

MagellanPlus: **TIMOR**

Tracing **M**onsoon, **O**cean currents and diagenetic carbon **R**edistribution

(19-22 May 2022, Vienna, Austria)



Summary

The idea of the workshop originated from the need to find modern-day examples of early diagenetic carbonate cementation in the shallow marine realm. All shallow marine limestones in the rock record have gone through this process, but it has never been observed in-situ. Current models of the early lithification of shallow marine limestones are based on some major assumptions that remain to be tested by the real world. As the Australian carbonate shelf was one of the best regions to study this question, we decided to combine it with the geographically more focussed questions around the Quaternary history of the Australian Monsoon and the Palaeoceanography of the Timor Sea. The workshop was planned to take place just before EGU and when EGU was moved due to Covid, we postponed the workshop to match the new EGU dates.

The aims of the workshop were to find locations and methodological approaches that would make it possible to carry out the science linked to both, questions of early diagenesis and questions of palaeoclimate and palaeoceanography, with the ultimate aim to write a combined MSP proposal. The first day contained a set of academic keynotes across a broad set of topics pertinent to both research areas covering sedimentological and geochemical aspects of early diagenesis, the roles of taphonomy and microbiology in diagenesis, and the palaeoclimate/palaeoceanography context of north western Australia. Keynotes were followed by discussions aimed at defining the scientific objectives and narrowing down possible drilling sites. The second day started with technical keynotes by the ECORD science operators and Allisson Schaap (National Oceanographic Centre, Southampton) talking about new developments in in-situ porewater measurements. The rest of the second and third day were spent in discussion groups to further narrow down the most suitable drilling sites, identify the most suitable platform, drilling methods, and analytical approaches.

From a CaCO_3 diagenesis perspective, drilling sites were constrained by the need to avoid the influence of freshwater diagenesis during the last glacial maximum, to have a varied and abundant mineral composition of the primary sediment (particularly a high amount of aragonitic components), and to have a range of grain-size and organic carbon variability across the sites. Furthermore, sites with significantly high water energy (e.g. due to tidal waves) needed to be avoided. From a palaeoceanographic/palaeoclimate perspective, it was desired to have a transect through the Timor strait and to get as continuous records as possible for the past 2 million years.

A particular challenge lies with finding and sampling the first sedimentary layers with early diagenetic carbonate cements and/or lithified limestone beds. Conventional drilling by APC or HAPC coring struggles with the expected sudden change in lithification and often results in the obliteration of primary sedimentary/diagenetic textures. Another challenge is also the measurement of ephemeral porewater parameters (particularly related to the carbonic acid system) as these change with degassing in the course of core retrieval.

An important aspect of early CaCO_3 diagenesis is how the primary CaCO_3 components are taphonomically filtered in the taphonomically active zone (ca. uppermost 1m of the sediment column). It became clear in the course of the workshop that this is outside the scope of ECORD/IODP projects as it too shallow. It was decided that a separate working group be formed to explore alternative funding for this particular aspect.

The workshop was a highly interdisciplinary and international experience with 47 registered participants (15 of them participated virtually) from 18 countries, including 5 PhD students and 6 postdoctoral early career scientists. The workshop was conducted in a very collaborative spirit and the following questions/objectives emerged for an MSP proposal:

CaCO₃ diagenesis:

- Where in the upper sediment column does early diagenetic CaCO₃ dissolution and precipitation happen in calcareous sediments? How is this linked to aragonite content and C_{org}? All calcareous rocks experienced early diagenesis, but it has never been observed in real world early marine burial.
- The sulfate-methane transition zone (SMTZ) is expected to play a critical role in the CaCO₃ cycle (but the processes have never been directly observed) and the microbial control of the position (and function?) of the SMTZ is poorly understood.
- How do different 'diagenetic fuels' (aragonite, calcite, C_{org}), 'diagenetic agents' (microbes, other biota) and the resulting geochemical gradients interact?
- How much of the primary CaCO₃ and C_{org} is buried, recycled, or lost? And what are the implications for the carbon cycle?
- Under which conditions are primary climate/environmental signals overprinted / obscured by diagenetic processes?
- What is the role of microbial biogeography/biodiversity in diagenesis?

