MagellanPlus Workshop

Indian Ocean Delving into the Past "IO:DIP"

Workshop dates: 27th to 30th of September 2022
Graz, AUSTRIA

Summary of the Workshop

History of IO:DIP: The workshop was initially planned for 2020 and was intended to define and incubate new proposals for the 2nd phase of IODP. The COVID-19 pandemic resulted in a 2-year delay and shifted the workshop close enough to the end of this phase of IODP that only MSP proposals were being accepted, so time was spent on discussing how to structure proposals during this period of uncertainty. It should be noted that an online event was held to provide continuity for the project (DATE) and was successful (Expand). This workshop was designed to usher a new generation of scientists towards a new phase of IODP and did so by introducing them to the procedures currently being utilized while providing them with tools to write excellent proposals in the new phase of scientific ocean drilling.

Workshop Goals: This workshop was designed to define overarching community-driven research goals that strategically strengthen forthcoming Indian Ocean drilling proposals and directly link to the new IODP Science Plan. This outline was shifted during the 2-year interim to also push forward in the current climate of uncertainty, following the end of the current phase of IODP and the restructuring of the next phase starting after 2024. To this effect, the panel discussion on the first day was in part dedicated to the question of how the community will be able to generate pressure towards funding agencies and stakeholders of IODP in order to continue the highly successful research endeavors in the region. A strong focus was placed on identifying the key open questions still to be answered through a new phase of scientific drilling in the Indian Ocean while putting forth the next generation of researchers (**Goal 1**). The first task was to identify big questions from disciplinary perspectives, cross-pollinate by switching groups, map the questions to the 2050 Framework, and identify working groups to develop proposals around those questions.
Additionally, a second goal (**Goal 2a**) was to revise a recently deactivated proposal (Broken Ridge) and define overarching scientific objectives with existing (Kerguelen Plateau Climate Chronicles) and new pre-proposal (Tasman Leakage) in development. Based on clear community interest, a dedicated breakout group, began to develop a new pre-proposal in the Western Indian Ocean (Mascarene Plateau, **Goal 2b**). The structure of the workshop facilitated both goals by spending Day 1 on a series of talks that presented drilling ideas (recently deactivated or imagined), results, and overviews of previous expeditions. Day 2 was focused on defining the big questions (**Goal 1**) and restructuring/rethinking the Broken Ridge proposal idea (**Goal 2**), within dedicated breakout groups. Day 3 was spent considering the best locations and approaches for answering the big questions through scientific ocean drilling and identifying working groups to move forward in future workshops to fully develop the proposal focusing on the Mascarene Plateau (**Goal 2b**).

Workshop Participants: The workshop included a substantial amount of European early career researchers, many still Ph.D. students, and so many were both unfamiliar with the proposal process, history of ocean drilling (and thus the availability of older workshop reports and the list of active proposals), or some of the practical decisions that go into creating a drilling proposal. A number of new professors with experience writing IODP proposals were also present. Several mid and late-career participants, including 4 from the U.S., had a lot of experience on panels, as co-chiefs, and as proposal authors/ proponents. In total, the workshop had 39 registered participants, of which 16 (41 %) were early career researchers. Of the 39 registered participants, 25 attended the workshop in person, with 10 participating online. Some registered attendees (see table 1 below) could not make it on short notice for personal reasons. In total, the workshop thus had close to 50% early career attendees, with a good gender balance. Some registered attendees could not make it on short notice for personal reasons. Of these participants, 12 ECORD-Member-based participants were funded by the workshop budget provided by MagellanPlus. The International Association of Sedimentologists (IAS) offered additional travel support for early career participants. U.S. Science Support Program (USSSP) fully funded the U.S. delegation (4 senior scientists) participating in the workshop.

List of Participants

Table 1: List of Participants, attending country, and their early career scientist (ECS) status.

Family name	*Given name*	*Country*	*Participation*	*ECS*
Auer	Gerald	Austria	In Person	Yes
Drury	Anna Joy	United Kingdom	In Person	yes
Batenburg	Sietske	Spain	Online	yes
De Vleeschouwer	David	Germany	In Person	
Piller	Werner	Austria	In Person	
Gallagher	Stephen	Australia	In Person	
Holbourn	Ann	Germany	registered	
Sarr	Anta-Clarisse	France	In Person	yes
Westerhold	Thomas	Germany	In Person	
Christensen	Beth	USA	In Person	
Feakins	Sarah	USA	In Person	
Clift	Peter D.	USA	In Person	
Rosenthal	Yair	USA	In Person	
Thirumalai	Kaustubh	USA	Online	
Singh	Gursewak	India	Online	
Anand	Pallavi	UK	In Person	
Jeż	Maciej	Poland	Registered	yes
Ford	Heather	UK	Online	yes
Petrick	Benjamin	Germany	In Person	yes
Matsuzaki	Kenji	Japan	In Person	yes
Manoj	M C	India	Online	yes
Bialik	Or M.	Israel	In Person	
Muthusamy	Praksam	India	Online	yes
Nagarajan	Anbuselvan	India	Online	yes
Khim	Boo-Keun	Korea	In Person	
Del Gaudio	Anna Valentina	Austria	In Person	yes
Arrigoni	Anna	Austria	In Person	yes
Albert	Galy	France	In Person	
Littler	Kate		Online	
Groeneveld	Jeroen	Taiwan	Online	
Le Houedec	Sandrine	Switzerland	In Person	
Kunkelova	Terezia	United Kingdom	In Person	yes
Manish	Tiwari	India	Online	
Liu	Jing	Germany	In Person	yes
Spieß	Volkhard	Germany	In Person	
Zorzi	Coralie	France	In Person	yes
Brierley	Chris	United Kingdom	In Person	
Kuhnt	Wolfgang	Germany	Registered	
Clarke	Leon	United Kingdom	Registered	

