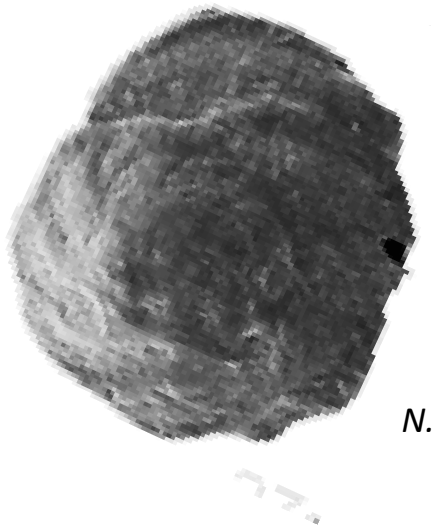
Changing paleoclimates in the Creatceous southern high latitudes

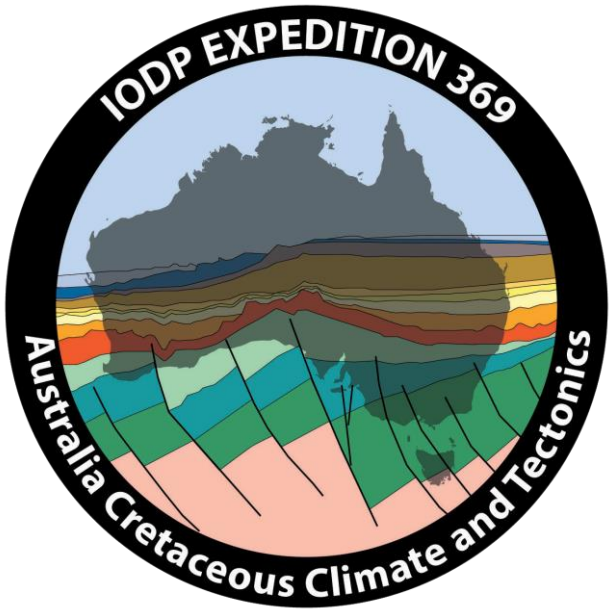
Wolfgring, E. (WG Heinz)

~90 Ma

G. linneiana



N. rakauroana



FWF
Der Wissenschaftsfonds.

Changing paleoclimates in the Creatceous southern high latitudes

Wolfgring, E. (WG Heinz)

