have primarily been based on astronomical cycle counting, yielding estimates ranging from 300 to 900 Kyr, with variance largely due to disagreements as to which astronomical cycles the observed stepwise shifts are assigned to. Several, often interrelated, causal mechanisms have been proposed, including the release of methane from clathrates, or thermally metamorphosed coals and shales, direct gaseous emission of greenhouse gases from a large igneous province (LIP), and a disrupted and retreating cryosphere, though not all of these are consistent with astronomical forcing. Here we investigate the role of LIP volcanism as a potential driving mechanism of the T-OAE by resolving the relationship between volcanic episodes, evidenced by sedimentary mercury concentration anomalies, and carbon cycle perturbations. This high-resolution study of the GSSP outcrop in Peniche (Lusitanian Basin, Portugal) builds on previous work showing generally elevated levels of sedimentary mercury concentration across the T-OAE interval, but with records that have been of insufficient resolution to discern any lead-lag relationships.

Here we show that rapid increases in sedimentary mercury concentration (normalised to total organic carbon) coincide with and precede each of the four negative carbon isotope steps, followed by an exponential decline towards baseline levels, before rapidly rising once again prior to the subsequent isotope step.

These results suggest a direct link between LIP magmatic pulses, evidenced by Hg deposition in the sedimentary record, and carbon cycle perturbations. This relationship draws into question the astronomical origins of the $\delta^{13}C$ steps during the onset interval of the T-OAE – if the Hg anomalies and $\delta^{13}C$ are directly magmatically forced, the supposed astronomical control on $\delta^{13}C$ records may be illusory. Evidence presented here instead suggests that pulsed LIP volcanism overprinted any astronomically forced climate change during this onset interval, and that this LIP volcanism acted as the driver of the stepped carbon isotope signals recorded globally, and by extension the T-OAE itself.

AALENIAN PROTOGLOBIGERINIDS FROM THE AMMONITICO ROSSO FACIES OF GERECSE AND BAKONY MTS., HUNGARY

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The early planktic foraminifers – also known as protoglobigerinids – were an important part of the marine zooplankton, thus the food chain from the late Bajocian, based on the numerous fossil records of the Tethyan Realm. They already appeared in the Late Triassic, but we have extremely little and incomplete data from the early period of their evolution until the late Bajocian. It is especially true for the Aalenian. Until now, the only surely Aalenian (most probably lower Aalenian, Opalinum Zone) protoglobigerinids locality was known from Domuz Dag, Turkey. The relatively large-sized (up to 320 μm) forms, often with a thick outer wall are known only from rock thin-sections. Based on their sections, these forms could only be classified tentatively into species or even genera. Therefore, the discovery of protoglobigerinids in well-dated Aalenian successions of the Transdanubian Central Range, Hungary, is of great importance. They were collected from the Gerecse Mts. in the section of Nagy-Pisznice (Opalinum and Comptum subzones of the Opalinum zone, lower Aalenian, and Concavum Zone, upper Aalenian) and Tölgyhát B section (Comptum Zone, lower Aalenian), and from the Bakony Mts. from the section of Bakonycsernye (Murchisonae Zone, middle Aalenian and Concavum Zone, upper Aalenian). These successions were built up of red and grey nodular flaser-bedded, Ammonitico Rosso-type limestone (Tölgyhát Limestone Formation).

The protoglobigerinids were studied in thin-section and as isolated specimens, extracted with glacial acetic acid from the living chamber of ammonites. The associated microfauna contained predominantly *Bositra*-like thin-shells, radiolarians, benthic echinoderms, foraminifera, ostracods, globochaetes, and juvenile ammonites. The foraminiferal assemblages were dominated by spirillinids (60–80%), lagenids (mostly smooth-walled nodosarids and lenticulinids, up to 10%), and conical forms (trocholinids and paalzowellids), additionally epistominids and a few agglutinated forms also occurred.

The shells of the protoglobigerinids were poorly to moderately preserved and comprise 1–2% of the foraminifera fauna, except in the oldest layer, where their amount reached nearly 30%. All forms were relatively small, less than 250 μm, and thin-walled. The majority of the tests have a low to medium-high trochospire with 2.5–3 whorls and four chambers on the last whorl. All of them have an umbilical aperture, sometimes bordered by a lip. They belong to the *Globuligerina oxfordiana* morphogroup. There are also forms with high trochospire. They could be classified to the *Globuligerina bathoniana* morphogroup. The morphology of the tests of the studied assemblages most resembles the only known Toarcian association from Domuz Dag, Turkey then the Aalenian one from the same area. Based on our previous research this latter association is similar to that of characteristic in the basinal facies of the Tethys until the end of the early Bajocian. Thus, two scenarios are possible, the age of Domuz Dag locality is incorrect, or the deep-water forms with cortex appeared earlier in the eastern part of Tethys.

This research sought to fill the gap in knowledge regarding the evolution of the protoglobigerinids. We could study these forms from each Aalenian substage, but further examinations are needed from other localities.

WHERE SHOULD THE JURASSIC SYSTEM END?

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The new Berriasian Working Group started its activity in February 2021. It was confirmed that Tethys domain provides the best quality continuous stratigraphical dataset, based on integrated calpionellid, calcareous nannofossil and magnetic stratigraphy, ranging from the base of late Tithonian up to the Berriasian/Valanginian boundary. In a search of good candidate for the J/K boundary position, we have tested a broad interval from the upper Tithonian (base M20n1r) up to the lower Berriasian (base M17r), trying to integrate biotic and palaeoenvironmental trends which might help to overcome the well-known faunal provincialism. At present, the J/K boundary at the base of Calpionella alpina Subzone (base NC0 nannozone, within M19n2n magnetosubzone) works very well within the Alpine Tethys, however its exact correlation with "Purbeckian" and "Volgian" is far from being precise. Shifting the J/K boundary a bit up or down might apparently solve some problems. The position of the boundary in the lower Berriasian around the base of magnetozone M17r and base of C. elliptica Subzone would approximately correspond to base of NC1 nannozone, being slightly older than the base of Occitanica Ammonite Zone, and the Volgian/Ryazanian boundary. The boundary is possible to identify in platform limestones based on benthic foraminifera and calcareous algae. Placing the J/K boundary in the upper Tithonian, between M20n1r and base M19r, falls in the interval of important palaeoecological changes within the Tethys domain (demise of *Saccocoma*, first nannofossil calcification event). It is apparently close to the base of Crassicollaria intermedia calpionellid Subzone, base of NJT17 nannozone, base of Protacanthodiscus andreaei Zone of the Mediterranean subrealm, the middle/upper Volgian boundary of the Boreal region and might coincide with the VOICE excursion on $\delta^{13}C_{org}$ curve. The three options outlined above might be roughly related to palaeohumidity variations documented in the NW European and Russian sections: aridification in the upper Tithonian, fully arid conditions around the Tithonian/Berriasian boundary and a return to more humid conditions between lower and upper Berriasian.

MESOZOIC EVOLUTION OF THE PANNONIAN REGION

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A long-lasting, complex, multi-stage evolution led to development of the Pannonian Basin-system that is surrounded by the Alpine, Carpathian and Dinaridic Mountain Ranges. The pre-Cenozoic geologic structure of this region is rather complicated. It exhibits a mosaic pattern made up of heterogeneous structural elements; a collage of allochthonous terranes derived from different parts of the Tethyan realm. Moreover, these elements (structural units) were arranged in different ways during the course of the long evolutionary history of the Pannonian region reflecting the motions of the European and African plates from the Palaeozoic to the Cenozoic. As to the Mesozoic formations, three major structural units have significant importance in the territory of Hungary: the Tisza Megaunit which was derived from the margin of the Eurasian Plate, the ALCAPA Megaunit and within it the Transdanubian Range Unit that is considered as the uppermost element of the Austroalpine Nappe System, and the Mid-Hungarian Megaunit, which occurs in a wide shear zone between them and contains dislocated elements of mostly Dinaridic–South Alpine origin.

The Mesozoic evolution of the Pannonian region was mostly determined by the evolution of the Tethys and the Atlantic oceans and the Alpine orogeny triggered by the collision of the African and Eurasian plates. During the early period of the Alpine plate tectonic cycle, that lasted from the Late Permian to the Middle Jurassic, the structural evolution was mainly governed by the heterochronous opening of the Neotethys and the Alpine (Atlantic) Tethys, leading to a disintegration of the margins of the surrounding continental plates and a separation of microcontinents. Due to north-westward propagation of the Neotethys, the final disruption of the marginal carbonate ramps took place in the mid-Anisian and neutral and basaltic rift volcanism initiated in the Ladinian that was followed by ocean floor spreading during the Late Triassic to Early Jurassic. The continental rifting of the Alpine Tethys commenced in the Late Triassic and the spreading phase begun in the Late Jurassic. The major extensional phase was coeval with the onset of Middle Jurassic intra-oceanic subduction of the Neotethys. The subduction resulted in the formation of an accretionary complex in front of the obducting ophiolite nappe which mostly contains supra-subduction oceanic lithosphere. Post-obductional contraction remarkably influenced the Early Cretaceous evolution of the eastern part of the Transdanubian Range and of the Bükk Units. Closure of the Alpine Tethys branches took place during the Cretaceous to early Paleogene and led to major nappe stacking both in the ALCAPA and Tisza Megaunits. The composite terranes forming the basement of the present-day Pannonian Basin were juxtaposed after nappe stacking, probably during the middle Cenozoic by major strike-slip displacement. The Pannonian Basin was formed by lithospheric stretching leading to basin subsidence and intense volcanism during the Miocene to Quaternary times.

INITIAL RESULTS OF CORING AT PREES, CHESHIRE BASIN, UK (ICDP JET PROJECT); TOWARDS AN INTEGRATED STRATIGRAPHY, TIMESCALE, AND EARTH SYSTEM UNDERSTANDING FOR THE LOWER JURASSIC

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Drilling for the Early Jurassic Earth System and Timescale ICDP project (JET) was undertaken between November 2020 and January 2021. The drill site is situated in a small-scale latest Triassic to Jurassic sag basin formed above a major Permian–Triassic half graben system. The borehole was located to recover an expanded and complete succession to complement legacy core from the Llanbedr (Mochras) Farm borehole drilled through 1967-69 on the edge of the Cardigan Bay Basin, N. Wales; the overall aim is to construct an astronomically calibrated integrated timescale for the Early Jurassic and to provide insights into the operation of the Early Jurassic Earth System.

Core of Lower Jurassic and Upper Triassic mudstone was obtained from two shallow geotechnical holes (Prees-2A to 32.2 m and Prees-2B to 37.0 m), and from the principal hole, Prees-2C, which was cored from 32.92 m to 651.32 m (corrected core depth scale). Core recovery was 99.7%. The recovered stratigraphy ranges from the upper Triassic (probably upper Norian) to the lower Pliensbachian (Ibex Ammonite Chronozone). In the Jurassic strata all ammonite chronozones are proven. The lithological succession comprises the Branscombe Mudstone and Blue Anchor formations of the Mercia Mudstone Group, the Westbury and Lilstock formations of the Penarth Group, and the Redcar Mudstone Formation of the Lias Group. A distinct interval of siltstone is recognized within the upper Sinemurian of the Redcar Mudstone Formation and the name Prees Siltstone Member is proposed. Depositional environments range from playa lake in the Late Triassic to distal marine in the Jurassic.

Initial datasets compiled from core include radiography, natural gamma, density, magnetic susceptibility and XRF. A full suite of downhole logs was also run. Intervals of organic carbon enrichment occur in the Rhaetian (late Triassic) Westbury Formation, and in the earliest Hettangian and earliest Pliensbachian Redcar Mudstone Formation, where up to 4% Total Organic Carbon (TOC) is recorded. Other parts of the succession are generally organic lean, containing less than 1% TOC. Carbon-isotope values from bulk organic matter have also been determined, initially at a resolution of ~ 1 m, and these provide the basis for detailed correlation between the Prees-2 succession and adjacent boreholes and GSSP outcrops. Multiple complementary studies are currently underway and preliminary results promise a fully astronomically calibrated biostratigraphy, magnetostratigraphy and chemostratigraphy for the combined Prees and Mochras successions, as well as insights into the dynamics of background processes and major palaeoenvironmental change events.

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AMMONOID BIOSTRATIGRAPHY OF A NEW LOWER JURASSIC LOCALITY FROM THE DEATH VALLEY NATIONAL PARK (CALIFORNIA, USA)

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The number of Jurassic ammonoid localities known from western North America is far less than those in Europe and their fauna remains less studied. However, analysis of faunal assemblages may add crucial information to our understanding of the tectonically complex orogen of the North American Cordillera. The new locality presented here contributes to our knowledge of the Early Jurassic Eastern Pacific ammonoid faunas and their paleobiogeographic distribution. Biostratigraphic assignments help to test the applicability of a regional standard zonation. The new data may also be used to constrain reconstructions of paleogeography and tectonic history.

The study area is located within the Basin and Range Province, where Cenozoic extension created pull-apart basins and horst-and-graben structures. The Death Valley National Park, near the border of California and Nevada, features bedrocks ranging in age from the Neoproterozoic to present. The new locality at Butte Valley exposes the Mesozoic formation of the same name, first described in 1957. The age of the formation was thought to be Triassic, on the basis of a few poorly preserved ammonoids. However, here we present newly obtained fossil collections of Jurassic age from the topmost part of the formation.

In 2018, 190 specimens were collected at a locality informally referred to as "Ammoniteville". Most specimens are flattened internal and external molds. Although species-level identification is hampered by the poor state of preservation, ammonite biostratigraphy allows assignment of the studied section to the early middle Hettangian. The lower part falls into the Polymorphum Zone, whereas the upper part represents the Coronoides Zone of the North American regional zonation. The genera present in the collection are best compared with those from the Gabbs Valley area in Nevada and Haida Gwaii (Queen Charlotte Islands) in British Columbia. At each of the three areas cosmopolitan genera (e.g. *Kammerkarites* and *Franziceras*) dominate the assemblages, supplemented by few other East Pacific taxa (e.g. *Eolytoceras*). The revised Early Jurassic, rather than Early Triassic age of the uppermost Butte Valley Formation requires reconsideration of some depositional, paleogeographic and tectonic models of the Mojave Desert region.

NANNOFACIES ANALYSIS IN SOLNHOFEN AND OTHER PLATY LIMESTONES

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The genesis of platy limestones is still under debate. The small grain size makes the sedimentological study of this type of limestone difficult, and few systematic studies exist. Meanwhile, digital light microscopy has been developed so much further that now it allows for nannofacies analysis directly in the rock samples. This had been possible only with SEM microscopes in the past. The fast and easy access to the texture of platy limestone makes it easy to compare the fabric of platy limestones from various deposits throughout the Mesozoic. First results are here presented. Platy limestone from the research excavation of the Jura-Museum at Ettling, Bavaria (Lower Tithonian, Upper Jurassic) is here compared to platy limestone from the Upper Cretaceous of north-eastern Mexico. They reveal differences and specific forming conditions for each deposit. The differences in fabric allow for an evaluation of existing models for platy limestone formation.

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GRAIN SIZE AS A KEY TO UNDERSTANDING PALAEOENVIRONMENTAL PARAMETERS IN JURASSIC SEDIMENTARY ROCKS

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The size distribution of mineral grains in sedimentary rock contains important information about depositional environments and may be linked to parameters such as transportation mechanism, sediment source, current strength and others. It has been proposed that the size of detrital quartz grains which dominate the silt content in marine fine-grained sediments represent a robust indication of transport distance, and thereby changes in sea-level. The evolution of grain size relates to lithofacies, contributing to the understanding of sedimentary sequences and climate dynamics. Additionally, cyclic grain size variations may also act as an indicator of astronomical forcing. Despite these important insights that can be derived from grain size data, these are seldom determined quantitatively but rather inferred from easily obtained, but possibly biased, geochemical proxy data.

The Lower Jurassic sequence in the Llanbedr (Mochras Farm) core (Cardigan Bay Basin, Wales, UK) is used here to address the value of quantitative grain size information as a link to regional sea level and periodic environmental change, and to test the validity of geochemical grain size proxies at various scales. This is especially relevant, as there are contrasting interpretations for depositional environments at Mochras – below and above wavebase – where variations in bottom current strength had an important role in controlling ichnofacies and sedimentary facies, and therefore influencing grain size trends.

To provide additional constraints on the nature of sediment transport and potentially strengthen either of the above hypotheses, direct measurements of quartz grain size based on SEM and Qemscan data were undertaken on the Mochras core at 1–5 metres resolution from 1,300 mbs – 865 mbs, translating to late Sinemurian to Pliensbachian age (approx. 192–183 Ma). Core scanning XRF yielding geochemical compositional data at 1 cm resolution were obtained in reasonably intact archive core material from 998 mbs – 880 mbs (middle to upper Pliensbachian).

The obtained data will be further discussed in the light of overall environmental change, to elaborate how astronomical cycles are encoded in geochemical grain size proxies in the Mochras core, and to shed light on cyclostratigraphic interpretation of the upper Pliensbachian (Margaritatus and Spinatum zone).

MAGNETOSTRATIGRAPHY OF EARLY JURASSIC SEDIMENTS: TOWARDS A GLOBAL STANDARD MAGNETOCHRONOLOGICAL TIMESCALE

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The Early Jurassic is an interval characterised by several major, global environmental perturbations and extinction events. To better understand the time scales involved in these upheavals and to test the potential links of geological phenomena with biotic change, precise ages and the construction of a robust stratigraphic framework via bio- and magneto-stratigraphy and others are paramount. Regarding the magnetostratigraphic framework for the Early Jurassic, however, the Global Polarity Time Scale (GPTS) is still comparatively poorly understood. Relatively few sections have been studied and there are discrepancies between existing records (e.g. the Paris Basin and the Breggia Gorge section), potentially made more severe by partial lack of biostratigraphic control.

Here, a magnetostratigraphic study of two biostratigraphically well-constrained and well-correlatable drill cores through Lower Jurassic rocks, particularly focusing on the Pliensbachian stage (191–183 Ma), is presented. The model is based on the Mochras (Cardigan Bay Basin, UK) and Prees 2C (Cheshire Basin, UK) cores, and used to complement existing datasets and to propose an updated GPTS for the studied interval.

Magnetostratigraphic information recovered from the Mochras core (1–3 meter resolution from 865.63 mbs–1330.05 mbs, 2–10 meter resolution from 1338.12 mbs – 1905.30 mbs) and 133 samples from Prees core at 1 meter resolution from 34.72 mbs – 170.87 mbs will be presented.

FOSSIL LEAF MERCURY (Hg) ANALYSES PROVIDES INSIGHT ON EARLY JURASSIC ATMOSPHERIC CONCENTRATIONS AND LIP VOLCANISM

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Past Large Igneous Province (LIP) volcanism often coincided with global environmental change events, however, the causal relationship between them has not been unambiguously accepted. In recent years, elevated levels of bulk sedimentary mercury concentrations across stratigraphic archives, have been commonly used as indicators of past large-scale volcanic activity, as volcanism is the largest source of natural Hg emission in the present-day environment. But this proxy is highly dependent on and impacted by variations in dominant lithology and/or depositional environment, and its usefulness is therefore debated.

Here, we present a different approach to reconstruct changes in past Hg-fluxes, and especially elevated levels of past atmospheric Hg-concentrations, by analyzing Hg-levels in modern and fossil *Ginkgo* leaf tissue. The adoption of fossil leaf material as a past atmospheric mercury indicator offers an independent approach to the validation of mercury as a volcanism proxy. Fossil leaves have been proven as a reliable indicator of paleo-pCO_2. Leaves gain their Hg-concentration dominantly through direct atmospheric uptake.

To test the variation in Hg-concentrations in modern leaves, we (i) collected samples of *Ginkgo biloba* leaves over a 5 month period to assess the impact of intra-seasonal growth, (ii) we compared this to atmospheric chemistry over that time period, and (iii) we analyzed intra-leaf-variability to generate individual leaf-Hg-maps. Furthermore, potential impacts of changes in climatic conditions on leaf-Hg-concentrations were established by analyzing *Ginkgo* leaves that were grown in controlled growth-chamber experiments, using set atmospheric conditions (e.g. atmospheric CO_2 concentrations, humidity and atmospheric S concentrations). With this, a baseline for variability in leaf-Hg concentrations was established. Combined, the analysis of modern leaves suggests that fossil leaf fragments, which are more common in the fossil record than intact leaves, may be representative of the whole leaf Hg-geochemistry, and can be used to deduct variations in atmospheric Hg over time.

Analyses of the Hg-concentration in Early Jurassic *Ginkgo* fossil leaf-cuticle through a stratigraphic succession, show 2–3 orders of magnitude variability in plant Hg-concentrations, much larger than any of the plant or climatic Hg-variability observed in modern *Gingko* leaves. This suggests that plant tissue can be reliably used to examine geochemical variations in past atmospheres and thus trace possible temporal occurrences of past volcanic events.

DEPOSITIONAL CONTROLS ON TOARCIAN MERCURY SEQUESTRATION (RÉKA VALLEY SECTION, MECSEK, SW HUNGARY)

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The Phanerozoic is interspersed with major environmental change and mass extinction events, many of which have a temporal link to Large Igneous Province (LIP) volcanism. However, their causal relationship is not uniformly accepted, partly because of a scarcity of sections with direct evidence for both magmatism and biological/environmental change.

Elevated sedimentary mercury concentrations have in recent years been increasingly used as a proxy for LIP volcanism, because volcanism is the dominant natural source of mercury in the present-day Hg-cycle. Mercury is a volatile element, which is emitted in its elemental (Hg^0) form into the atmosphere during an eruption and if it reaches the stratosphere, it can be globally distributed. Through wet and dry deposition, Hg can be deposited into both the terrestrial and the marine sedimentary record. Within the sediment, Hg is commonly associated with organic matter, but elevated sedimentary mercury concentrations (up to ppm-levels) have also been detected in organic-lean (carbonate) sedimentary records, possibly linked to the occurrence of sulfide phases.

For this study, we analyzed a lower Toarcian record from Réka Valley (Mecsek, SW Hungary). The record represents an open marine/deep basin depositional environment, and consists of marl with sandstone intercalations, and black shales representing the Toarcian Oceanic Anoxic Event (T-OAE). New mercury data, spanning the Lower Toarcian (including T-OAE) shows an increase in concentration parallel to the decrease in $\delta^{13}C_{org}$ values (indicative of the T-OAE negative carbon isotope excursion), suggesting a temporal correlation between carbon cycle disturbance and Karoo-Ferrar LIP (KaFLIP) magmatism.

Furthermore, thermal-alteration experiments on the studied samples, combined with the integrated dataset of organic and inorganic geochemical proxy-data for the same section allow us to address the major knowledge-gap that exists on understanding of (changes in) dominant Hg-sequestration pathways across this time-interval.

The research was supported by Geological Survey Ireland (GSI) and the Earth Surface Research Laboratory (ESRL).

CHRONOSTRATIGRAPHIC OVERVIEW OF THE TOARCIAN (EARLY JURASSIC) AMMONITE FAUNA FROM THE MECSEK MTS (SW HUNGARY)

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Toarcian (Early Jurassic) Ammonitina assemblages are described and illustrated from the eastern Mecsek Mts (SW Hungary). The studied material represents the NW European faunal province, hence the standard ammonite chronostratigraphic scale is applied for the Toarcian of the Mecsek.

For this research new field surveys were carried out and museum collections were reinvestigated. The most significant ammonite material studied is from Rudolf Hetényi's (1933–2003) collection. Hetényi worked as a mapping geologist in the Mecsek Mts and acquired a collection of more than 15,000 ammonoid specimens, mostly Pliensbachian to Callovian in age. This assemblage has been available for research since 2010, and it provides an excellent opportunity for a detailed revision and an updated chronostratigraphic study.

The last Jurassic chronostratigraphic summary of the Mecsek Mts was published 50 years ago. In that work the Toarcian stage was subdivided into three chronozones (Harpoceras falcifer – Hildoceras bifrons – Grammoceras thouarsense). This scheme requires revision following the most recent NW European chronostratigraphic scale. All Toarcian standard zones (Tenuicostatus, Serpentinum, Bifrons, Variabilis, Thouarsense, Dispansum, Pseudoradiosa, Aalensis) and some of their subzones are documented in the Mecsek for the first time, based on the occurrence of well-known standard index taxa.

The preservation of the Toarcian specimens in the region is generally mediocre but the large material is regarded as a representative sample. The diversity of the Toarcian Ammonitina in the Mecsek Mts is much lower than at fossiliferous localities of the same age in the NW European Province in England, France, Germany, N Spain or Bulgaria. Many subzonal indices or characteristic, widespread genera are rare or absent in the studied region.

The most similar Ammonitina assemblages were previously described from two regions of western Romania: the Eastern Carpathians and the Apuşeni Mts. Not only the faunal composition with common taxa and the relatively low alpha diversity resemble that of the Mecsek region, but also the pattern of diversity changes. In both regions a gradual increase is characteristic from the poorly diversified Tenuicostatum Zone to the much richer Bifrons Zone, followed by a decline in the Variabilis Zone, and again a diverse fauna in the Thouarsense Zone. The Dispansum, Pseudoradiosa and Aalensis zones are characterized by a pronounced decline both in the number of specimens and the species diversity. The similarity in diversity trajectories may relate to their paleogeographical proximity, as all three regions belonged to pelagic-hemipelagic basins of the Tisza Mega-Unit at the transition between the shallow epicontinental sea of NW European faunal province and the open Tethys Ocean.

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CORALS FROM THE ŠTRAMBERK CARBONATE PLATFORM (TITHONIAN–BERRIASIAN, CZECH REPUBLIC, POLAND, CARPATHIANS): AN OVERVIEW

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Olistoliths of the Štramberk Limestone occurring in the Cretaceous flysch (Kotouč Quarry in Štramberk, Czech Outer Carpathians) and pebbles and small blocks (exotics; sporadically small klippes: Kruhel, Andrychów) of the Štramberk-type limestones (Poland) are remnants of the Štramberk Carbonate Platform. This lost carbonate platform was developed in the Tithonian–early Berriasian as narrow platforms attached to intra-basinal highs (e.g., Baška Ridge, Silesian Ridge) in the Carpathian Basin. Numerous corals occur in coral-microbial boundstones (with common photophilic microencrusters). Corals were studied by M. Ogilvie (already at the end of the 19th century), O. Geyer, and especially extensively by H. Eliášová (Štramberk), and by E. Morycowa and B. Kołodziej (Poland). Coral assemblages contain about 120 species of 50 genera in the Štramberk Limestone and 80 species in the Štramberk-type limestones (where material available for studies is less abundant). Taxonomic uniqueness includes the prolific development of corals representing the suborder Pachythecaliina (=Amphiastreina): Amphiastreidae and phylogenetically related families are represented by about 30 genera, while other coeval coral assemblages typically contain no more than several genera representing this suborder. These corals are the most controversial post-Paleozoic coral group and have been placed by most researchers not into Scleractinia (like modern corals and other corals from the discussed limestones), but into the extinct order Hexanthiniaria.

Apart from coral reefs, there are also fragments of reefs with the microencruster-microbial-cement framework with very rare corals. Such reefs typically were developed on slopes of intra-Tethyan carbonate platforms. Tithonian corals from palaeogeograpically close, but epicontinental carbonate platforms, from the Ernstbrunn Limestone (Czech Republic) and from the subsurface of the Carpathian Foredeep (Poland) are much less common, and pachythecaliine corals are very sparse. Corals from the Štramberk Carbonate Platform represent the world's most diverse coral assemblages in reefs developed at the Jurassic/Cretaceous transition.

SYN-RIFT ORIGIN OF THE BAJOCIAN SUBMARINE SWELL (CZORSZTYN RIDGE) WITHIN CARPATHIAN BASINS

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One of the most important geotectonic elements within Western Carpathian basins was the Czorsztyn Ridge (Swell), which originated during the Middle Jurassic (Early Bajocian) time. Palaeogeographically, it has been the main object which separated, between the Middle Jurassic to the Late Cretaceous times, two large Carpathian basins, the Magura Basin on the NW side and the Pieniny Basin on the SE side. Therefore, the precise dating of its origin and first uplift is crucial for recognition of its geodynamic significance. Drastic change of sedimentation from dark/black shales of oxygen-poor environments (latest Pliensbachian–earliest Bajocian) to white/light grey crinoidal limestones of well oxygenated regimes, which presently directly overlie shales, were separated by a significant stratigraphical hiatus. It was biostratigraphically precisely dated by ammonites collected from the basal part of crinoidal limestones in several outcrops of the Polish part of the Pieniny Klippen Belt (PKB).

The Jurassic crinoidal limestones in the PKB in Poland consist of three formations (Smolegowa, Flaki, and Krupiaka Limestone formations), and constitute an important segment of the Middle Jurassic sequence in the so-called Czorsztyn, Niedzica and Czertezik successions. The onset of the crinoidal sedimentation, as proved by ammonite faunas, took place during the Early Bajocian and it was preceded by the marked aforementioned stratigraphical hiatus. This hiatus corresponds to the origin and uplift of the Czorsztyn Rigde. The evidence of a condensation event at the beginning of crinoidal limestone sedimentation is marked by numerous sedimentological features in the lowermost part (10–20 cm in thickness) of these limestones (e.g., phosphatic concretions concentration, pyrite concretions, large clasts of green micritic limestones, fossils including ammonites, belemnites, and brachiopods). Occurrence of such an important correlation horizon indicates the primary thickness of investigated crinoidal limestones (from ca. 10 m up to 100 m) and suggests an origin of synsedimentary tectonic blocks and troughs during a syn-rift episode, which influenced on their original (not recently tectonically reduced) differentiation of their thickness. This Bajocian tectonic activity within Pieniny Klippen Basin corresponds very well with other Western Tethyan geodynamic reorganizations in the Middle Jurassic.

When we try to estimate absolute time of this uplift event (= origin of the Czorsztyn Ridge) we can use two proposed scales of duration of the Early Bajocian. The first one is described and illustrated by Gradstein et al., which suggests 2 Ma for the whole Bajocian, and by this reason the hiatus has a duration of about 0.4 Myr only. The second idea is based on estimation of the duration of this sub-stage, based on a cyclostratigraphic analysis of the carbonate content from the Chaudon–Norante section (Subalpine Basin, France) published by Sucheras-Marx et al., which indicates that the Early Bajocian lasted *c*. 4.082 Myr. Using these authors' calibration of duration of the Early Bajocian ammonite zones (the Discites Zone lasted 0.66 Myr, the Laeviuscula Zone 0.84 Myr, the Propinquans Zone 1.37 Myr, and the Humphriesianum Zone 1.22 Myr) we can conclude that the hiatus, which corresponds with time necessary for origin/uplift of the Czorsztyn Ridge, is about 2 Ma. From a point of view geotectonical processes the latter calculation is more probable.

MANGROVES KILLED BY STORMS – PLIENSBACHIAN/EARLY TOARCIAN RECORD OF NEARSHORE TETHYAN PALAEOENVIRONMENTS IN THE ALBANIAN ALPS

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Generally, the localities with *in situ* fossil record of ancient mangroves are extremely rare due to their very low fossilization potential in highly hydrodynamic and extremely shallow-marine environments. Their identification up today was based mainly on the preservation of pollen and/or wood pieces, whereas the fossil record of root system of mangrove trees usually is missing, so, the existing knowledge about the Mesozoic mangrove record is full of gaps.