Agenda

The agenda for the workshop was adapted in order to accommodate the altered boundary conditions of the Integrated Ocean Discovery Program (IODP) beyond 2024:

Table 2: Revised workshop agenda

Ice Breaker – Sept. 27th, 2022	
Time	**Program**
17:30 – 21:30	**Ice Breaker** (Festsaal im Meerscheinschlössl)
Day 1 – Sept. 28th 2022	
Time	**Program**
09:00 – 09:30	**Introduction by the Organizers** (lecture hall HS 02.21)
09:30 – 10:30	Keynotes 1 **"Indonesian Throughflow and Australian Monsoon"** ***Speakers:*** Stephen Gallagher
10:30 – 11:00	Coffee Break (Foyer of the Insitute of Earth Sciences)
11:00 – 12:00	Keynotes 2 **" Monsoons, Weathering and Sedimentation"** ***Speakers:*** Peter Clift & Volkhard Spieß
12:00 – 13:30	Lunch Break (at Restaurant Propeller)
13:30 – 15:00	Keynotes 3 **"Indian Ocean Climate, (Paleo-)Circulation, and Model Integration"** ***Speakers:*** Thomas Westerhold; Anta-Clariss Sarr; David De Vleeschouwer
15:00 – 15:30	Coffee Break (Foyer of the Insitute of Earth Sciences)
15:30 – 16:30	**Plenary Discussion with P.I. panelists** *Theme1*: **"Open Questions and Umbrella Themes"** ***Panelists:*** Anta-Clariss Sarr David De Vleeschouwer
16:30 – 16:45	**Formation of Scientific Breakout Groups/Nomination of ECS Chairs** Breakout groups should focus on themes such as tectonics/basin analysis, (bio-)stratigraphy, paleoceanography, paleoclimatology, (carbonate-) sedimentology, latitudinal, and depth-transects etc. Thematic combinations/crossovers of individual groups are encouraged
Day 2 (Sept. 29th, 2022)	
Time	**Program**
09:00 – 10:00	**Plenary Session** **Peripheral Proposals:** "Proposal 1002" by **Yair Rosenthal** & "Tasman Sea" by **Anna Joy Drury**
10:00 – 10:30	Online Presentation of the ESO Science Manager **Dave McInroy**
10:30 – 11:00	Coffee Break/ECS Posters (Foyer of the Insitute of Earth Sciences)
11:00 – 11:15	Digital Core Processing Using CODD *Speaker:* **Anna Joy Drury**

11:15 – 12:00	**Breakout Discussions** Breakout Group 1: define overarching scientific goals for pre-proposal development on the Broken Ridge, that link this region with the Tasman Sea as well as the Kerguelen Plateau Breakout Group 2: Define Indian Ocean wide Questions concerning Ocean Health Breakout Group 2: Define Indian Ocean wide questions concerning Climate Tectonic Feedbacks Breakout Group 3: Define Indian Ocean-wide questions concerning ground-truthing future climate change.
12:00 – 13:30	Lunch Break (at Restaurant Propeller)
13:30 – 15:00	**Breakout Discussions** **(continued)**
15:00 – 15:30	Coffee Break/ECS Posters (Foyer of the Insitute of Earth Sciences)
15:30 – 17:00	**Breakout Discussions** (continued)
17:00 – 17:30	**Breakout Chair Summary Reports** (15 min each)

Day 3 (Sept. 30th, 2022)

Time	Program
09:00 – 09:30	**Breakout Chair Summary Reports** (15 min each) + ***Plenary Discussion on Targets of high interest*** (lecture hall HS 02.23)
09:30 – 10:30	**Breakout Session on regional goals** *) Ninentey East Ridge *) Mascarene Plateau
10:30 – 11:00	Coffee Break/ECS Posters (Foyer of the Insitute of Earth Sciences)
11:00 – 12:00	**Breakout Session on regional goals** *) Ninentey East Ridge *) Mascarene Plateau
12:00 – 12:30	**Breakout Chair Summary Reports** (15 min each) *) Report on regional working group progress and presentation of roadmaps towards the future development of proposals and targeted regional workshops. **Wrap-up and Farewell from the conveners**
12:30 – 14:00	Lunch Break (at Restaurant Propeller)

Outcome

The workshop achieved the primary goal of summarizing key scientific questions and drive new ECORD and IODP-related efforts within the wider Indian Ocean. Two dedicated breakout groups also began developing a set of proposal ideas for key regions of high scientific interest for future ocean drilling (the Mascarene Plateau and the Broken Ridge).