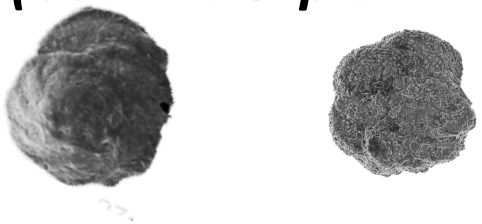
~90 Ma

FWF P-4444*: A benthic perspective on Cretaceous Austral climate evolution*

IODP Expedition 369

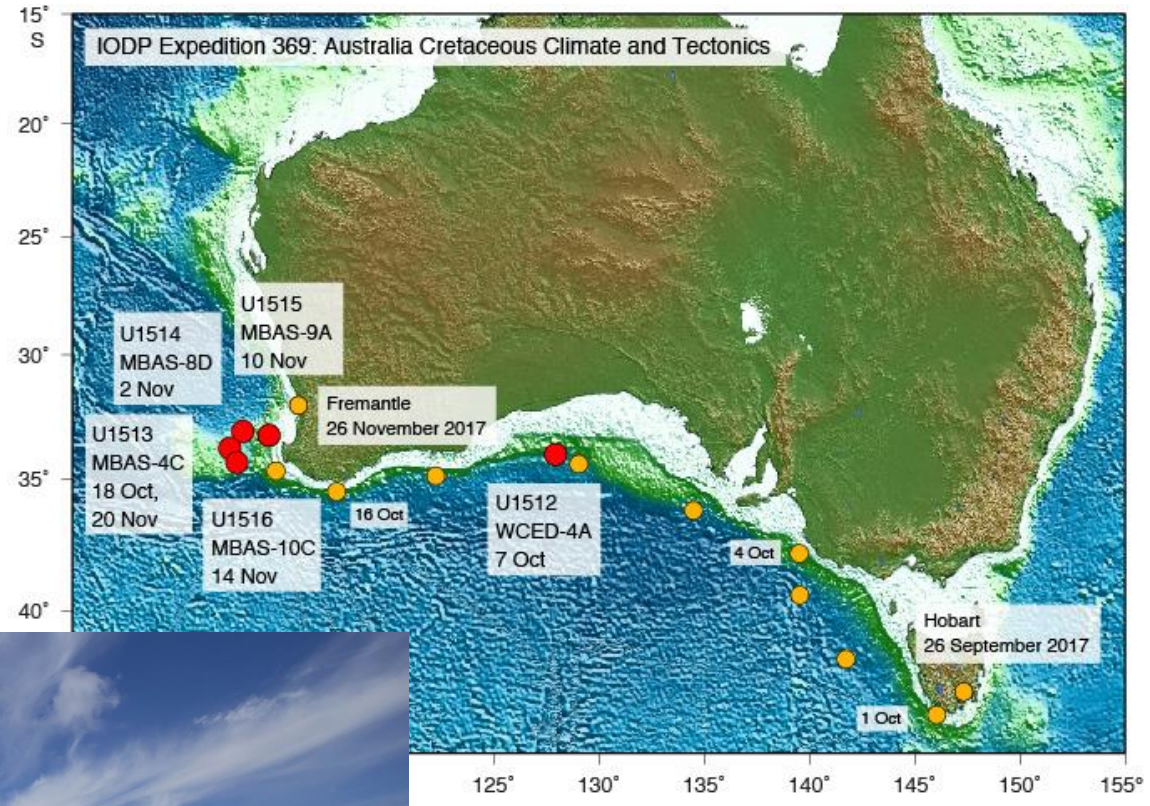
- ***the Cretaceous greenhouse***
- ***Breakup of Gondwana***
- ***Cretaceous Oceanic Anoxic Events (OAE)***
- ***Cretaceous paleoceanography***

Microfossils ->Foraminifera as proxy (benthic & planktic)

