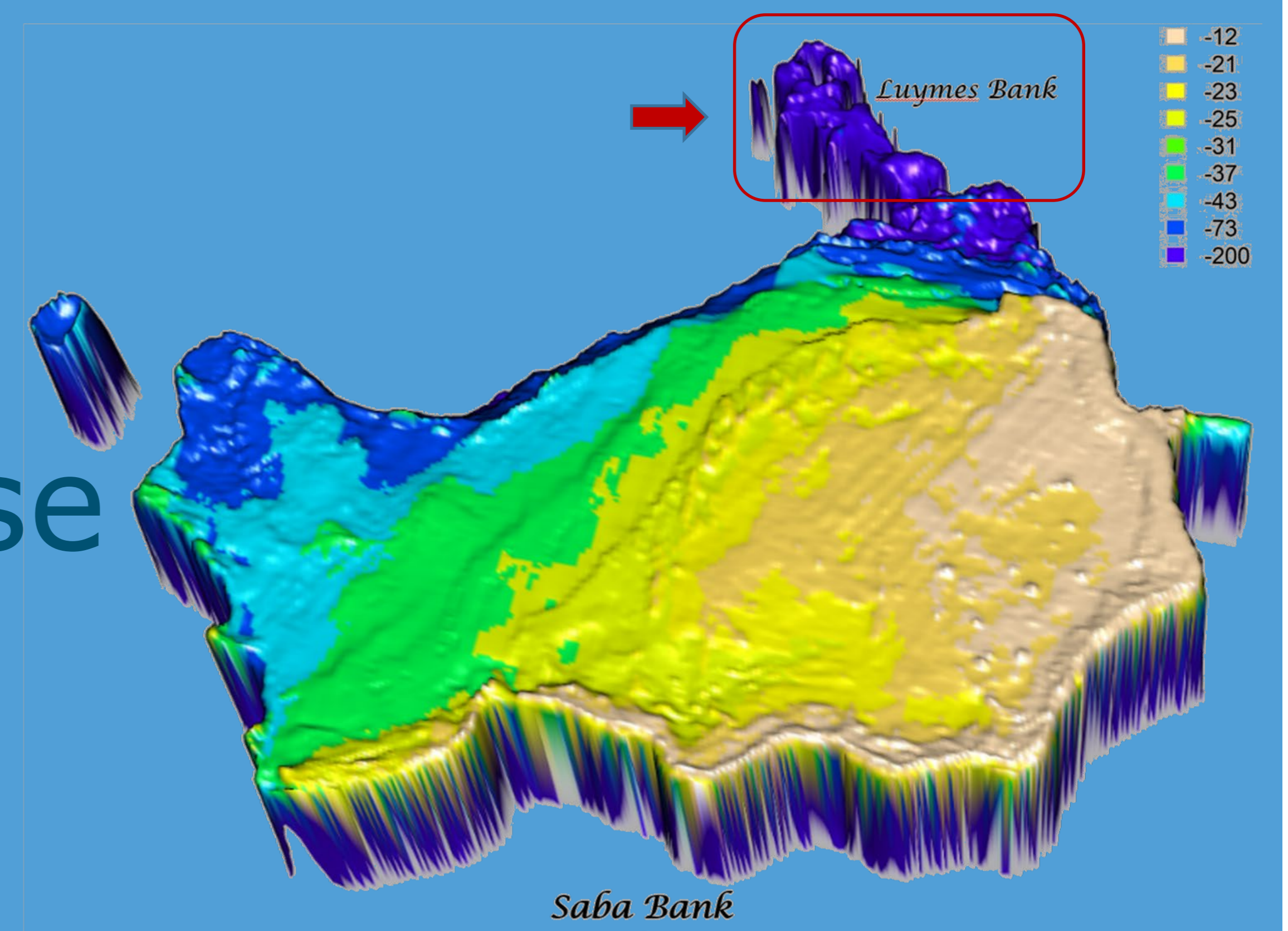


Saba Bank: a scientific surprise

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Background

The Saba Bank, west of the Caribbean island of Saba, is a large (2400 km²) submerged carbonate platform of 15-40m depth rising from 800-1000m depth and fringed with coral reefs along the eastern and southern sides. Saba Bank is the largest protected area of the Kingdom of the Netherlands and a hotspot of biodiversity. In 2018 during the NICO expedition we discovered that part of the Saba Bank, called the Luymes Bank, contains a number of large and deep sinkholes. In 2019 NIOZ and WMR returned to the bank to study these sinkholes and made some extraordinary discoveries.