In the Albanian Alps a continuous Triassic-Jurassic transition sequence of carbonate deposits crops out. The Lower Jurassic part of the section is represented by extremely shallow-water limestones and marly limestones with several episodes of emersions with calcretes and fossil karst phenomena. On the other hand, *Lithiotis*-type bivalves are concentrated in upper part, in Pliensbachian to Lower Toarcian rocks. There are at least five bivalve-rich horizons which are intercalated both by oolitic (often cross bedded) and oncolitic layers which indicate shallow-water (subtidal?) environments with high-energy regimes and dark grey, bluish marly limestones and bioclastic limestones. Some bivalve-bearing beds have oblique, lens-shape character of biostrome origin. These bivalves are the most significant representatives of buildup-makers of shallow marine to lagoonal bivalve mounds (reefs) in numerous places around the Pangaea during those time.

Additionally, in the studied section, several horizons of carbonate-clastic deposits occur with coal intercalations (up to 30 cm in thickness). In the underlying layers, practically always there are beds with an exceptionally well-preserved system of vertical roots, the maximum length of which exceeds 1 m. They are carbonized, although many of them are filled with a deposit identical to the surrounding matrix, which indicates that they have been originally filled with loose tissue and after its destroying passively filled by sediment. When alive, these were probably pneumatophores, specialised aerial roots, typical for trees of mangrove forests of subtropical areas. Short-term periods of marine regression resulted in increased development of marsh flora in coastal zones represented by plants of the genus *Pachypteris* (seed fern), the leaves of which were found in the deposits of these parts of the section and *Brachyphyllum* (conifer) remains. Particular species of both genera were supposed to be adapted to salty substrate and/or salty mist. Based on their gross morphology and cuticular structure as well as on depositional environments in which they are usually preserved, they were interpreted as growing in coastal habitats which here could be confirmed by root systems. Additionally, shell beds occur with features characteristic for storm origin (sharp erosional bottom, accumulation of bioclasts in their basal parts – bivalves, echinoderms, corals, with fractionation of bioclasts and hummocky cross stratification structures on the top). Several such tempestite horizons occur just above of root-bearing deposits and indicate catastrophic events which destroyed mangrove-type plants which occupied near-shore environments.

In conclusion, this sequence comprises several coal-bearing intercalations between intertidal carbonate rocks of fully marine to lagoonal to terrestrial transitional lithofacies. It records the effect of alternation of ingressions that caused flooding in the coastal area resulting in flora devastation and dryness of different degree, sometimes affecting swamp formation. The mangrove bushes were ”killed” by intense storms recorded by numerous tempestites which directly overlie the root-bearing beds.

THE OBSCURE LIFE OF LIASSIC NEPTUNIAN DYKES IN THE GEOLOGICAL GARDEN AT TATA (NW HUNGARY)

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Neptunian dykes are conspicuous synsedimentary features that could be divided into sedimentary dykes, whose open fissures were filled by simple, mostly gravitational processes; and injection dykes, whose geometry and internal structure indicate forceful injection of sediments. The Geological Garden at Tata exposes swarms of narrow neptunian dykes, whose dense network and diverse fillings reflect an intricate, semi-closed fracture system. Field observations and thin section investigations revealed that the hidden interior of these neptunian dykes was the place of shifting, sometimes slow, microbially dominated sedimentation that was accompanied by a changing fluid circulation system and was interrupted by vigorous, tectonically induced injection events.

The sediment-filled fractures are concentrated around the sharp base of the reddish Jurassic pelagic succession that covers the white beds of the Upper Triassic Dachstein Limestone, crosscutting horizontally elongated dissolution cavities. The dykes feather out upwards within the slightly nodular upper Hettangian–Sinemurian limestone beds that hold stromatactis-like cavities.

While the fissure-filling sediments are mostly similar to that of the seafloor, the fine crinoidal and micritic limestones were in many cases preceded by laminated pelmicrite and cement crusts. Competition between sediment and cement in the early dyke fills indicates that the filling processes were synchronous and rates were about equal. Initial fills of the fissures are typically laminated pelmicrite crusts, lining the subvertical dyke walls, forming a cement-like appearance. The thickness of the crusts might reach several centimeters, occasionally forming drape-like curved geometries with subvertical grooves. The crusts and overstepened perched mound structures indicate the importance of cryptic biomineralization during the first epoch of the dyke filling. The thin and branching fractures were most probably not open directly towards the seafloor; they rather branched out upwards in the early cemented limestone beds and the intervening muddy layers. In the occluding ducts the absence of grazing megafauna, lack of detrital sedimentation, accompanied by persisting water circulation could give birth of the peculiar cryptic, microbial dominated sedimentary environment.

The early, erect pelmicritic structures were covered by similar, but mechanically deposited pelmicrite sediments, whose hourglass geometry reflects grain-by-grain deposition in a narrow channel system. These fossil-free early dyke fillings were covered by allochemical and micritic limestones, comparable to that of the Liassic succession. New fissure fill generations indicate reopening dykes, and hence, moving walls. Due to seismic shocks or simply to the squeezing effect of the shaking or contracting dyke walls, many of the enclosed sediments were subjected to soft-sediment deformation, in-situ brecciation, or were injected into preexisting caverns and fissures opened along planes of weakness. Contracting dyke walls, and resuming seismic shocks induced dewatering, might generate short pulses of powerful water flux not only within the fissures, but also inside the partly cemented seafloor sediments above. Water expelled from the shocked dykes might have caused internal erosion and contributed to the formation of the stromatactis cavities.

NEW TITHONIAN BIOSTRATIGRAPHIC DATA FROM THE NEUQUÉN BASIN, ARGENTINE ANDES: A CONTRIBUTION FROM THE SOUTHERN HEMISPHERE

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We present new biostratigraphic data provided by ammonites, calcareous nannofossils, and calpionellids from Las Alcantarillas, a 127 m-thick section from the Neuquén Basin, western Argentina. The combined biostratigraphic information of these fossil groups enables to accurately correlate our findings from the Andes with the current Tithonian biozones-scheme of the Western Mediterranean Province of theTethyan Realm.

The biostratighaphic records show that the early Tithonian calcareous nannofossil NJT 15 Zone correlates with the early Tithonian *V. andesensis*, *P. zitteli*, *A. proximus,* and *W. internispinosum* ammonite Zones, while its upper part correlates with the *Chitinoidella* calpionellid Zone. In the studied section, the lower/upper Tithonian boundary is defined by the base of the *Crassicollaria* calpionellid Zone, which is close to the base of the NJT 16 nannofossil Zone and to the base of the upper Tithonian *Corongoceras alternans* ammonite Zone. Levels assigned to the NJT17 nannofossil Zone (upper Tithonian) are recognized and correlated with the upper part of the *Crassicollaria* calpionellid Zone and with the *Substeueroceras koeneni* ammonite Zone. So far, it has not been possible to define accurately the Jurassic/Cretaceous boundary in Las Alcantarillas. However, in the upper levels of the section, the *Argentiniceras noduliferum* and the *Spiticeras damesi* ammonite Zones, traditionally assigned to the Berriasian, have been identified.

In addition to the paleontological analyses, bulk-rocks were sampled every 6 cm to measure magnetic susceptibility and $\delta^{13}C_{org}$, and tuff layers were sampled to obtain precise absolute ages on U-Pb zircons. An astrochronological framework has been obtained from the spectral analyses on magnetic susceptibility, which was integrated to the radiochronology results from the zircons. The high-resolution (every ~20 ka) $\delta^{13}C_{org}$ curve, the first of its kind obtained in the Neuquén Basin, will help in the global correlation of the Andean Late Jurassic and add a new perspective in the understanding of the stratigraphic distribution of its fossil associations.

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EARLY-STAGE ORE FORMING PROCESS OF THE ÚRKÚT AND EPLÉNY MANGANESE ORE DEPOSITS (HUNGARY)

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The Early Jurassic Toarcian Oceanic Anoxic Event (T-OAE) is a major event of past global change. Its stratigraphic record has been investigated from many aspects, but its raw materials potential and metallogenesis has received relatively less attention despite its increased relevance. Formation of the Hungarian manganese ore deposits at Úrkút and Eplény (Transdanubian Range) are related to the T-OAE and have long been in the focus of industrial and scientific research. Although the mines are now closed, open scientific questions still remain about the source of the manganese and spatially restricted occurrence of economic deposits within the Úrkút and Eplény basins while correlative Toarcian sediments are widespread.

We studied the geochemistry and mineralogy of the environmental changes at the Pliensbachian Toarcian boundary to understand the processes leading to the ore accumulation and why deposits occur only in the Úrkút and Eplény Basins. We examined Pliensbachian and Toarcian sediments through the Transdanubian Range from the following locations: Úrkút, Eplény, Lókút and Tölgyhát-quarry. X-ray powder diffraction (XRD), scanning electron microscopy (SEM-EDX), X-ray fluorescence spectroscopy (XRF) and inductively coupled plasma mass spectrometry (ICP-MS) were used to analyze the samples.

Contrary to previous studies, we found that the smectite content in the Lower Jurassic sediments within the Transdanubian Range is not limited to the manganese orebodies but smectite appears in the footwall of the Úrkút and Eplény deposits and in the Upper Pliensbachian strata of Lókút as well. The smectite appearance in the Pliensbachian rocks is always associated with increased silica content. In a few cases, the source of the increased Si is biogenic (probably radiolarians) but dominantly the elevated Si content is related to recrystallized quartz. The geochemical investigation of the Pliensbachian and Toarcian strata yielded similar results through the whole Transdanubian Range. Pliensbachian rocks nowhere recorded any increased manganese or any significant associated trace elements content. On the contrary, Toarcian sediments show manganese and redox sensitive elements enrichment everywhere, even in those locations from where economically viable accumulations are unknown.

The most probable source of the local silica enrichments could be radiolarian blooms in the late Pliensbachian, induced and fed by local upwelling systems. The manganese and other redox sensitive trace elements could be transported by anoxic oceanic bottom waters, enriched in these elements through the alteration of fresh Neotethys oceanic floor. The upwelling systems, indicated by the radiolarian blooms, also brought and mixed these bottom waters with oxygen-rich surface waters, causing the oxidation and precipitation of manganese, iron, silica and smectite. This is how the Mn "proto-ore" precipitated locally in the Eplény and Úrkút basins. This mineralogical and geochemical fingerprint is common in the Transdanubian Range, but its intensity significantly varies from place to place. The economic-grade accumulations in Eplény and Úrkút could be best explained by a previously proposed model of basin, where seamounts could cause the local upwellings with strong intensive mixing and abundant precipitations and had relatively low-energy areas behind the seamounts thus thick Mn-Fe rich orebeds were generated. In more restricted environments that were less exposed to the bottom currents (e.g. Lókút), only traces of this metallogenic event can be found.

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NEW GEOCHEMICAL RECORDS OF THE PLIENSBACHIAN-TOARCIAN CLIMATE CHANGES NEAR THE NORTH POLE

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The Pliensbachian-Toarcian transition was a period of dramatic climate changes characterized by general climate warming and a global marine transgression. Two global carbon cycle perturbations have been recognized over this period, the Pliensbachian-Toarcian boundary event and the major Jenkyns-event, also known as Toarcian Oceanic Anoxic Event. Each of these perturbations is defined by a significant decrease in $\delta^{13}C$ in both the atmospheric and marine reservoirs, attributed to the release of large amounts of ^{13}C-depleted CO_2. Nevertheless, records of these episodes of rapid environmental perturbation mainly come from marine strata deposited at low paleolatitudes, whereas existing temperature records mainly rely on the carbonate $\delta^{18}O$ proxy and are highly uncertain due the unknown contribution of changes in the hydrological budget of the studied basins. In this study, we present new geochemical ($\delta^{13}C$, $\delta^{18}O$, Δ_{47}) records of Pliensbachian-Toarcian climate changes at high paleolatitude using collection material as well as recently collected samples from North Siberia. Siberian bivalve $\delta^{13}C$ values, although 2 to 3 ‰ higher than brachiopod $\delta^{13}C$ values from the western Tethys, allow us to identify the different stages of the Jenkyns event. Calcite shells of *Harpax* collected in Upper Pliensbachian, located bellow the glendonite-bearing strata record Δ_{47} temperatures comprised between 1 and 4°C and low water $\delta^{18}O$ (-4 to -8 ‰ VSMOW). Aragonite shells from within late Pliensbachian glendonite-bearing levels, record Δ_{47} temperatures ranging from 13 to 16°C, and water $\delta^{18}O$ from -1 to -3 ‰ VSMOW. Lower Toarcian aragonite shells of *Tancredia* and *Dacryomya* sampled from strata deposited during and after the Jenkyns event record Δ_{47} temperatures ranging from 13 to 18°C with few samples recording Δ_{47} temperatures as low as 7°C, and water $\delta^{18}O$ ranging from -2 to -5 ‰ VSMOW. Δ_{47} temperatures from aragonite *Dacryomya* shell are about 8°C higher than coeval calcite *Liostrea* shell from the same horizon while recording similar carbonate $\delta^{18}O$. These significant differences in Δ_{47} between calcite and aragonite samples could reflect the preferential solid-state bond reordering of aragonite shells, taphonomic processes (postmortem displacement of some of the shells) or differences in timing of shell growth (seasonal biases). Depending on the preferred hypothesis, the long term Pliensbachian-Toarcian warming in North Siberia can be estimated to have ranged from 4 to up to 13°C.

CYCLOSTRATIGRAPHY OF THE OPALINUSTON FORMATION IN THE SWABIAN ALB DEDUCED FROM X-RAY FLUORESCENCE DATA

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The Swabian Alb is one of the most distinctive regions in Germany where Jurassic strata is exposed. During the Middle Jurassic, this region experienced predominant deposition of fine clastic sediments in a tropical climate. Common sediments of this period are dark clays and oolithic ironstones, whereas condensation and discontinuity surfaces occur in many instances. Three new drill cores along a 140 km long NE-SW transect in the southern German Swabian Alb are penetrating strata from the Pliensbachian to Bathonian stages (~190–166 Ma) and were recovered in order to develop a sequence stratigraphic model at the transition from the Early to Middle Jurassic time. Here, we use X-ray fluorescence data from this stratigraphic record to perform a cyclostratigraphic analysis in selected intervals. The focus lies on the Aalenian stage, especially on the Teufelsloch Subformation of the Opalinuston Formation, as it holds the most continuous and most extended record in all three boreholes. Predicted timespans of these intervals obtained by cyclostratigraphic methods, using the TimeOpt-function in the R-package "astrochron", yield similar results of ~1.2 Ma for the Lower Aalenian and might provide a new benchmark in terms of cyclostratigraphic resolution of the Middle Jurassic.

PALEOENVIRONMENTAL STUDY OF THE JURASSIC–CRETACEOUS BOUNDARY INTERVAL IN THE TRANSDANUBIAN RANGE (HUNGARY)

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The Transdanubian Range (NW Hungary) constitutes one of components of the Alcapa Mega-unit. During the Mesozoic it was located in between the Austroalpine and South Alpine domains, facing the Neotethys Ocean to the south-east and Alpine Atlantic to the north-west. Biostratigraphic, paleomagnetic, geochemical and sedimentological data collected from the Tithonian–Valanginian of the Hárskút and Lókút successions are considered here in terms of their paleoenvironmental significance. Although studied sections are geographically close, they record different sedimentary zones of the Bakony Basin. In the Lókút, early Tithonian red nodular limestones are followed by monotonous succession of the late Tithonian–early Berriasian Maiolica-type limestone with cherts. Hárskút composite section also starts with *ammonitico rosso*, however these are replaced by pelitic limestones as high as within the upper Tithonian; besides, nodular limestones reappear within the upper Berriasian–lowermost Valanginian. Nonetheless, both successions provide a consistent record of different paleoenvironmental processes.

In principle, the Tithonian–Berriasian accounts for a decreasing trend in lithogenic influx; this changed only during the late Berriasian, when tectonic uplift in the Neotethyan Collision Belt led to increased erosion and intensified clastic supply to neighboring areas. Various paleoclimate proxies, such as Al/K, Th/K (both K-leaching related), Ga/Rb (adopted as a kaolinite/illite ratio) and Zr/Al (approximating the efficiency of eolian transport) point to progressing aridization during the Tithonian, with a maximum at the Tithonian–Berriasian transition (M18–M19 polarity chrons). Besides, bottom-water redox proxies indicate worsening seafloor ventilation during the late Tithonian, the early Berriasian 'interlude', and another period of seafloor hypoxia during the late early–early late Berriasian. Noteworthy, corresponding record is provided by nutrient-style trace metals (e.g. P, Ba and Zn), what suggests common mechanism controlling paleoredox conditions and trace metals accumulation. Ultimately, the so-called nannofossil calcification events (NCE's) were documented and correlated in both successions. The older NCE I falls in the lower/upper Tithonian boundary interval, whereas the younger, NCE II, occurred during the latest Tithonian–earliest Berriasian. The latter event is characterized by rapid increase of nannoconids, which presumably proliferated around the nutricline and preferred well stratified water column.

Integration of collected data allowed us to infer about importance of the latest Jurassic–earliest Cretaceous climate perturbations for the Transdanubian Range's ecosystem. In this scenario, predominantly humid climate of the early Tithonian was favorable for induction of monsoonal upwelling. This resulted in well-mixed water column, oxic seafloor conditions and – despite relatively high detrital input – relatively low burial of micronutrients due to efficient nutrient shuttle system. This balance was interrupted during the late Tithonian, when progressing aridization weakened the monsoonal circulation, limiting chances for induction of upwelling. Under such conditions water column become stratified, leading to seafloor hypoxia, whilst slowdown in the nutrient shuttle increased burial of micronutrients. This changed only during the late Berriasian when tectonic activity largely affected the regional sedimentary system.

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SEDIMENTOLOGY AND SEQUENCE STRATIGRAPHY OF THE AALENIAN FROM SOUTHERN GERMANY

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Middle Jurassic sedimentary deposits in southern Germany have accumulated in a shallow-marine shelf environment and are typically dominated by thick clayey lithologies with increasing occurrences of sandstones in the upper parts. The sedimentary evolution and paleoclimatic significance of these often poorly exposed deposits remain largely unexplored. Here we present a suite of high-resolution x-ray fluorescence (XRF) core scanning data from southern Germany covering the entire Aalenian stage. The overall objective of this study is to identify transgressive-regressive cycles based on the analysis of three cores obtained during scientific drilling campaigns in 2019-2021. Cores have been analyzed with an Avaatech XRF Core Scanner at a 10 mm sampling interval, an energy of 10 keV and a current of 500 µA to measure element intensities ranging from aluminium through iron. Resulting trends in elemental ratios indicative for subtle grain-size variations such as Si/Al are used to reconstruct shoreline trajectories and establish a sequence stratigraphic framework. Particularly the thick and largely homogenous Opalinuston Formation appears suitable in that respect, likely resulting from extraordinarily high sedimentation rates during the lower Aalenian in southern Germany, thus providing a complete but unexplored archive of paleoclimatic signals. For the upper Aalenian, a Fennoscandian sandstone provenance resulting from uplift of the North Sea dome has been suggested. Such an exotic source area has important implications regarding transport processes and, consequently, the underground architecture of upper Aalenian sandstones. Accordingly, this project will also investigate sediment provenance in order to provide a holistic view of the sedimentary evolution of the South German Basin during the Aalenian.

A REVIEW OF JURASSIC-CRETACEOUS TRANSITION SEQUENCES IN JAPAN

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The status of current knowledge including the lithology, stratigraphy, fossil contents and radiometric age data of Jurassic–Cretaceous (J–K) transition beds in Japan is reviewed. There are two types of sequences are recognized in the Japanese Islands: shallow marine-terrestrial sequences and pelagic sequences. The former includes the Torinosu Group in the Outer Zone of southwest Japan, the Tetori Group in the Inner Zone of the southwest Japan, and the Somanakamura Group in northeast Japan. These strata deposited in the eastern margin of the Asian Continent. The latter is typified by radiolarian-rich chert sequence embedded in accretionary complexes in the Southern Chichibu and Northern Shimanto belts of southwest Japan and the Tokoro and Sorachi–Yezo belts in Hokkaido.

The Torinosu Group and its equivalents are of entirely marine origin and yield abundant molluscan fossils including bivalves and ammonoids of Tethyan affinity. Most ammonoid specimens from the group are indicative of Tithonian in age. The Somanakamura Group is characterized by an alternating occurrence of marine and non-marine succession. The J–K transition beds are correlated to a transitional part from non-marine to marine sequence. Marine beds yield abundant molluscan fossils including Berriasian ammonoids such as *Parakilianella umazawensis*, *Dalmasiceras muneoi*, *Neocosmoceras*? *akiyamae* and others. These beds contain plant fossils and palynomorphs. The equivalent beds to the Somanakamura Group yield belemnite species belonging to the genus *Hibolithes* of Tethyan affinity. Both the Torinosu and Somanakamura groups contain radiolarian fossils as well. Acidic tuff beds embedded in the terrigenous sequences have a high potential for U–Pb zircon radiometric dating.

The Tetori Group is characterized by an alternating occurrence of marine and non-marine sequences. The J–K transition sequence is correlated to a transitional part from non-marine to marine sequence. Marine beds contain abundant bivalves, and yield Berriasian ammonoids such as *Neocosmoceras* sp. and others of Tethyan affinity and cylindroteuthidid belemnites such as *Cylindroteuthis* aff. *knoxvillensis* and *Arctoteuthis tehamaensis* of Boreal affinity. Thus, this sequence can be correlated with the coeval sequences in northern California and Siberia based on the belemnite biostratigraphy.

Chert beds which represent the J–K transition are recorded on Ie Island, Okinawa, in the Southern Chichibu belt. Chert beds within mélange of the Shimanto belt in Shikoku and Kii Peninsula also include the J–K transition beds. An accretionary complex composed mainly of basaltic rocks originated from seamounts in the Tokoro belt, east Hokkaido, contains radiolarian cherts with the J–K transition. Hemipelagic tuff sequences of the Sorachi Group in central Hokkaido also include the J–K transition beds. These pelagic and hemipelagic beds are barren of age-diagnostic megafossils. However, co-occurrence of radiolarian fossils and ammonoids in the Torinosu and Somanakamura groups enables to correlate directly radiolarian zones to ammonoid ones.

PLIENSBACHIAN (EARLY JURASSIC) AMMONOIDS FROM THE KURUMA GROUP AROUND MT. KIKUISHI IN ITOIGAWA, NIIGATA, CENTRAL JAPAN

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The Kuruma Group comprises Lower Jurassic terrestrial and shallow marine sediments exposed widely in eastern Toyama, western Niigata, and northern Nagano prefectures, central Japan. The distribution of the group is divided into the Inugatake area in the west and the Kotakigawa-Akahageyama-Kuruma area in the East. The most complete succession is observable in the Inugatake area where the group is subdivided into the Jogodani, Kitamatadani, Negoya, Teradani, Shinatani, Otakidani and Mizukamidani formations in ascending order. Later, the Mizukamidani Formation is regarded as a part of the Lower Cretaceous Tetori Group. In the Kotakigawa-Akahageyama-Kuruma area, the group is subdivided into the Gamaharazawa, Odokorogawa and Yoshinazawa formations in ascending order.

The Kuruma Group consists chiefly of sandstones, mudstones and conglomerates, and is characterized by alternation of marine and non-marine sediments. The group has yielded a variety of fossil taxa including ammonoids, bivalves, belemnites, brachiopods, crinoids, turtles, sea reptiles, dinosaur footprints and land plants. Among the above-mentioned fossils, geochronologically important ones are early Pliensbachian ammonoid (*Eoderoceras*) from the Negoya Formation, late Pliensbachian ammonoids (*Amaltheus*, *Canavaria*) from the Teradani Formation, and latest Toarcian ammonoids (*Grammoceras*, *Hammatoceras*) from the Otakidani Formation. Recently we clarified the ammonoid succession in three sections in the upper stream area of the Sakaigawa River including the Teradani Valley, the type locality of the Teradani Formation.

Outcrops of the Teradani Formation of the Kuruma Group are exposed on the ridgeway and western slope of the Tsugami Shindō Trail ca. 50 m north of Mt. Kikuishi. In our 2021 field research we have successfully discovered ammonoid specimens from the Teradani Formation of the Kuruma Group north of Mt. Kikuishi. Some of them can be assigned to *Canavaria* sp. in our preliminary identification. The *Canavaria* assemblage zone is the upper zone among the three successive ammonoid assemblage zones established in the Teradani Formation. The exposures that yielded ammonoids obtained in our research can be attributed to the *Canavaria* assemblage zone, corresponding to the latest Pliensbachian. In previous study, some *Amaltheus* ammonoids (*A. stokesi* (Sowerby) and *A. margaritatus* de Montfort) were obtained from Mt. Kikuishi. Therefore, we expect to discover other zone-diagnostic ammonoid species of the genus *Amaltheus* in future research.

In terms of paleobiogeography, it has been pointed out that the genus *Amaltheus* is a typical Boreal ammonoid while the genus *Canavaria* is a Tethyan one. It is important to elucidate how ammonoid faunas change in a continuous sequence because ammonoids are key taxa to give both geological ages and paleogeographic information. The succession exposed north of Mt. Kikuishi has a potential to trace not only ammonoid faunal change but also bivalve and gastropod faunal changes.

X-RAY IMAGING OF BEETLE BORINGS (*DEKOSICHNUS MENISCATUS*) IN MIDDLE–LATE JURASSIC ARAUCARIAN CONIFER WOOD FROM ARGENTINA

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Insects have a patchy fossil record in Jurassic strata of the Southern Hemisphere. However, the representation of terrestrial arthropod herbivory and detritivory guilds can be evaluated via the traces left on the vast record of fossil leaves and as microcoprolites in sediments. We provide a case study of one such feeding guild (wood boring) from Jurassic continental strata of the Southern Hemisphere. Borings in the inner secondary wood of a silicified Middle–Late Jurassic conifer from Argentina are attributed to the ichnotaxon *Dekosichnus meniscatus*. The longitudinally aligned borings contain finely granular frass particles arranged in meniscoid laminae. Synchrotron X-ray computed tomographic reconstruction of the borings reveals new characters of this ichnotaxon, such as opposing orientations of menisci in some adjacent borings, regular spacing of minor and major meniscoid laminae, a scarcity of tunnel branching, and rare occurrences of cylindrical–spherical terminal (pupation) chambers on excavations. Architectural and distributional characters of the galleries suggest excavation by cerambycid beetle larvae, thus representing one of the earliest potential fossil records of this group. The borings are confined to the inner wood of a young tree that experienced a moderately seasonal climate in a volcanically influenced landscape. By detecting subtle heterogeneities in composition, this study demonstrates that high-energy synchrotron X-ray tomography can characterize anatomical features and complex ecological interactions within even densely permineralized (silicified) plant fossils.

STRATIGRAPHY VS. DIAGENESIS: HOW USEFUL ARE $\delta^{13}C$ ANALYSES OF BULK ROCK SAMPLES? – NEW DATA FROM THE LOWER TOARCIAN OF SOUTH GERMANY

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Stable carbon isotope values are a widely used proxy for carbon cycle perturbations which lead to noticeable excursions in the isotopic record. A prominent event associated with a distinct $\delta^{13}C$ excursion in the Early Jurassic is the Toarcian Oceanic Anoxic Event (T-OAE) caused by enhanced volcanic activity in southern Gondwana and accompanied by rapid global warming, widespread anoxia, and ocean acidification. Due to the global nature of the T-OAE, the event was recognized in numerous successions around the world using stable carbon isotopes. For such investigations, calcitic shells of marine organisms are often used as sample material since it is assumed that they approximately reflect the original isotopic signature of the sea water. But especially during severe biotic crises and environmental turnovers the availability of shell material in the rock record can be limited. Bulk rock samples are therefore an important alternative to obtain complete isotopic records for chemostratigraphic purposes in very high resolution. However, it must be considered that the primary isotopic signal can be overprinted by diagenesis. This study provides new $\delta^{13}C$ data as well as microfacies and SEM analyses from the Lower Toarcian of Buttenheim (Bavaria, Germany) comparing the stratigraphic significance of three different lithologies (limestone beds, concretions, and marls) in a heterogeneous, macrofossil-poor succession. The micritic concretions show $\delta^{13}C$ values below -15 ‰ VPDB indicating that they received most of their carbonate cement from the anaerobic decay of organic matter within the sulfate reduction zone and thus reflect the geochemical composition of the pore water and not the sea water signature. The micritic limestone beds have imported large amounts of carbonate cement provided by the dissolution of aragonite and show values around -1 ‰ VPDB whereas the marls remained almost uncemented but mechanically compacted during diagenesis. This means that the isotopic signal of the marls, which show $\delta^{13}C$ values similar to the limestone beds, was not affected by the import of diagenetic carbonate and therefore approximately reflects the $\delta^{13}C$ signature of the sea water mainly provided by calcareous nannoplankton. This suggests that bulk rock samples from marls and – to a limited extent – also limestone beds should be used as the preferred lithologies for chemostratigraphy in this case.

ULTRASTRUCTURE OF CALPIONELLID LORICAE FROM THE JURASSIC/CRETACEOUS BOUNDARY

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Tiny calpionellid loricae were believed to be formed of organic substance, replaced by skeletal calcite. Others supposed, that the loricae could have been formed by agglutination of calcitic particles of preyed coccolitophorids. On the other hand, possibility of original aragonite lorica composition, and early transformation into calcite has been indicated by other ultrastructure studies.

Calpionellids of Tithonian Crassicollaria Zone were 75–85 μm in size, but 50 to 65 μm wide in the Berriasian Alpina Zone. Lorica wall thickness attained 4–5 μm; however, this value could have been secondary enlarged by test recrystallization and by accretion of individual crystallites, or thinned by dissolution. Our result shows that lorica ultrastructure seems to be variable not only between individual lithologies, but also between individual parts of the same specimen. Transparent matter of this layer easily (often laterally) turned into columnar crystals normal to the surface (possibly, a difference between "slowly formed" and „quickly formed" parts of the lorica must have existed).

Anterior cross sections of *Calpionella alpina* from the Brodno section (Intermedia Subzone up to the Alpina Zone) show laminar pattern of several (3–4) parallel laminae, while the outer surface is covered by spiral hexagonally arranged rhombi. On the other hand, lorica wall could be changed into columnar densely spaced scalenoeders (1–3 μm thick, up to 17 μm long), oriented normally to the test surface ("slowly formed" part of lorica). Outer test outline is blurred by crystal growth, the infilling of test cavity can be recrystallized into irregular calcite crystals which penetrate through the inner test surface. During diagenesis, the whole test wall could has been transformed into an aggregate of rhombi. Very early diagenetic changes affected parts the lorica more intensively than the surrounding matrix.

Chitinoidellid tests appearing dark in optical microscope have been supposed to be built of chitinous substance. However, the wall is little resistant against acid bath. SCAN observations have shown dispersed calcite rhombi in fine matrix. Both sides of the lorica have been smooth, nevertheless, new post mortal increments of calcite rhombi are oriented out of the lorica. The inner lorica surface is ornamented by calcite rhombi imprints. Sharpness of these planes indicates that the wall was rimmed by different layers in contrast with "hyaline" calpionellid loricae, where the external surface can be smoothed during recrystallization.

Parallels in loricae architecture of Mesozoic calpionellids with modern tintinnids are interesting. Chitin, cellulose, other polysaccharides, neutral polysaccharides, glycolipids, phospholipids and unsaturated fatty acids have been excluded as lorica building materials, and hyaline organic matter, most probably proteins are regarded as the main components. Due to calcium carbonate composition, many micropaleontologists excluded affinity of modern tintinnids with calpionellids. However, the character and abundance changes of uppermost Jurassic/Lower Cretaceous calpionellid associations evoke assumption that the calcite saturation of loricae walls was not the primary sign of these animals and perhaps they could survive e.g. the late Hauterivian–Barremian time with non-calcified tests.