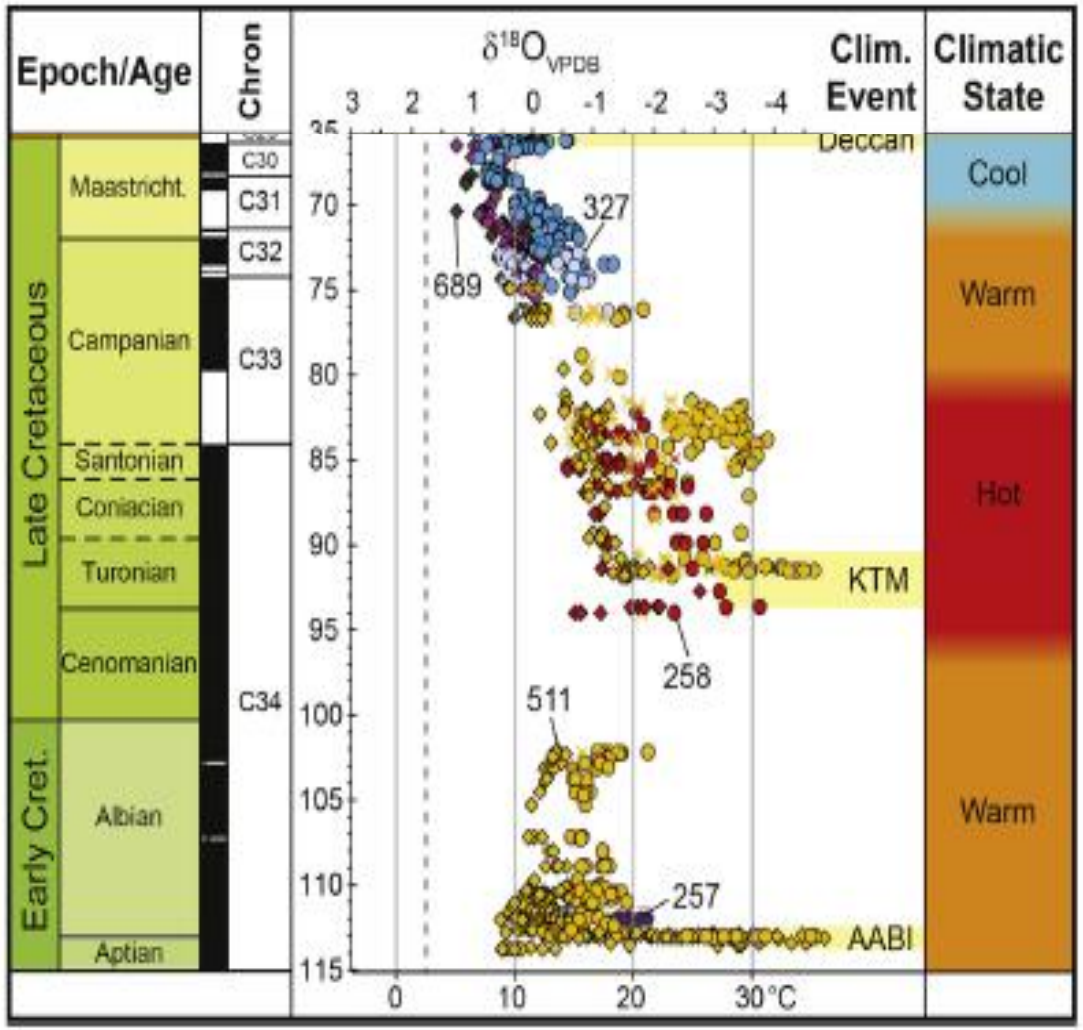


FWF Der Wissenschaftsfonds.

A benthic perspective on Cretaceous Austral climate evolution

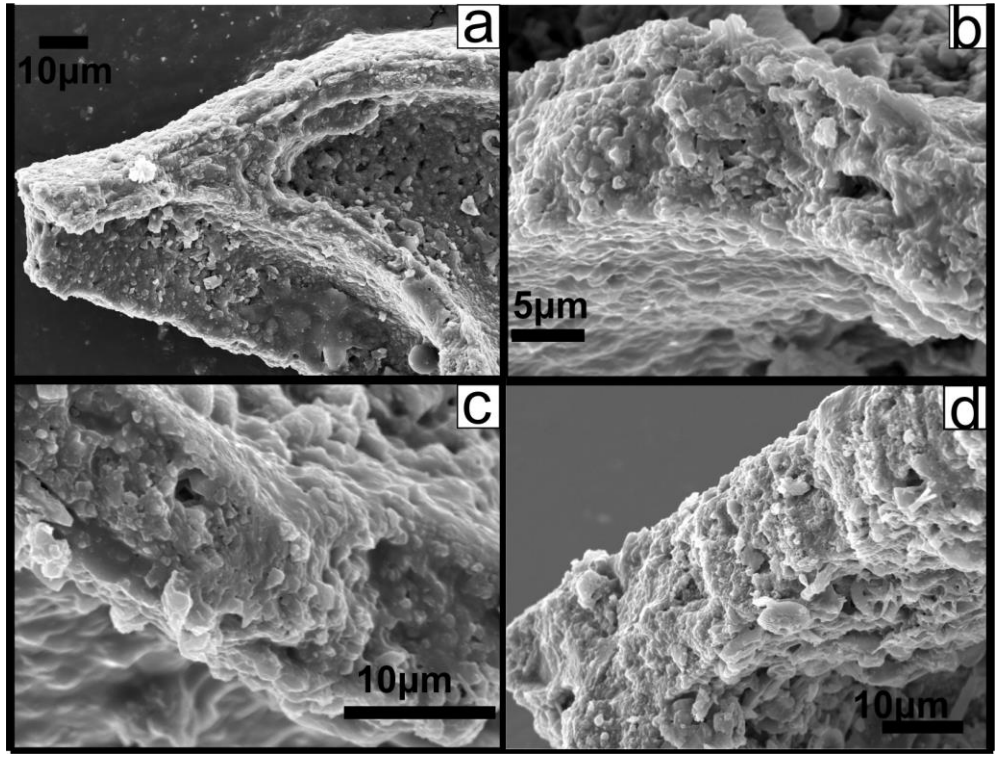


Why the Upper Cretaceous record of IODP Sites U1512/U1513/U1516 is important:



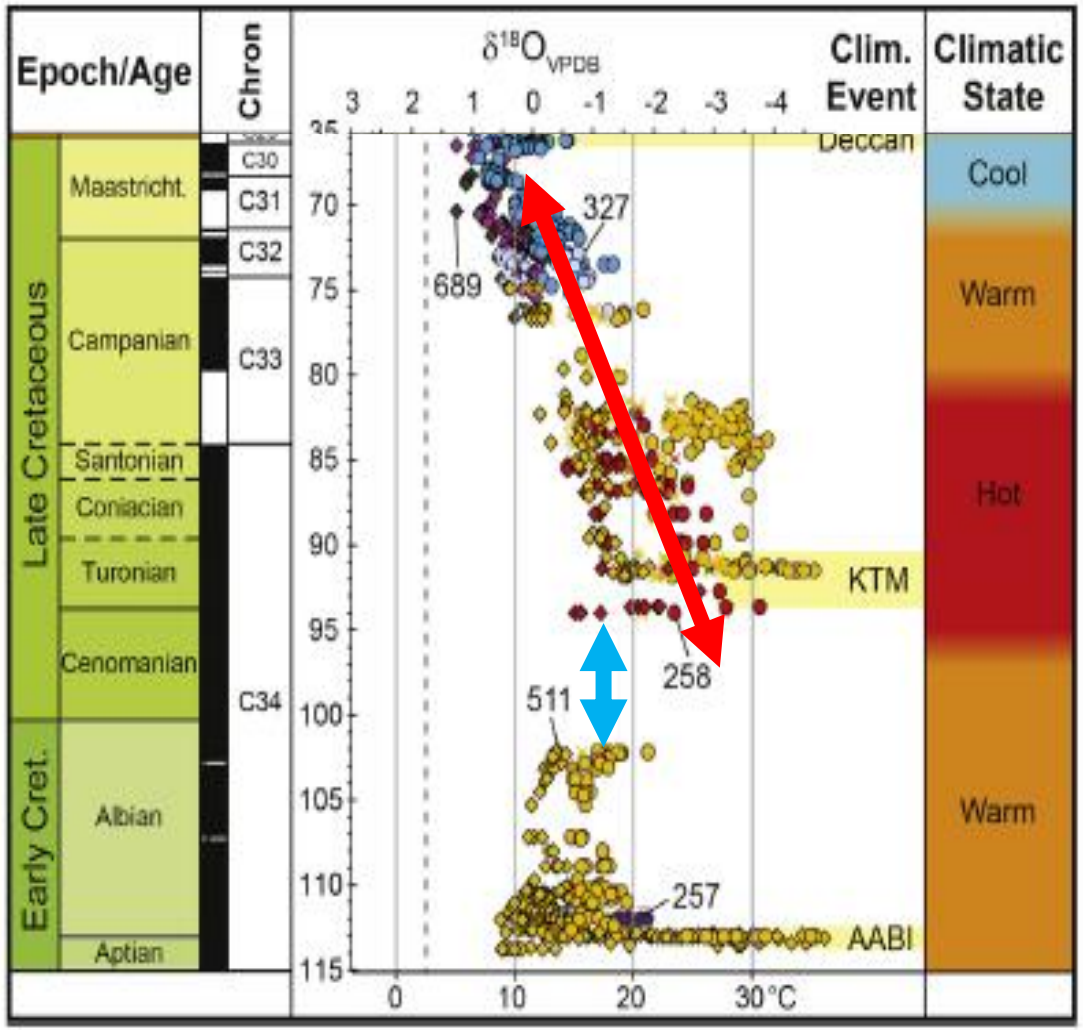
Huber et al., 2018

Stable isotope ratio of foraminiferal tests used for temperature reconstruction



Wolfgring et al., 2022

Why the Upper Cretaceous record of IODP Sites U1512/U1513/U1516 is important:



Huber et al., 2018

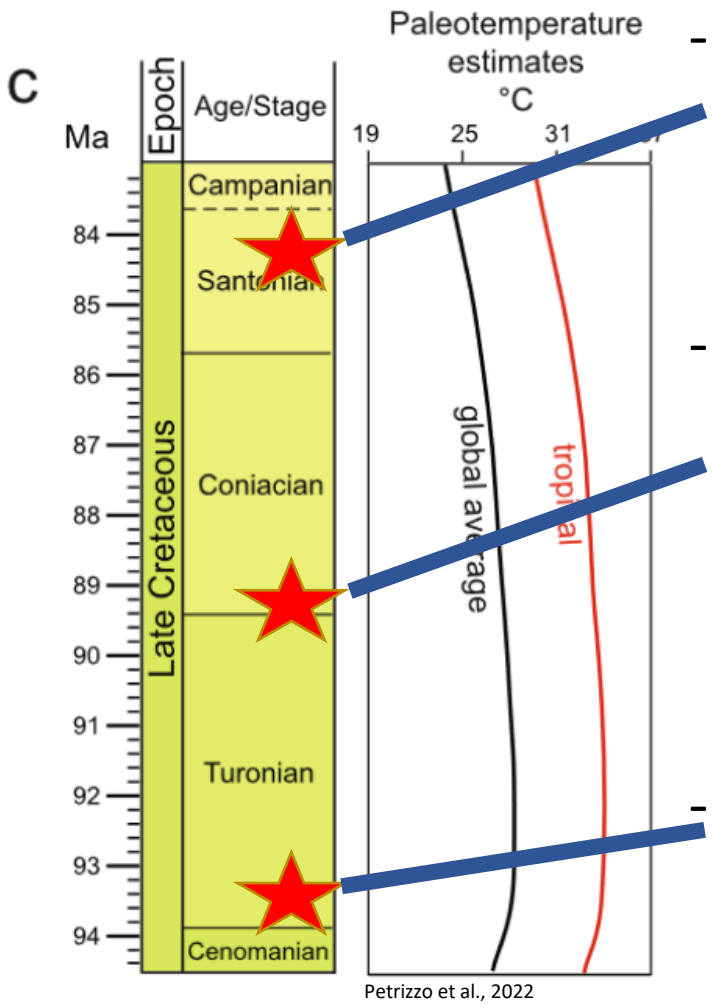
Stable isotope record of benthic and planktonic foraminifera:

Late Cretaceous between 25 and 10° average surface water temperature
From "hothouse" to "cool greenhouse

