

**Report of the Magellan+ Workshop
 "IODP-drilling off of the Belize Barrier Reef (Central America) to reconstruct
 postglacial environmental changes"
 Frankfurt, Germany, July 8-10, 2022**

Organizers:

Eberhard Gischler, Goethe University, Frankfurt am Main, Germany
 Flavio Anselmetti, University of Bern, Switzerland
 Stefano Fabbri, University of Bern, Switzerland

The workshop had to be postponed twice due to the covid pandemia, but eventually took place in July 2022 at Goethe University in Frankfurt am Main, Germany. Prior to the workshop, there were 20 registrations from colleagues from 10 countries. Three colleagues cancelled their participation on relatively short notice, mostly due to covid infections. The IODP watchdog also cancelled a few days prior to the workshop. Eventually, the list of participants included:

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|-----------------------------|-------------------------------------|--------------|
| Anselmetti, Flavio (SUI) | sedimentology, geophysics | convener |
| Basso, Daniela (ITA) | paleontology; red algae | |
| Diaz, Mara (USA) | microbiology | |
| Dickens, Gerald (IRL) | paleoceanography | |
| Droxler, Andre (USA) | sedimentology; paleoceanography | |
| Eberli, Gregor (USA) | sedimentology, geophysics | |
| *Fabbri, Stefano (SUI) | geophysics | convener |
| Felis, Thomas (GER) | coral sclerochronology | keynote |
| Gischler, Eberhard (GER) | sedimentology, reefs | convener |
| *Jez, Maciek (Poland) | economic, structural geology | |
| *Knebel, Oliver (GER) | coral sclerochronology | |
| Rabideaux, Nathan (USA) | geochemistry | |
| Sardar Abadi, Mehrdad (GER) | geophysics | |
| Vinnepand, Mathias (GER) | geophysics | |
| **Webster, Jody (AUS) | sedimentology; reefs | keynote |
| Peckmann, Jörn (GER) | sedimentology; organic geochemistry | keynote |
| *Zoppe, Simon (GER) | paleontology; corals | |
| *Diers, Diana (GER) | coral sclerochronology | cancellation |
| *Schmitt, Dominik (GER) | sedimentology | on short |
| Seidenkrantz, Marit (DEN) | IODP watchdog | notice |

*young scientist

**participation via Zoom

There were six registrations of young scientists, four of which eventually participated in the workshop. The other two had to cancel on short notice due to a covid infection and a death in the immediate family including funeral.

The following nine colleagues contacted the conveners, expressed their interest in the initiative, but could not participate due to schedule collisions. They asked to be kept on the mailing list.

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| Bracchi, Valentina (ITA) | paleontology; red algae |
| Eisenhauer, Anton (GER) | U-series dating |
| Harms Ulrich (GER) | drilling specialist |
| Jorry, Stephan (FRA) | carbonate sedimentology |
| Obrist-Farner, Jonathan (USA) | sedimentology; lakes |
| Pandolfi, John (AUS) | ecology; paleoecology |
| Stocchi, Paolo (NED) | modelling; geophysics |
| Whalen, Michael (USA) | sedimentology; fossil reefs |
| Zeeden, Christian (GER) | geophysics |

The workshop started in the evening of Friday, June 8, 2022, with an ice-breaker-like meeting of the participants at the Relexa Hotel near the Geocentre of Goethe University. There was an one-hour meeting at the hotel bar, followed by a joint dinner at the hotel restaurant.

From Saturday, June 9 in the morning until Sunday, June 10, at midday, the talks and discussions commenced. There was another joint dinner in a nearby restaurant on Saturday night. The participants split Sunday, June 10, at midday. A smaller group, whose flights and trains left later in the day, had lunch together. The schedule of the workshop was as follows.