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THE EARLY TOARCIAN CALCIFICATION CRISIS: OUR KNOWLEDGE SO FAR

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The early Toarcian (~ 183 Ma) was a period when a series of environmental perturbations deeply affected the Earth system leading to a second-order mass extinction. Two events have been recognized, the Pliensbachian-Toarcian boundary event (Pl-To), and ~ 600 kyr later the Jenkyns Event which had a more significant impact on the global biogeochemical systems. These events are linked to the emplacement of the Karoo-Ferrar large igneous province (LIP), mainly to the eruptive phases, suggesting that large volume greenhouse gas emissions were the main trigger behind the disruptions. A series of environmental changes, such as global warming, acceleration of the hydrological cycle, marine anoxia and carbon cycle perturbations were associated with these events, which drastically developed and culminated during the Jenkyns Event.

Numerous pieces of evidence imply a simultaneous calcification crisis as well. Calcium carbonate concentration in epicontinental basins generally shows a gradual decrease after the Pl-To, reaching the minimum during the Jenkyns Event, while hemipelagic and pelagic carbonate successions are disrupted by hiatuses and condensation, suggesting severe conditions for benthic and pelagic carbonate producers. Meantime, shallow marine carbonate factories experienced a shutdown, and also hypercalcifier organisms like the Lithiotis bivalves and the Palaeodasycladus calcareous algae disappeared during the Jenkyns Event. Several paleontological studies also demonstrated that the calcifying micro- and macrofauna were exposed to increasing environmental stress. The reasons behind these observations are fairly complex. As a result of the accelerating hydrological cycle, intense continental weathering and a related nutrient level increase could play a significant role in the demise of shallow marine carbonate systems. Seawater temperature fluctuation, including a rapid large temperature rise during the Jenkyns Event, likely had a huge impact on marine calcifiers too. In addition, due to large-volume CO_2 emission into the atmosphere-ocean system as a consequence of the activity of the Karoo-Ferrar LIP, it is expected that ocean acidification also accompanied the events. Brachiopod-based boron isotope pH reconstructions imply that seawater pH already started dropping during the Pl-To and gradually reached an extreme minimum at the onset of the Jenkyns Event.

Here, I aim to summarise our current knowledge of the early Toarcian calcification crisis by taking into account the various processes and phenomena involved and would like to highlight the controversies and the questions seeking answers.

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TRACING PALEOENVIRONMENTAL CHANGES DURING THE JENKYNS EVENT IN THE NORTHWESTERN TETHYAN MARGIN (SACHRANG, EASTERN ALPS)

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The early Toarcian Jenkyns Event (~183 Ma) was a series of environmental changes including global warming, carbon cycle perturbations, and marine anoxia, which were associated with large volume greenhouse gas emissions during the main phase of activity of the Karro-Ferrar large igneous province. Although considerable evidence, such as the widespread deposition of black shales and various geochemical anomalies, supports the hypothesis of global expansion of oxygen-depleted marine environments during the early Toarcian, our knowledge of this event is overwhelmingly derived from very well-studied, albeit hydrographically restricted NW European epicontinental basins. Thus, additional data from localities that were in paleogeographic proximity to oceanic environments, where biasing effects may have been smaller, is highly desirable.

Here, we present new geochemical ($\delta^{13}C_{org}$, $\delta^{13}C_{carb}$, TOC, HI, T_{max}, major elements, redox-sensitive trace elements) and biostratigraphic data (based on calcareous nannofossils and ammonites) from the Sachrang section (Eastern Alps). During the early Toarcian, the study section was deposited in a trench on the northwestern continental margin of the Neotethys Ocean, at a location proximal to the open ocean. The section exposes a ~42-m-thick hemipelagic succession consisting of manganiferous shaly marls (lower ~25 m) and black shales (upper ~17 m) of the Sachrang Member of the Middle Allgäu Formation. Our biostratigraphic data confirm the presence of the lower Toarcian NJT5c, NJT6a and NJT6b nannoplankton zones, and ammonites document the Serpentinum Zone in the lower black shale. $\delta^{13}C_{org}$ data exhibit low and fluctuating values (~–31 ± 0.5‰), with a prominent negative carbon isotope excursion (CIE) that is the characteristic hallmark of the Jenkyns Event. Redox-sensitive trace element data suggest that dysoxic/suboxic conditions existed at the seafloor during deposition of the manganiferous marls, followed by a shift to euxinic conditions during deposition of the black shale. Declining concentrations in the upper part of the black shale, despite persistence of high TOC values, reflect drawdown of aqueous trace-metal reservoirs. Our findings contribute to an improved understanding of the nature and extent of oceanic oxygen depletion on continental margins during the Jenkyns Event.

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THE JURASSIC/CRETACEOUS BOUNDARY IN TERMS OF RADIOLARIANS FROM THE SÜMEG AREA (TRANSDANUBIAN RANGE, HUNGARY)

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Sixty-four genera and 142 moderately to poorly preserved radiolarian taxa have been identified and documented from continuous Jurassic–Cretaceous boundary sections from the Sümeg area, (Transdanubian Range, Hungary) which are the following: the Süt-17 borehole and the compiled Mogyorós-domb section (Mogyorós-domb I classical section and Dosztály's section). The radiolarian biostratigraphic studies indicate an uppermost Tithonian (UAZ 13) to Middle Hauterivian (UAZ 20–22) age range in the Süt-17 borehole, the presence of uppermost Tithonian (UAZ 13) in the Dosztály's section, and a Berriasian to Hauterivian (UAZ 14–20) age range for the Mogyorós-domb I classical section. Globally, the Late Jurassic–Early Cretaceous interval represents the highest peak in radiolarian diversity at the species level, although there is no significant revolution or extinction event across the J/K boundary. The oceanic conditions favored radiolarians, however, the radiation of the calcareous phytoplankton caused the termination of widespread radiolarite sedimentation from the Tithonian. Based on the obtained radiolarian assemblage from the Sümeg sections, there is no definable boundary based on radiolarians in the Jurassic–Cretaceous transition interval.

ULTRASTRUCTURE AND COMPOSITION OF CALPIONELLIDS IN THE UPPER JURASSIC AND LOWER CRETACEOUS PELAGIC DEPOSITS

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Chitinoidellids and calpionellids became abundant and rock-forming during the Tithonian. Their appearance stratigraphically coincides with a replacement of nodular by non-nodular deposits in pelagic environments and with an increase in abundance of calcareous nannoplankton. However, their appearance, turnover, and the shift from agglutinated (microgranular) to calcitic (hyaline) loricae remain poorly understood.

The microgranular loricae of the genus *Chitinoidella* are formed by micron-sized rhombohedral transversely oriented calcite crystals embedded in and organic cement (Reháková & Michalík, 1993). In contrast, hyaline loricae of calpionellids (*Crassicollaria, Calpionella*) consist of relatively coarse (> 5 μm) calcite crystals. However, the stratigraphic transition between chitinoidellids and calpionellids, represented by the so-called praecalpionellids with two-layered walls (*Praetintinnopsella* a *Semichitinoidella*), was not assessed under the scanning electron microscope (SEM) until now.

Here, we revisit the ultrastructure and composition of loricae with an emphasis on the transition represented by the two-layered praecalpionellids. We analysed chitinoidellids and calpionellids from the Tithonian and Berriasian deposits of the Czorstyn and Pieniny formations (Western Carpathians) under the SEM and with electron microprobe (backscattered electron images, BSE, and wavelength-dispersive spectroscopy).

The BSE revealed the presence of loricae with microgranular structure from the interval between Boneti Subzone and Crassicollaria Subzone (identified as *Chitinoidella*, under the light optical microscope). We observed that the microgranular layer – is approximately 5 μm thick and is formed by angular, densely-packed needles or plates of low-Mg calcite (< 1 μm). These needles are locally replaced by larger rhombohedral diagenetic crystals of origin. The interstices between needles and plates are formed by acid-resistant material. Although, abundant nannofossil tests occur in the micritic matrix, we did not directly observe their tests or fragments within the microgranular layer. However, it can be hypothesized that the needles in the microgranular layer are derived from fragments of nannoplankton plates. The SEM observations revealed that the microgranular layer in these chitinoidellid-like specimens is enveloped by a very thin (2-3 μm) external (hyaline-like) layer formed by regularly arranged bladed crystal prisms. This external layer is also visible in BSE, but it is more obvious in SEM due to the lack of the contrast in the chemical composition between the lorica and the surrounding matrix. This type of test can be assigned to semichitinoidellids as described Nowak (1978), indicating that the taxonomic separation of *Chitinoidella* and *Semichitinoidella* requires the SEM analyses.

In calpionellids, the lorica is formed only by the hyaline layer. This layer is often indistinct on BSE images; the microgranular wall is missing. SEM reveals that the hyaline wall consists of prisms of fibrous or bladed crystals that are oriented perpendicularly relative to the wall surface.

CONTRASTING APPROACHES TO THE CONSERVATION OF JURASSIC PALAEONTOLOGICAL HERITAGE AND SITES AND ITS CONSEQUENCES FOR JURASSIC SCIENCE

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Considerations of geological heritage conservation issues are now as fundamental to fieldwork planning as the simple logistics of 'getting there', not least as there can be legal consequences if they are ignored… Ideally, the implementation of geoconservation measures should be beneficial to science, through ensuring that key localities remain available for study by providing a mechanism to prevent loss of the locality (e.g. due to infill or construction), damage (e.g. due to intensive specimen collecting) and by providing a mechanism to manage the locality (e.g. periodic clearance of vegetation). Conversely, however, highly restrictive measures in place in some regions or countries, can virtually prevent continued scientific study. The reasons for the latter are complex, but often stem from a confusion with the highly protective regimes required for living species conservation and a misunderstanding of the needs of the geosciences. In many cases, such restrictions also represent attempts to safeguard a national heritage which had historically been plundered or, more insidiously, attempts by individual, politically influential scientists or institutions, to 'control' a resource for their own 'exclusive' use. In a few cases, however, the motivations are altogether darker, and it is an unfortunate fact that the palaeontological resource, in particular, can be economically controlled by oppressive regimes or criminal activity. Elsewhere, despite geoconservation measures being, in theory, in place, intensive commercial and other collecting activities continue to take place, or are even encouraged, leading to a very serious depletion of the resource available for scientific study – and damage to key aspects of the resource. A notorious example of this is the so-called 'Jurassic Coast', World Heritage site in Dorset and part of East Devon, which continues to be intensively, commercially exploited to supply a global fossil trade – despite radically different approaches in other UNESCO-designated areas, especially Global Geoparks, where commercial trade in geological heritage is prohibited. Crucially, however, as many national conservation systems fail to recognise, there can be a genuine benefit to science if some level of *managed* and informed 'amateur' collecting is permitted in appropriate areas, as building a relationship with what is effectively a voluntary sector, can have great benefits for science through new discoveries. In an attempt to try and establish some rationale to conservation decision making, the Geoconservation Working Group of the ISJS proposed in 2002 some guidelines to inform national and regional conservation systems about the scientific needs of palaeonotological conservation, which were hoped could be applied with the context of whatever national legal system might be in place. Crucially, however, over the last 20 years there has also been a considerable amount of *coordinated* global activity in developing and promoting the practice and implementation of Geoconservation measures, including the complex issues of moveable geological heritage (i.e. collected specimens). As such measures can have consequences for ongoing scientific studies, not least on the Jurassic System, it is important that colleagues engage in the process to ensure that that the implementation of any new measures is properly informed and supports rather than hinders our scientific progress.

TOWARDS A HIGH RESOLUTION AND GENUINELY 'STANDARD' CHRONOZONATION FOR THE HETTANGIAN STAGE

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By 1961, the Hettangian Stage had been consolidated as a sequence of three ammonite zones (Planorbis-Liasicus-Angulata) and six subzones, based entirely on European successions (e.g. Northwest European and Mediterranean (bio)provinces). Subsequent detailed stratigraphical work in the south and north Americas (e.g. Andean and Athabaskan provinces, respectively), however, revealed that although a broadly similar succession of ammonoid faunas at a generic level to Europe could be recognised, at specific level there were significant differences. These faunal differences have created significant intercontinental correlation issues, ultimately leading to the development of alternative zonal 'standards'. With the discovery of South American *Psiloceras* ex gr. *spelae* Lange in Austria, however, *below* characteristic Mediterranean/ Northwest European province species, at least the base of the Stage, and hence the system, could be defined globally with a GSSP in 2010 (and hence inserting a fourth, Tilmanni 'Zone' at the base of the European sequence). As discussed extensively elsewhere, Jurassic ammonoid 'Standard Zones' such as these are chronozones and should be explicitly stated and used as such, including with alternative indicators such as microfossil markers and geochemical 'events' (the ammonoid-sourced name for the unit being no more than a convenient 'label'). However, in order to unambiguously establish such chronostratigraphical meaning, every such unit requires a suitable stratotype. In addition, to ensure that any such 'standard zonation' is precisely that, some mechanism to achieve agreement on any scheme, and indeed subsequently regulate changes is necessary. For the Cretaceous System, the 'Kilian Group' Working Group of the Cretaceous Subcommission was established to reach such agreement, but for the Jurassic System, however, no such group exists. In order to catalyse the beginning of such a standardisation process, starting with the Hettangian, a series of *provisional* stratotypes for ammonoid zones and subzones will be proposed, based on the extensive and permanently exposed coastal sections of West Somerset (SW England). Crucially, as this sequence has been calibrated against orbital cyclicity, the ammonoid biochronology can be readily converted into a true chrononology measured in 1000s of years. In addition, the great faunal similarities across Europe, from Northwest European to Mediterranean Province areas means that only one chronozonal and subchronozonal framework is necessary and hence a genuine 'standard' for the region can be proposed. Although other zonal schemes may remain necessary for some other (bio) provinces, not least Andean and Athabaskan areas, it is highly likely that some of these can be similarly amalgamated, for instance at the level of subrealm, and hence provide supporting zonal 'standards' for the stage. As genuine faunal differences do exist, even between regions where a single scheme at the level of chronozone may be applicable, the use of biohorizons maintains the potential for establishing and maintaining high resolution correlations which can be of great utility for other studies. Within the Northwest European Hettangian currently 56 such biohorizons have been established and correlated, and these will be, at least provisionally, correlated with equivalent schemes available elsewhere across Europe, and beyond.

WORLDWIDE CORRELATION OF THE BASE OF THE OXFORDIAN STAGE AND UPPER JURASSIC USING AMMONOIDEA

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As discussed by W.J. Arkell and J.H. Callomon, A. d'Orbigny's original interpretation of the Oxfordian Stage in 1842-1849, was inspired by the Oxford Clay *Formation* of Yorkshire (NE England), *not* the region of Oxford *city* itself, in southern England. As a consequence, the first occurrence of the Yorkshire ammonite species *Cardioceras scarburgense* (Young and Bird) (Cardioceratidae) became established as an indicator of the base of the Stage and sections around its type locality of Scarborough have been taken as reference sections. The subsequent discovery an assemblage intermediate between *C. scarburgense* and its ancestor *Quenstedtoceras lamberti* (J. Sowerby), and named '*Cardioceras' paucicostatum* by W. Lange in 1973, provided an alternative correlation for the base of the stage, but also created considerable discussion as to whether the species should be considered to be referred to '*Quenstedtoceras*' (i.e. still Callovian) or '*Cardioceras*' (i.e. Oxfordian) – the stage boundary being interpreted as coinciding with the first development of a 'keel' in the evolutionary lineage. As the only section currently available globally where the evolution of this lineage can still be studied in detail is the candidate GSSP for the base of the Stage at Redcliff Point near Weymouth, Dorset (southern England), the site is clearly fundamental to interpretations of the Stage. Initial sampling at the site identified an assemblage intermediate between '*Q.*' *paucicostatum* and *C. scarburgense*, which was named *C. redcliffense* by Page, Wright and Melendez in 2009 and proposed as an indicator for the base of the Stage (the assemblage, or 'biospecies', indicating an intraspecific variability including not only keeled -*scarburgense*-style morphs, but also 'unkeeled' *paucicostatum* morphs). Crucially, this assemblage is also recognisable in assemblages from the two other candidate GSSPs, in the Vocontian Basin in SE France and in the Saratov region in Russia – but obscured by different taxonomic approaches. At mid to high latitudes across the Jurassic world, cardioceratid faunas of the terminal Callovian and early Oxfordian are very widely recognised due to their expansion from their original Boreal 'home' as far south as some Tethyan areas, hence their potential for circum-global correlation is very high. At low to southern latitudes, however, Cardioceratidae are unknown, and hence other ammonoid groups, such as Peltoceratidae and Hecticoceratidae become important for correlation. As these key groups, along with Kosmoceratidae, Pachyceratidae, Distichoceratinae, Perisphinctinae and Grossouvrinae, are also represented in the Redcliff trans-boundary faunas, this section can also be important for wider global correlations, as any GSSP ideally should. Crucially, these associated taxa can be closely compared with the range of similar taxa found in association with various Cardioceratidae at the SE France candidate GSSP. In addition to the ammonite record originally published in 2009, high-resolution sampling in 2014 and 2021, has considerably expanded the ammonite record from Redcliff and enabled further stratigraphical and taxonomic resolution to be established. These new results will be presented and their implications for worldwide correlation of the base of the Oxfordian Stage, and hence the Upper Jurassic, will be discussed.

A NEW PROXY FOR PALEOENVIRONMENT USING ZIRCONIUM AND HAFNIUM

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Geochemical proxies have been widely used in evaluating sedimentary depositional environments: e.g., Mo, Re, and U contents for paleo-redox conditions, Cd and N isotopes for upwelling, and Hg contents and Hg/TOC ratios for volcanism. In particular, organic-rich black shales of the Upper Jurassic to Lower Cretaceous represent a period of high productivity (e.g., the Hekkingen Formation). Here, we use several geochemical proxies to investigate the paleoenvironment of organic-rich shale (0.7<TOC<12 wt%) from two drill cores in the Agardhfjellet Formation (DH2 and DH5) located 7 km apart in central Spitsbergen, Svalbard. Among the proxies we examine are the Zr and Hf contents and their ratios. Zirconium and Hf have been treated as geochemical twins because they are not fractionated between mantle and crust through igneous processes. Recent studies, however, have reported fractionation of Zr and Hf through preferential Hf uptake by estuarian organic matter and Fe-Mn oxides or Hf oxide precipitation on evaporite crystal surfaces. Thus, seawater may acquire Zr/Hf ratios far above the upper continental crust average (~35) as these media preferentially draw down Hf. We present Zr/Hf ratios as a potential new paleoenvironmental proxy in the Agardhfjellet shales. Our samples cluster into four distinct groups: (1) Zr/Hf ~ 35 with moderate Zr and Hf contents (100<Zr<200 ppm and 2<Hf<6 ppm), (2) Zr/Hf ~ 25 with moderate Zr and higher Hf contents (100<Zr<200 ppm and 6<Hf<8 ppm), (3) Zr/Hf ~ 25 with low Zr and moderate Hf contents (50<Zr<100 ppm and 2<Hf<4 ppm), and (4) variable Zr/Hf ratios characterized by the lowest Zr and Hf contents (<50 ppm Zr and <1 ppm Hf). Group 1 has Zr/Hf ratios similar to the upper continental crust (~35), indicating little modification of Zr and Hf contents during transport of continental runoff to the site of shale deposition (n = 63 out of 104 samples). Group 4, with its much lower Zr and Hf contents, may indicate deposition in a deeper basin with less terrigenous input (n = 7). Groups 2 and 3 (n = 21 and n = 13, respectively) have Zr/Hf ratios of ~ 25, which may reflect the drawdown of Hf by nearshore organic matter or in a hypersaline depositional environment. Note that the Zr/Hf ratios in halite and other salts range from 8 to 44. Several of the described Groups may occur within a ~20-cm stratigraphic interval, suggesting significant sea-level changes over short time periods. Our study introduces a new paleoproxy, Zr/Hf ratios, as a potential indicator of salinity and sea-level changes in sedimentary sections. Follow-on studies will include other localities and time intervals.

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CARBON CYCLE RECORD AT THE EARLY–MIDDLE OXFORDIAN TRANSITION: NEW INSIGHT FROM THE PARIS BASIN

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The Early–Middle Oxfordian transition is marked in the eastern Paris Basin, as well as in most of the western European Tethyan basins, by the recovery of carbonate production following a period of crisis in carbonate platforms dominated by clayey sedimentation during the Middle–Late Jurassic Transition (MLJT). At that time, major disruptions of the carbon cycle were recorded worldwide, but the causes of these perturbations are not yet fully understood. We propose here a detailed analysis of the sedimentology, mineralogy, and geochemistry of the Andra borehole EST433 (eastern Paris Basin), with high-resolution sampling, using ammonites to constrain the age model. The main goals are *i)* to decipher mechanisms initiating the recovery of the carbonate factory in relation to the increased diversity of calcareous producers, and *ii)* to characterize the evolution of the carbon cycle in this area. Facies, petrographic observations, and mineralogical analyses suggest some limited local diagenetic effects (calcite recrystallization, epigenetic modification) that should have little impact on the primary signal of carbon and oxygen isotope values from carbonates and organic matter. The $\delta^{13}C_{carb}$ trend obtained, showing a positive excursion initiated at the Plicatilis/Transversarium (?) ammonite zones, is consistent with curves from other Tethyan and proto-Atlantic areas at lower resolutions. This net increase is also observed in the carbon isotope data from organic matter ($\delta^{13}C_{org}$). The carbon isotopic signal however is decoupled between carbonates and organic matter in the Middle Oxfordian (likely Transversarium Zone): a pronounced negative shift is recognized in the $\delta^{13}C_{org}$ signal, while $\delta^{13}C_{carb}$ values remain high. Such a negative excursion in organic matter was observed in some other basins worldwide (French Subalpine and Swiss Alpine basins, Hebrides Basin, Gulf of Mexico, and Northern Asia). This excursion is associated with a period of organic matter accumulation in relation to changes in productivity, likely associated with climate change (aridity/humidity cycles) and paleogeographic modifications. The eastern Paris Basin therefore constitutes a valuable site where these environmental changes are recorded in a well-constrained stratigraphic framework, thus facilitating comparison and correlation with other basins worldwide. Such isotopic events are likely linked to the global changes in climate, sea-level and paleogeography that occurred during the Oxfordian, favoring an increase in carbonate production, which is particularly visible in the Paris Basin.

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CARBON CYCLE, CYCLOSTRATIGRAPHY AND U-PB AGES OF THE TITHONIAN FROM THE NEUQUEN BASIN, ARGENTINA

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Calibrating the Jurassic/Cretaceous boundary is of prime importance for interbasinal correlations and identification of global *vs* local geodynamic events. We present here the first high-resolution carbon isotope curve ($\delta^{13}C_{org}$) provided in the Vaca Muerta Formation from the Las Alcantarillas section (Neuquén Basin, western Argentina) during the Early/Late Tithonian and Early Berriasian, to compare carbon cycle variations from this well-constrained and continuous series across the Jurassic-Cretaceous boundary with other basins worldwide. The section of Las Alcantarillas (127 m-thick) is newly dated using ammonites, calcareous nannofossils and calpionellids allowing South America biostratigraphic zonation to be established. The numerous volcanic ash layers (K-bentonites and consolidated carbonated ash layers) intercalated in the mixed carbonate-clastic organic-matter-rich marine sediments serve for the temporal calibration of the section: zircon from five volcanic levels have so far been dated using CA-ID-TIMS U-Pb techniques, yielding very precise ages ranging from 146.147 ±0.036 Ma in the *P. zitteli* ammonite biozone of the Early Tithonian to 143.199 ±0.040 Ma in the *S. koeneni* ammonite biozone of the Late Tithonian. In parallel, bulk rock was sampled to measure magnetic susceptibility every 6 cm, with spectral analyses providing an astrochronological framework that is anchored to the U-Pb dates obtained from volcanic ash layers.

Despite a marked burial diagenetic overprint in the Neuquén Basin reaching the oil window at least, the carbon isotopic signal from organic matter is still preserved, as indicated by the non-scattered signal, the coherent absolute values and consistent trends recognized in equivalent Late Jurassic basins worldwide. A net decrease of $\delta^{13}C_{org}$ values from ~-25 ‰ in the *P. zitteli* biozone (Early Tithonian) to ~-30 ‰ close to the *C. alternans*/*S. koeneni* ammonite biozone boundary (Late Tithonian) is recorded, reaching a plateau before increasing to values comprised between -26 ‰ and -28 ‰ in the Late Tithonian (*S. koeneni* Zone). Although the Jurassic/Cretaceous boundary is still not precisely defined on the Las Alcantarillas section from coupled data of ammonites, nannofossils and calpionellids, the recovery to common values (around -27 ‰) appears either in the very Late Jurassic or in the very Early Cretaceous (i.e. Berriasian, *A. Noduliferum* ammonite Zone). This large negative carbon isotope excursion (5 ‰ in amplitude) recorded in the Late Jurassic can be compared to the VOICE event (VOlgian Isotopic Carbon Excursion) recognized in the Boreal domain, which would suggest a global disruption of the carbon cycle at the J/K boundary whose causes must now be sought.

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REVISED CALPIONELLID STRATIGRAPHY AND MICROFACIES OF THE TORRE DE´ BUSI SECTION (LOMBARDY BASIN, J/K BOUNDARY)

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The revision of calpionellid taxonomy and their succession in the upper Tithonian–lower Berriasian sequences of Torre de´ Busi section (northern Italy) allowed to determine 4 standard zones and 6 subzones as follows: Chitinoidella Zone (Boneti Subzone), Praetintinnopsella Zone, Crassicollaria Zone (Remanei, Intermedia and Colomi subzones) and Calpionella Zone (Alpina and Ferasini subzones). Generally, calpionellids are poorly preserved, and not very abundant, their redeposition was localy documented. Correlation with previously published magnetostratigraphic, calcareous nannofossil biostratigraphy and chemostratigraphy was performed.

Calcified radiolarians and spicules are dominating in the majority of microfacies observed along the section interval reevaluated. Spiculite-radiolarian wackestone/packstone, radiolarian wackestone/packstone also *Saccocoma*-spiculite-radiolarian wackestone, *Saccocoma*-radiolarian wackestone occur in the Kimmeridgian and lower Tithonian. The Rosso ad Aptici unit contains calpionellid index-species of the Chitinoidella and Praetintinnopsella zones, from lower half of CM21n up to uppermost CM20n2n. Calpionellids start to be more frequent in microfacies since the onset of the Crassicollaria Zone, just below the CM20n1r. Calpionellid-spiculite wackestone/mudstone and Calpionellid-spiculite-radiolarian wackestone with the index species of the Remanei Subzone dominated in deposits of the transition interval between Rosso ad Aptici and Maiolica. In the Maiolica limestones, calpionellid index markers of upper Tithonian Intermedia and Colomi subzones correlate with magnetic intervals CM19r and lower half of CM19n2n. Spiculite-calpionellid wackestone, calpionellid wackestone, calpionellid-radiolarian wackestone, and radiolarian-calpionellid wackestone prevail in the lower Berriasian Alpina and Ferasini subzones (upper part of CM19n, CM18r and CM18n. The revised calpionellid data in Torre de´ Busi section correlated with magnetozones and nannofossil biostratigraphy are consistent with the majority of Tethyan sections documented in the literature.

A WORLD-CLASS HETTANGIAN TRACKSITE FROM POLAND – A NEW LIGHT ON THE EARLY EVOLUTION OF DINOSAURS

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Numerous (so far >1000 tracks) and perfectly preserved ornithischian, theropod and sauropodomorph footprints, representing at least ten different species of these animals, were discovered in the upper Hettangian (Lower Jurassic) barrier-lagoon deposits, outcropping in the ceramic clay pit in Borkowice (Przysucha County, Poland). A large part of the specimens shows (especially visible in 3D scans) three-dimensional natural casts of dinosaur feet, on which anatomical features and impressions of the scaly skin of their producers are preserved in unusual details. These are the best-preserved ichnites of dinosaurs so far discovered in Poland and the quality of their preservation is equal to the best-known discoveries worldwide. For such a state of preservation to be possible, a very special sequence of sedimentary/taphonomic events had to take place in a very short time. The collection also includes records of ethology (behavior) left by dinosaurs. Bone remains of ornithischian dinosaurs preserved in the form of casts, as well as possible gastroliths, have also been found. Dinosaur footprints are accompanied by supposed pterosaur tracks (cf. *Pteraichnus* isp.) and numerous invertebrate trace fossils. Dinosaur tracks have been identified in several Lower Jurassic sedimentary units across the northern Mesozoic margin of the Holy Cross Mountains (Poland), which are preserved in a variety of continental and marginal-marine palaeoenvironments. Considering numerous finds from the newly discovered Borkowice tracksite, tridactyl/tetradactyl ornithischian tracks from the middle-late Hettangian of the Holy Cross Mts. region are revised. Ornithischian tracks are dominating in the Borkowice record, they resemble "*Anomoepus*" *pienkovskii*, "*Moyenisauropus*" *natator*, "*Moyenisauropus*" isp. and "*Moyenisauropus*" *karaszewski* known from other mid-late Hettangian sites of Poland. *"Anomoepus" pienkovskii* from Gliniany Las and a newly recognized tetradactyl/pentadactyl "*Moyenisauropus*"-like tracks from Borkowice are clearly endemic ornithischian ichnotaxa, know only from the late Hettangian track assemblages of Poland. *"Anomoepus" pienkovskii* has been identified originally as track of medium-sized ornithopod and later reinterpreted as probable basal thyreophoran imprint. A few, exquisitely preserved specimens, e.g. manus-pes sets (trackway discovered in 1999, 2001 in Gliniany Las) and new "*Moyenisauropus*"-like trackways, manus-pes sets from Borkowice, shed new light on their trackmaker taxonomic affinity. The trackways show a semiplantigrade quadrupedal gait. They lack the inward rotation of the pes typical for all non-ankylosaurian ornithischians. The manus prints in both tracks are pentadactyl, unusually large among anomoepodids. The morphology of these tri-/tetra-/pentadactyl pes imprints resembles ankylosaur ichnites more than any other Early Jurassic tracks of ornithischian dinosaurs. The ankylosaurians are heavily armored, obligatory quadrupedal, ornithischian dinosaurs that appeared during the late Early to Middle Jurassic and underwent considerable radiation during the Early Cretaceous. The new finds from Poland provide a unique information about the early evolution of ornithischians, perhaps allowing us to understand the mode and directions of early dinosaur evolutionary radiation. The prospects for further exploration are very promising, thus it is necessary to act in cooperation with local authorities and the entrepreneur exploiting the clay deposits in order to secure and protect the geoheritage site.