Objectives

- To study the distribution and environmental conditions (e.g. nutrients, O₂, particulate organic matter, water movement, CO₂ chemistry) of benthic communities on the platform between sinkholes and in the sinkholes with emphasis on areas with regularly distributed pillar-like structures in sinkholes.
- To take high resolution pictures of the benthic communities with high-resolution camera system and NIOZ video frame in order to describe the benthic communities.
- To collect bottom samples in order to determine the species diversity of these communities.
- To collect pillars and assess the species consortia producing the pillars, their life history strategies, accretion rates and stratigraphic history.
- To survey and investigate the carbonate chemistry of sinkholes of different size and depth and detect the effects of possible stratification in sinkholes.
- To determine metagenomics and metabolomics in water samples from sinkholes of different size and depths.
- To investigate light-dark shifts in metagenomics and metabolomics in near bottom water samples in relation to nutrients, O₂, carbonate chemistry and POM in shallow sinkholes (20-40m deep) with and without pillar-like structure and the platform community at approx. 80m depth.
- To collect plankton samples for closer studies of plankton communities over the Luymes Bank.

Methods

- Multibeam to survey the bathymetry of the deeper parts of the Luymes Bank and missing parts of the Saba Bank;
- CTD rosette to obtain profiles of salinity, temperature, density, oxygen concentrations, fluorescence, underwater light measurements (PAR) and collect water samples with Niskin bottles for nutrient and CO₂ chemistry analysis;
- HD-video frame equipped with HD video, two Nikon D800 cameras, a GoPro camera, laser and two and a transponder (Fig. 1). Frame was used for online recording of benthic communities;
- Two moorings equipped with sediment trap, Nortek Aquadopp current profiler, oxygen- temperature sensor and light logger used for diurnal monitoring of processes inside of sinkholes;
- Grabber from Bluestream (Fig. 2) to collect protruding pillars from the sinkholes.
- Boxcorer for taking sediment cores in sinkholes;
- Triangle dredge to collect bottom samples of the platform community.