8 July: Arrival of participants at Hotel Relexa, Lurgiallee 2, 60439 Frankfurt am Main (in walking distance to Geocentre of Goethe-University)

18:00 possibility of first casual meeting of participants at hotel bar
19:00 dinner at hotel

9 July: First workshop day. Room 2.102 of Geocentre, Altenhoferallee 1, 60438 Frankfurt am Main

9:00-9:45 E. Gischler: Welcome, introduction, and overview of the barrier and atoll reef system of Belize

9.45-10:00 questions/discussion

10:00-10:30 J. Webster: Keynote 1 on Quaternary reef response to sea-level and environmental change - via Zoom

10:30-10:45 questions/discussion

10:45-11:15 coffee break

11:15-11:45 T. Felis: Keynote 3 on high-resolution climate data from postglacial corals

11:45-12:00 questions/discussion

12:00-12:30 J. Peckmann: Keynote 2 on microbialites in postglacial reefs

12:30-12:45 questions/discussion

12:45-13:45 Lunch

13:45-15:30 Discussion and identification of possible research questions

15:30-16:00 Coffee break

16:00-18:00 Continuation of discussion

18:00 15-min. walk to restaurant (1.1 km)

18:30- Dinner at "Lahmer Esel", Krautgartenweg 1, 60439 Frankfurt am Main

10 July: Second workshop day. Room 2.102 of Geocentre

9:00-9:15 E. Gischler, F. Anselmetti: Resume of day 1 and overview of day 2
9:15-9:45 F. Anselmetti, S. Fabbri: Results of 2022 site survey along the Belize Barrier Reef margin
9:45-10:00 questions/discussion
10:00-10:30 A. Droxler: Results of recent surveys along Lighthouse Reef margin and English Cay Channel, Belize
10:30-10:45 questions/discussion
10:45-11:15 Coffee Break
11:15-13:00 Final discussion including identification of drill sites, strategies, development of IODP pre-proposal (deadline: 1 Oct. 2022), roadmap
13:00 End of Workshop
13:00-14:30 Lunch of 7 participants whose trains and flights left only later in the day in a nearby restaurant ("Park Avenue, Riedbergplatz 3, 60438 Frankfurt am Main")

The program on Saturday started with a 45-minute introductory talk by Eberhard Gischler on the Belize margin with a focus on the late Quaternary development of the study area. After a short general discussion, Jody Webster gave a keynote on postglacial reef development focussing on his work in the Great Barrier Reef drilling of IODP leg 325. Several questions in the discussion revolved around possible drilling techniques in somewhat deeper water and ended with the use of "prods" for seafloor drilling. Thomas Felis followed with a keynote on the possibilities of using coral skeletons from reef drill cores as highly resolved windows in climate reconstruction during the past ca. 20 kyrs. The ensuing discussion dealt with the possible diagenetic alteration of fossil coral skeletons and coral taxa for analysis other than *Pseudodiploria* and *Orbicella*. Finally, Jörn Peckmann introduced tropical reef microbialites, which have turned out to be promising archives of environmental change as shown in work following IODP legs 310 and 325 as well as in other studies. Among other issues, it was discussed whether geochemical proxies such as ^{11}B could be used as proxies for pH, in addition to microbialite thickness and volume.

After lunch, the participants started out with discussing how the tentative objectives suggested by the conveners (deciphering reef architecture and composition as expressions of late Quaternary sea-level and environmental changes; reconstruction of post-glacial sea-level rise in the western Atlantic; reconstruction of environmental parameters using corals and microbialites; analysis of Pleistocene reef ecology) could address the themes and challenges of the IODP Science Plan 2013-2023. It was also discussed how to formulate and to underline that the Belize Margin is a special/unique and a potential site for IODP drilling.

The schedule above was changed during the discussion in that the group of participants agreed to prepone the two talks on site surveys initially scheduled for Sunday. The participants made the point that it would be easier and more efficient to have all the existing data on the table to have a better and comprehensive discussion.

First, Flavio Anselmetti and Stefano Fabbri reported on the site survey of May 2022 in the fore-reef area along the central Belize Barrier Reef, which was recently

conducted by the conveners. Afterwards, Andre Droxler gave an overview of his 2017-survey of the deeper fore reef of Lighthouse Reef Atoll, offshore Belize.

The program on Sunday started out with a brief summary by Eberhard Gischler of items discussed during the previous day. Then the group focussed on the themes and challenges of the IODP Science Plan and agreed that a project along the Belize margin would definitely contribute to both challenge 1 ("climate and ocean change") and challenge 2 ("deep life") of the science plan. The participants agreed that challenges 1, 2, 3, 4, 5, and 7 could be addressed.