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ICHNOLOGY, SEDIMENTOLOGY, AND ORBITAL CYCLES IN THE HEMIPELAGIC EARLY JURASSIC LAURASIAN SEAWAY (TOARCIAN, CARDIGAN BAY BASIN, UK)

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The continuous Lower Jurassic (Toarcian) section of the Llanbedr (Mochras Farm) borehole, Cardigan Bay Basin, UK) comprises hemipelagic calcareous mudstone, wackestone/siltstone and subordinate packstone/sandstone. Similarly to the Pliensbachian section, the sedimentary structures/cycles are typical of contourite drift facies. The narrow and deep Cardigan Bay Strait played an important role in the Early Jurassic (at least Pliensbachian and Toarcian) oceanic circulation, providing a major link between the northern and southern part of the Laurasian Seaway (and in general between the Boreal and Peri-Tethys domains), funneling currents flowing from the north to the south. Trace fossils are strongly dominated by *Phycosiphon incertum* (represented by four morphotypes), which was produced by opportunistic colonizers. *Thalassinoides, Schaubcylindrichnus* and *Trichichnus* are common (the latter is a deep-tier trace fossil produced by filamentous sulfide-oxidizing bacteria with a high tolerance for dysoxia), accompanied by less common *Zoophycos*, *Planolites*, *Palaeophycus*, *Teichichnus*, *Rhizocorallium*, *Chondrites* and dwelling and resting structures, such as cf. *Polykladichnus*, *Siphonichnus*, *Skolithos*, *Arenicolites*, *Monocraterion* and *Lockeia.* The ichnofabrics are usually simple, which results from generally high rates of deposition, unstable, water-saturated soft-ground substrate, and the domination of *Phycosiphon*, but there are also cyclic appearances of more complex ichnofabrics with dwelling structures, reflecting more stable bottom conditions. A new detailed analysis of the core has allowed cycles to be distinguished based on combination of ichnological and sedimentological features, pointing to distinct cyclicity of oceanographic mechanisms, influenced by orbital forcing and driving the inferred fluctuations in benthic life conditions, controlled mainly by variation in contour current intensity and oxygenation of bottom water reflected by trace fossils. The ichnological cycles show four-order hierarchy, which can be attributed to the orbital cycles: precession and obliquity (4th order), short eccentricity (3rd order), and long eccentricity (2nd order). The longest (~2.5 Myr) 1st order cyclicity is attributable to the longer "grand orbital cycles" (period related to the Earth–Mars secular resonance), with long-term impacts on palaeoclimate and oceanic circulation, pointing to alternating periods of slower and faster contour current circulation. The most severe oxygen crisis evidenced by the trace fossils is at the Pliensbachian/Toarcian boundary and ends at the beginning of Toarcian Oceanic Anoxic Event (T-OAE), which contradicts the prevalence of this anoxic phenomenon. On the other hand, T-OAE event might have shortened the duration of the corresponding grand orbital cycle. Spectral analysis of the binary data of ichnotaxa appearances gives high confidence of orbital signals and allows refined estimation of successive ammonite zones and duration of the Toarcian (~9.6 Myr). It should be noted that in the *bifrons*, *variabilis/thouarsense* transition and *levesquei* zones, omission surfaces are marked by stiff-ground levels and local erosion occur. Although probably not very long in duration, these non-sedimentation levels could have resulted in somewhat incomplete record – and underestimated calculated durations.

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OXYGEN AND CARBON ISOTOPE VARIATION IN THE EARLY JURASSIC OCEAN

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The oxygen isotope composition of skeletal marine carbonates is a widely used palaeotemperature proxy. The challenge is, however, that oxygen isotopes in modern (and ancient) marine systems vary as a function of both ambient temperatures and the oxygen isotope composition of seawater. This presentation will evaluate the controls on the oxygen (and carbon) isotopes of Jurassic oceans controls on Jurassic Tethyan seawater. To achieve this, carbon and oxygen isotope data derived from belemnites are presented. These data are from published and new records derived from the Pliensbachian-Toarcian boundary (equivalent to the Margaritatus to Tenuicostatum Zones, i.e. immediately prior the Toarcian oceanic anoxic event) from a number of sites across the Tethys Ocean including Skye and Dorset, UK, the Lusitanian Basin, Portugal, the Basque-Cantabrian Basin, Spain and the Middle Atlas, Morocco. The belemnite oxygen isotope data presented here shows the most positive values at the lowest latitude site (Morocco) and most negative values at the highest latitude sites. Given that the opposite trend would be expected from a normal temperature profile (i.e. warm subtropics and cooler temperate regions), suggests that temperature is not the dominant control on belemnite oxygen isotope values. Reference to the carbon isotope data may well help explain the oxygen isotope trends. The carbon isotope data show the most positive values for data from Scotland and most negative values from the low latitude Morocco site suggesting spatial heterogeneity in the carbon isotopic composition of dissolved inorganic carbon in the Early Jurassic Ocean. A proposed mechanism to explain the observed trends is that higher latitude waters were less saline during this time interval compared to lower latitudes. Increased fresh water supply to the basin may have promoted the development of anoxic conditions through haline stratification of the water column, although notably the interval examined is prior the Toarcian oceanic anoxic event.

THE EFFECTS OF EARLY JURASSIC (PLIENSBACHIAN–TOARCIAN) WARMING EPISODES ON THE COMPOSITION AND THERMAL STRUCTURE OF BENTHIC MARINE MACROINVERTEBRATE COMMUNITIES

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Anthropogenic climate change has raised concerns about the reorganization of marine ecosystems. The fossil record preserves the consequences of ancient episodes of ocean warming in terms of the taxonomic composition, ecological characteristics, and evolutionary dynamics of marine biota. We studied the response of benthic marine communities of bivalves, brachiopods, and gastropods to hyperthermal pulses over the Pliensbachian-Toarcian boundary and the Toarcian Oceanic Anoxic Event (TOAE) in the well-sampled NW Tethys and adjacent epicontinental seas. Assemblage vulnerability to reorganization can be predicted by the thermal niches of its component species, but the link between thermal adaptations within an assemblage and the risk of local or global extinction remains unclear. To address this knowledge gap, we infer species' thermal niches based on observed distributions of Jurassic benthic macroinvertebrates on Late Pliensbachian to Early Toarcian paleoclimate maps. We evaluate evidence that those species disappearing locally from a fossil assemblage after warming, and those species that went extinct globally, were most likely from the pool of species already close to their upper thermal limits prior to warming. Conversely, assemblage immigrants possessed warmer thermal niches than the pre-warming assemblage average. Shifting species distributions across the TOAE interval were likely affected primarily by rising temperatures in the NW Tethys, while central and northern European assemblages were squeezed between the poleward push of marine isotherms and the spread of anoxic bottom waters.

GIANT TRACE FOSSILS FROM THE KIMMERIDGIAN (UPPER JURASSIC) OF THE IBERIAN CHAIN (SPAIN)

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This work analyses the occurrence of the giant trace fossil *Megaplanolites ibericus* from the Kimmeridgian of the Iberian Chain with a multidisciplinary approach combining sedimentology, micropalaeontology, ichnology and photogrammetry with the purpose of interpreting the palaeoenvironmental conditions as well as to improve characterization of this outcrop with interest for geological heritage, which is in serious risk by erosion and slope instability.

The studied outcrop is located in the locality of Bueña, 42 km north from Teruel (eastern Spain). From geologic point of view, the studied materials are located in the Sierra Palomera at the central sector of the Iberian Chain. The materials studied are the lower part of the Sot de Chera Marls Formation where the presence of ammonite *Orthosphinctes polygyratus* indicates the Planula Zone (lower Kimmeridgian). This formation overlies the Oxfordian spongiolithic limestones of the Yátova Formation.

The Bueña outcrop has been surveyed by means of UAS photogrammetry (DJI Mini2 and a FC7303 4.5 mm/12 MP camera) and a terrestrial laser scanner (TLS; FARO Focus 3D X 130 HDR). The products were a continuous orthoimage (1 cm resolution) and a high resolution 3D model (point cloud density of approx. 4 points/cm). Next, *Megaplanolites* were mapped and measured on both orthoimage and 3D model. The processing was carried out with Agisoft Metashape 1.8, CloudCompare V2 and QGIS 3.22 software.

The studied section consists of 32 m-thick of sandy marlstones with some marly-limestone beds in the base and sandstone beds to the upper part usually ranging from 5 to 30 cm in thickness. Sandy marlstones present common foraminifera, ostracods and thin echinoid spines. Among the foraminifera *Lenticulina*, *Saracenaria* and *Epistomina* dominate the assemblage. Some samples are composed almost exclusively by *Epistomina*. The marly-limestones beds of the lower part of the section are mudstone. The sandstone beds present parallel lamination at the base as well as groove casts and flute casts. In thin section, sandstone beds ranges from fine to medium sand size with abundant quartz grains showing angular shape and variable amount of iron oxydes, muscovite, peloids and phytodetritus. Some sandstone beds show fining upwards.

Trace fossils are observed in the marly-limestones and sandstones. Ichnotaxa identified are mainly *Chondrites*, ?*Helicodromites*, *Nereites*, *Ophiomorpha*, *Planolites*, *Phycodes* and *Thalassinoides*.

The giant trace fossils are located in the lower surface of an indurated sandy marlstone level of 40-50 cm thick, located 25 m over the top of the Yátova Formation. They are horizontal tubular trace fossils with a diameter ranging from 7 to 32 cm (most of them between 15 and 25 cm). The maximum length observed in the outcrop is 10.57 m and there is a dominant palaeo-orientation ranging N 140-160º E. These giant trace fossils are commonly straight but some of them show a variably sinuousity. Traces are unbranched and unlined.

The record of ammonites and mainly the high abundance of *Epistomina*, which is related to open marine conditions and sea-level rise, indicate an environment for *Megaplanolites ibericus* relatively deep (> 80 m) but with a high input of terrigenous, in some cases related to high energy deposits.

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IMPACT OF THE JENKYNS EVENT (EARLY TOARCIAN) ON DINOSAUR ASSEMBLAGES

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The early Toarcian Jenkyns Event was characterized in terrestrial environments by global warming, perturbation of the C-cycle (negative carbon isotopic excursion), enhanced weathering and wildfires. We might expect that heating and potential acid rain on land should lead to a loss of forests and would affect the diversity and composition of land plant assemblages and the rest of the trophic web.

The Early Jurassic plant assemblage was dominated by conifers, mainly Cheirolepidiaceae and Pinaceae, and ferns with large fronds. Cycadophytes, ginkgophytes, and bennetitaleans were also common, whereas seed-ferns were less abundant. In some areas bryophytes and lycophytes (mosses) suggest wet conditions. In this context, among terrestrial tetrapods, Sauropodomorpha dominated the herbivore guild and diversified northwards being recorded in outcrops from Asia to North America. The prosauropods Anchisauria and Massospondylidae radiated from Hettangian to Pliensbachian, after the extinction of typical Triassic Plateosauridae. Basal Sauropoda diversified in the Early Jurassic, with the first eusauropod, *Tonganosaurus* (Mamenchisauridae) from the Hettangian (China).

Ornithischians diversified in the Early Jurassic in Gondwana with the radiation of Heterodontosauridae and the origin of Fabrosauridae. A new suborder, Thyreophora, represented by the Family Scelidosauridae, diversified in Laurasia. The potential first genus of Neornithischia, *Stormbergia*, appeared during the earliest Jurassic.

Among theropods, Coelophysidae and Dilophosauridae dominated and colonized Asia and Africa during the Hettangian and Sinemurian. New in the earliest Jurassic were also basal forms of Ceratosauria and Tetanurae.

At the onset of the Jenkyns Event, palynological assemblages and land plants decreased in diversity and richness. Low-diversity forests were dominated by conifers (Cheirolepidiaceae, Pinaceae) and cycads, indicating seasonally dry and warm conditions. Climatic and vegetation changes drove the extinction of all Prosauropoda at the base of Toarcian and basal Sauropoda survived across the Jenkyns Event. Of course, the record is incomplete, but most of these basal Sauropoda disappeared before the Aalenian. Scelidosauridae disappeared during the Toarcian, but the record of ornithischians is scarce from Toarcian to Bajocian. Coelophysidae and Dilophosauridae died out in the Toarcian, but new genera of basal Ceratosauria were recorded in the Toarcian.

After the Jenkyns Event, low diversity land-plant communities persisted, with dominance of thermophilic groups, and the conifers Araucariaceae, Cheirolepidiaceae and Cupressaceae in the northern and southern hemispheres, indicating seasonally dry and warm conditions. Many Eusauropoda appeared in South America, Africa, and Asia. Mamenchisauridae, Cetiosauridae and Neosauropoda (Dicraeosauridae and Macronaria) began to appear in the Middle Jurassic. These sauropods, with massive skeletons, skeletal pneumaticity, pillar-like limbs, and delicate skulls, show great size increase, with African Macronaria and Asian mamenchisaurids at more than 20 m and 17 t.

Among ornithischians, new families of thyreophorans debuted from Bajocian and Bathonian such as Stegosauridae, Ankylosauridae and Nodosauridae, being recorded from Europe, Asia, Africa and South America. During the Bathonian and Callovian, ornithischians diversified: heterodontosaurids and fabrosaurids extended to the north, neornithischians diversified in Eurasia, and the first hypsilophodontid (*Hexinlusaurus*) occurred in the Bathonian and Callovian of China.

The recovery of theropods after the Jenkyns Event is marked by the first allosauroid, *Asfaltovenator* (Argentina, Upper Toarcian). A theropod radiation occurred during Middle Jurassic with appearition of basal Tetanurae and superfamilies Megalosauroidea, Allosauroidea and Tyrannosauroidea. The size of some theropods increased during the Middle Jurassic, especially in Megalosauroidea and Allosauroidea reaching more than 10 m. Therefore, we identify the Jenkyns Event as pivotal in a major remodelling of terrestrial ecosystems, including plants and dinosaurs.

HOW FAR TO THE WEST WAS THE SLOVENIAN BASIN EXTENDING?

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The Mesozoic paleogeography of the transitional area between the Alps and the Dinarids (present-day Slovenia) is characterized by the Dinaric (Adriatic, Friuli) Carbonate Platform in the south, intermediate, E-W extending Slovenian Basin and the Julian Carbonate Platform in the north. Towards the west, however, the basinal sequences disappear, which has led to some misinterpretations in the past. The westernmost outcrops of rocks that can be defined as typical of the Slovenian Basin succession appear on Ozben Hill near Kobarid, about 5 km from the state border with Italy. Further west sequences occur that still show shallow marine developments in the Lower Jurassic. Therefore, this area could be considered paleogeographically as a bridge between the Dinaric and Julian carbonate platforms. In this paper, we present a study of Jurassic development in the Matajur and Kobariški stol mountains, which are located on the state border and belong to two tectonic blocks that are crucial for understanding the sedimentary evolution of this area. In both places, the Lower Jurassic (pre-Toarcian) is developed in shallow marine limestone. Above this, with a stratigraphic hiatus, a deep marine sequence of Middle and Upper Jurassic is deposited. It starts with thick layers of limestone breccias (calcidebrites) alternating with micritic (pelagic) limestones and calcarenites (calciturbidite). The breccias disappear upward, and *Saccocoma* bioclasts occur in the pelagic limestone. On the Matajur these beds contain chert nodules, on the Kobariški stol initially also, while upwards they pass into the Ammonitico rosso limestone. The Jurassic sequence ends with the Biancone limestone. The whole sequence of deep marine rocks does not exceed 40 m. The subsidence of the area probably occurred in the middle of the Middle Jurassic. This drowning event is interpreted as a consequence of the extensional (transtensional) tectonic pulse recently documented along the entire southern margin of the Slovenian Basin, where the collapse of the Dinaric Carbonate Platform margin formed a sequence of limestone blocky breccias up to 80 m in thickness. The composition of the matrix in the breccias is similar (characterized by ooids), but the diversity of clasts in the Slovenian Basin breccias is much greater compared to those from the areas presented here. This indicates a more dramatic slope, dissected by faults and deeply incised, in the segment where the Dinaric Carbonate Platform passed into the basin, in contrast to the less pronounced slope in the segment of the area presented here. After the drowning, this pre-Toarcian shallow marine bridge turned into a submarine plateau characterized by the sedimentation of allodapic limestones, whose source was the Dinaric Carbonate Platform, and pelagic limestones. The latter are more condensed on the Kobariški stol and are characteristic of the succession of the Julian High (drowned Julian Carbonate Platform).

SYNONYMOUS USE OF T-OAE AND T-CIE? SPATIOTEMPORAL VARIABILITY IN ORGANIC CARBON ISOTOPE SIGNATURE AND ORGANIC MATTER ACCUMULATION DURING THE EARLY TOARCIAN

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During the early Toarcian (Early Jurassic; ~182 Ma) severe environmental changes, comprising global warming, elevated pCO_2, intensified continental weathering, and a high amplitude sea level rise, led to the genesis of a Toarcian Oceanic Anoxic Event (T-OAE), expressed by the widespread occurrence of organic carbon (OC)-rich sediments (black shales) forming on anoxic epicontinental shelves. The causal relationship is thought to be that global warming led to strongly increased weathering causing enhanced nutrient inputs into shelf seas and thereby boosting marine primary production. Subsequent aerobic degradation of plankton biomass will have led to increased oxygen consumption. In shelf areas with long bottom water renewal times, due to hydrological restriction and water column stratification, anoxia-euxinia was established. Pore and bottom water anoxia-euxinia developed in restricted shelf areas that were controlled by local paleoceanographic conditions, such as basin hydrology and water column stratification. The complex interaction of global and regional-local factors is expressed by a high spatial and temporal variability in deposition of OC-rich strata. Consequently, the T-OAE, when defined in terms of the stratigraphic distribution of OC-rich sediments, varies greatly in its duration.

Here, we discuss the spatio-temporal variability of early Toarcian OC-rich strata. We not only discuss patterns in OC-richness, but also in OC accumulation rates. Based on these data, the climax of the T-OAE can be defined as the stratigraphic interval in which the OC-rich deposits reach their greatest areal distribution on global scale. Data further indicate that in some depocenters, in particular in black shale basins, OC-rich deposits have formed under rather low OC accumulation rates. This suggest that factors other than marine primary productivity controlled the organic richness of early Toarcian black shales.

Stratigraphically, the T-OAE climax roughly corresponds to but is not identical with the core of the negative Toarcian carbon isotope excursion (T-CIE) that is expressed in both organic and inorganic carbon isotopes in variable extent. The T-CIE of $\delta^{13}C_{org}$ in part was controlled by organic facies changes due to a global transgression and deposition of well-preserved marine (light $\delta^{13}C_{org}$) versus more degraded terrigenic organic matter (heavy $\delta^{13}C_{org}$) and in part by a global increase in atmospheric pCO_2 with an exceptionally light $\delta^{13}C$ source. In most basins both processes coincided but the combination of the two processes and their respective intensity caused large variation in the magnitude of the $\delta^{13}C_{org}$ CIE. Local variations in the temporal extent of the CIE and that of the T-OAE are due to the organic facies regime prevailing, mainly the degree of anoxia as a function of basin morphology and restriction. We attempt to disentangle here the atmospheric light $\delta^{13}CO_2$ forcing from that of organic facies change in selected basins to clarify the synonymous use of T-CIE and T-OAE.

THE FIRST STAGE FROM THE GULF OF MEXICO EVOLUTION WAS A PROTO-HISPANIC CORRIDOR (LATE TRIASSIC-PLIENSBACHIAN) AS A PRODUCT OF A HOT SPOT WITH TRIPLE JUNCTION

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The separation of North America from Eurasia and Gondwanaland has been dated as Late Triassic after marine paleomagnetic, geochronologic, and paleontological information, but continental structural data are represented by 30 faults (Newark Basins) dated succesfully by paleopalynology, as Late Triassic-Early Jurassic. Traverse (1988) established that "basin sedimentation began along whole front in Late Triassic, ended after a few millon years, but from (Culpeper Basin) northern Virginia to Nova Scotia palynological evidence show that it continued until well into the Jurassic, at least to Pliensbachian, a total of about 40 millons years". The lack of Jurassic rocks in the southern basins was explained as the effect of structural uplift and regional erosion, remaining only Triassic rocks. Also, Traverse inferred Newark Basins in the subsurface of North and South Carolinas, Georgia, and Florida at a place what Rueda-Gaxiola (2016) considered as the southernmost fault basin of "Newark System", and where the Tethysian waters arrived to the east of Florida and advanced southwestward through the South Georgia Rif Tinto the Early Gulf of Mexico. Near this place were deposited the oldest (palynologically dated as Late Triassic–Liassic by Jux, 1961) marine evaporites in salt domes of the Eagle Mills Formation in southern Texas and Louisiana, dated as Late Triassic by Moy and Traverse (1986). Later, Traverse stated that: "Closing the semicircle: palynofloras of the Eagle Mills Formation and South Georgia Basin date the initial rifting-precursors of the Gulf of Mexico and Atlantic Ocean". From this place, following southwestward, the Tethysian waters arrived up to Huayacocotla Embayment, where Late Triassic–Liassic continental and marine palynomorphs and Sinemurian ammonites of Pacific and Tehysian-Atlantic affinities have been found. As Tethysian waters advanced towards southwest, they arrived up to the Pacific Ocean border of the Chortis Block, connecting the Pacific and Atlantic oceans, forming the Proto-Hispanic Corridor, flowing above subsident channels formed by divergence of two main branches of the triple junction, proposed since 2003, from a hot spot. Nevertheless, it was not easy to know where was the connection of this Corridor with the Tethysian Sea. Following plate tectonic and biostratigraphic evidences of continental-marine Triassic-Liassic units, it was possible to found the NE continuation of the Fosa de Campeche with the buried South Georgia Graben System and the USA and Canadian Triassic-Liassic rifts bordering the Atlantic Ocean. Fortunately, they have good palynostratigrafic data which were correlated with those from the Tethysian Triassic-Liassic from Northern Switzerland, it was possible to follow the Proto-Hispanic Corridor from the Central European Basin up to the Anticlinorio Huizachal-Peregrina in Northern Mexico and also to the Pacific Border of Chortis Block. During this stratigraphic revision it was also possible to know that, during Pliensbachian, the erosion of the cratonic rocks, bordering the rifts around the hot spot, increased the presence of metamorphic quartz in sedimentary sequences as evidence of Traverse's regional uplifting during the Toarcian-Aalenian, and of a displacement towards SW of Huayacocotla, Tlaxiaco and South America blocks and also, the end of the Proto-Hispanic Corridor.

THE SECOND STAGE FROM THE GULF OF MEXICO EVOLUTION WAS THE HISPANIC CORRIDOR (BAJOCIAN-TITHONIAN) AS A PRODUCT OF THE HOT SPOT WITH TRIPLE JUNCTION

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The initial separation of South America from Africa changed the direction of seafloor spreading in the early Atlantic. During Toarcian-Aalenian the doming stage increased when the Huayacocotla and Tlaxiaco blocks and South America moved southwestward and the Tethysian waters came into the Gulf of Mexico region from the SE. They came back to the Gulf, by the Old Bahamas Channel, filling the West Florida Basin formed by the separation of Yucatan from Florida, then Atlantic waters intended flowing toward the ancient Proto-Hispanic Corridor but, due to the slow cooling of the Campeche Escarpment region, it was higher than ocean level and the new basin developed an anoxic/euxinic enviroment, as shown by biochemical and palynostratigraphic analysis of the synrift Middle Jurassic San Cayetano Formation. To the west, only at the Huayacocotla Embayment marine conditions remained and endemic Liassic ammonites developed. The cratonic erosion increased and formed huge volumes of metamorphic quartz and rock fragments were transported west- and southwestward by rivers and deposited above redbeds. These metamorphic sediments correspond to the known Cuarcítica Cualac Allo Formation, outcropping at Huizachal and Tlaxiaco anticlinoria. Later, the movement also uplifted the Triassic-Liassic sequences deposited in the western El Alamar-Tlaxiaco and Real de Catorce half-grabens; they were eroded and their red clastic sediments deposited around the uplifted regions, as shown by the redbed Cahuasas Fm. with abundant pollen and spores. As a product of the Bajocian-Bathonian rifting and sinking stages of the thermally diminishing hot spot evolution, the "Hispanic Corridor" formed across the early Gulf of Mexico, where Zorrillo and Taberna formations represent cycles of retrogradation and abandonment, transgression and subsidence of the basin (Vite del Angel, 2014) allowing the Pacific and Atlantic oceans connection, as stated by the mixture of Tethysian and Pacific ammonites found in the Taberna Formation. The existence of the Hispanic Corridor was proved by the palynostratigraphic correlation of sedimentary Bajocian-Callovian sequences drilled in four different localities from Cuba up to the western Mexican subbasins in the Gulf of Mexico. During the Callovian-Oxfordian drifting stage, because the Chiapas-Yucatán South American subplates were still joined, only the Texas-Louisiana and Western Region of Mexico subplates were displaced northwestward, reactivating the precambrian Texas-Boquillas-Sabinas and the Vancouver-Bahamas megashears and the subduction zone along the Pacific border of the North American Plate. The Campeche Escarpment and Nautla-Pico de Orizaba arms of the Triple Junction became wider ridges and seafloor spreading zones, giving origin and distribution of the Callovian salt above the Triassic-Liassic rocks, initiating the Late Jurassic evolution of the Gulf of Mexico, its sedimentary subbasins and its oil potential. During the Kimmeridgian-Tithonian, the oceanic crust continued its thermal cooling, the subsidence increased, the Hispanic Corridor became wider and the marine enviroments filled all subbasins. During the Tithonian, the SW continental border rose, and the Gulf became a closed basin with euxinic conditions (Pimienta Fm.) where oil and gas systems, and the type and abundance of hydrocarbons, are mainly the product of the hot spot evolution. Finally, during the Early Cretaceous, Chiapas-Yucatan and South America subplates separated and the Caribbean Seaway appeared.

REDUCED PLATE MOTION CONTROLLED TIMING OF EARLY JURASSIC KAROO-FERRAR LARGE IGNEOUS PROVINCE VOLCANISM

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Large igneous province (LIP) emplacement is commonly associated with mantle plume upwelling, leading to surficial magmatism, proposed to have driven past global change events by volcanic carbon emission. One of Earth's largest past environmental perturbations, the Early Jurassic Toarcian oceanic anoxic event (T-OAE; ~183 Ma), has been linked to emplacement of the Karoo-Ferrar LIP. However, the role of mantle plumes in controlling the onset and timing of LIP magmatism is poorly understood.

Here, utilizing global plate reconstruction models, and Lower Toarcian sedimentary mercury (Hg) concentrations from the Mochras borehole (Wales, UK), we demonstrate (1) that the Early Toarcian OAE occurred coevally with Karoo-Ferrar LIP emplacement, and (2) suggest that the timing and duration of LIP-emplacement was governed by a reduction in local Pangean plate motion associated with a reversal in plate movement direction.

With this, we present a new model that mechanistically links Earth's interior and surficial processes, and we show that this mechanism is consistent with the timing of several of the largest LIP volcanic events throughout Earth history and thus, by inference, the timing of many of Earth's past global climate change and mass extinction events.

BOREAL AND TETHYAN CEPHALOPOD FAUNAS AT THE AALENIAN/BAJOCIAN BOUNDARY (MIDDLE JURASSIC): EXAMPLES FROM SOUTHERN LUXEMBOURG AND THE ATLAS MOUNTAINS, MOROCCO

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Paleontological research conducted at the Luxembourg Natural History Museum focused in the last 10 years on ammonite and belemnite faunas from the Aalenian/Bajocian boundary beds (Murchisonae to Humphriesianum zones) of Luxembourg and Morocco. The study of collection material and new findings allowed to describe in detail the ammonite faunas of the middle and upper Aalenian and the lower Bajocian of Luxembourg and the belemnite faunas from the upper Aalenian to lower Bajocian of Luxembourg and Morocco.

Ammonite faunas from the Middle Aalenian (Murchisonae zone) to the early Bajocian (Discites Zone) in the Tethyan Realm (Middle Atlas and High Atlas, Morocco), show affinities to both Mediterranean faunas (Tmetoceratinae, Grammoceratinae, Hammatoceratinae, Erycitinae, Zurcheriinae and Bradfordinae) and with the Euro-boreal faunas (Graphoceratinae). *Staufenia*, a typically boreal genus, is absent, but some Pacific elements (*Asthenoceras* and *Fontannesia*) are present. On the other hand, in the Euro-Boreal domain (Luxembourg), the ammonite faunas consist mainly of Graphoceratidae, including the genus *Staufenia*.

It is interesting to note that in the Moroccan Atlas, ammonite faunas from the Aalenian-Bajocian boundary can sometimes show a rhythmic alternation expressed by successive assemblages sometimes dominated by the Euro-boreal faunas, sometimes by Mediterranean Province taxa together with open-sea faunas (phylloceratids and lytoceratids). These last two taxa are however virtually absent in Luxembourg.

Regarding ammonite faunas of the Laeviuscula and Propinquans zones, the contrast seems to be attenuated between the two paleogeographic domains. They are more cosmopolitan while retaining certain regional particularities. Indeed, many genera and species are common to these two regions. These are among the Sonniniidae, the genera *Witchellia*, *Fissilobiceras*, *Shirbuirnia* and *Papilliceras* and among the Stephanoceratacea, the genera *Docidoceras*, *Oroites* and *Emileia*. The genus *Pseudoshirbuirnia* is virtually absent in Morocco.

Finally, both in Morocco and in Luxembourg, the ammonite faunas of the Humphriesianum zone show a cosmopolitan character marked by the persistence of *Dorsetensia* at the base, the broad expansion of *Stephanoceras* in the middle part and the development of *Teloceras* at the top part.

Belemnite faunas from the studied interval show a marked provincialism: belemnites from the Euro-Boreal domain (Luxembourg) are composed by Megateuthididae and Belemnopseidae, with a clear predominance of the former. In the Tethyan Realm (Middle Atlas and High Atlas, Morocco) only Belemnopseidae are present, together with very rare elements of Dicoelitidae.

SIGNIFICANCE OF THE ANKARA MÉLANGE: AN ANCIENT SUBDUCTION-ACCRETION COMPLEX OF THE NORTHERN NEOTETHYS, TURKEY

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North-dipping subduction of the northern branch of the Neotethyan oceanic lithosphere during the latest Paleozoic to Mesozoic under the Sakarya ribbon continent to the north caused accreted oceanic nappes at ca. 180 Ma to ca. 80 Ma, reflecting progressive southward-younging subduction transition along the Izmir–Ankara–Erzican Suture Zone within the Eastern Mediterranean region.

The Ankara Mélange represents an intraoceanic subduction-accretion complex within the northern Neotethys in north-central part of Turkey. Blocks-in-mélange formed by tectonic deformation include serpentinized peridotite, basalt, limestone and chert blocks in a serpentinite, volcaniclastic and/or siliciclastic matrix. The blocks of mainly seamount and minor oceanic plateau volcanic–volcaniclastic rocks and shallow marine limestone in Middle–Late Triassic to Cretaceous age are encountered in the Ankara Mélange. The blocks of oceanic crust were of MORB, P-MORB and OIB character within an ancient subduction–accretion complex of the northern Neotethys. Blocks-in-serpentinite much less include high-grade rocks metamorphosed during subduction episode. These are blocks of blueschist and metabasalt (amphibolite). The high-grade blocks are proposed for exhumation by thrust faults and/or serpentinite diapirs. The olistoliths and olistostromes of serpentinite, spilitic volcanic rocks and cherty limestones are also observed. They reflect episodes of subduction erosion that removed some previously accreted material into the trench resulted from the shortening of oceanic crust between the continental blocks because of the continent-continent collision of the Sakarya ribbon continent to the north and the Anatolide–Tauride Platform to the south.

The Ankara Mélange is structurally overlain by the nearly unmetamorphosed rocks of the Eldivan ophiolite. The Eldivan ophiolite displaying a nearly complete pseudostratigraphy comprises mainly mantle peridotites, isotropic gabbros, plagiogranite dykes, diabase sheeted dykes, pillow lavas and deep sea cover sediments. The ophiolitic plagiogranites were dated by U-Pb zircon ages of 180 Ma while the basaltic rocks of the Eldivan ophiolite yielded 78 Ma by Ar-Ar whole rock ages. According to petrochemical data, the lower part of oceanic crust and basalts have SSZ characteristics.