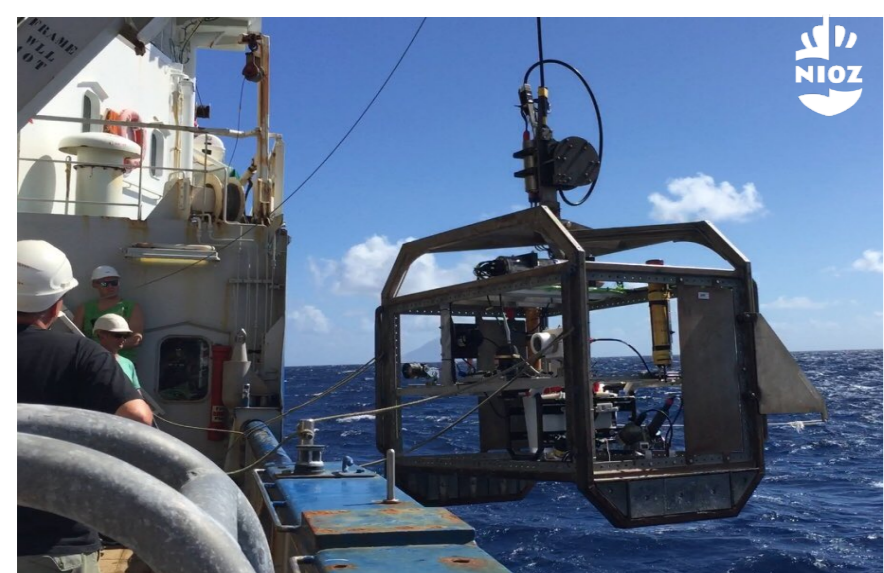


Fig 1. NIOZ high resolution camera and video system



Fig 2. Bluestream grabber



Fig 3. Participants of the expedition

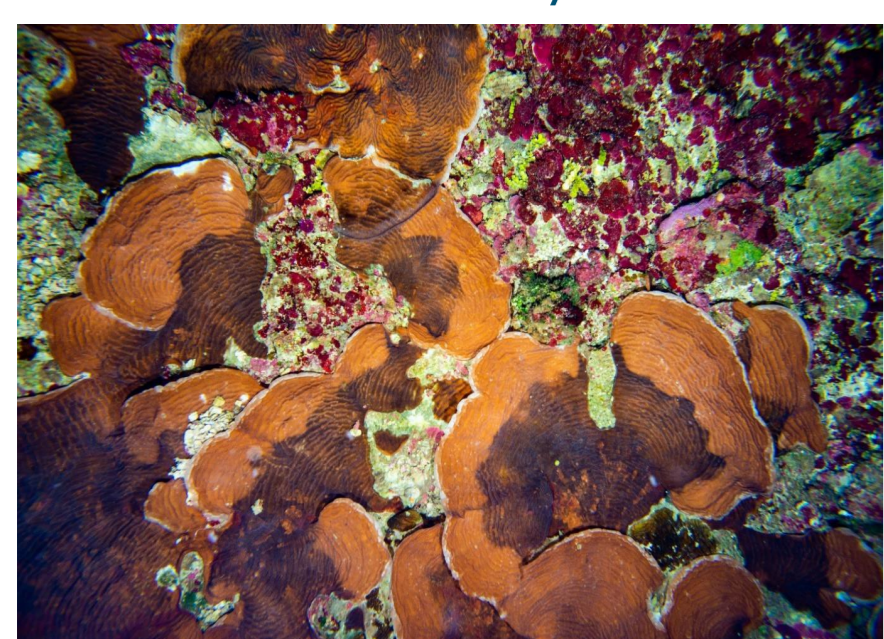


Fig 4. Top of bank community

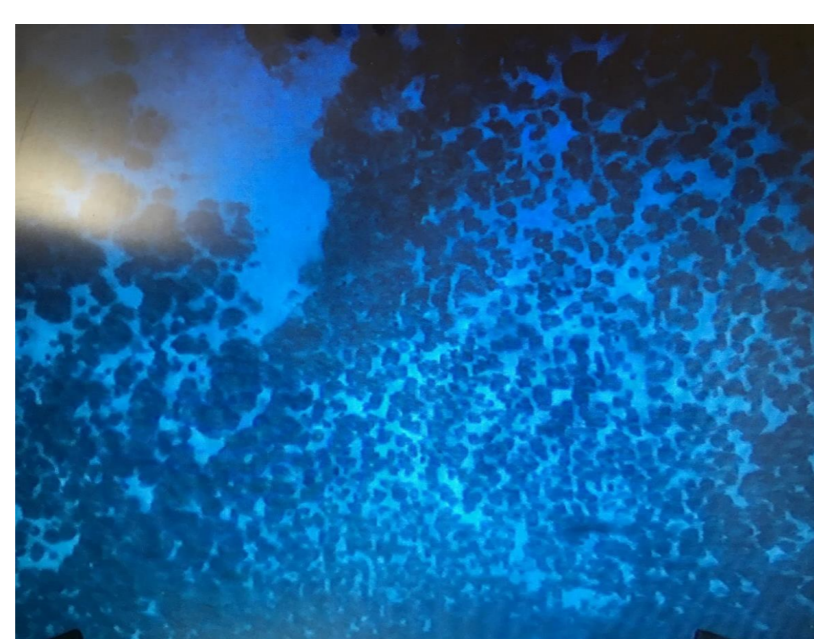


Fig 5. Coralline pillars from a distance



Fig 6. Crustose coralline pillars on the bottom of sinkhole



Fig 7. Upper part of a pillar is approximately 25 cm high and 15 cm wide

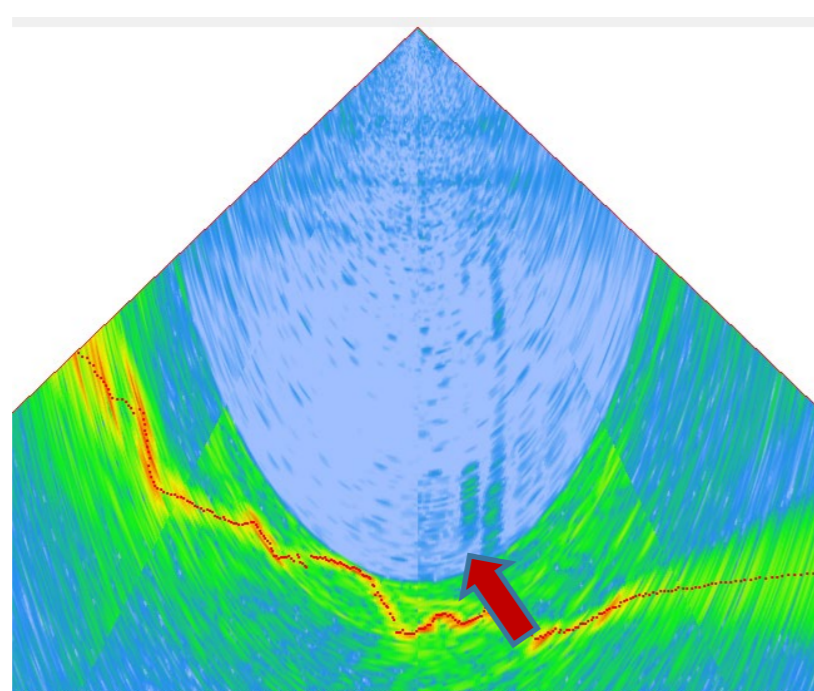


Fig 8. Multi-beam image of gas seeps (centre right)

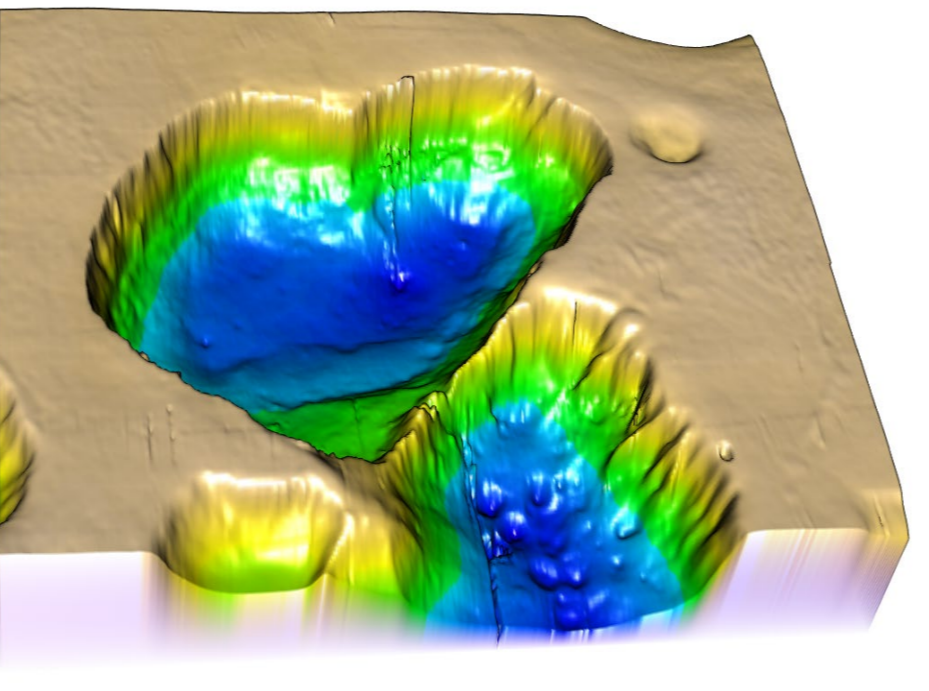


Fig 9. The heart shaped acid lake

Results

Biological communities:

- On the top of the Luymes Bank between 80 and 100m depth, rich communities of corals, crustose coralline algae and sponges are completely covering the bottom (Fig. 4).
- Only a limited number of sinkholes contain the characteristic coralline pillar communities (Fig. 5, 6 & 7), generally between 95-120m.
- Each pillar is built by crustose coralline algae and accommodates small solitary corals, sponges, tunicates, byozoans, and other invertebrates.

Abiotic environment:

- Gas seeps (Fig. 8) have created a unique submarine acid lake (Fig. 9, 10 & 11) which sometimes overflows into an adjacent sinkhole.

Geomorphology:

- The sinkholes of the Luymes Bank rank among the largest and deepest submarine sinkholes in the world.
- Some sinkholes have merged possibly as a consequence of erosional activities or by acid dissolution.
- The acid environment of at least one sinkhole may lead to a still-increasing depth.