Gap in tmp. record Coniacian/Turonian

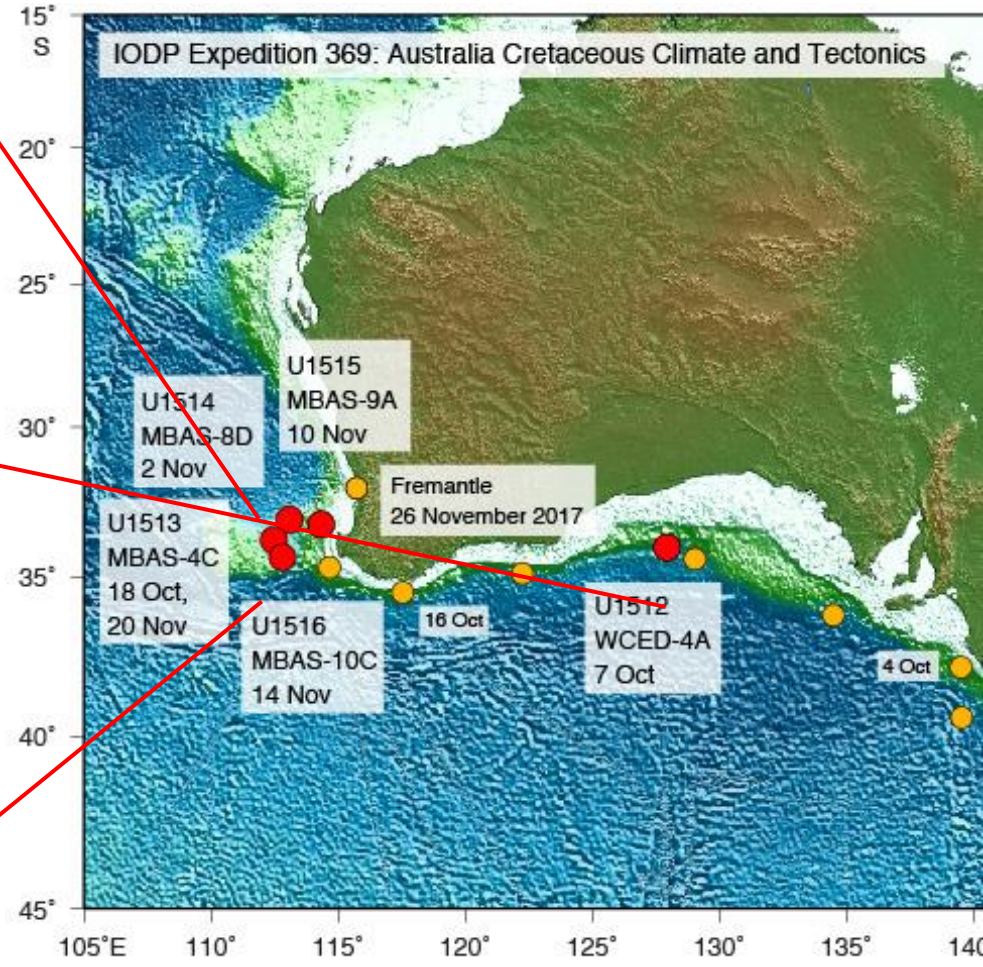
Huber et al., 2019

Three case studies – exploring evidence of Cretaceous climate change



Petrizzo et al., 2022

- **C.3: Benthic foraminifera in a cool climate change setting**
- **C.2: A marginal-marine/estuarine basin after the Cretaceous hothouse**
- **C.1: Cenomanian/Turonian hothouse in the southern high latitudes**



Huber et al., 2019

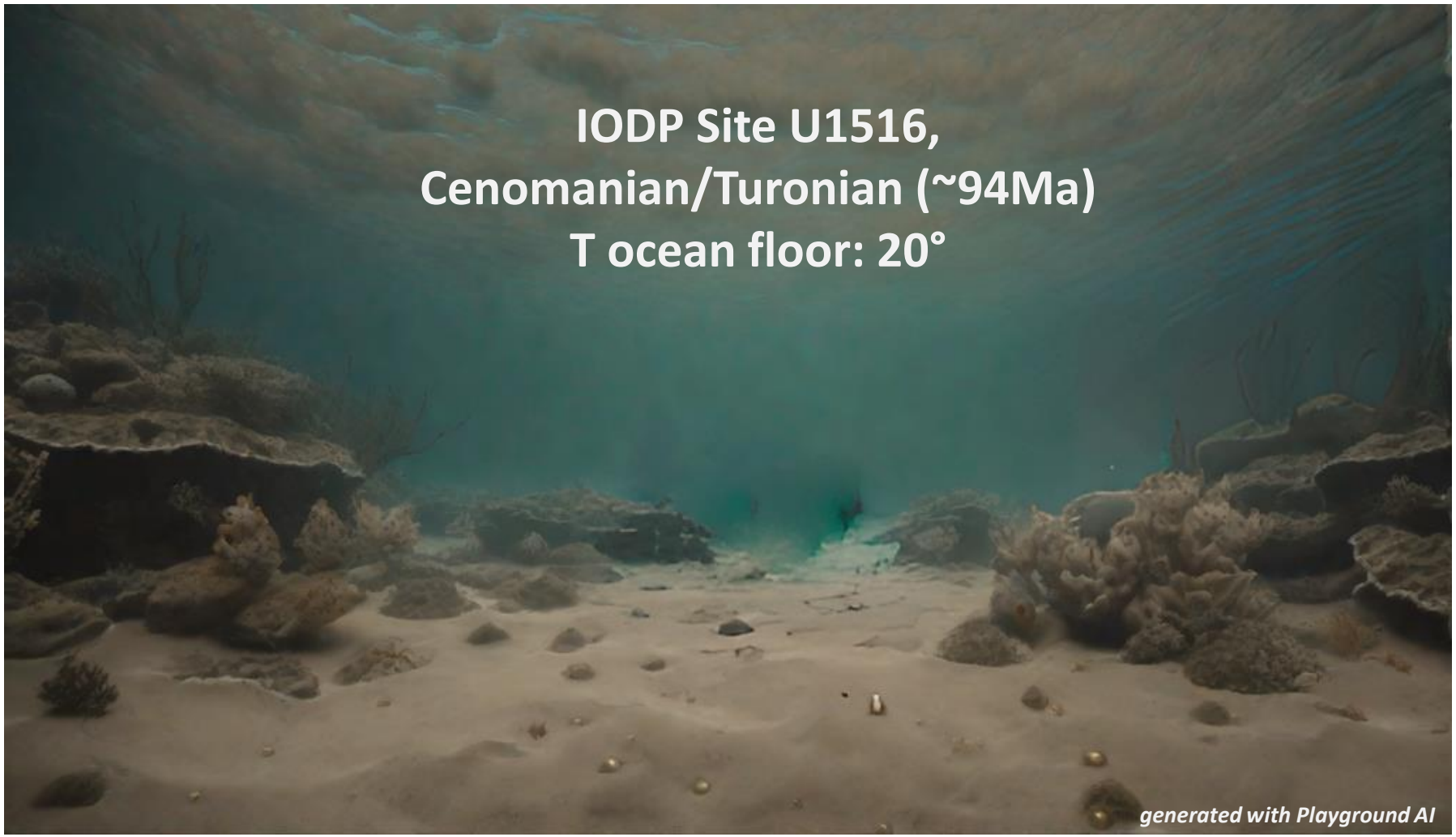
Case study 1:
Benthic foraminifera during the Oceanic Anoxic Event 2 (OAE) in the Mentelle Basin IODP Site U1516