The Ankara Mélange and the Eldivan ophiolite are overlain by clastic–carbonate rocks of the forearc basin of Late Jurassic to Late Cretaceous. The ophiolite thrust sheets have gained their actual positions due to the N–S trending collision between the Sakarya ribbon continent in the Pontides representing the southern margin of Eurasia and Anatolide–Tauride Platform of northern margin of Gondwana in Middle Eocene and following Late Miocene–Pliocene neotectonic regime (e.g. the North Anatolian Fault Zone).

Finally, the Ankara Mélange and the Eldivan ophiolite, relicts of northern Neotethys ocean have similar affinities to the Franciscan Complex and the Coast Range ophiolite, respectively, across standing to the Pacific Ocean plate, and the San Andreas fault system.

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NEW RESULTS ON THE STRATIGRAPHY OF THE ARIETENKALK FORMATION (SINEMURIAN, SW GEMANY)

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The Arietenkalk Formation of SW Germany consists of an up to 22 meter (most sections 2.5–6.0 meters) thick section of shallow-marine biodetritic limestones with intercalated marly layers and occasional bituminous shales in its upper part. It is sandwiched between the Hettangian Angulatensandstein or Angulatenton formations, respectively, and the clayey Late Sinemurian Obtususton Formation. The lower part of the Arietenkalk Formation is Early Sinemurian in age, whereas its higher part already represents Late Sinemurian strata. During the past two centuries, a large number of ammonites were recovered from many meanwhile completely abandoned limestone quarries, a few natural outcrops and some temporarily exposed sections. The fossil content of the Arietenkalk Formation was studied since the earliest days of scientific palaeontology. Ammonites were mainly described in the monographs by Quenstedt (1845–1849, 1856–1857, 1883–1885), Oppel (1856, 1862), Reynès (1879), Hyatt (1889), and Jaworski (1931). The latest major attempts for providing detailed biostratigraphic schemes of the Lower Sinemurian deposits were undertaken by Fiege (1926, 1929) followed by Walliser (1956). Only few further data have been published, mostly dealing with rare or newly recorded taxa.

The Conybeari and Rotiforme subzones of the Bucklandi Zone are well represented in the vicinity of Stuttgart-Vaihingen, whereas the Bucklandi Subzone can excellently studied in the Wutach and adjacent Baar areas as well as in the foreland of the W Swabian Alb. The Semiforme, Turneri and Obtusum zones can study in detail especially in the Wutach and Baar areas as well as in E Swabia.

Some of the limestone beds of the Arietenkalk Formation distinguished by the old quarrymen (e.g., “Kupferfelsbank”, “Dreispälter”, “Schneckenfels”) contain a succession of tempestites with individual ammonite faunas. Other beds are strongly condensed, often including phosphorite concretions and reworked fossils. Over distances of only few kilometres, several limestone beds can merge into a single bed of remarkable thickness (e.g., “Schneller”), or a single bed splits into several individual beds with intercalated marlstone layers (e.g. in the Bucklandi Subzone and Semicostatum Zone of the Wutach area). These phenomena were not adequately recognized in older literature and strongly hampered exact lithostratigraphic correlations which resulted in biostratigraphic uncertainties and erroneous ranges for numerous ammonite taxa.

During the past years, hundreds of ammonites from the Arietenkalk Formation were sampled bed-by-bed by one of us (A.S.). The large quantity of the ammonite faunas consist of Arietitidae and some Psiloceratidae. For many important ammonite taxa described in the classical papers their previously unknown type horizons can be precisely identified. Meanwhile, more than forty ammonite biohorizons are distinguishable within the Arietenkalk Formation. This results in one of the highest biostratigraphically resolved frames of the Sinemurian worldwide and provides a basis for the identification of faunal migrations and other events as well as exact correlations with neighbouring areas.

RIFT-ASSOCIATED DEEP-WATER ARCHAEA IN BLACK SHALES OF THE TOARCIAN MANGANESE DEPOSIT AT URKUT, HUNGARY

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During the early Toarcian (Early Jurassic; ~182 Ma) in Central Europe a suite of Mn-rich carbonate microbialites were deposited that are associated with black shales. The Hungarian Úrkút deposit formed in a failed rift that protruded from the western margin of the deep Alpine-Mediterranean Tethys westwards into the shallow epicontinental Tethyan shelf. It has been proposed that Mn-enrichment at Úrkút occurred diagenetically via microbially mediated replacement of Ca in primary carbonates, most likely in a two-step process, first under oxic and subsequently under hypoxic to anoxic conditions. The organic matter content of Mn-carbonates is very low with TOC<0.1%, whereas the intercalated black shales exhibit TOC concentrations between 0.7 to 4.93% and Rock Eval hydrogen indices of 40 to 490 mg HC/g TOC. Molecular geochemical investigations demonstrate a predominance of marine derived organic matter based on n-alkane distributions, which show a high relative abundance of nC17, most likely derived from cyanobacteria. Long-chain odd-numbered n-alkanes are present in very minor proportions and may derive from eolian influx. The thermal maturity of the sediments is very low, despite Rock Eval T_{max}-values ranging from 420 to 425°C, as evidenced by the predominance of hopanes in the immature 17ß(h), 21ß(H)-configuration and the presence of unsaturated hopenes and neohopenes.

The very low thermal maturity allowed for the preservation of glycerol dialkyl glycerol tetraethers (GDGTs), membrane constituents of archaea. These microorganism live in the deeper part of the water-column in the dysphotic to aphotic zone and thrive by heterotrophic or chemotrophic metabolisms. GDGTs have been utilized as paleo-water temperature indicators as they have to adapt their membrane fluidity to the temperatures prevailing in their habitat. GDGTs contributed from terrigenic soil microbiota show high proportions of branched GDGTs, which are virtually absent at Úrkút, thus demonstrating a sole origin of GDGTs from marine archaea. The relatively low methane index of <0.2 calculated from GDGT isomer distributions is taken as evidence that archaeal consortia were not sustained by submarine methane clathrate degassing.

In black shales from the Úrkút manganese deposit, the GDGT-based reconstruction of water temperature yields exceptionally high temperatures of on average 48°C for the basal black shale, 41°C for the middle and 28°C for the upper black shale unit, using the TEX_{86}^{H}-calibration for elevated temperatures. Enhanced water temperatures are corroborated by the presence of a mid-chain bridged GDGT isomer (H-1020) that only occurs at hydrothermal vents (e.g. Red Sea deeps, oceanic spreading axes, or terrestrial hot springs). The elevated deep-water temperatures are in accordance with a vicinity of the Úrkút site to rift-associated hydrothermal vents (grey smokers in an off-axis position), which will have provided the basis for proliferation of hydrogenotrophic archaea. The decline in deep-water temperature from the basal to the top black shale, may indicate either a decline in rifting activity or a change in the venting direction.

This is the first report of rift-associated deep-water habitats for archaea in Early Jurassic time and a further step in the understanding of manganese-deposits in Early Jurassic black shales.

JURASSIC SEALIFE PRESERVED IN THE NUSPLINGEN FOSSIL LAGERSTÄTTE (UPPER KIMMERIDGIAN, SW GERMANY)

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Scientific excavations of the Late Jurassic fossil Lagerstätte of Nusplingen have been conducted for almost 30 years by a team of the Stuttgart Natural History Museum. This Lagerstätte is latest Kimmeridgian (Beckeri Zone, Ulmense Subzone) in age and represents the westernmost occurrence of marine laminated limestones ("plattenkalks") of the Solnhofen Archipelago. A steep relief of the *c.* 80 to 100 meters deep basin triggered the formation of turbidites, mudflows and slumping, but apart from such events, the environment was extremely calm. In contrast to the classical sites in the vicinity of Solnhofen and Eichstätt in Bavaria, the small (extension *c.* 2.5 square kilometers) and rather isolated site of Nusplingen is relatively rich in fossils. Marine taxa predominate by far; they are accompanied by fossils derived from terrestrial habitats of nearby islands, e.g., a low-diversity terrestrial flora, charcoal, insects and pterosaurs. The most abundant marine fossils are ammonites including their aptychi, and belemnite guards, in addition to further coleoids, prawns, fishes and various types of coprolites (e.g., *Lumbricaria*). Nusplingen has become famous for the angel shark *Pseudorhina acantoderma* (O. Fraas), which has been recorded from almost all plattenkalk beds of the exploited section. Thalattosuchian crocodylomorphs (*Cricosaurus*, *Dakosaurus*) acted as top-predators. At a lower level, meter-long sharks (*Sphenodus*) were omnipresent. A high proportion of the diversity, especially of benthic organisms (e.g., brachiopods, bivalves, lobsters, annelids), results from predation in neighbouring shallower habitats; many of these taxa are only recorded by a few or single specimens. Plankton is represented by coccolithophorids, radiolarians and pelagic crinoids (*Saccocoma*). Pabulites (lost prey) as well as stomach contents, regurgitalites and coprolites provide direct evidence for the reconstruction of the food web in this Jurassic lagoon. Many fossil taxa recorded from Nusplingen are slightly distinct from related ones of the Solnhofen plattenkalks, probably due to the difference in the stratigraphic age and/or some environmental peculiarities. For most groups of fossils except ammonites, belemnites and pseudoplanktic oysters, juvenile stages are virtually absent. Another interesting aspect of the Nusplingen Lagerstätte is the presence of ichnofossils in some beds. Only two layers of the section show mass mortality. This concerns short-term opportunistic benthic communities of nuculid bivalves and echinoids, respectively. The formation of Plattenkalk is still poorly understood since modern analogues have never been convincingly reported. Therefore, the palaeoenvironment of the Nusplingen lagoonal basin and its surroundings must be reconstructed using an integrated approach by combined field and laboratory observations. Here, several case studies of typical fossils from the Nusplingen site with special focus on their taphonomy provide evidence for high sedimentation rates, early diagenetic cementation, a mostly dysoxic seafloor, formation of microbial mats, environmental fluctuations and the presence of a stratified waterbody.

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THE RECORD OF EARLY JURASSIC ORGANIC MATTER PRESERVATION INTERVALS (OMPI) IN THE CENTRAL AND NORTH ATLANTIC CONJUGATE MARGINS

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Lower Jurassic sedimentary successions cropping out in many central and northern Atlantic basins include relatively thick organic-rich intervals. Despite decades of research, it is still unclear which mechanisms led to the deposition of these sediments during the Early Jurassic. In this presentation, we will (1) present a detailed temporal and geographical framework of Sinemurian and Toarcian organic matter preservation intervals (OMPIs; subdivided into local, regional, and superregional) and (2) broadly constrain the relationship of OMPIs with the Early Jurassic $\delta^{13}C$ record. For this, we combine in-depth analysis of the distribution of organic-rich facies in the Sinemurian and Toarcian with new geochemical data [total organic carbon (TOC) and organic matter pyrolysis] from selected outcrop sections from Portugal, Spain, and Morocco.

The here presented OMPI framework suggests a strong local control on organic matter preservation during most of the Sinemurian. Regionally widespread organic-rich facies are associated with the most negative $\delta^{13}C$ values of the broad Sinemurian–Pliensbachian negative carbon isotopic trend (including the Sinemurian–Pliensbachian Boundary Event). Pliensbachian OMPIs are expressive in the areas bordering the proto-Atlantic Ocean and are often linked with positive $\delta^{13}C$ excursions and short-lived warm intervals, but OMPIs are also observed for the Late Pliensbachian cool interval. Early Toarcian superregional OMPIs are associated with some of the most pronounced $\delta^{13}C$ excursions of the Mesozoic. Toarcian maximum TOC content occurs with the positive $\delta^{13}C$ (recovery) trend following the $\delta^{13}C$ negative shift typically linked to the Early Toarcian Oceanic Anoxic Event (T-OAE), supporting the notion that peak carbon sequestration/ocean anoxia post-dated the main phase of carbon input. However, additional superregional OMPIs predate and postdate the T-OAE, indicating that conditions favouring preservation of organic matter (increased productivity and/or enhanced preservation) during the Early Toarcian were not restricted to the T-OAE interval.

We will also briefly discuss how future research should aim to disentangle (1) the complexities in estimating original TOC and organic carbon accumulation rates, (2) temporal and spatial variability in environmental or Earth system feedback mechanisms driving sedimentary carbon sequestration, and (3) their combined impact on the global carbon cycle. Further work is also expected to define additional Early Jurassic OMPIs and to improve current understanding of the spatial and temporal distribution of individual OMPIs.

This study is a contribution to the UNESCO IUGS projects IGCP 655 Toarcian Oceanic Anoxic Event: Impact on marine carbon cycle and ecosystems and IGCP 739 The Mesozoic–Paleogene hyperthermal events.

ASSEMBLAGES OF TRACE FOSSILS DOCUMENTING EARLY RECOVERY AFTER THE TOARCIAN OCEANIC ANOXIC EVENT (WESTERN CARPATHIANS, SLOVAKIA)

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A relatively continuous ichnological record exposed in the Upper Pliensbachian and the Lower-Middle Toarcian succession is preserved in the Central Western Carpathians at the Skladaná skala section (Šimo and Tomašových 2013; Šimo and Reolid 2021; Müller et al. 2020). This succession, characterized by the deposition of spotted marls and limestones in the outer-shelf and slope environments of the Western Tethys, documents extinction and recovery patterns of burrowers in response to significant environmental changes that occurred at the Pliensbachian/Toarcian boundary and during the Toarcian Oceanic Anoxic Event (T-OAE). The stratigraphic changes in the association of trace fossils are accompanied by changes in microfacies. The association of trace fossils in limestones and marly limestones with spiculitic microfacies of the uppermost Pliensbachian (*Spinatum* Zone) consists of *Chondrites intricatus*, *Chondrites* cf. *targionii*, *Lamellaeichnus imbricatus*, *Teichichnus longummurus*, *Thalassinoides* isp., *Palaeophycus heberti*, *Planolites* isp., and *Zoophycos* isp. Although the most common trace fossil in the entire Pliensbachian sequence is represented by *Lamellaeichnus*, the occurrences of *Zoophycos* isp. increase in frequency in the lowermost Toarcian where they dominate in marly limestones and marls with spiculitic-radiolarian microfacies (above the Pliensbachian/Toarcian carbon isotopic anomaly). A 60 cm-thick black, organic-rich shale with abundant pyritic grains (with a negative isotopic anomaly in $\delta^{13}C_{org}$ in the upper part) documents the onset of the Toarcian anoxic event layer and does not contain any evidence of bioturbation.

Trace fossils above the T-OAE black shale layer occur in marls and marly limestones that reflect an overall deepening (*Exaratum* and *Falciferum* subzones of the *Serpentinum* Zone) but also low input of skeletal particles (in bioclast-poor microfacies, with rare or absent sponge spicules). Although the density and diversity of trace fossils in the *Exaratum* and *Falciferum* subzones is generally smaller than in the spotted facies that were deposited prior to the T-OAE event, a new sampling devoted to this recovery interval revealed the presence of new and unique taxa that occur above the black shale. Trace fossils capturing the early phase of recovery are represented by a novel association formed by *Halimedides annulata*, *Paradictyodora* isp. and *Polykampton* isp. *Chondrites intricatus*, *Lamellaeichnus imbricatus*, *Thalassinoides* isp. and *Zoophycos* isp. also co-occur with these distinct trace fossils. *Paradictyodora* and *Polykampton* are documented for the first time in deposits recording the early stages of recovery after the T-OAE extinction in the Western Carpathians. The occurrences of *Halimedides annulata* and *Polykampton* isp. indicate that bottom-water conditions were not limited by concentrations of dissolved oxygen and were characterized by the seasonal/episodic supply of particulate organic matter. *Halimedides* is a typical member of assemblages recovering after oceanic anoxic events (e.g. after the T-OAE in the Lusitanian and Asturian basins).

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LEVEL-BOTTOM MACROFAUNAL COMMUNITY STRUCTURE IN THE EARLY JURASSIC OF MOROCCO

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During the Early Jurassic there were significant perturbations in environmental conditions around the globe, such as thermal stress, low oxygen levels, and acidification in some parts of the ocean, likely triggered by the Karoo-Ferrar Large Igneous Province eruption. It is thought that these changes led to multiple (or multi-phased) biotic crises, notably at the Pliensbachian/Toarcian boundary, ~183.5 million years ago, and during the Toarcian Oceanic Anoxic Event (TOAE), ~183 million years ago, which although significant, were not as severe as the biggest mass extinctions events. The exact causes of the extinctions are debated, in part, because of limited data availability from shallow water carbonate strata from tropical settings. Previous work from Lower Jurassic sections in the High Atlas of Morocco suggests that biotic changes in communities living in carbonate shelves in Morocco were coincident with a two-phased carbonate factory collapse; however, the carbonate communities seemed to recover relatively quickly. Changing environmental conditions on community structure during the late Pliensbachian-early Toarcian transitions likely resulted in significant changes to benthic community dynamics. Specifically, this work documents the paleoecology of level-bottom macrofaunal communities, their extinction, survival, and recovery across the targeted intervals. In this study, we quantify the occurrences and abundances of different fauna sampled from multiple late Pliensbachian and early Toarcian localities in Morocco. The macrofaunal groups studied include ammonites, bivalves, brachiopods, echinoids, and gastropods. Quantification of these fossil invertebrate communities allow for analyses of long-term trends in community structure and provide data to assess the plausibility of local kill mechanisms. Our quantified data shows that the marine communities structure changed across the stage boundary and TOAE due to multiple kill mechanisms, such as ocean warming and acidification. Our methods are producing new paleontological data from multiple Early Jurassic sites in Morocco. Such data about tropical shallow water macrofaunal communities have rarely been collected for this interval, since previous work has focused on deeper-water, extratropical shales. In addition, the study provides important data about the patterns of biotic change in tropical marine communities and how these communities recovered from significant global events like those we are facing now.

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NEW INSIGHTS INTO CALCAREOUS NANNOPLANKTON RESPONSES TO THE TOARCIAN OCEANIC ANOXIC EVENT

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The Toarcian Oceanic Anoxic Event (T-OAE; ~183 million years ago) has long been associated with a 'biocalcification crisis' of calcareous nannoplankton, whereby ocean acidification and/or related factors compromised marine biogenic calcium carbonate ($CaCO_3$) production. Although observed declines in $CaCO_3$ and nannofossil abundances through T-OAE strata potentially support this hypothesis, the extent to which diagenetic processes may have influenced these signals remains unclear. Here we present an almost entirely overlooked form of cryptic fossilisation – imprints of nannofossils exquisitely preserved on the surfaces of organic matter particles, including on pollen, spores, marine organic-walled plankton and amorphous organic matter. The imprints were found globally, and their assemblages reveal that diverse and abundant nannoplankton communities persisted throughout the T-OAE. The presence of imprints without their $CaCO_3$ nannofossil casts suggests that acidic pore waters, which often form during diagenesis of black shales, dissolved much of the $CaCO_3$, severely distorting the $CaCO_3$ record. This model is supported by the presence of large carbonate nodules that commonly occur within T-OAE black shales – these nodules likely represent the final geological repository for the dissolved and remobilised $CaCO_3$. Our findings suggest that the declines in $CaCO_3$ and nannofossil abundances associated with the T-OAE are diagenetic signals, rather than representing a primary response of nannoplankton communities to ocean acidification or other environmental changes during the event. Rather than experiencing a severe biocalcification crisis during the T-OAE, the new imprint record indicates that nannoplankton communities were more resilient than the traditional nannofossil and CaCO3 records would suggest.

EXTENSIVE ANOXIA AFTER THE END-TRIASSIC MASS EXTINCTION: URANIUM ISOTOPE EVIDENCE FROM THE TRIASSIC-JURASSIC BOUNDARY SECTION AT CSŐVÁR

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The end-Triassic mass extinction (ETE) ranks as one of the 'Big Five' biotic crises in Earth history. The processes that led to the ecosystem collapse are thought to have been triggered by the volcanism of the Central Atlantic Magmatic Province (CAMP). However, there is an ongoing debate about which environmental effect was the primary proximal trigger for the marine extinction. Our research aimed to produce a new uranium isotope dataset from the Triassic-Jurassic boundary section of Csővár and to carry out Earth system modelling to understand the role of anoxia in driving the extinction and/or delaying the subsequent biotic recovery.

The uranium isotope ratio ($\delta^{238}U$) is a novel paleoredox proxy as its application dates back only a few years. The main advantage of the method is that $\delta^{238}U$ measured in limestone is a global proxy, i.e. it provides information on the redox conditions of the whole ocean rather than that of the local basin. It can be used to reconstruct the proportion of the global seafloor that was under anoxic conditions during the deposition of the studied sediment. Our $\delta^{238}U$ measurements were performed on the recently installed NEPTUNE Plus™ MC-ICP-MS instrument at the Institute for Nuclear Research (ATOMKI) in Debrecen. The obtained data represent only the second $\delta^{238}U$ dataset from the Triassic-Jurassic boundary worldwide.

The studied Csővár section is suitable for uranium isotopic analyses as the deposition took place in an oxic environment and was continuous across the boundary interval, as proven by biostratigraphy of multiple fossil groups and cyclostratigraphy. The section is of international importance as it was among the first sections in the world where the TJB event was recognized in the carbon isotope record.

We detected a major negative uranium isotope anomaly right immediately below the Triassic-Jurassic boundary, which is a global signal and indicates widespread marine anoxia. This anomaly coincides with the previously detected carbon isotope anomaly and Hg peaks, which are associated with the volcanism of the CAMP and mark the extinction horizon. Our results support the hypothesis that volcanism indirectly induced anoxia in the ocean, which may have played a role in triggering the marine ETE.

Using the geochemical data ($\delta^{13}C$, Hg, $\delta^{238}U$) and the astrochronological age constraints of the section, we modelled the coupled behaviour of carbon, phosphorus and uranium cycles after volcanic carbon emissions. The model allowed us to estimate when the anoxic conditions were the most severe in the ocean. Our results suggest that anoxia did not reach its maximum extent during the extinction but only about 200-250 kyr later, when approximately 13% of the global ocean floor may have been depleted in oxygen. This delayed peak of anoxia is probably the result of the later, extrusive phase of the CAMP marked by the prominent Hg peak of the section. Our geochemical and modelling results suggest that marine anoxia played a key role in hindering the biotic recovery after the end-Triassic extinction.

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EXTINCTION INDUCED CHANGES TO MOROCCAN REEF ECOLOGY IN THE EARLY JURASSIC

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Current research on the effects of the Pliensbachian/Toarcian (Pl/T) boundary event and the Toarcian Oceanic Anoxic event (T-OAE) on shallow water reef ecosystems lacks the resolution necessary to either quantify the ecological changes caused by the extinctions or determine how specific extinction drivers influenced those changes. The shallow waters of the Atlas Rift Basin in Morocco experienced severe collapses of the carbonate factory across both the Pl/T and the T-OAE. During the collapses, we see large siliciclastic deposits and a reef gap, before the carbonate factory and reef systems recovered. Following each extinction, the biotic structural components of the reefs change, giving insight on how the extinction drivers impacted those taxa at the time of their onset. The unique expanded Jurassic section within the Central High Atlas Mountains of Morocco has allowed us to thoroughly sample reefal units from multiple locations and facies from the early Pliensbachian, late Pliensbachian, earliest Toarcian, and post-OAE Toarcian. An ongoing detailed quantitative analysis of each reef site and facies will allow us to determine overall structural changes occurring within reefs through the Early Jurassic, as well as assess how the roles of specific taxa change within the reefs during the same interval. Although the Karoo-Ferrar large igneous province has been well established as the likely cause of both the Pl/T and the T-OAE, current evidence suggests that the extinctions were not caused by entirely the same drivers. Notably, no evidence for ocean acidification has been found for the Pl/T. We hope to use fossil data to identify variability in how taxa responded to each of the extinctions and determine if those differences could be explained by differing extinction drivers.

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INSIGHTS INTO THE EARLY JURASSIC CARBON-CYCLE, PALEOENVIRONMENT AND CLIMATE USING ALGAL-DERIVED BIOMARKER *p*CO_2 RECONSTRUCTIONS

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The Early Jurassic period (~201–174 Ma) was marked by two intervals of significant climatic and environmental change, namely the Triassic–Jurassic transition (~201.5 Ma) and the Early Toarcian oceanic anoxic event (~183 Ma). These intervals are recognized in the geochemical record by negative and positive stable carbon-isotope ($\delta^{13}C$) shifts, which are interpreted to reflect changes in the flux of isotopically light volcanic and/or biogenic and/or thermogenic carbon into the ocean–atmosphere system, and the sequestration of organic carbon into sediment, respectively. The Hettangian to Early Toarcian geological record, archiving the paleoenvironmental evolution of the time interval in between these two large-scale carbon-cycle disturbances, is marked by multiple positive and negative $\delta^{13}C$ shifts of different magnitude and duration, as well as multiple organic-matter preservation intervals of local to supra-regional nature, and short-lived episodes of climatic warming and cooling. These events appear smaller in magnitude and geographical extend compared to, i.e., the Early Toarcian oceanic anoxic event. However, the appearance is striking as there is no integrated understanding of the interplay between oceanographic changes vs carbon fluxes and carbon sources as possible mechanisms modulating the paleoenvironment and climate during this time interval. Here, biomarker-, compound-specific $\delta^{13}C$-, and algal-based *p*CO_2 records of Sinemurian and Pliensbachian strata from different depositional settings are generated with the aim to constrain $\delta^{13}C$ shifts in the marine and atmospheric carbon reservoir, and to quantify concomitant changes in atmospheric carbon.

Preliminary results include a compound-specific $\delta^{13}C$ record of mid-Sinemurian to mid-Pliensbachian strata of the Prees drill-core, Cheshire Basin, UK, allowing the comparison of the long-term carbon-isotope trends recorded in bulk-organic matter *vs* marine algae and terrestrial plant waxes. Exceptionally preserved organic-rich and thermally immature sediments form the western Iberian margin (Lusitanian Basin, Portugal) and the western Hispanic corridor (DSDP Site 547) provide initial algal-based *p*CO_2 reconstructions of the *oxynotum* Zone hyperthermal event and the Sinemurian–Pliensbachian transition.

STRATIGRAPHIC CONSTRAINTS ON THE LOWER TOARCIAN STRATA OF THE LAS OVERAS SECTION, NORTHERN NEUQUÉN BASIN, ARGENTINA

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The Lower Jurassic Toarcian oceanic anoxic event (T-OAE, ~183 Ma) was marked by globally recognized environmental perturbations, most notably including global carbon-cycle and climate disturbances, and the widespread development of oxygen-deficient conditions in marginal marine basins and large inland lakes. Geochemical records of the T-OAE generated from the warm temperate climate zone of the NW European realm are well studied and have aided understanding of local to regional paleoenvironmental responses to carbon-cycle and climate perturbation. Coeval geochemical records from the Southern Hemisphere are, however, comparatively scarce. Here, we present a biostratigraphically calibrated litho- and chemostratigraphic record, as well as preliminary U-Pb geochronology, of the Las Overas section located in the northern Neuquén Basin, Argentina. The section covers strata of the uppermost *D. tenuicostatum* to *Dumortieria* Andean ammonite zones of the Toarcian Stage, equivalent to the uppermost *Tenuicostatum* to *Pseudoradiosa* European standard zones, representing almost the entire Toarcian stage. The geochemical data illustrate a stratigraphically expanded ~7‰ negative bulk organic carbon-isotope excursion, elemental Hg enrichment, as well as a strikingly low content of sedimentary organic carbon in the strata associated with the T-OAE. We interpret the low sedimentary carbon content as a local to regional signal, linked to an interplay of syn-sedimentary basin development and ocean dynamics overprinting the characteristic organic-rich signal known from other parts of the Neuquén Basin, the European epicontinental seaway and elsewhere. Preliminary results on U-Pb CA-ID-TIMS geochronology data derived from intercalated ash beds support recently published age projections on the *D. tenuicostatum*–*D. hoelderi* ammonite Zone boundary and offer new age constraints on the lowermost *C. chilensis* and the *P. tenuicostatum* zones (equivalent to the NW European *Tenuicostatum*–*Serpentinum* boundary, upper *Bifrons* Zone and *Thouarsense* Zone, respectively).

TAXONOMY OF THE TOARCIAN PALAEOENTOMOFAUNA ASSEMBLAGE OF ALDERTON HILL, GLOUCESTERSHIRE (UK)

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The geological record for the Early Jurassic contains several well-documented fossil insect horizons across Europe, including the UK, Germany, and Luxembourg. These insect horizons are all preserved in marine deposits, indicating that the insect remains were transported into the epicontinental sea from neighbouring landmasses. The occurrence of these insect accumulations are restricted to a short, specific period of time at the beginning of the Lower Toarcian (*exaratum* Subzone, lower *falciferum* Zone), coinciding with the negative carbon isotope excursion of the Toarcian Oceanic Anoxic Event (T-OAE); suggesting that their occurrence may be linked to palaeoclimatic and palaeoecological conditions of the Toarcian event. However, the impact of this event on terrestrial biota is poorly understood.

The succession of Alderton Hill, Gloucestershire (~150 km northwest of London, UK) has yielded one of the best-preserved Toarcian insect assemblages in the UK. This historic locality occurs within the Whitby Mudstone Formation of the Severn Basin, in which insects are preserved in a single layer of early diagenetic, laminated limestone nodules referred to as the 'Dumbleton Fish Bed'. However, whilst these insects have been known since the 19th century, the majority of the specimens have remained largely understudied, in contrast to the diverse and well-documented entomofaunas of Germany.

With the aim of exploring and comparing the distribution and ecological diversity of the European Toarcian insect-bearing horizons, this study has first focused on cataloguing and re-examining the palaeoentomofauna assemblage of Alderton Hill from museum and institutional collections which have received limited scientific study since discovery.

Three hundred and sixty insect fossils have been located within museum collections and the taxonomy of each specimen was reviewed and analysed. The results of this analysis highlight a diverse palaeoentomofauna represented by 12 insect orders and 25 families, among 226 identifiable specimens. Coleoptera and Hemiptera are the most commonly recorded orders, followed by Neuroptera, Orthoptera and Odonata, indicating a strong bias towards heavily sclerotized taxa. Insects in the Alderton Hill assemblage are mostly preserved as highly disarticulated, and often fragmented compression fossils, represented mostly by isolated wings.

Our results indicate that the Alderton Hill insect fauna is important for understanding the diversity of Early Jurassic entomofaunas and can be compared with those from the Strawberry Bank Lagerstätte of Ilminster (Somerset), in addition to the rich entomofaunas of Grimmen, Dobbertin & Braunschweig (Germany); and Bascharage & Sanem (Luxembourg) to provide a unique snapshot into the diversity of terrestrial invertebrate life at the height of the T-OAE.

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THE JURASSIC/CRETACEOUS TRANSITION: NEW AMMONITE DATA FROM AMMONITICO ROSSO/BIANCONE SECTIONS OF THE BAKONY MOUNTAINS (TRANSDANUBIAN RANGE, HUNGARY) AND A PROPOSAL FOR THE MEDITERRANEAN AMMONITE ZONAL SCHEME

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The late Tithonian–early Berriasian ammonite taxonomy and the stratigraphy of the Mediterranean was heavily re-organized during the past decade. There is still no consensus on the position of the Tithonian/Berriasian boundary and the Jurassic/Cretaceous (J/K) GSSP is also pending. This is the last system boundary of the Phanerozoic which lacks the Golden Spike.

The sections presented here are located in the Bakony Mountains (BM) in the Transdanubian Range (TR). The area was part of the western Tethyan oceanic belt during the J/K time interval and represented a particular unit within the Alpine-Carpathian-Dinaric orogeny, as its tectono-sedimentary evolution was related to both Dinaric and Austroalpine domains. Reliable recent data of the uppermost Jurassic–lowermost Cretaceous circum-Mediterranean localities have been taken into consideration, thus putting the Hungarian data in a broader context.