Palaeoceanography / Palaeoclimate:

- What was the Australian Monsoon's past variability, its forcing processes and the coupling to Northern Hemisphere monsoonal subsystems?
- What was the Australian Monsoon's impact on latitudinal/interhemispheric temperature gradients, sea level, greenhouse gases, and what are the linkages to ENSO and IOD dynamics?
- What is the influence of the Indonesian throughflow (ITF) and the West Pacific Warm Pool on the Indian Ocean's heat budget and circulation? What are the implications for regional and global climate?
- How are the Holloway and Leuwing currents linked to ITF variability and eustatic sea level? How is its variability linked to tropical and subtropical reef development along the western Australian margin?

The workshop was concluded by assigning active participants to three separate working groups: a group focussing on seismic data, and two groups to focus on the scientific writing of the CaCO₃ diagenesis and palaeoceanography/palaeoclimate areas, respectively. The aim is to write a MSP pre-proposal.

Participants (PhD = PhD student; PD = postdoc or recently offered first faculty position):

	Last Name	ECS	virtual	Institution	Country
organisers					
Uwe	Balthasar			University of Plymouth	UK
Jennifer	Biddle			University of Delaware	USA
Clara	Boulton		YES	Cerege	France
Hal	Bradbury	PD		University of Cambridge	UK
David	De Vleeschouwer			University of Münster	Germany
Ann	Holbourn		YES	University of Kiel	Germany
Wolfgang	Kuhnt		YES	University of Kiel	Germany
Axel	Munnecke			University of Erlangen	Germany
Theresa	Nohl	PD		University of Erlangen	Germany
Kirsty	Wright	PD	YES	between jobs	UK
Martin	Zuschin			University of Wien	Austria
keynote speakers					
Brad	Opdyke			Australian National University	Australia
Steve	Gallagher		YES	University of Melbourne	Australia
Adam	Tomašových			Slovakian Academy of Science	Slovakia
Hildegard	Westphal			KAUST / University of Bremen	Saudi Arabia
Paul	Wright		YES	Cardiff	UK
Anne-Sofie	Ahm	PD		University of Victoria	Canada
Jeffrey	Marlow			Boston University	USA
Allison	Schaap			NOC	UK
David	McInroy		YES	BGS	UK
Patrizia	Geprägs		YES	MARUM	Germany
other participants					
Peter	Clift			Louisiana State University	USA
Gerald	Auer			University of Graz	Austria
Adnan	Ullah			Karakoram International University	Pakistan
Muhammad	Awais	PhD		University of Naples	Italy
Lars	Reuning		YES	CAU Kiel	Germany
Song	Zhao	PhD		Australian National University	Australia
Faheem	Ahmed		YES	University of Peshawar	Pakistan
Udara	Amarathunga		YES	Australian National University	Australia
Johnthini	Munir Ahamed		YES	Kaohsiung Medical University	Taiwan
Niklas	Hohmann	PhD		University of Warsaw	Poland
Benjamin	Petrick			Kiel University	Germany
Eun Young	Lee	PD		University of Vienna	Austria
Maria	Mesar	PhD		University of Vienna	Austria
Patrick	Moss		YES	The University of Queensland	Australia
Craig	Oakley			The Mountbatten School	UK
Sergio	Herrera		YES	ICP-Ecopetrol	Columbia
Udara	Amarathunga		YES	Australian National University	Australia
Stephen	Lokier			University of Derby	UK
Ayushi	Ram		YES	Indian Institute of Technology	India
Emilia	Jarochowska			Kharagpur Utrecht University	Netherlands
Arvind	Shukla	PhD	YES	CSIR-National Institute of Oceanography	India
Oliver	Suplius	PD		Utrecht University	Netherlands
Jinpeng	Zhang			Guangzhou Marine Geological Survey, China Geological Survey	China
Thomas	Teillet	PD		KAUST	Saudi Arabia
Beth	Christensen			Rowan University	USA
Devapriya	Chattopadhyay			IISER Pune	India