- **Cenomanian/Turonian hothouse setting**
- **Large Igneous Province (Kerguelen Plateau ?) volcanism**
- **global avg. temp. 25°**

Benthic foraminifera during the Oceanic Anoxic Event 2 in the Mentelle Basin IODP Site U1516

Mays, et al., 2014
Wolfgring et al., 2019

Petrizzo et al., 2022



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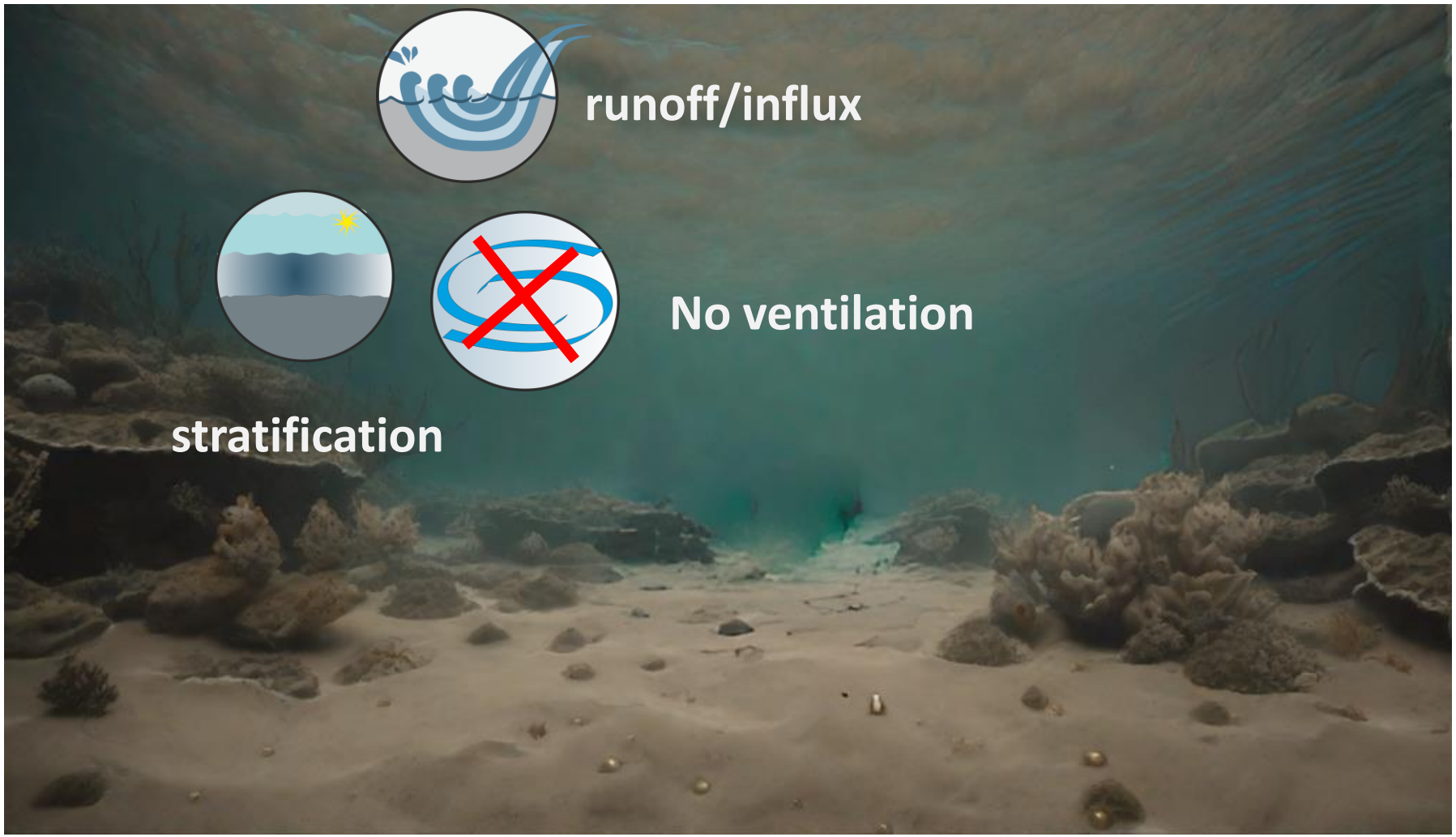