The present study is mainly based on large, typically Mediterranean ammonite faunas that were collected several decades ago, bed-by-bed, from four ammonitico rosso/biancone sections of the BM: Hárskút HK-II and HK-12/a, Szilas Ravine and Lókút (LH-I, LH-II and LH-II/I). For the HK-12/a and Lókút LH-II sections, magnetostratigraphic and micropalaeontological constraints have already been established (Lodowski et al. 2022). Besides, new collecting campaigns have provided additional ammonite material from the HK-12/a and HK-II sections in order to determine the position of ammonite zones. The sections are partly condensed, but as they are not resedimented, the original stratigraphical order of their succession could be accurately ascertained. Taxon ranges of ammonites were established and these were compared with available magneto- and chemostratigraphic or micropalaeontological framework. Stratigraphically important ammonite taxa were also summarised from a critical perspective (Szives and Főzy, 2022). As a result, an updated ammonite zonal scheme for the late Tithonian–early Berriasian interval for the Mediterranean region is proposed. To achieve a constrained order of zones, the focus here has been solely on those ammonite groups for which a clear taxonomic concept is already given and to those sections where ammonites were collected bed-by-bed and recently calibrated against other stratigraphical datasets.

After the compilation of ammonite assemblages including our new results, the position of *Volanense* and *Andreaei* zones could be calibrated against magnetostratigraphy. The integrated results presented here are slightly different from previous data as the base of the *Volanense* Zone is in M20r, the base of the *Microcanthum* Zone falls within the M20n2n magnetozone in the *Chitinoidella* Zone (*Boneti* Subzone), while the base of the *Andreaei* Zone falls in the upper M20n1n, its top being in M19n2n. These results may help to choose the new position of the J/K boundary, which we tentatively placed between the *Chaperi* and *Progenitor* Zones within the M19n magnetozone.

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LATE JURASSIC FORAMINIFERAL PLANKTON IN THE NORTHERN TETHYS: NEW DATA FROM THE POLISH OUTER CARPATHIANS

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Globigerina-like specimens (protoglobigerinids) were found for the first time in the oldest sedimentary rocks belonging to so-called Cieszyn beds which occur in the westernmost part of the Polish Outer Carpathians. Although they have been known for a long time, there are still problems with finding them in the study area. This is due to their low resistance to destruction and the possibility of preservation in sediments. They are more often described in thin sections of compact rocks (mainly limestones) than as isolated forms in less consolidated sediments (marls, shales), in which makes it difficult to determine their morphology, structure and their relationship.

Until now the Jurassic plankton was known from thin sections of carbonate blocks (Oxfordian, Tithonian) occurring in age-differentiated flysch series dominating in this region. Presented foraminifers were extracted from the Tithonian carbonate sediments (marls and shales of the Verovice Fm. and Cieszyn Limestones Fm.) under thermal shock conditions obtained by alternating boiling and freezing without the use of chemicals. The studied sediments were formed under conditions of high tectonic activity and mass underwater transport in the early Alpine Tethys basin, which was created by the rifting along southern margins of the European Platform in the Late Jurassic. Under these conditions, the plankton was particularly sensitive to destruction and re-deposition. It was also particularly sensitive to recrystallization and dissolution. A consequence of these processes seems to be their poor preservation state and occasional occurrence. For this reason, they usually survived as single, partially altered specimens in the studied sediment. These scarce forms resemble early planktonic foraminifera of the Western Tethys (*Gl. oxfordiana, F. hoterivica*) as well as epicontinental and sub-Tethyan seas located north (*"Gl." stellapolaris*) and east (*Gl. balakhmatovae, G. terquemi*) of the studied area. The taxonomy, abundance and state of preservation show the relationship with gradually degraded platform areas which were inhabited by coeval planktonic communities originating both from Tethyan and Boreal seas.

The origin of plankton in the studied sediments is ambiguous. On the one hand, the data confirm the migration of plankton foraminifera at that time from the platform areas located north of the Tethys as well as from its eastern part (through the Crimea). However, due to their scarcity and state of preservation, these forms seem to be rather related to the material provided from elements of platforms that were destroyed during the geotectonic transformation of the basin at the end of the Jurassic.

MICROFOSSILS RELATED TO THE ROPICE HORIZON (CZECH AND POLISH OUTER CARPATHIANS): CHANGES IN TETHYAN BASINS AT THE JURASSIC/CRETACEOUS BOUNDARY

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During the Neocimmerian movements regression took place on the European Tethyan shelf. In the Tithonian, in the Western Outer Carpathians, breccias and allodaphic limestones occurred that originated from shallow water areas spreading along the margins of the European platform. Numerous boulders, olistoliths and klippen of limestones of Štramberk-type demonstrate this. They occur in various lithostratigraphic members of the Silesian and Subsilesian units in Poland and the Czech Republic. In the Silesian basin this supply culminates in the upper Tithonian and forms horizons, which are known from the Cieszyn Silesia. They spread from Chotěbuze (Czech Republic) through Cieszyn to Bielsko-Biała (Poland). The horizon occurs in the uppermost part of the Verovice Fm. which was defined in the Czech Outer Carpathians where additionally the so-called Ropice horizon is known. Olistoliths are poorly diversified and restricted only partly to very diluted limestones of Štramberk-type and the majority of cases are represented as allodapic Cieszyn Limestone type in the Polish Carpathians. However, the Ropice horizon, apart from numerous blocks of the limestones of Štramberk-type, also contains calcareous sandstones, claystones along with boulders of quartz, metamorphic and magmatic rocks. Probably, the calcareous material has been derived from destruction of the Štramberk reef complex and carbonate platform close to Baška Rise. Consequently, numerous calcareous and single agglutinated shallow-water foraminifers of Lituolidae are noted partly in rocks which contain the mentioned olistoliths and mainly in the directly overlying marls and marly shales. In the Polish Carpathians specific calcareous forms belong in the first place to numerous Involutinidae (*Andersenolina*, *Neotrocholina*, *Trocholina*) and Placentulinindae (*Paalzowella feifeli* and *Discorbis crimicus*) which are accompanied by nodosarids dated at the uppermost Tithonian. Moreover, agglutinated taxa are represented by shallow-water lituolids: *Pseudocyclammina sp.* and others. The larger forms (i. e. *Haplophragmoides*), being better preserved but not so numerous, occur in some samples collected by the authors from Ropice in the south of Cieszyn in the Czech Carpathians. Additionally, the fragments of reef macrofauna (crinoids, bryoazas, and corals) in theses horizons are noted. Finally, it seems that both kinds of the horizons may be regarded as record of reorganization of the Carpathian (Silesian) Basin at the Tithonian-Berriasian (Jurassic/Cretaceous) boundary what resulted in the disappearance of an extensive shelf with shallow-water carbonate sedimentation.

GEOCHEMICAL EVIDENCE FROM THE MT. SPARAGIO SECTION, SICILY, ITALY: A CONTINOUS PERITIDAL SUCCESSION ACROSS THE TRIASSIC/JURASSIC BOUNDARY

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The Mt. Spàragio section consists of a thick and continuous peritidal succession of a Tethyan carbonate platform deposited between the Late Triassic and Early Jurassic, recording thus Triassic/Jurassic boundary and the End-Triassic mass Extinction (ETE). The Mt. Spàragio section crops out in north-western Sicily (Italy), and it has been deeply investigated bio- and chemostratigraphically. Micro- and macrocalcified organisms, such as the large bivalves ubiquitous in Upper Triassic carbonate platforms (e.g. megalodontoids) and microfacies associations (e.g. foraminifer *Triasina hantkeni*) apparently experienced a size decrease, similar to the Lilliput effect documented in other stressing intervals like mass extinction events (e.g. at the Permian-Triassic boundary). Successively, the typical Triassic fauna was substituted by a 10 meter thick interval consisting of an oolitic grainstone followed by subtidal facies almost totally formed by calcisphere particles. Upward in the section, a Jurassic association characterized by *Thaumatoporella* sp. and *Siphovalvulina* sp occurs. This fossil association change coincides with environmental variations including shallow ocean deoxygenation, as inferred by the isotopic and geochemical records. The isotope data of C (from carbonates and organic matter), O, and S and the I/(Ca + Mg) ratio are in fact indicative of serious environmental perturbations, change in surface water temperatures and dissolved oxygen content, confirming the acidification processes that affected the benthic community, as recorded worldwide. The environmental variations have been related to the Central Atlantic Magmatic Province (CAMP) activity, as inferred by Zn, Pb, Sr isotope data collected along the Mt. Sparagio section, offering additional evidence on a tight control of CAMP volcanism on the End-Triassic mass Extinction (ETE).

STRATIGRAPHIC CHANGES IN SHELL SIZE OF THE BIVALVE *HARPAX SPINOSUS* DURING THE LATE PLIENSBACHIAN AND EARLY TOARCIAN

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Abrupt changes in seawater temperature and chemistry during the end-Pliensbachian and early Toarcian significantly affected not only species richness and composition of benthic ecosystems, but also led to changes in body size at intraspecific and community levels. However, intraspecific and community-level trends in body size are intertwined: large-sized species decline in abundance whereas some rare species or immigrants can increase in size. *Harpax spinosus* is an Early Jurassic plicatulid, bimineralic bivalve that was abundant during the Pliensbachian but went extinct at the onset of the Toarcian oceanic anoxic event. Here, we have collected occurrences of this species to assess temporal changes in size-frequency distributions of this species at high stratigraphic resolution at Peniche and at other sections in the Lusitanian Basin.

Preliminary analyses of *H. spinosus* at Peniche (~3,000 specimens) show that this bivalve generally achieved 10–15 mm during the deposition of the *margaritatus* and *spinatum* Zones, with left-skewed or bimodal distributions, and median size consistently exceeding 10 mm prior to termination of the Pliensbachian stage. However, this species shows a first significant decline in median size to <10 mm within the *spinatum* Zone (in the upper part of the *apyrenum* Subzone), coinciding with the appearance of small koninckinid brachiopods, followed by a return to larger sizes in the upper part of the *spinatum* Zone. A second decline in size occurs in the lowermost Toarcian (as also reported by Paredes et al. 2018) where *Harpax* co-occurs with small-sized *Koninckella-Nannirhynchia* assemblage (*Koninckella* fauna), immediately above the *mirabile* Subzone. Although this abrupt decline in size can be accentuated by condensation, the size distribution at bedding plane is strongly left-skewed (with infrequent small-sized individuals), in contrast to the size distribution in the overlying marl. *Harpax* assemblages in the *semicelatum* Subzone are characterized by right-skewed or normal-shaped size distributions, with median size <10 mm. Preliminary analyses of stable isotopes are consistent with the hypothesis that one of the major factors driving the shift in size structure is related to seawater warming.

CONODONTS FROM THE NORIAN/RHEATIAN BOUNDARY TO THE HETTANGIAN: HOW LONG DID THEY SURVIVE IN THE JURASSIC FOR?

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The Katsuyama-B (KTY) section from the Inuyama area (southern Honshu Island, Japan) consists of bedded chert sequences in the Jurassic accretionary complex of the Mino Belt in central Japan, which was accumulated within low to middle latitude pelagic areas of the Panthalassa Ocean (Paleo-Pacific) during Middle Triassic to Early Jurassic, and it is interpreted being deposited below the carbonate compensation depth (CCD). The KTY section is about 13 m thick and ranges from the upper uppermost Triassic (upper Sevatian) to lowermost Jurassic without a major hiatus, and it is composed of 1–10 cm thick, rhythmical chert and shale beds, red and purple in color. In particular, the upper Norian and Rhaetian beds are of light red-brown color, the uppermost Triassic beds are dusty red, while the bedded cherts across the TJB interval are purple with a thickness of ca. 2 m.

A very detailed integrated investigation of conodonts and radiolarians permits to mark two important biochronostratigraphic boundaries, that are 1) the Norian/Rhaetian boundary which is identified with the first occurrence of conodont *Misikella posthernsteini*; and 2) the Rhaetian/Hettangian (Triassic/Jurassic) boundary with the occurrence of a typical Jurassic radiolarian association (e.g. *Amuria impensa, Pantanellium kluense, P. tanuense*, etc). This section is also biostratigraphically correlated to other Triassic/Jurassic sections in the same area, where the three typical $\delta^{13}C_{org}$ negative excursions that characterized the Triassic/Jurassic transition have been documented. Based on the radiolarian biostratigraphy and on the organic carbon correlations, the occurrence of conodonts in Jurassic layers is confirmed. Conodonts have been in fact collected from several samples above Triassic/Jurassic boundary, along with a typical Hettangian radiolarian association. Conodonts have been not considered reworked because there is no evidence of resedimented material (e.g. calcarenites) or other tractive structures along the section, which was deposited in a pelagic environment (below the CCD) and significantly distant from any continents, in the mid-Panthalassa. These characters permit to consider the sedimentation rates as mostly constant along the section and it corresponds to 120 cm/my, calculating by dividing the thickness of about 5.27 m of the Rhaetian stage in KTY section by the duration of 4.4 My of this stage (base and top are placed on 205.7 and 201.3 Ma respectively). Conodonts thus should have survived ca 1.22 My in the Hettangian, since they have been collected up to 1.02 meter above the biostratigraphic Triassic/Jurassic boundary in KTY section.

ORE-FORMING PROCESSES ON MICROMETRE-SCALE IN THE ÚRKÚT MANGANESE ORE DEPOSIT, HUNGARY

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Geological and biogeochemical processes related to the environmental changes caused by the Toarcian Oceanic Anoxic Event (T-OAE) led to the deposition of oxidic and carbonatic manganese ores at Úrkút (Hungary). In the last decades, fundamental discoveries were made on the genesis of carbonatic ore, but the micrometre-scaled characterization of the oxidic parts still can improve the understanding of mineralogical processes resulting the complex textural relations and the large variety of manganese-bearing minerals both in the oxidic and carbonatic parts of the deposit. Investigation of micro- and nanometre-scaled manganese oxides and oxide hydroxides in their original textural positions could provide a deeper insight into the local environmental changes leading to the accumulation of economically significant ore deposits. Although the manganese mine in Úrkút closed in 2016, well-documented samples from geological profiles representing full sequences of the alternating oxidic and carbonatic ore layers are still available for further analysis. Our sampling focused on the oxidic ore and its transition zones from the underlying rocks toward the carbonatic ore.

To identify the mineral species and observe their textural relations X-ray powder diffraction (XRD), scanning electron microscopy (SEM), electron beam microanalysis (SEM+EDX) and Raman spectroscopy have been combined. To reveal the chemical and mineralogical changes on a micrometre-scale, few hundred nanometre thin slices have been cut with plasma-focused ion beam (PFIB-SEM) technique for STEM analysis and elemental mapping. This methodology allowed us to describe the fine textural features of the manganese-bearing mineral assemblages. The most characteristic manganese-containing mineral phases of the deposit are manganite: $Mn^{3+}O(OH)$, cryptomelane: $K(Mn^{4+}, Mn^{3+})_8O_{16}$ and rhodochrosite: $MnCO_3$. These minerals represent different oxidation states of the manganese (Mn^{2+}, Mn^{3+} and Mn^{4+}) so their various appearance in distinguished textural positions indicates the changes in the redox conditions. One of these significant positions is related to bioclasts. Manganese-bearing minerals with different oxidation states often occur as replacement material after the carbonatic shell of the fossils in the following stages. #1 Calcite shells surrounded and filled by oxidic manganese matrix and/or veins, #2 manganese free carbonate shells partly replaced by manganite and/or manganese oxides, #3 originally calcite shells fully replaced by manganite and/or manganese oxides. In some cases, all three steps can be observed within one fossil. The original shape of the bioclast has been preserved well, suggesting that the substitution process should have been slow and gentle enough to result in perfect pseudomorphs. These replacements usually start with a few micrometres thin potassium-bearing manganese oxide phase, followed by manganite. A similar pattern can be observed in the case of zonations appearing in sublayers of the oxidic ore and also within veins and veinlets crossing the samples.

The observed fine-textural relations describe not just the geochemical changes during the development of the deposit but also help to understand the pre-, sin- and/or post-diagenetic mineral formation processes.

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NEW EVIDENCES FROM MIDDLE JURASSIC CONTINENTAL STRATA OF TUNISIA, FRANCE AND MOROCCO CHALLENGE PREVIOUS PALAEOBIOGEOGRAPHIC THOUGH RELATED TO THE PANGEA BREAKUP

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Micropalaeontological investigation of Middle Jurassic continental strata from Tunisia and Morocco (north Gondwana) as well as France (south Laurasia), reveal new insights on the palaeobiogeography of the charophyte flora during the beginning of the Pangea breakup event. The recently described charophyte assemblages composed of 11 taxa from Tunisian continental deposits represent the richest and most diverse species known so far from this time interval, challenging therefore previous thoughts that Middle Jurassic charophyte flora was uniformly species poor and suggest instead that this time span witnessed a great deal of active evolutionary change, with the first appearance of significant Upper Jurassic–Early Cretaceous and the last occurrence of some Upper Triassic species. Equally, coeval rich and diverse charophyte floras discovered from French and Moroccan terrestrial strata provide further arguments in favor of significant biological flow between Laurasian and Gondwanan islands, indicating that Peri-Tethyan biogeography remained relatively uniform during the Middle Jurassic. Hence, our new results unravel a new Middle Jurassic charophyte bioprovince, described for first time in the Peri-tethyan palaeogeographic domain (present-day North Africa and southern Europe), from which species migrated to reach the east (North America) and west (China) of Laurasia, as well as southern Gondwana (India).

Enhanced by the capacity of many charophyte species to colonize brackish (thalassic and athalassic) environments, as it has also been confirmed by the associated ostracod fauna, both microfossil groups shed new light on potential migration routes of larger animals (pterosaurs, dinosaurs and early birds) which worked as passive dispersal vectors to cross palaeogeographic and palaeoclimatic barriers during the Middle Jurassic time interval. This argues against a model of low-lying and isolated islands far from inter-continental terrestrial organism migration as previously assumed during the Pangea breakup.

Consequently, understanding "natural" (due to lack of fossil record) from "artificial" (due to lack of data) bias in previous hypothesis on the endemism of notably Jurassic continental organisms, is crucial.

This study arose from the IGCP Project 710-Western Tethys meets Eastern Tethys, subproject "Non-marine – marine correlation and sea-level changes in the Mid-Jurassic Tethys: Tectonic versus climate events" funded by the Austrian Academy of Science (ÖAW).

BRACHIOPOD GEOCHEMISTRY AND SHELL STRUCTURES HELP CONSTRAIN PALAEOECOLOGY AND PHYLOGENY

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Oxygen and carbon isotope data derived from brachiopods, especially rhynchonellids, are of great importance to reconstruct carbon cycle and seawater temperatures of the Paleozoic and Mesozoic. Such data, when derived from well-preserved fossil rhynchonellids, are likely to be only minimally affected by biases arising from isotopic disequilibrium imposed by the shell secretion mechanism. For the present study, such brachiopod material, supplemented by data from fossils oysters, has yielded the currently best-constrained record of bottom-water temperature and carbon cycle evolution in shelf environments through the Early Jurassic Toarcian Oceanic Anoxic Event.

Comprehensive screening for diagenetic overprints of the original shell signatures was carried out by analysis of element/Ca ratios of shell fragments and the study of shell textures using scanning electron microscopy. Whilst such data are often acquired for at least a fraction of the studied material to constrain the fidelity of isotope signatures, they have so far not been exploited systematically to improve the understanding of the palaeoecological characteristics and phylogenetic relationships of the fossil taxa.

Here, we employ the acquired chemical signatures and shell textures of the well-preserved representatives of seven brachiopod genera found in lower Toarcian strata in Portugal and Spain to create novel tools for the palaeoecological characterization of taxa and to highlight their potential for elucidating phylogenetic relationships. The proxies established to this end are: i) organic matter content of shell material, where high organic matter content speaks for high metabolic cost of shell formation; ii) shape and texture of individual shell fibres of the secondary shell layer, where common surface features and cross sectional shape hint at evolutionary links; iii) Sr/Ca and Mg/Ca ratios, where high element/Ca ratios are indicative of faster shell secretion; iv) isotopic variability in individual fossils, where high variability speaks for high growth rate, allowing to image seasonal variability in bottom water conditions.

All four proxies clearly separate the seven studied brachiopod genera into two distinct groups. Group I (*Choffatirhynchia, Gibbirhynchia*, *Homoeorhynchia* and *Quadratirhynchia*) is characterized by comparatively high shell organic matter content, flattened shell fibres, Sr/Ca ratios between c. 0.9 and 1.2 mmol/mol and Mg/Ca ratios between c. 4 and 7 mmol/mol, and elevated C and O isotopic variability. Group II (*Cirpa*, *Nannirhynchia* and *Soaresirhynchia*) features c. 1 % lower shell organic matter content, shell fibres with distinct surface lineation and rectangular cross section, Sr/Ca ratios of c. 0.5 to 0.6 mmol/mol and Mg/Ca ratios of c. 2 to 3 mmol/mol, and subdued isotopic variability barely exceeding analytical uncertainty.

Taken together these data indicate that the studied genera followed different ecologic strategies, where group I was characterized by elevated growth rate and was more invested into energy expenditure towards shell secretion. Group II, more prominently found in deeper environments, built shell more slowly and at lower cost, suggesting overall lower metabolic rates.

GEOCHEMISTRY OF MACROFOSSILS, BULK ROCK AND SECONDARY CALCITE IN THE MOCHRAS CORE

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The Mochras core, drilled onshore in the late 1960s in the Cardigan Bay Basin (UK), contains an exceptional, expanded record of Lower Jurassic sediments that has been used for multiple studies establishing the Mochras record as reference for specialized stratigraphic tools and for the reconstruction of past environmental conditions. The geochemistry of the carbonate fraction of the core, however, has so far received limited attention and only bulk carbon and oxygen isotope data were determined at comparatively low resolution of c. 7 m per sample over the 1,300 m thick Lower Jurassic interval.

Here, we present a detailed study on the various carbonate constituents of the core, macrofossils, bulk rock and diagenetic phases, to evaluate diagenetic history and biases superimposed on the geochemical records derived from bulk and macrofauna, and to establish high resolution datasets that can be compared to existing Early Jurassic records. More than 7,700 analyses of carbonate content further allow the construction of a quantitative record of carbonate content in the core.

Carbonate content fluctuates systematically and ubiquitously responds to known phases of environmental perturbations with negative carbon isotope excursions by a loss of bulk carbonate content, which is most prominently observed in the Lower Toarcian (Early Toarcian Oceanic Anoxic Event) and upper Sinemurian (Liasidium Event). These two phases of environmental change are also characterized by the presence of early diagenetic siderite, highlighting perturbations of the sulfur cycle at least at a local level.

Diagenetic vein and slickenside calcite is prominent in Toarcian and upper Pliensbachian strata and otherwise rare, with isotopic signatures typically somewhat depleted in ^{13}C (median -0.3 ‰) and ^{18}O (median -1.0 ‰) with respect to adjacent bulk material and increasing depletion with increasing core depth. A significant fraction (c. a third) of vein calcite carries a high Sr signature highlighting the presence of early diagenetic celestine in the core that was later partially replaced by diagenetic calcite.

Bulk carbonate carbon isotope ratios pick up the well-established isotopic perturbations of the Early Jurassic faithfully, but magnitudes of isotopic excursions are often inflated due to concomitant loss of carbonate and partial remineralization of organic matter which impacts carbonate $\delta^{13}C$ more strongly in intervals of low bulk carbonate content. Overall trends in carbonate $\delta^{13}C$ throughout the lower Jurassic of Mochras are incompatible with macrofossil $\delta^{13}C$ and organic $\delta^{13}C$ data from the same core, suggesting that diagenetic biases on the bulk carbonate signal may be significant throughout the entire Lower Jurassic sequence.

Well-preserved macrofossil calcite is generally rare during major phases of environmental change and where macrofossil wood abundance is very high, and yields trends compatible with compilations from other UK basins. However, Pliensbachian and Toarcian fossils generally record $\delta^{13}C$ values at the low end and $\delta^{18}O$ values at the high end of the range observed in the nearby Cleveland Basin, pointing at potential oceanographic differences between these two basins.

A MAJOR VEGETATION TURNOVER ACROSS THE TRIASSIC-JURASSIC BOUNDARY OF SWEDEN

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The Triassic-Jurassic transition in Sweden is marked by a change from lithologies dominated by coals and dark, organic-rich mudstones in the pre-ETE (end-Triassic extinction) successions, to light grey to whitish silt- and sandstones, post-ETE. Facies change from continental in the uppermost Triassic, to marginal marine in the Hettangian, and are locally enriched in iron ooids in the Sinemurian. The Swedish Museum of Natural History hosts large collections of plants from the Rhaetian–Hettangian successions of southern Sweden. Detailed taxonomic work on these assemblages has been carried out over the last two centuries resulting in their incorporation of many type specimens of fossil leaves and cones. Our new investigations, focusing on the diversity and abundance patterns of these floras, show that the post-extinction gymnosperms of the Hettangian Höör Sandstone are dominated by *Nilssonia*, *Sagenopteris* and *Podozamites*.

Here we complement the thorough systematic work on these floras, with a major study assessing the plant diversity and abundance across the end-Triassic event from multiple localities from southern Sweden. The initial results reveal a substantial change, from a diverse and varied floral assemblage hosted in the Rhaetian coal-bearing deposits, to a lycophyte and fern-dominated interval within the mudstones overlying the coals. The post-extinction Jurassic floras are dominated by *Nilssonia*, *Sagenopteris* (*Caytonia*-plant) and *Podozamites*. This dramatic change in the flora, also expressed in the palynological record, is most probably linked to volcanic activity in the Atlantic volcanic province, where a short-term volcanic winter caused darkness and cooling, leading to the demise of vegetation, before the onset of high CO_2 conditions with a new flora emerging. A subsequent transgression is traced in the marine fauna, which is mainly represented by bivalves in successive monospecific assemblages. Other evidence of the marine environment include trace fossils, shark eggs, foraminifera, and, in the Sinemurian, rare ammonites.

MULTIPROXY CYCLOSTRATIGRAPHY AND ASTROCHRONOLOGY OF A TRIASSIC-JURASSIC BOUNDARY SECTION FROM CSŐVÁR, HUNGARY

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The intensively studied section of Vár-hegy near Csővár (northeast of Budapest) preserved the Triassic-Jurassic boundary (TJB) in an intraplatform basin that was located on the outer part of the Dachstein platform system, on the western shelf of the Neotethys. The carbonate succession represents slope, toe-of-slope and basinal depositional environments. Although the section has been studied for more than two decades and yielded important geochemical and paleontological data from around the system boundary (e.g. carbon isotope curves with multiple negative anomalies including the initial CIE, a major mercury anomaly, spore and prasinophyte peaks), a high-resolution age model has been missing and exact placement of chronostratigraphic boundaries have been hindered by a sparse fossil record. As a previous sequence stratigraphic analysis suggested the presence of 3rd and 4th-5th order carbonate sequences and a smaller scale pelagite-turbidite cyclicity in the succession, cyclostratigraphy and astrochronology held promise to establish a precise and reliable age model.

A multiproxy cyclostratigraphic analysis was carried out on the existing $\delta^{18}O$ and $\delta^{13}C$ dataset and the data series of eleven elements obtained by a hand-held XRF device. Three dominant cycles were recognised that can be matched with the 405 kyr long eccentricity, the ~100 kyr short eccentricity and the ~34 kyr obliquity cycles. The ~17–21 kyr precession cycles were not detectable from the original data series due to inadequate sample spacing. However, these cycles could also be succesfully detected from an additional $\delta^{18}O$ and $\delta^{13}C$ dataset with shorter stratigraphic extent but higher resolution.

Astrochronology of the recognised cycles suggests that the ~52 m thick succession was deposited in 2.9–3 Myr with an average sedimentation rate of 1.75–1.8 cm/kyr. The section contains the last one million years of the Rhaetian and almost the entire Hettangian. These findings are consistent with the existing biostratigraphic constraints. The sedimentation rate is comparable with other sections from similar environments. The length of the ICIE is ~40-80 kyr in this section. Our results establish a high-resolution age model and significantly decrease the uncertainty of the placement of the TJB in this section.

The 4th-5th order sequences are in good agreement with the long eccentricity cycles up to the ICIE but after this level the relationship becomes blurred. This can be either due to the environmental and climatic changes related to the end-Triassic events or the long-scale transgression during the TJ transition and early Jurassic.

On the basis of multiple proxies with cyclic nature, we could establish a complex environmental model for the Csővár basin. The main driver of the cyclicity was the opposite response of the detrital input and the carbonate accumulation in the basin to changes driven by aquifer- and limno-eustasy and the "megamonsoon" system that characterized the peri-Tethyan realm during the existence of Pangea.

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CYCLOSTRATIGRAPHY AND ASTROCHRONOLOGY OF THE LACUSTRINE TO PARALIC MECSEK COAL FORMATION (SOUTHWEST HUNGARY)

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The uppermost Rhaetian to Lower Sinemurian Mecsek Coal Formation was deposited in a half-graben with lacustrine to paralic environments. It contains economically important coal measures and was intensively explored and mined in the 20th century in Hungary. However, our understanding of the formation is still incomplete. Owing to the scarcity of age-diagnostic fossils and the effect of subsequent Alpine deformation, the exact time span of the formation is not well constrained and the depositional environment in wich the coal was deposited is also a matter of debate.

Although the presence of sedimentary cycles was already documented during the early phase of industrial exploration, no detailed cyclostratigraphic study has been carried out previously, mainly due to the prevailing assumption that these cycles are of autocyclic rather than allocyclic origin.

We conducted a cyclostratigraphic and astrochronologic analysis to help establish an age model for the Mecsek Coal Formation and to gain more information about its depositional environment. After the closure of the former mines, we used archive borehole data of the K-134 and K-176 cores that were drilled near the mining town of Komló. For the time series analysis, we first built a lithological index dataset from careful reinterpretation of the original lithological logs. Due to the Alpine deformation and intrusion of basaltic sills we were only able to analyse relatively short, undisturbed parts of the succession but after the removal of the basaltic sills (up to 1.9 m in thickness) we were able to construct three composite segments with only cm-scale faults. The three composites represent 175.9, 132.8 and 77.7 m thick segments of the ~350 m of the entire succession, of which the first two are overlapping.

We detected the long and short eccentricity cycles as well as four cycles linked with obliquity and two precession cycles. Apparently sub-Milankovitch cycles are also present in the succession. The average sedimentation rate was 7.5–9 cm/kyr and it remained relatively stable throughout the studied sections. Remarkably, after the change to entirely paralic depositional environment, the signal of obliquity and precession cycles strengthened.

The 77.7 m thick composite represents the Triassic part of the formation, contains a previously identified spore peak, but does not extend up to the Triassic-Jurassic boundary (TJB). Considering the time-gap between the spore peak and the TJB, the Rhaetian part of the Mecsek Coal Formation represents ~460–490 kyr. The two longer composites are probably entirely Sinemurian in age, representing ~2.2 Myr.

Our cyclostratigraphic analysis suggests that deposition of the thickest coal seams was orbitally controlled and corresponds to the absolute minima of seasonality, whereas the absolute maxima of seasonality resulted in the deposition of coarse-grained sandstone beds. However, this relationship is not consistently clear as it is affected by sedimentary noise and overprint by autocyclic processes. Nevertheless, allocyclicity and orbital signals can be unambiguously detected in the Mecsek Coal Formation despite the presence of faults and basaltic sills. This study also provides an example for possible uses of old, archive borehole data in modern research.