(1) How does earth's climate system respond to elevated levels of CO₂? - approach via analysis of coral skeletons and microbialites

(2) How do ice sheets and sea level respond to warming climate? - development of postglacial sea-level curve

(3) What controls regional patterns of precipitation...? - addressed via analysis of coral and coralline algal skeletons

(4) How resilient is the ocean to chemical perturbations? - look into shelf versus ocean fractionation of carbonate production; coral sclerochronology

(5) What are the origin, composition, and global significance of deep seafloor communities? - access via DNA and functional gene analyses of microbialites

(7) How sensitive are ecosystems and biodiversity to environmental changes? - approach via analysis of microbialite thickness in the light of postglacial decrease in carbonate saturation state

Following this discussion, the objectives as suggested by the conveners were somewhat modified:

- reconstruct evolution of a mixed carbonate-siliciclastic reef margin during late Quaternary as expressions of late Quaternary environmental change

- develop LGM- and post-glacial sea-level rise in the western Atlantic

- reconstruction of environmental parameters using corals and microbialites (and coralline algae)

- analyze reef paleoecology in relation to postglacial sea-level rise...; do we see same/other reaction as compared to Indo-Pacific reef systems?

- assess deep life in barrier reef system

The possibility to put forward the uniqueness of the Belize reef margin was summarized as follows:

- largest reef system in Atlantic Ocean

- comparison with GBR; miniature version of GBR

- possibility to look into differences in biodiversity/benthic communities between Atlantic vs. Indo-Pacific

- mixed carbonate-siliciclastic record – test influence on reef system

- adjacent lowstand delta right next to barrier reef system

- ocean system; southward current along the reef

- sources of siliciclastic sediment

- occurrence of Pleistocene ooids

The next part of the discussion focussed on possible drill sites along the Belize margin. The participants suggested to select three areas in the central Belize Barrier Reef (based on the final evaluation of site survey data that is still ongoing) where drill core transects consisting of 3-4 cores should be proposed. One suggestion for area was off of Carrie Bow Cay where shallow drilling was previously conducted in the

shallow fore reef. A second area still needs to be identified. In general, cores are to be drilled into ridges parallel to the reef margin to depths of approx. 100 m in order to recover the entire postglacial, glacial, and older Pleistocene (MIS 3, 5) units in each core. Based on the existing data, it was hypothesized that the outermost ridge (above the wall) would be composed of \pm vertically stacked succession of postglacial units. A third area suggestion was south of English Cay Channel where a N-S-trending series of build-ups occurs in water depth of approx. 80-20 m. The water depths of drill sites would range from approx. 20-150 m. One or two cores should also be collected in the offshore region for comparison with the marginal, reefal succession. It was suggested to also recover a core from the siliciclastic English Cay channel delta.

The possibility to expand the drilling transects to the offshore Belize atolls (Lighthouse Reef) was proposed but did not find a full support by the workshop participants. Eventhough there would be interesting targets, the majority of the participants preferred a rather slim design of the drilling program to remain focused on the barrier-reef system.

In this context, the discussion returned to drilling techniques, and sea-floor prods as well as jack-up platforms. It was also discussed, that LIAG Hannover could provide the slimhole logging tools needed to perform state-of-the-art wireline logging.

At the end of the discussion, the group agreed that it would be worthwhile to submit a pre-proposal to IODP aiming at the October 1st-deadline. The three conveners suggested to write a first draft that would subsequently be circulated among the group of lead proponents (identified to be composed of: Anselmetti, Basso, Diaz, Dickens, Droxler, Eberli, Felis, Gischler, Peckmann, Webster). The participants also agreed that E. Gischler should be the lead proponent and S. Fabbri the data lead / proponent for site characterization data. The other participants in the workshop will be participants, including C. Zeeden (per suggestion of M. Vinneband and M. Sardar-Abadi).

During the coffee break on 10 July, the workshop participants took a group photo in front of the Frankfurt Geocentre.



Magellan+ workshop participants from left to right: D. Bassi, M. Diaz, A. Droxler, S. Fabbri, G. Eberli, E. Gischler, F. Anselmetti, J. Dickens, M. Sardar-Abadi, J. Peckmann, M. Jez, M. Vinnepand, O. Knebel, S. Zoppe. (T. Felis and N. Rabideaux not shown due to early departure.)