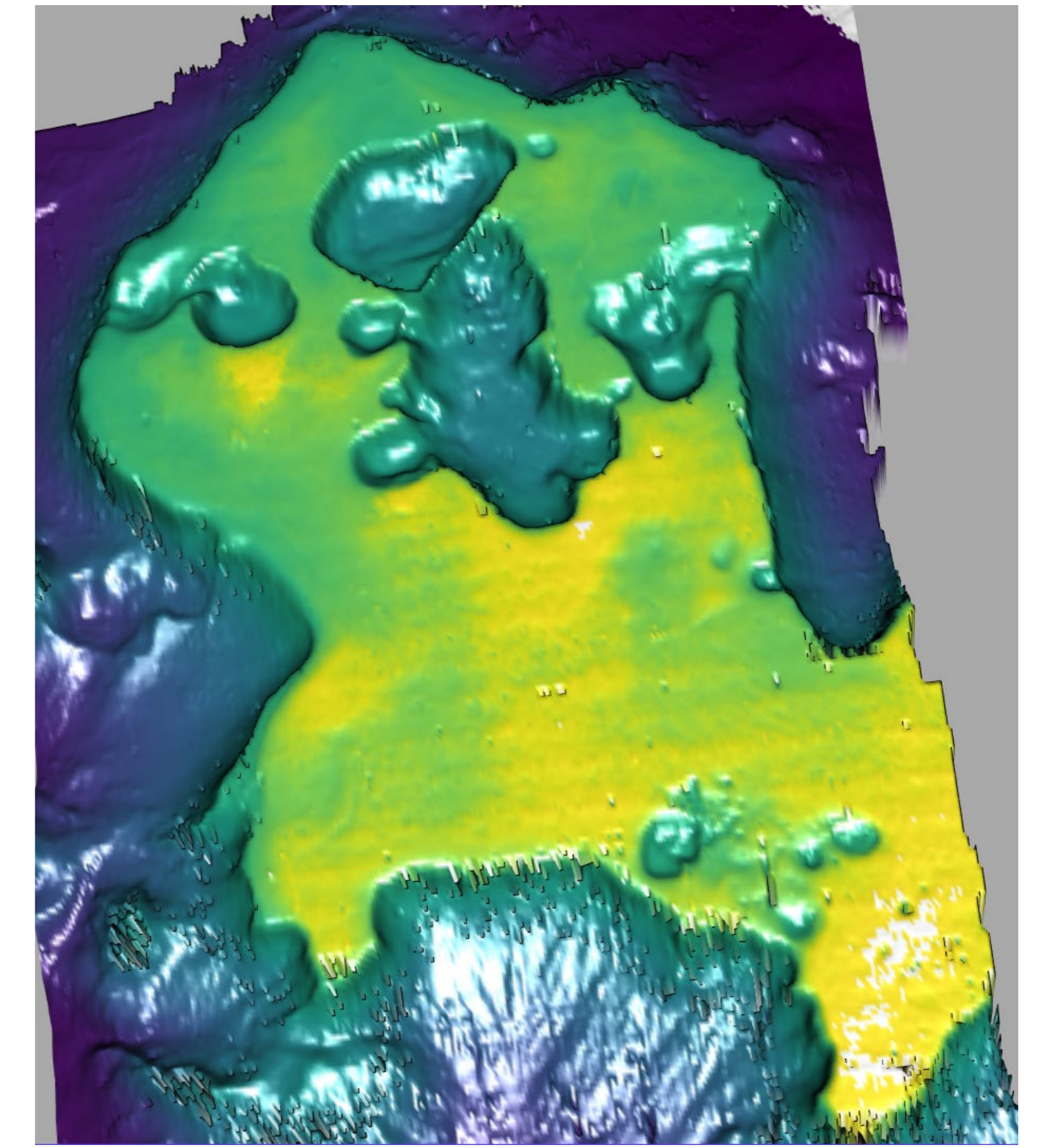


Fig. 10. Sinkholes in the Luymes Bank. Some sinkholes have merged with others.