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SEQUENCE STRATIGRAPHIC ARCHITECTURE OF THE MIDDLE AND UPPER JURASSIC OF THE ARABIAN PLATE

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Based on extensive outcrop and subsurface data a regional sequence stratigraphic model has been constructed for the Middle and Upper Jurassic strata of the eastern Arabian Plate. This model documents the evolution from mixed siliciclastic-carbonate ramps to the creation and partial asymmetrical infill of large intrashelf basins along a master-transect of 2000 km from Northern Iraq to the ocean margin in Oman. This type of regional synthesis allows to address fundamental sedimentological and stratigraphic questions such as: What were the tectonic controls? What are the drivers behind the creation of intrashelf basins? What was the composition and timing of their infill? How did the carbonate factories evolve? In addition, since the Arabian Plate was tectonically stable for most of this time interval, these rock successions provide a good proxy for eustatic sea level fluctuations.

The synthesis is compiled using seismic lines, published well logs, core descriptions, bio- and chemostratigraphy and outcrop information. The regional approach is motivated by the cross-border nature of the geological patterns, and thus allows to address fundamental misconceptions existing in the literature originating from the often local nature of previous studies. An evolution in four phases is defined: (1) during the Bajocian and Bathonian, the deposition of mixed carbonate-siliciclastic ramp systems in an overall tectonically active setting with differential subsidence around the Qatar High, (2) during the latest Bathonian/earliest Callovian to Early Kimmeridgian, the creation of two large intrashelf basins occured (Hanifa in the South, and Gottnia in the North), mostly as a result of differential accumulation of carbonates and a minimal impact of compaction or tectonic deformation at that time, (3) during the early Kimmeridgian to early Tithonian, the Hanifa basin was infilled with anhydrites, organic-rich facies and mudstones, following by grainy carbonate ramps, whereas the Gotnia Basin was starved, and accumulated organic-rich facies, (4) during the Middle and Late Tithonian, shelf-wide deposition of highly cyclic, evaporitic deposits occurred on the infilled southern part of the plate (Arab and Hith formations), likely controlled by uplift along the Oman margin, whereas along the margins of the starved Gotnia Basin evaporitic shelf margin wedges were deposited.

This plate-wide synthesis is used to evaluate the impact of global vs local control on the sedimentation pattern, including climate change, eustasy and tectonic plate reorganization.

OXYNOTUM ZONE (UPPER SINEMURIAN) OF ASTURIAN AND LUSITANIAN BASINS, IBERIAN PENINSULA: AMMONOID SUCCESSION AND CORRELATION

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In this work we analyse the ammonoid successions from the uppermost part of the Obtusum Zone (Denotatus Subzone) to lowermost part of the Raricostatum Zone (Densinoludum Subzone). This interval is observed in the East Rodiles, Peñarrubia (central-eastern Asturian Basin), and São Pedro de Moel (north-western Lusitanian Basin) sections, Iberia. In the Asturian Basin, the interval studied belongs to the Buerres Member (Valenzuela et al. 1986) of the Rodiles Formation, where sections are relatively expanded and show few significative discontinuities. In the Lusitanian Basin, the São Pedro de Moel section is also expanded, and the interval examined corresponds to the upper part of Coimbra Formation and to the Polvoeira Member (Duarte & Soares 2002) of the Água de Madeiros Formation and, in no case, the discontinuties have a bigger rank than an horizon.

Oxynoticeratidae and Echioceratidae are the most common ammonoid families in both the Asturian and Lusitanian basins, but scarce Eoderoceratids were also found. In the Simpsoni Subzone, the oxynoticeratids and echioceratids specimens are infrequent and use to be incomplete phragmocones. In the Oxynotum Subzone, Oxynoticeratids are more common, specially in the lower part of São Pedro de Moel section, and they are preserved as compressed inner moulds of macroconchs and microconchs. In the first levels of the subzone, they are associated to frequent Echioceratidae, represented by *Plesechioceras* sp. nov. In the upper levels, oxycones are accompanied by rare eoderoceratids.

The lower boundary of the Oxynotum Zone could be marked by the first occurrence of *Gagaticeras* in the two basins studied. In the first levels of this zone *Eparietites* remains, namely *E. impendens* (Young & Bird) and *E. glaber* Guérin-Franiatte. In both basins, the Simpsoni Subzone is characterised by the presence of *Gagaticeras gagateum* (Young & Bird) and *Oxynoticeras simpsoni* (Simpson). Moreover, in the Asturian Basin *Palaeoechioceras* is as well registered. The Oxynotum Subzone was defined by the appearance of the index species, *Bifericeras bifer* (Quenstedt) and *Gleviceras doris* (Reynès).

In the Raricostatum Zone (Densinodulum Subzone), the differences among the identified ammonoid assemblages are markedly accentuated. In the Asturian Basin, the ammonite record is very scarce, and above *Gleviceras doris*, only one level with *Plesechioceras* cf. *delicatum* (Buckman) has been recognised, followed by two levels of *Plesechioceras* gr. *edmundi* (Dumortier) before the first appearance of *Echioceras* in the Raricostatum Subzone. In the Lusitanian Basin, over the last *Oxynoticeras oxynotum* (Quenstedt) specimens, that are associeted to *Plesechioceras*, *Oxynoticeras* (macroconch) – *Cheltonia* (microconch), *Gleviceras subguibalianum* (Pia), *Crucilobiceras densinodulum* (Buckman) and “*Oxynoticeras*” *lymense* (Wright) were found. In the lower part of the Raricostatum Subzone, the ccurrence of *Echioceras raricostatoides* (Vadász) is a good correlation key between the N and W of Iberian Peninsula and with other basins of the Northwest European Province.

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GEOHERITAGE IN THE MINETT UNESCO BIOSPHERE (SOUTHERN LUXEMBOURG): INVENTORY, EVALUATION, AND CONSERVATION ASPECTS OF REPRESENTATIVE GEOSITES

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The southwestern part of Luxembourg, known as Minett in the local language use, exposes an exceptionally high diversity of marine near-shore sediment rocks from the Early to Middle Jurassic, owing to its proximal position at the north-eastern margins of the Paris Basin. The iconic Minette ironstone formation is known as the worldwide largest oolitic ironstone deposit from the last 500 Ma and the abandoned open cast mines are nowadays protected sites with a high biodiversity, intrinsically linked to geodiversity. The *schistes bitumineux* unit, as lateral equivalent of the well-known *Posidonienschiefer* of the Holzmaden region (South Germany), is frequently studied for its exceptionally preserved fossils of marine vertebrates, cephalopods, and insect remains, deserving its status as a Fossil-Lagerstätte of international relevance. Of regional importance are the Rumelange limestones, with coral patch-reef paleo-environments. The geomorphological main feature of the region is the Cuesta of the Middle Jurassic ('Dogger-Schichtstufe'), with several outliers ('Zeugenberge') that represent widely visible landmarks in the landscape. In this paper, 16 geosites, representative of the geological, palaeontological, geomorphological, and hydrogeological heritage in the Minett UNESCO biosphere, are presented and evaluated according to scientific, educational, and geotouristic criteria.

SEA LEVEL CHANGES AND PALAEOGEOGRAPHICAL CONTROLS ON THE EVOLUTIONARY DEVELOPMENT OF AULACOSTEPHANID AMMONITES

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The Upper Oxfordian and Lower Kimmeridgian ammonites of the family Aulacostephanidae of Europe being the subject of the study are typical of the Subboreal Province but they also occurred in the adjoining parts of the Boreal and Submediterranean provinces. This family underwent a smooth evolutionary development in some stratigraphical intervals and fairly sudden turnovers in others. The beginning of the family (genus *Decipia*), and its following recovery (genus *Ringsteadia*) during the Late Oxfordian are related to marine transgressions which stimulated the ammonite evolution by unstable ecological conditions. The decline of faunal turnovers corresponds to high sea-level characterized by occurrence of small-sized cardioceratid ammonites, interpreted as nektopelagic. Such forms were associated with common development of the radiolarian faunas and the presence of nutrient-rich waters. A major turnover of Aulacostepahnidae is marked by splitting of *Ringsteadia* lineage into that of *Pictonia* (in NW Europe) and two others related to *Vineta* and *Vielunia* (in NE Europe). It corresponds to the Pseudocordata/Baylei zonal boundary (Subboreal) and the Hypselum/Bimammatum zonal boundary (Submediterranean) which define the base of the Kimmeridgian. The turnover is related to the allopatric speciation which resulted from geographical isolation of the marine basins by emergence of the separating land-barriers. The stratigraphical interval of the lowermost Kimmeridgian of the Baylei Zone in NW Europe and the Bimammatum and Planula zones in SE Europe is characterized by marked differences in ammonite faunas and the general type of deposits. The almost continuous succession of small cardioceratids in dark silty shales in NW Europe is possibly related to common occurrences of the shelf dysoxic-anoxic events (SDAE), whereas in SE Europe such conditions were encountered sporadically, being confined to specific levels where both small-sized cardioceratid and NW *Pictonia* migrants occurred. The strongly faunistically and lithologically contrasted interval of the lowermost Kimmeridgian corresponds of the 2nd order transgressive cycle. The ammonite turnover at the transition between the Planula-Platynota zones (Submediterranean) and at the end of the Baylei Zone (Subboreal) of the Lower Kimmeridgian is marked by the appearance of various heavily ribbed aulacostephanids. One of the most important Submediterranean to NE-Subboreal lineages consists of *Pictonia* (*Pictonites*), *P.* (*Pomerania*) and *Rasenia* (*Pachypictonia*), ranging from the Platynota Zone to the Hypselocyclum Zone. This was successively replaced by lineage comprising heavily ribbed *Vielunia* to *Eurasenia-Involuticeras.* The relationship between the development of the shallow-water carbonate deposits and the occurrence of the indicated aulacostephanid ammonites, especially of the former lineage, is clearly observed. This stratigraphical interval is characterized by strong progradation of the carbonate platforms corresponding to the 2nd order regressive cycle. The major aulacostephanid ammonite turnover is recognized at the boundary of the Hypselocyclum and Divisum zones (Submediterranean) and the base of the Askepta Subzone (Subboreal). It can be correlated with beginning of the new, large transgression resulting in appearance, and a wide distribution of new *Rasenioides* faunas in northern Europe. This, along with succeeding elimination of older aulacostephanids (*Rasenia*, *Eurasenia-Involuticeras*), replaced by new aulacostephanid lineages, opened a final stage in aulacostephanid history at the beginning of the Late Kimmeridgian.

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A NEW COMBINED HIGH-RESOLUTION JURASSIC C-ISOTOPE CHEMO- AND BIOSTRATOGRAPHIC CORRELATION FROM NORTHERN SWITZERLAND

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The Opalinus Clay, an argillaceous to silty claystone formation deposited mainly during the latest Toarcian to Early Aalenian, is the selected host rock for disposal of radioactive waste in Switzerland. With the aim of finding the best suited site for a deep geological repository, Nagra (National Cooperative for the Disposal of Radioactive Waste) in recent years has drilled nine deep boreholes in northern Switzerland. During this drilling campaign not only the Opalinus Clay but also the confining units were investigated in detail, as they additionally contribute to radionuclide retention in the geological barrier.

To establish a chronology in these Jurassic successions with the highest possible resolution we applied carbon-isotope chemostratigraphy combined with ammonite and palynomorph biostratigraphy. The metre-resolution of the sampling for isotope geochemical investigations allows a very detailed correlation and thus complements the biostratigraphic findings in intervals with increased sedimentation rates.

In this study, we took advantage of the fact that nine new deep boreholes were drilled over a distance of around 50 km, and that they can be compared with additional four existing drill cores. The dense underground recovery allows a detailed and unique investigation from the Early to Late Jurassic time period. The newly established C-isotope chemostratigraphy on carbonates and on organic matter provides sufficient variability (distinct negative and positive excursions) to establish a very high-resolution correlation for the Toarcian to the Kimmeridgian, which can be followed across all drill cores. The major perturbations in the C-isotopes such as the Toarcian Oceanic Anoxic Event (T-OAE), the positive shift during the Early Bajocian (Laeviuscula to Humphriesianum ammonite zones), as well as the Middle Oxfordian positive excursion are nicely documented. The several chemostratigraphic profiles allow a detailed correlation and interpretation of the Aalenian to Callovian time which, from a scientific point of view, is poorly documented compared to other successions in the Mesozoic.

ENHANCED GLOBAL WEATHERING IN RESPONSE TO CENTRAL ATLANTIC MAGMATIC PROVINCE ACROSS THE TRIASSIC–JURASSIC TRANSITION

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The Triassic–Jurassic transition (~201.5 Ma) is marked by a series of positive and negative carbon isotope excursions in marine and terrestrial sedimentary records, thought to reflect global carbon cycle perturbations in response to massive and abrupt carbon release from Central Atlantic Magmatic Province (CAMP) volcanogenic degassing. The associated doubling–tripling of atmospheric pCO_2 had major repercussions for global climate and environment, leading to global warming, ocean acidification and the development of marine anoxia, which are thought to collectively have led to the end-Triassic mass extinction, one of the 'Big Five' mass extinctions of the Phanerozoic.

Climatic and environmental change on land at this time is however relatively poorly understood, but major changes in terrestrial vegetation patterns and ecosystem compositions likely reflect major changes in humidity and may locally have led to significant increases in erosion and soil loss. Constraints on global weathering rates in response to major carbon release, and associated changes in global-average temperature and hydrological cycle, are limited for this time-interval, but are crucial to understand changes in the fluxes of elements and nutrients across Earth surface environments, and their cycling between the biosphere and geosphere. It is also crucial for understanding of the Earth system feedback mechanism in response to this major carbon cycle perturbation and mass extinction event.

Organic-rich sediments trace the evolution of the seawater osmium (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. Here, we present the first $^{187}Os/^{188}Os$ isotope data across the Triassic–Jurassic transition in the Prees core (Cheshire Basin, UK). The Prees Borehole, drilled in 2020 by the International Continental Drilling Program (ICDP) JET (Early Jurassic Earth System and Timescale) project, represents one of the most continuous and complete Triassic–Jurassic records worldwide (stratigraphy provided by the JET project initial data; Hesselbo et al. in prep). Our new Os-isotope data shows a major negative shift in values across the Triassic–Jurassic transition as a result of the CAMP emplacement, with superimposed a positive recovery right at the onset of the negative carbon-isotope excursion (reflective of global carbon release). The data suggest a major re-balancing in the relative importance of mantle vs. continental crustal weathering, suggesting a major change in continental global weathering rates at this time.

FIRST RECORD OF THE MIDDLE OXFORDIAN POSITIVE CARBON ISOTOPE EXCURSION WITHIN THE KORALLENOOLITH FORMATION, LOWER SAXONY BASIN, GERMANY

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The middle Oxfordian *transversarium* Zone is characterized by pronounced changes in the carbon isotope ($\delta^{13}C$) trend, recorded from various marine and terrestrial organic and inorganic substrates. These isotopic events have been associated with climate fluctuations, changes in marine carbonate production, and long-term sea-level rise. Unfortunately, a crucial $\delta^{13}C$ isotope data-set is still lacking for the Oxfordian within the Lower Saxony Basin (LSB), which complicates the calibration of the various sections from the LBS. In this study, a high-resolution inorganic carbon isotope record was obtained from a scientific borehole (Konrad # 101) from the southwestern part of the LSB in order to constrain carbon cycle dynamics and the palaeoenvironmental conditions during the Oxfordian. The observed $\delta^{13}C$ isotope trend in the lower part of the studied core (assigned to the Lower Korallenoolith Formation) shows a noticeable positive $\delta^{13}C$ excursion reaching up to 3.6 ‰ and then exhibits two short-lived negative $\delta^{13}C$ isotope excursions, followed by a relatively stable trend in the Upper Korallenoolith Formation. This stratigraphic pattern is similar in shape and magnitude to what is characteristically observed in middle to late Oxfordian carbonate isotope profiles from Europe, western Asia, and the Gulf of Mexico. Hence, the different records may reflect synchronous changes in the global marine dissolved inorganic carbon pool, probably in response to middle Oxfordian reef proliferation caused by climatic changes. This is the first record of the middle Oxfordian positive carbon isotope excursion within the Korallenoolith Formation in the LSB. Our high-resolution data-set prompts a re-evaluation of the nature and origin of middle Oxfordian carbon-isotope excursions.

NEW PERSPECTIVES ON OPALINUS CLAY FACIES DESCRIPTIONS BASED ON DRILL CORES FROM CENTRAL NORTHERN SWITERZLAND

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The Opalinus Clay, an argillaceous to silty claystone formation, is known in Switzerland as being the selected host rock for deep geological disposal of high-, intermediate- and low-level radioactive waste. Since the 1990s, various geotechnical, mineralogical and sedimentological properties of the Opalinus Clay have been studied within the framework of the Nagra (National Cooperative for the Disposal of Radioactive Waste) deep drilling campaigns and the Mont Terri Project (international research program dedicated to the investigation of claystone). The Opalinus Clay succession was deposited during the Late Toarcian to Early Aalenian in an epicontinental sea covering central Europe.

The Opalinus Clay is relatively homogeneous at formation-scale compared to other Mesozoic formations in northern Switzerland. At higher spatial resolution, however, sedimentological facies variations do occur. Besides meter-scale lithofacies variations, high, intra-facies lithological variability occur at dm- to cm-scale. The facies diversity is primary attributed to regional differences in depositional, environmental and diagenetic conditions. In order to harmonize petrographic descriptions in an objective and quantitative way within all fields of research related to the Opalinus Clay, a subfacies classification scheme has been developed. Five subfacies are distinguished by texture (grain size, bedding, fabric and colour) and composition (nature and mineralogy of components). The subfacies types can be further refined by additional attributes and sedimentary characteristics (biogenic, diagenetic, structural). Subfacies descriptions are crucial to understand the lateral and vertical facies variability at regional scale. Moreover, accurate petrographic descriptions are an important prerequisite to many geotechnical studies and the predictive modelling of petrophysical properties.

The main goal of the present study is to revise the subfacies classification model covering the entire Opalinus Clay succession of the Mont Terri rock laboratory and successions deposited further to the east where nine new drill cores are available. Based on the revised subfacies classification, facies and intra-facies variability will be captured and regional facies heterogeneities included at basin-scale. This will form the base for the revision of depositional models and the refinement of the lithostratigraphy for the Opalinus Clay using a basin-wide approach.

PELAGIC VS. NERITIC FORAMINIFERAL FAUNAL CHANGE DURING THE LATE PLIENSBACHIAN–LATE TOARCIAN, CAUSED BY ENVIRONMENTAL PERTURBATIONS

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During the late Pliensbachian–Toarcian interval, several global scale perturbations were recognized in the temperature and the sea-level which were driven by the changes in the concentration of the atmospheric CO_2. We aimed to study the effect of these environmental perturbations on the neritic foraminiferal fauna of the epicontinental carbonate-siliciclastic ramps of the Boreal-Atlantic Foraminiferal Biome and the hemipelagic-pelagic one from the Ammonitico Rosso-type carbonates of the Mediterranean Foraminiferal Biome.

The records were obtained from our research on the Hungarian sections and literature. The following sections were taken into consideration from the pelagic region: Bakonycsernye (Tűzkövesárok N and C, Kígyóvölgy) Bakony Mts, Hungary; Nagy-Pisznice and Tölgyhát Quarry sections, Gerecse Mts., Hungary; Büdöskút, Bükk Mts., Hungary; Iznalloz section, Betic Cordillera, Spain; Montebibico and Valdorbia sections, Umbria-Marche Apennines, Italy; and Anabrisada section, Ionian Basin, Greece.

From the neritic environment, we analyzed the fauna of the distal ramp from the sections of Réka Valley, Bakvölgy, Kasadó and Cseresnyák, Mecsek Mts., Hungary; Maria Pares and Peniche sections, Lusitanian Basin, Portugal; Saharan Atlas, Morocco, and Traras Mts., Algeria. The foraminifers of the transitional ramp from Lafarge Quarry, France and proximal ramp from Almonacid section, Betic Cordillera, Spain; San Andrés section, Basque-Cantabrian Basin; and Tournadous and Penne sections, France were also studied.

For the evaluation of the faunal changes microfacies studies, taxonomic and palaeoecological analyses (abundance, diversity, morphogroups, and ecozones) were used.

The foraminifera fauna indicated low to moderate oxygen levels in the upper Pliensbachian–lower Toarcian, high from the middle Toarcian. In the late Pliensbachian when the climate was relatively cold (JPl8 event), the faunal composition of the pelagic and neritic systems was similar. Everywhere, the order Lagenina was common, and within this suborder *Lenticulina*, ornamented *Paralingulina*, *Ichthyolaria*, and *Marginulina* were characteristic. The same foraminiferal biozones can be used for both biomes. Two main differences could also be recognized: the relative abundance of *Ammodiscus*–*Glomospira* species was higher in the pelagic region indicating that the farshore environments were nutrient-poor compared to the nearshore ones and in the neritic systems the dominance of the ornamented lenticulinids increased towards the coast.

In the early Toarcian, the differentiation of the foraminiferal composition of the pelagic and neritic systems became stronger because of global warming and sea-level rise (JTo1-3 events): The ornamented forms became subordinated and the opportunistic, epifaunal grazer spirillinids appeared in mass in the pelagic region while the neritic faunas hardly changed. The spirillinids could graze on a microbial and/or fungal biofilm or could be fed on marine snow. Thus, the existence of the main foraminiferal groups depended on the microbial activity which increased during the warmer intervals.

From the middle Toarcian, spirillinids became even more abundant in the pelagic region, similarly to the lenticulinids in the neritic region.

During the Toarcian OAE, no black shales occurred within the upper Pliensbachian – upper Toarcian Ammonitico Rosso successions in the pelagic system, but the change in the foraminiferal fauna was more distinct than in the neritic environment.

FIELD TRIP GUIDE

Mid-conference field trip of the 11th International Congress on the Jurassic System to Tata

31 August, 2022

KÁLVÁRIA HILL AT TATA: A FINELY EXPOSED SUCCESSION OF UPPER TRIASSIC TO LOWER CRETACEOUS MARINE SEDIMENTARY ROCKS CHARACTERISTIC OF THE ALPINE-CARPATHIAN REGION

ISTVÁN SZENTE

ELTE Tata Geological Garden, Hungary

Introduction and historical background

Kálvária Hill (Kálvária-domb in Hungarian or Calvary Hill, if fully translated) is a fault-bounded rocky horst of around 150 m altitude above sea level, located within the town of Tata at the foot of Gerecse Mountains, around 70 km to the west of Budapest (Fig. 1).

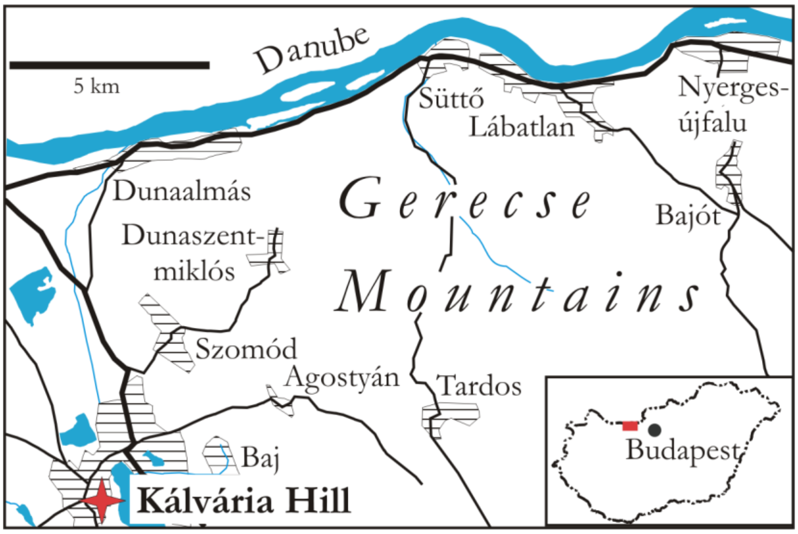

Fig. 1: Location of the Kálvária Hill

Abandoned quarries and cleaned rock surfaces concentrated in an area of approx. 4 ha over there are of outstanding historical as well as scientific importance for the Jurassic geology of Hungary. Now the hill is a nature conservation area protected by both Hungarian and municipal legislation. Thus, hammering and collecting is prohibited. Surrounded by an extensive area dominated by soft, easily weathering Cenozoic and Quaternary formations on the surface, hard Mesozoic rocks aroused the interest as early as the Copper Age when Middle Jurassic radiolarian chert was exploited by the ancient man (Fülöp 1973; Biró –T. et al. 2018). Several centuries later, quarries were opened in Upper Triassic, Lower Jurassic and Lower Cretaceous limestones. The Lower Jurassic red limestone, often called "marble" is by far the most conspicuous of them and has been especially widely used. Robert Townson, an English traveller and naturalist who visited Tata (that time called Dotis or Totis) in 1793, characterized it as "a town built upon a rock of variegated red marble" (Townson 1797).

Scientific study of the Kálvária Hill Jurassic began with the pioneering work of the acknowledged Austrian geologist Franz Ritter von Hauer. As a result of the study of a fossil collection made by Joseph Leopold Ferstl von Förstenau, he determined the Early Jurassic age of the red ammonite limestone (Hauer 1850). Also based on a specimen found by Ferstl at Tata, Hauer later introduced *Ammonites ferstli* (= *Adnethiceras ferstli*, according to Géczy, Meister 2007), the first Jurassic ammonite species described as new – and apparently the first one identified at the species level – from the territory of the present-day Hungary (Hauer 1853) (Fig. 2).

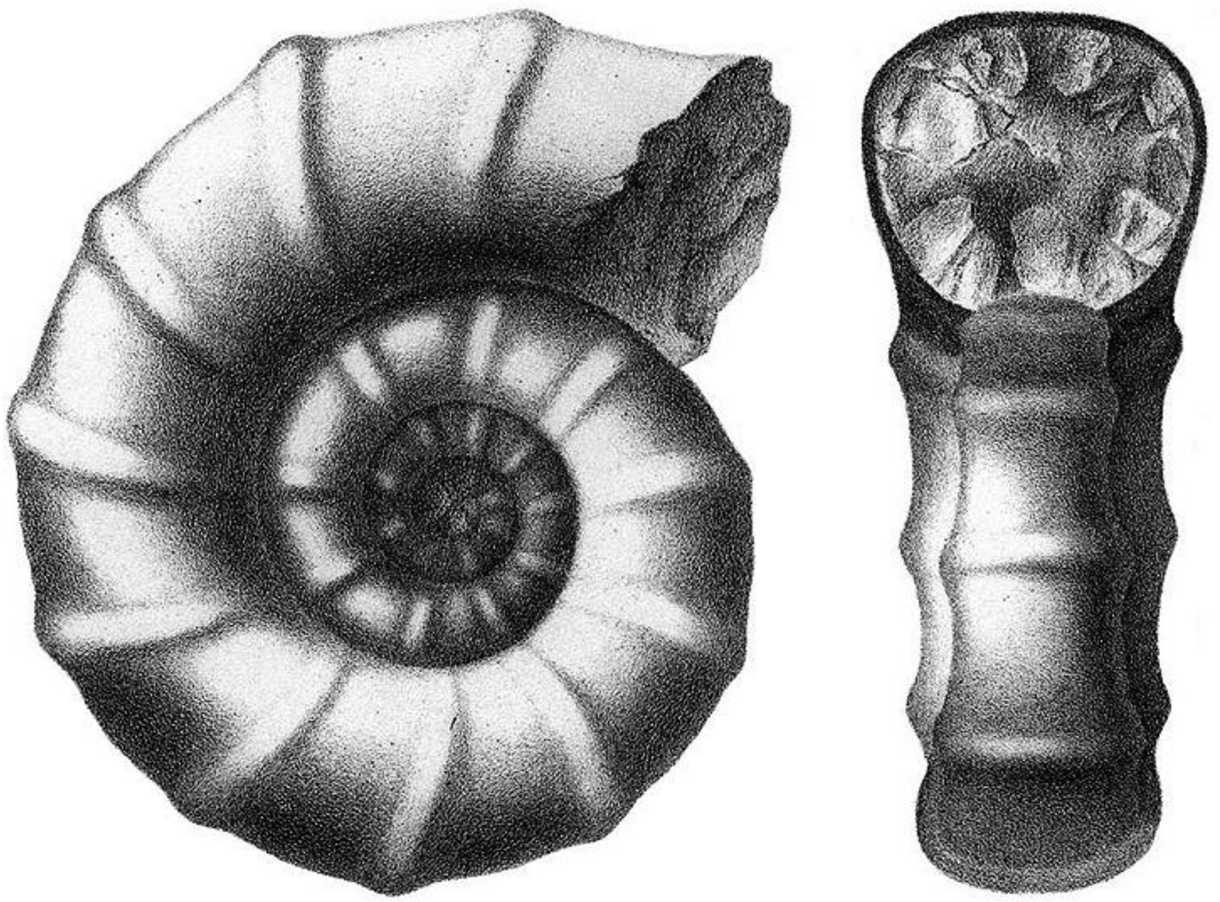

Fig. 2: Holotype of *Adnethiceras ferstli* (Hauer, 1853) as illustrated by Hauer (1854, pl. 2, figs 1, 2). Diameter of the specimen is near 10 cm

The first detailed account on the stratigraphy of the Kálvária Hill was given by Koch (1909). Observations were made mostly in three quarries, called Fehérkő-, Vöröskő-, and Kékkő-bánya (= Whitestone Quarry, Redstone Quarry and Bluestone Quarry if translated, respectively), operating at those times.

The '50s of the 20th century saw a remarkable renewed interest in the Mesozoic of the Kálvária Hill, resulting in the comprehensive works of Fülöp (1954) and Szabó (1961). József Fülöp (1928-1994), an extremely influential person in Hungarian geology from the early '50s until the end of '80s, had the opportunity to make large rock surfaces clean in order to study the Middle and Upper Jurassic rocks that have never been quarried for being unsuitable as building material. A detailed geological survey carried out by him led to the recognition of scientific and educational importance of the Kálvária Hill Jurassic succession, and a part of the hill was declared to be a nature conservation area in 1958. In the course of geological study, two chert mining pits dug by the Copper Age men were also discovered.

Quarrying came to an end completely in the late 1970s. By this time, the extent of the protected area had increased step-by-step to 3.5 ha and since 1976 it serves as an open-air geological museum, founded by the former Hungarian Geological Institute. The management of the site, now called at full length 'ELTE Tata Geological Garden – Nature Conservation Area and Open-Air Geological Museum', was taken over by the Eötvös Loránd University in 1994. Since then, it functions as a venue for public outreach, recreation and teaching. Its extent, visibility and accessibility make the Geological Garden one of the most valued Hungarian geosites. In addition to the geological and archaeological exploration, Fülöp intendedly converted the dusty abandoned quarries into a garden in every sense. As a result of this effort the Geological Garden now also houses a wealth of botanical values.

Until 1992, technicians from the former Geological Institute cleared away the soil and loose rock pieces as well as plants from the rock surfaces in the summer months. Around 1600 man-hours were needed once in two years to keep the area clean. In addition to the termination of this service, budget cuts resulted in the reduction of the staff members from five to two, making maintenance rather difficult. Rocky surfaces became more and more vegetated and covered with loose rock pieces and soil. In 2014, Eötvös University received a grant of € 175,300 from the European Union in the frame of the programme "Environment and Energy Operational Programme" (Project "Reconstruction of Key Geological Sections at the Tata Nature Conservation Area"). The support provided an opportunity to stop "forestation" and renewal the garden. The work was done in 2015 by a professional company, as well as by the staff of the Geological Garden. Plants, soil and loose rock pieces were removed from quarry walls and rock surfaces using hand tools. Nearly 60 cubic meters of rock debris and soil was removed. Thus, on average, a little more than 1 cm thick layer had to be removed. The actual amount, however, significantly depended on the dip of rocky surface and, principally, on lithology. The Toarcian marl and the Bathonian–Callovian radiolarite beds as well as the Middle Jurassic limestone were found especially deeply weathered.