TIMOR - Magellan Plus Workshop / 18th – 21st of May 2022

Location: University of Vienna (Austria), Geozentrum (Althanstraße)

Key	Presentations	Discussions in subgroups	Discussions with all participants	Breaks
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DAY 1 – Thursday 19th of May 2022

Time	Title	Speaker(s)
09:00 – 09:15	Welcome	
09:15 – 09:45	Introduction: Aragonite-driven early diagenetic carbon redistribution	Uwe Balthasar / Hal Bradbury / Axel Munnecke / Theresa Nohl
09:45 – 10:15	Introduction: Palaeoclimate / Palaeoceanography of the Timor Sea	Clara Bolton / Ann Holbourn / Wolfgang Kuhnt / David De Vleeschouwer
10:15 – 10:45	Keynote: Palaeoclimate / Palaeoceanography	Brad Opdyke
10:45 – 11:00	Coffee Break	
11:00 – 11:30	Keynote: Taphonomy of biogenic carbonate production	Adam Tomašových
11:30 – 12:10	Keynote: Carbonate Diagenesis 1	Hildegard Westphal / Paul Wright
12:10 – 12:40	Keynote: Carbonate Diagenesis 2	Anne-Sofie C. Ahm
12:40 – 14:00	Lunch Break	
14:00 – 14:40	Keynote: Microbiology	Jennifer Biddle / Jeffrey Marlow
14:40 – 15:10	Keynote: Drilling in North Australia	Steve Gallagher
15:10 – 15:40	Coffee Break	
15:40 – 16:30	2 Discussion Groups: Group 1: Palaeoclimate / Palaeoceanography Group 2: Diagenesis / Taphonomy / Sedimentology / Microbiology	Aims: Define Scientific Objectives and relate them to IODP Science Plan
16:30 – 17:00	Feedback from discussion groups (15 min. per group)	
17:00 – 18:00	Discussion (all participants): Which sites to choose?	Aim: Narrow down the list of drilling sites

DAY 2 – Friday 20th of May 2022

Time	Title	Speaker(s)
09:00 – 09:30	Keynote: Drilling and sampling alternating lithified / unlithified layers	ECORD Science Operators (exact speaker tbc)
09:30 – 10:00	Keynote: Sampling pore water chemistry	ECORD Science Operators (exact speaker tbc)
10:00 – 10:30	Keynote: In-situ pore water measurements	Allison Schaap
10:30 – 11:00	Coffee break	
11:00 – 12:30	2 Discussion Groups: Group 1: Palaeoclimate / Palaeoceanography Group 2: Diagenesis / Taphonomy / Sedimentology / Microbiology	AIM: Define drilling / sampling strategy
12:30 – 13:00	Report from discussion groups (15 min. per group)	
13:00 – 14:00	Lunch break	
14:00 – 15:30	Focus groups for the different scientific objectives	AIM: Formulate science objectives for proposal
15:30 – 16:00	Coffee break	
16:00 – 16:30	Summary of proposal and organisation of focus groups to work on remaining aspects of the proposal	
16:30 – 18:00	Focus groups NOTE: this is responsive to earlier progress	AIM: finish off / develop further aspects of the proposal

DAY 3 – Saturday 21st of May 2022

Time	Title	
09:00 – 09:30	Summary of proposal and organisation of focus groups to work on remaining aspects of the proposal	
09:30 – 11:00	Focus groups NOTE: this is responsive to earlier progress	AIM: finish off / develop further aspects of the proposal
11:00 – 11:30	Coffee break	
11:30 – 13:00	Focus groups NOTE: this is responsive to earlier progress	AIM: finish off / develop further aspects of the proposal
13:00 – 14:00	Lunch break	
14:00 – 16:00	Focus groups NOTE: this is responsive to earlier progress	AIM: finish off / develop further aspects of the proposal
16:00 – 17:00	Reports from breakout groups and Conclusions	