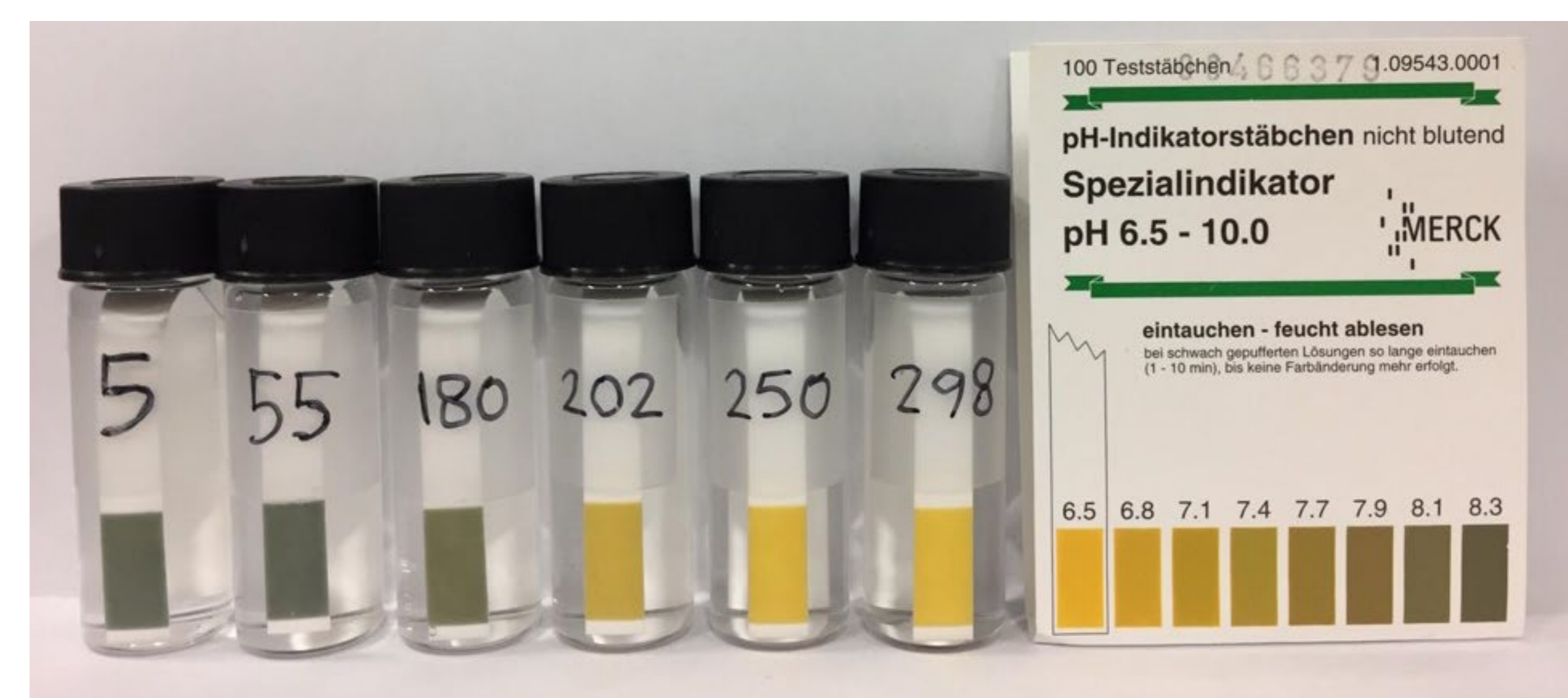


Fig 11. pH at 5, 55, 180, 202, 250, and 298m depth inside of the heart shaped sinkhole.

Conclusions

- The Luymes Bank contains at least 21 sinkholes ranging in depth from 110 to more than 300m.
- Some sinkholes contain unique biological communities unknown to science and probably the result of the special environmental conditions.
- The Luymes Bank contains an acid lake, which is a major discovery given the pH of the surrounding ocean waters (pH ca. 8).
- On the bottom of several sinkholes gas seeps have been observed.

References

- van Duyl, F.C.; Meesters, E.H. (2020). Cruise report RV Pelagia 64PE465 : Sinkhole expedition, 5 December - 18 December 2019 Guadeloupe-Guadeloupe. NIOZ Royal Institute for Sea Research: Texel. 79 pp.
- van Duyl, F.C., Meesters, E.H. (2018). Cruise report RV Pelagia 64PE433 : Saba, St Eustatius and Saba Bank Benthic habitat mapping, and Benthic-Pelagic coupling, 26 February - 10 March 2018, St Maarten-St Maarten (NICO expedition leg 6). NIOZ: Texel. 60 pp.

Acknowledgements

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