The last five years saw a welcome increase in the number of the staff that makes maintenance much more efficient as compared to the preceding decades. Since 2016, one of the staff members has been working in the frame of the programme "Workfare work in museums", coordinated by the Hungarian National Museum, and another one is employed by the local community of Tata. In addition, since that year the botanical values of the Geological Garden have been maintained by a gardener expert employed by the University. As a consequence of the work carried out by the staff, long forgotten stairways and paths have been re-conquered from the vegetation since 2016. Maintenance of the chert pit excavated in 2015 as well as the state of the sub-horizontal cleaned rock surfaces raised the question whether or not they can be conserved for a long time in their present state. 3D scanning and filling them seem to be an alternative. In that case, visitors could see the rocks lying beneath their feet using VR glasses.

Stratigraphy and scientific significance of the Mesozoic succession of Kálvária Hill

On the Kálvária Hill an approx. 50 m thick Upper Triassic (Rhaetian) to Lower Cretaceous (Aptian) succession, subdivided into nine formations, is exposed (Fig. 3).

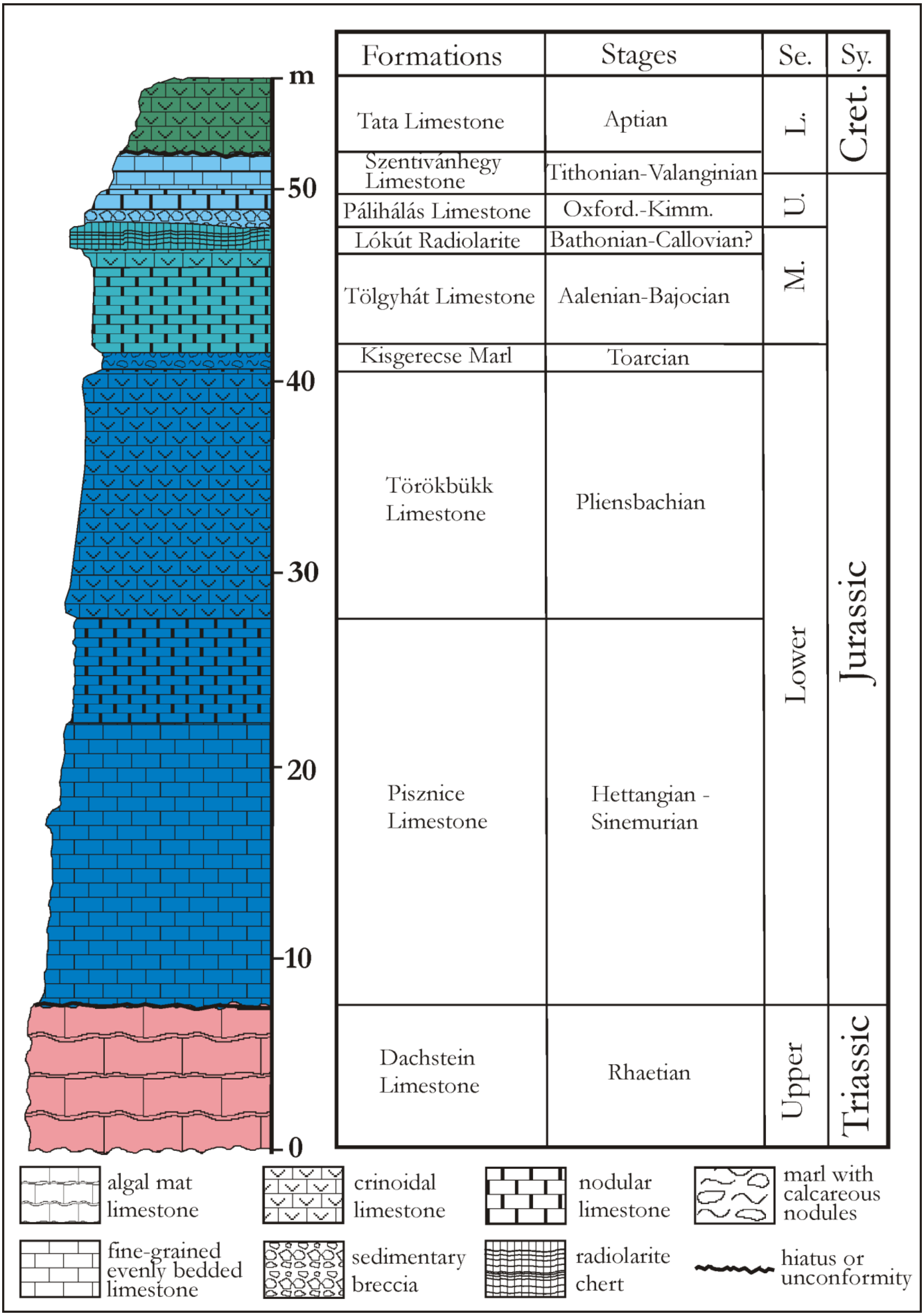

Fig. 3: Stratigraphic column of the Mesozoic cropping out on the Kálvária Hill. (Abbreviations: Oxford.–Kimm. = Oxfordian–Kimmeridgian; Se. = Series; L. = Lower; M. = Middle; U. = Upper; Sy. = System; Cret. = Cretaceous) (after Haas 2007, modified)

Stop 1. Whitestone Quarry

The oldest rock cropping out on the Kálvária Hill is the well-stratified Upper Triassic Dachstein Limestone, the namesake of the quarry, of which an approx. 12 m thick succession is exposed. The beds dip to the east at around 10-15°. Macro- and microfossils indicate a Rhaetian, *i.e.* Late Triassic age. A wide variety of sedimentary environments of the huge Late Triassic carbonate platform ranging from supratidal areas occasionally exposed sub-aerially for a longer time to lagoons of some meters of water depth are represented in the succession formed by six "Lofer" cyclothems (Fülöp 1976). Beds deposited in lagoons – corresponding to the "C" member of the cyclothems – are by far the thickest and contain abundant megalodontid bivalves studied in detail by Végh-Neubrandt (1982). More than 10 taxa have been recorded from there (Fig. 4).

Fig. 4: Cross-sections of megalodontid bivalves in the Dachstein Limestone

Weathered surface of megalodontid beds often display abundant gray calcite dots reaching 1 mm in diameter. These are cross-sections of the large-sized, presumably algal symbiont-bearing foraminifera *Triasina hantkeni* Majzon, 1954 (Fig. 5).

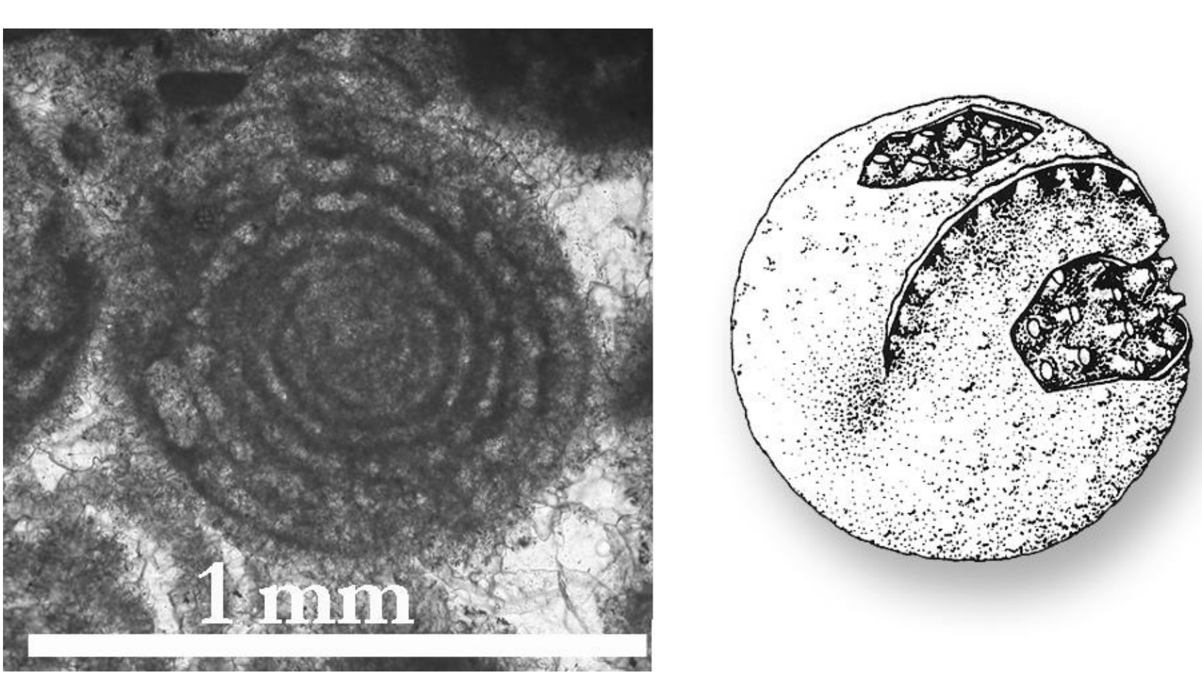

Fig. 5: Section and cut-away diagram of *Triasina hantkeni* (Drawing after Di Bari, Rettori 1996)

The genus *Triasina* was introduced in 1954, partly on the basis of specimens originated from the Dachstein Limestone penetrated by a borehole at Tata. Since its description, this peculiar form has been recorded from NW America (Yukon River region) throughout the Alpine-Himalayan Belt to the NW shelf of Australia (Exmouth and Wombat Plateaus), everywhere from Norian or Rhaetian rocks.

Although subordinate if their cumulative thickness is considered, beds deposited in intertidal environment ("B" member of the cyclothems) are also conspicuous, due to their texture. These limestone or dolomitic limestone beds display characteristic birds-eye and laminated microbial mat structures. Their fossil content is very poor, only foraminifers and ostracods have been encountered. Although "A" members witnessing sub-aerial exposure of the carbonate platform are even more uncommon, their brownish red, ochre or greenish gray colour makes them easily identifiable.

Another spectacular features exposed are the submarine fissure fillings (a. k. a. neptunian dikes) penetrating both the Dachstein Limestone and the overlying Lower Jurassic Pisznice Limestone. They are oriented in a NW–SE direction and their thickness ranges from some cm-s to some tens of cm-s. Their walls are covered with a layer of sparry calcite. The filling is predominantly pink or red fine-grained limestone often containing clasts of the host rock. Subordinately, fissures filled with red crinoidal limestone can also be encountered.

The Dachstein Limestone is overlain by pink then red fine-grained Jurassic limestone beds assigned to the Pisznice Formation. The boundary between the Triassic and Jurassic is a remarkably flat erosion surface truncating megalodontid bivalves at some places. According to Haas (1995) the surface cuts into different cyclothem members of the Dachstein Limestone indicating around 1.5-2° difference between the dip of the Triassic and the Jurassic successions. The Middle Hettangian age of the onset of Jurassic sedimentation was refined by Pálfy et al. (2007). Duration of the gap is discussed in detail in Pálfy et al. (2021) using inferences from cyclostratigraphic analysis. Fossils (ostracods and crinoids) extracted from the lowermost beds of the Pisznice Limestone indicate a depositional depth exceeding 200 m (Pálfy et al. 2007). Traditionally, the sharp boundary between the Upper Triassic carbonate platform deposits and the overlying deeper-water Lower Jurassic red limestone was regarded as a spectacular example of drowning unconformities (e. g. Haas et al. 2018). Pálfy et al. (2021), however, recently explained the demise of the Dachstein carbonate platform – partly on the basis of the study of Kálvária Hill section – by the ecological collapse of reefs once rimming the platform.

The lower 10 m of Pisznice Limestone, of which around 6 m is exposed in the Whitestone Quarry, is of massive appearance with hardly recognizable bedding. The basal 1 m is slightly darker than the overlying part and rich in crinoid, cephalopod, gastropod and brachiopod remains. The fossils are, however, hardly extractable from the rigid rock. At about 25-30 cm above the T/J boundary there is a 30-40 cm thick, poorly delineated layer containing oncoids of some cm in diameter. Encrusted shells of brachiopods and ammonites are relatively frequent while gastropods are subordinate elements of the macrofauna. In the upper 3 m the frequency of macrofossils gradually decreases. A dolomite body, a previously unknown phenomenon in deeper-water red Jurassic limestone of the Transdanubian Range was reported recently by Győri et al. (2018) from the lower part of the succession.

Stop 2. Redstone Quarry

The 100 m wide and around 15 m high quarry wall largely exposing a Lower Jurassic succession is by far the most prominent element of the view of the lower yard of the Geological Garden (Fig. 6).

Fig. 6: Aerial view of the Kálvária Hill with the Redstone Quarry appearing in the middle of the picture as a nearly horizontally elongated quarry wall. Photo taken by Norbert Varga (1974-2021)

The lower, massive member of the Pisznice Limestone is overlain by a light red, well-bedded interval of 4 m in thickness in which brachiopods are the dominant macrofaunal elements. Characteristic features of the upper 10 m of the formation include conspicuous stylolitic bedding planes as well as abundant intraclasts coated with Fe-Mn oxide. Brachiopods and ammonites are frequent, along with rare *Atractites*. The Pliensbachian Stage is thought to be represented by an intensively bioturbated encrinite, *i.e.* a crinoidal limestone known as Törökbükk Limestone Formation. Although named after a quarry situated in the northern Gerecse Mountains, this formation was introduced by Fülöp (1976) on the basis of the "Redstone Quarry" section.

The aforementioned two formations, commonly referred to as the "Gerecse red marble" in the older literature, have been exploited in the Gerecse Mountains for centuries, leaving a plenty of abandoned quarries usually hidden in the forest. Although ammonites can be found throughout the "red marble", no systematic bed-by-bed collecting work has been carried out yet. Thus, neither the exact positions of stage boundaries nor a zonal subdivision of the succession have been established yet. An overview of Hettangian and Sinemurian forms, based on old findings and accompanied with photos of some specimens can be found in Géczy (1976).

The "red marble" succession is more than 30 m thick, whereas the cumulative thickness of the younger Jurassic strata does not reach 15 m.

Stop 3. Fault zone

The Törökbükk Limestone is followed by a less than 1 m thick vivid red marl succession known as Kisgerecse Marl Formation. This latter formation of Toarcian age is a typical representative of the *rosso ammonitico* facies. It is rather poorly exposed on the surface due to its friable, recessive nature. The Kisgerecse Marl is one of the most fossiliferous formations of the Jurassic of the Gerecse Mountains and has yielded several thousands of ammonites collected bed-by-bed at four sections (Géczy 1985). In contrast, on the Kálvária Hill – probably due to its reduced thickness – it proved to be comparably poor in macrofossils.

At the eastern end of the large ENE–WSW striking quarry wall a normal fault running approximately parallel with it dissects the largely undisturbed "red marble" succession. There, Pisznice Limestone exposed in the lower half of the wall is juxtaposed with chaotically dipping younger Jurassic formations. A stone masonry was built to support the block of thinly-bedded Middle Jurassic limestone undercut by the erosion of the Kisgerecse Marl (poorly exposed). The Middle and Upper Jurassic as well as the Lower Cretaceous beds can be studied in excellent exposures some meters higher, on the upper terrace. The lower and upper terraces of the Geological Garden are connected by a stairway formed by and made of Lower Jurassic crinoidal limestone.

The latter formation is also well exposed in a neighbouring small quarry usually passed over when returning to the starting point of the guided tour. There, two memorial plaques also can be seen. One of them was unveiled in 1969 on the centenary of the Hungarian Geological Institute. The other one has been presented by the Eötvös Loránd University in 2008, on the occasion of the 50 year jubilee of the Geological Garden as a nature conservation area. Of historic interest, limestone blocks exploited in that quarry were used as plinth of the Joseph Stalin monument, erected in Budapest in 1951 and torn down in 1956, during the Hungarian Revolution.

Stop 4. Upper cleaned rock surface and Copper Age chert pits

On the upper terrace an area of near 2000 m^2 exposes the eastward dipping Pliensbachian to Lower Cretaceous succession, dissected by several normal faults. The older part of the Middle Jurassic series, attributed to the Tölgyhát Limestone Formation, is considerably diverse in facies: red, marly limestone rich in Fe-Mn oxide nodules, crinoidal layers as well as beds containing small-sized bivalve shells (*Bositra*) in rock-forming quantity occur. The Middle Jurassic biostratigraphy of the Kálvária Hill is poorly known. During the 2015 cleaning action ammonites indicating only the Sauzei Zone of the Bajocian were found (personal communication of András Galácz). According to Fülöp (1976), however, Aalenian (Murchisonae Zone) and younger Bajocian (Humphriesianum Zone) ammonites also occur. These findings, however, have not been documented yet in detail.

In the second half of the Middle Jurassic the nature of sedimentation changed fundamentally: accumulation of carbonates was largely replaced by silica-rich deposits now forming the Lókút Radiolarite Formation. The material of the minute siliceous tests of radiolarians was usually dissolved during diagenesis and has been precipitated as chert layers and nodules, later exploited by the Copper Age men. The pits, now protected by an exhibition building, are the only prehistoric mining sites accessible to visitors in Hungary. Due to weathering, the originally dark red chert occurs as white or gray debris on the surface.

The basal member of the Upper Jurassic is a peculiar sedimentary breccia bed of some tens of centimetres in thickness, forming a conspicuous marker horizon covering the radiolarite much less resistant to surface weathering. The origin of the enigmatic "Oxfordian Breccia" (also known as "Oxfordian Bed"), a widespread member in the Gerecse Jurassic characterised in detail by Fodor and Főzy (2013), is still to be explained. According to Fodor and Főzy (2013), it represents most probably a single depositional event, e.g. gravity-driven re-deposition of lime mud. On the other hand, $\delta^{13}C$ values commonly show a systematic shift through the bed, indicating deposition over an extended period (Price 2013).

Stop 5. Bluestone Quarry

Higher parts of the Upper Jurassic as well as the lowermost Cretaceous are developed in a thin succession of red and light gray pelagic limestone. The Jurassic/Cretaceous boundary can be drawn within the calpionellid-rich Szentivánhegy Limestone. This formation represents the Tithonian, Berriasian and part of the Valanginian stages and was named after the medieval settlement (Szentivánhegy) once located on the Kálvária Hill, that time called Szentiván Hill. The Jurassic/Cretaceous boundary beds were studied in detail by Szinger et al (2007).

The Upper Jurassic and Berriasian beds are rich in fossils of which ammonites are by far the most common. Bedding planes of the condensed Pálihálás Limestone of Kimmeridgian age appear as "ammonite pavement" and are one of the highlights of the Geological Garden (Fig. 7). Altogether, nearly 1200 ammonite specimens, along with around 150 brachiopods and 20 bivalves were collected from the Oxfordian–Berriasian interval. Other groups such as corals and gastropods are represented by only very few specimens. Unfortunately, the diverse ammonite assemblages studied by the late expert Gusztáv Vigh have been documented mostly in the form of faunal lists and only some photos were published by Vigh (1971, 1981) and Fülöp (1976). Tithonian bivalves were described recently by Szente (2013).

Fig. 7: A perisphinctid (?) ammonite in the Kimmeridgian limestone exposed at the Bluestone Quarry

Hard-grounds and clasts coated with Fe-Mn oxide are common throughout the Kimmeridgian. The Kimmeridgian beds exposed at the Bluestone Quarry are dissected by a network of fissures with Lower and/or Upper Tithonian infill. The infill of fissures as well as the basal beds of the Tithonian limestone contains abundant debris and blocks of older limestone, indicating significant erosion and re-deposition. Although the Jurassic succession of the Kálvária Hill was studied in detail in the past, some important questions still remain unanswered. Identification of the Tithonian bed from which the calcareous alga *Clypeina jurassica* was identified by Szabó (1961) is a challenge, this tantalizing record being the first evidence of a photic zone organism in the Upper Jurassic of the Transdanubian Range.

The present-day area of the Transdanubian Range was deformed during the Berriasian to Barremian Ages of the Early Cretaceous, due to the first Eoalpine compressional phase. As a result, a submarine high (fore-bulge) located in its central part including the environs of Tata, was formed (Tari 1994; Budai et al. 2018). There, the more or less continuous marine sedimentation that began in the Olenekian Age of the Early Triassic and lasted for more than 110 million years until the Valanginian Age of the Cretaceous was interrupted. On the Kálvária Hill approximately 20 million years, representing the Late Valanginian, Hauterivian, Barremian and Early Aptian Ages, are not recorded in rocks. It is worth mentioning that almost exactly the same stratigraphic interval is represented by a several hundreds of meters thick marl and sandstone succession exposed in large quarries south of the town of Lábatlan, located at a distance of less than 20 km to the NE of Tata. The sedimentation, renewed around 115 million years ago in the Clansayesian Substage of the Late Aptian, led to the deposition of the Tata Limestone Formation, *i.e.* the namesake of the Bluestone Quarry. Outcrops of this formation are scattered along a more than 100 km long belt in the Transdanubian Range between Tata and the town of Sümeg situated in the SW. At the Kálvária Hill it overlies the eroded surface of tilted Upper Jurassic limestone beds, providing a spectacular example of angular unconformity. The surface is encrusted by a brownish-yellow, laminated phosphorite layer formed under anoxic conditions (Molnár et al. 2018).

The Tata Limestone, once exploited in the "Bluestone Quarry" at the Kálvária Hill, is the youngest known example of the vanished lithofacies "regional encrinite" sensu Ausich (1997), *i.e.* a crinoidal formation of several tens of meters thickness and several tens of kilometres areal extent, which has no counterpart in modern seas. Type sections of both the Szentivánhegy and Tata Limestone Formations have been designated in the "Bluestone Quarry" by Fülöp (1976).

The Tata Limestone is an appropriate building stone – for example, the Tata Castle was largely built of it at the beginning of the 15th century – but extremely poor in identifiable fossils. In small depressions of the uneven top surface of the Upper Jurassic limestone, however, a large amount of fossils, especially ammonites, brachiopods and gastropods have been found. The ammonite assemblage was described by Szives (2007). Several new ammonite species including *Constrictoceras foezyi* – named after the acknowledged palaeontologist István Főzy – and *C. steineri* – named after Tibor Steiner (1940–2021), the leading collector of the "Fülöp Aptian Collection" and a former enthusiastic keeper of the Geological Garden – have recently been described by Szives (2008) from the area. Such limestone bodies full of fossils were encountered at the base of the crinoidal limestone succession proper only at three places in the whole Transdanubian Range. Cretaceous rocks younger than the Tata Limestone do not occur within the Geological Garden, although they are known from the subsurface as encountered in trenches, wells and boreholes to the north-east and south-east.

References

Ausich, W. I. (1997): Regional encrinites: a vanished lithofacies. In: Brett, C. E., Baird, G. C. (eds) Paleontological Events, Stratigraphic, Ecological and Evolutionary Implications. Columbia University Press, New York, pp 509–520.

Biró –T. K., Harman –Tóth, E., Dúzs, K. (2018): New research at Tata-Kálváriadomb, Hungary. In: Werra, H. D., Woźny, M. (eds) Between History and Archaeology – Papers in honour of Jacek Lech. Archaeopress Publishing Ltd, Oxford, pp 49–57.

Budai, T., Fodor, L., Csillag, G., Kercsmár, Zs., Sztanó, O., Selmeczi, I., Lantos, Z., Ruszkiczay-Rüdiger, Zs. (2018): Geological history of the Gerecse. In: Budai, T. (ed.) Geology of the Gerecse Mountains. Mining and Geological Survey of Hungary, Budapest, pp. 387–398.

Di Bari, D., Rettori, R. (1996): Morphological features of Triasina hantkeni Majzon, 1954 (Foraminiferida, Aulotortidae) and remarks on the test wall structure. Revue de Micropaléontologie 39(4): 305–313.

Fodor, L., Főzy, I. (2013): Late Middle Jurassic to earliest Cretaceous evolution of basin geometry in the Gerecse Mountains. In: Főzy, I. (ed.) Late Jurassic–Early Cretaceous fauna, biostratigraphy, facies and deformation history of the carbonate formations in the

Gerecse and Pilis Mountains (Transdanubian Range, Hungary). GeoLitera Publishing House, Institute of Geosciences, University of Szeged, pp 117–135

Fülöp. J. (1954): Geological study of the Mesozoic horst block of Tata. Földtani Közlöny 84: 309–325 (in Hungarian).

Fülöp J (1973) Funde des prähistorisches Silexgrubenbaues am Kálvária-Hügel von Tata. Acta Archaeologica Academiae Scientiarum Hungaricae 25: 4–25.

Fülöp J (1976) The Mesozoic basement horst blocks of Tata. Geologica Hungarica Series Geologica 16: 2–229

Galácz, A. (1989): Tata, Kálvária Hill, Geological Conservation Area. Upper Triassic – Jurassic – Lower Cretaceous sequence. In: Császár, G. (ed.) IAS Tenth Regional Meeting Excursion Guidebook, pp. 136–143.

Géczy, B. (1976): Lower Liassic Ammonites. In: Fülöp, J. (1976), pp. 30–32.

Géczy, B. (1985): Toarcian Ammonite Zones in the Gerecse Mountains, Hungary. In: Michelsen, O., Zeiss, A. (eds) International Symposium on Jurassic Stratigraphy (Erlangen) I, pp. 218–226.

Géczy, B., Meister, C. (2007) Les ammonites du Sinémurien et du Pliensbachien inférieur de la montagne du Bakony (Hongrie), Revue de Paléobiologie 26: 137-305

Győri, O., Mindszenty, A., Haas, J., Czuppon, Gy. (2018): The dolomite body in the Lower Jurassic limestone of the Kálvária Hill, Tata. Földtani Közlöny 148: 27–34.

Haas, J. (1995): Upper Triassic platform carbonates in the Northern Gerecse Mts. Földtani Közlöny 125: 259–293.

Haas, J. (2007): Geological Garden in Tata, Transdanubian Range, Hungary. Nova Acta Leopoldina Neue Folge 94: 237–251.

Haas, J., Győri, O., Kocsis, T. Á., Lantos, Z., Pálfy, J. (2018): Global crisis at the Triassic-Jurassic boundary and its stratigraphic record in Hungary. Földtani Közlöny 148(1): 9–26.

Haas, J, Hámor, G. (2001) Geological garden in the neighborhood of Budapest, Hungary. Episodes 24: 257-261.

Hauer, F. R. von (1850): Ueber die Gliederung der geschichteten Gebirgs bildungen in den östlichen Alpen und den Karpathen. Sitzungsberichte der mathematisch-naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften, Wien 4: 274–314.

Hauer, F. R. von (1853): Ueber die Gliederung der Trias-, Lias- und Juragebilde in den nordöstlichen Alpen. Jahrbuch der kaiserlich-königlichen geologischen Reichsanstalt 4: 715–783.

Hauer, F. R. von (1854): Beiträge zur Kenntnis der Capricornier des österreichischen Alpen (Mit III Tafeln.). Sitzungsberichte der mathematisch-naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften, Wien13: 94 - 121.

Koch, N. (1909): Die geologische Verhältnisse des Kalvarienhügels von Tata. Földtani Közlöny 39: 285–307

Molnár, Zs., Kiss, Gabriella B., Dunkl, I., Czuppon, Gy., Zaccarini, F., Dódony, I. (2018): Geochemical characteristics of Triassic and Cretaceous phosphorite horizons from the Transdanubian Mountain Range (western Hungary): genetic implications. Mineralogical Magazine 82(S1): S147–S171.

Pálfy, J., Dulai, A., Szente, I. (2007): 2.1/a. Kálvária Hill Quarry, western yard. Upper Triassic (Rhaetian) and Lower Jurassic (Hettangian), Dachstein Limestone and Pisznice Limestone formations. In: Pálfy, J., Pazonyi, P. (eds) Palaeontological field-trips in Hungary and Transylvania. Hantken Press, Budapest, pp 41–44 (in Hungarian).

Pálfy, J., Kovács, Zs., Demény, A., Vallner, Zs. (2021): End-Triassic crisis and "unreefing" led to the demise of the Dachstein carbonate platform: A revised model and evidence from the Transdanubian Range, Hungary. Global and Planetary Change 199,103428.

Price, G. D. (2013): Stable isotope variation in the Late Jurassic of the Gerecse Mountains, Hungary. In: Főzy, I. (ed.) Late Jurassic–Early Cretaceous fauna, biostratigraphy, facies and deformation history of the carbonate formations in the Gerecse and Pilis Mountains (Transdanubian Range, Hungary). GeoLitera Publishing House, Institute of Geosciences, University of Szeged, pp 95–99.

Szabó, I. (1961): Die Ausbildungen der mesozoischen Scholle von Tata aus der Jurazeit. Annales Instituti Geologici Publici Hungarici 49: 599–605.

Szente, I. (2013): Late Jurassic bivalves from the Gerecse Mountains and its environs (Transdanubian Range, Hungary). In: Főzy, I, (ed.) Late Jurassic–Early Cretaceous fauna, biostratigraphy, facies and deformation history of the carbonate formations in the Gerecse and Pilis Mountains (Transdanubian Range, Hungary). GeoLitera Publishing House, Institute of Geosciences, University of Szeged, pp. 361–375.

Szente, I., Harman-Tóth, E., Weiszburg, T. G. (2019a): The Geological Garden at Tata (Hungary): A geosite of outstanding scientific and geo-educational significance. European Geologist 48: 33–37.

Szente, I., Takács, B., Harman-Tóth, E., Weiszburg, T. G. (2019b): Managing and Surveying the Geological Garden at Tata (Northern Transdanubia, Hungary). Geoheritage 11: 1353–1365.

Szinger, B., Görög, Á., Császár, G. (2007): Late Jurassic - Early Cretaceous sections from Tata (Pelso Unit, Hungary): sedimentology, marine palaeontology, palaeoenvironment. Geophysical Research Abstracts 9, 08989, 2007 SRef-ID: 1607-7962/gra/EGU2007-A-08989

Szives, O. (2007): Aptian Stage. In: Szives, O. (ed.) Aptian-Campanian ammonites of Hungary. Geologica Hungarica Series Palaeontologica 57: 31–74.

Szives, O. (2008): Two new species of *Constrictoceras* nov. gen. (Ammonoidea) from the Early Cretaceous (Aptian) of Hungary. Geobios 41: 297–308

Tari, G. (1994): Alpine Tectonics of the Pannonian Basin. PhD thesis, Rice University, 501 p.

Townson, R. (1797): Travels in Hungary with a short account of Vienna in the year 1793. GG and J Robinson, London, 570 p.

Végh-Neubrandt, E. (1982): Triassische Megalodontaceae – Entwicklung, Stratigraphie, Paläontologie. Akadémiai Kiadó, Budapest, 526 p.

Vigh, G. (1971): Oberjurassische — berriasische Ammonoideen-Faunen aus dem Nordteil des Transdanubischen Mittelgebirges. Annales Instituti Geologici Publici Hungarici 54(2): 263–274.

Vigh, G. (1981): Neue sowie pathologische Braciopoden und Ammoniten aus den jurassischen Schichten des Kalvarien-Hügels von Tata. A Magyar Állami Földtani Intézet Évi Jelentése az 1979. évről: 333–355.

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