Statements key scientific objectives in the Indian Ocean include

1. ***Sustaining Indian Ocean Health:***

Based on IODP Scientific Framework Flagship Initiative #4 Diagnosing Ocean Health, the Indian Ocean region was identified as a key testbed for studying the impact of environmental change on ocean health across different temporal and spatial scales. It thus represents an ideal marine drilling laboratory to study extreme perturbations in the regional or global climate system, beyond those currently experienced. New drilling campaigns in the Indian Ocean are expected to provide novel, key data to constrain tipping points in the Earth's ocean-climate system when ecosystems had to adapt/evolve to climate change, or possibly go extinct when they lacked resilience. Tippings points uniquely qualified to be tested within the Indian Ocean include: extreme temperature, ocean acidification, ocean deoxygenation, and oceanic dead zones, as well as related changes in nutrient availability.

2. ***Feedbacks in the Indian Ocean:***

The Indian Ocean was identified as the best place globally for exploring feedback between the evolution of the solid Earth, oceans, and atmosphere. The rationale is the close interaction tectonically driven uplift of the Himalayan orogen and its important feedback on monsoonal circulation and precipitation in the region. However, recently, it has become clear that while significant progress has been made concerning the reconstruction of the climate, erosion, and mountain building during the Neogene, the older history of monsoon intensification remains obscure. Renewed sampling of pre-Neogene sediments, therefore, needed to fully disentangle the interaction between uplift, atmospheric circulation patterns, precipitation, and erosion in deeper time, such as the Oligocene and Eocene.

This, in particular, relates to the fact that the Oligocene has been increasingly highlighted as a critical transition time between earlier weak monsoon and younger powerful monsoon wind and rainfall and may thus serve as a crucial time interval to test complex ocean-atmospheric interactions and their tectonic mediation. This feedback is key to understanding their role in the sequestration of CO2 from the atmosphere, particularly due to the enhanced burial of organic matter.

3. ***Groundtruthing future climate change in the Indian Ocean:***

Scientific ocean drilling in the Indian Ocean can yield uniquely powerful evidence for the past climate which is relevant for future climate change. Renewed drilling and the resultant data in the Indian Ocean will be crucial to refine past analogs for and inform about possible climate destinations, along with examples of trajectories, tipping points, and sensitivities. For instance, deep water temperature records are key to understanding upwelling zone temperatures. While deep or bottom water temperature records are limited globally, they are almost completely lacking in the Indian Ocean. These data are needed because simulating upwelling zones is a challenge for climate models, and this has contributed to systematic biases in regional rainfall projections in existing climatic models. Therefore, reconstructions of past (preferably pre-Neogene) deep and bottom water temperatures are key to ground-truthing scenarios for future climate change scenarios when these zones will potentially warm and lead to associated changes in monsoonal flow and cyclone risk over the Arabian Sea. These data gaps further represent a key missing link to deconvolving ice volume and high-latitude temperature change with low-latitude climate feedback. Refining trends and transitions in deep ocean temperatures within the Indian Ocean will help to inform on tipping points in the global climate system in overturning circulation in the ocean.

Future Outlook

Based on these three key scientific objectives, the workshop further developed concepts for future drilling in the Indian Ocean based on one currently deactivated and one newly developed proposal idea.

1. ***Resubmission of pre-proposal "Tracing Tasman Leakage through the Cenozoic".***

The recently deactivated proposal focused on the Broken Ridge "*Tracing Tasman Leakage through the Cenozoic*" was discussed in its breakout session, and input was gathered on the potential for improvement based on the information of participants of the breakout session. Revision of the pre-proposal based on the results of the breakout session is ongoing.

2. ***Development of a new drilling proposal targeting the Mascarene Plateau***

The Mascarene Plateau was identified as a high-potential region for near-future scientific drilling based on the above key scientific objectives. The breakout session on developing the drilling proposal on the Mascarene Plateau identified primary scientific goals and strategic drilling objectives. The dedicated breakout session on the Mascarene Plateau within IO:DIP resulted in a working plan, including plans for a dedicated workshop for proposal writing in France within 2023/24.

3. ***IO:DIP-related session at EGU2023 (Vienna 23-28 April 2023)***

The workshop further galvanized a dedicated session proposed for EGU2023 in Vienna. Convened by participants and organizers of IO:DIP. The session '*The Cenozoic evolution of the Indian, Pacific and Southern Oceans and their gateways: global climate sensitivity and teleconnections*' will serve as a platform for continued discussion and a possibility to meet and update on the progress of drilling-related research in the Indian Ocean.