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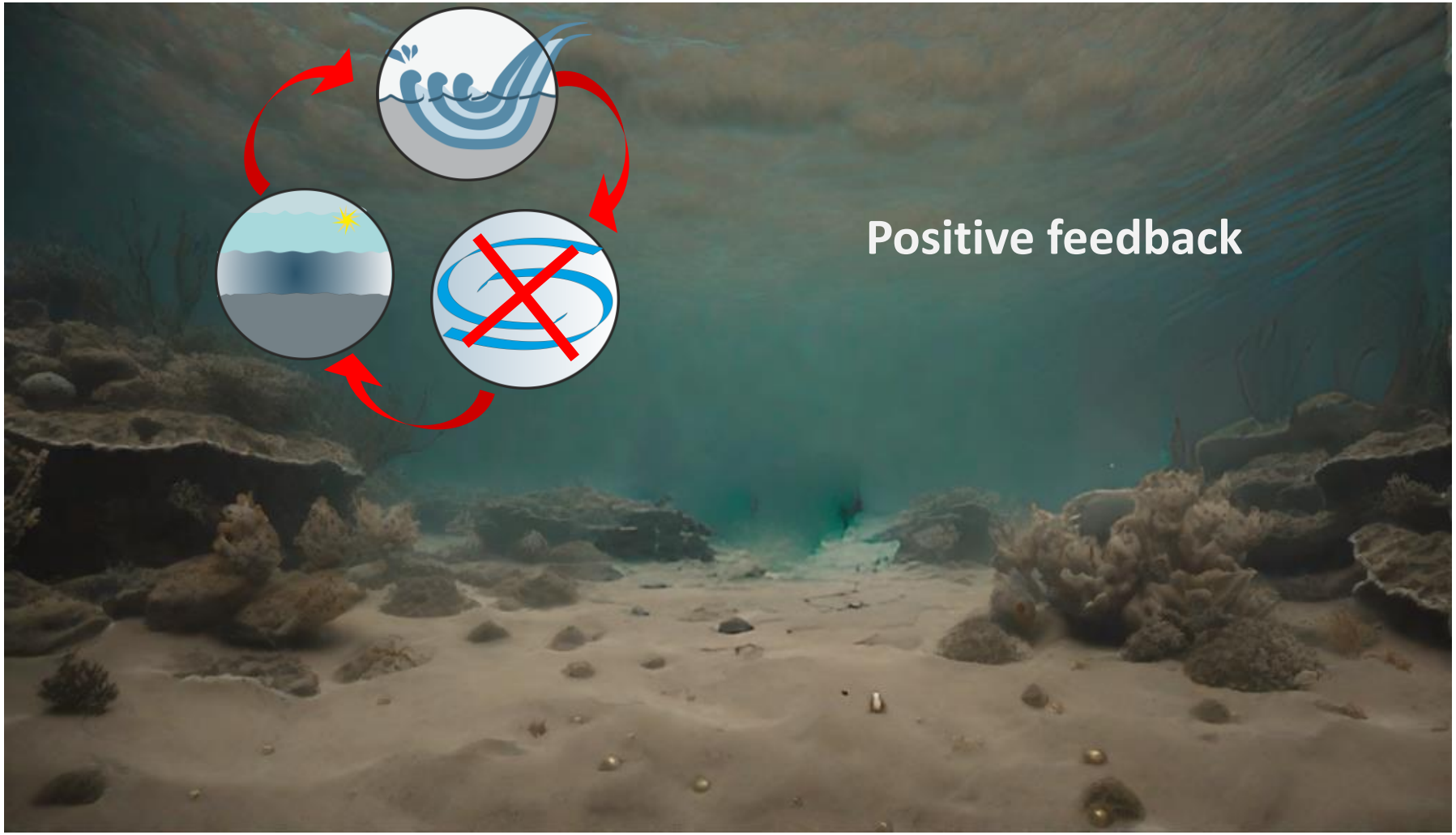

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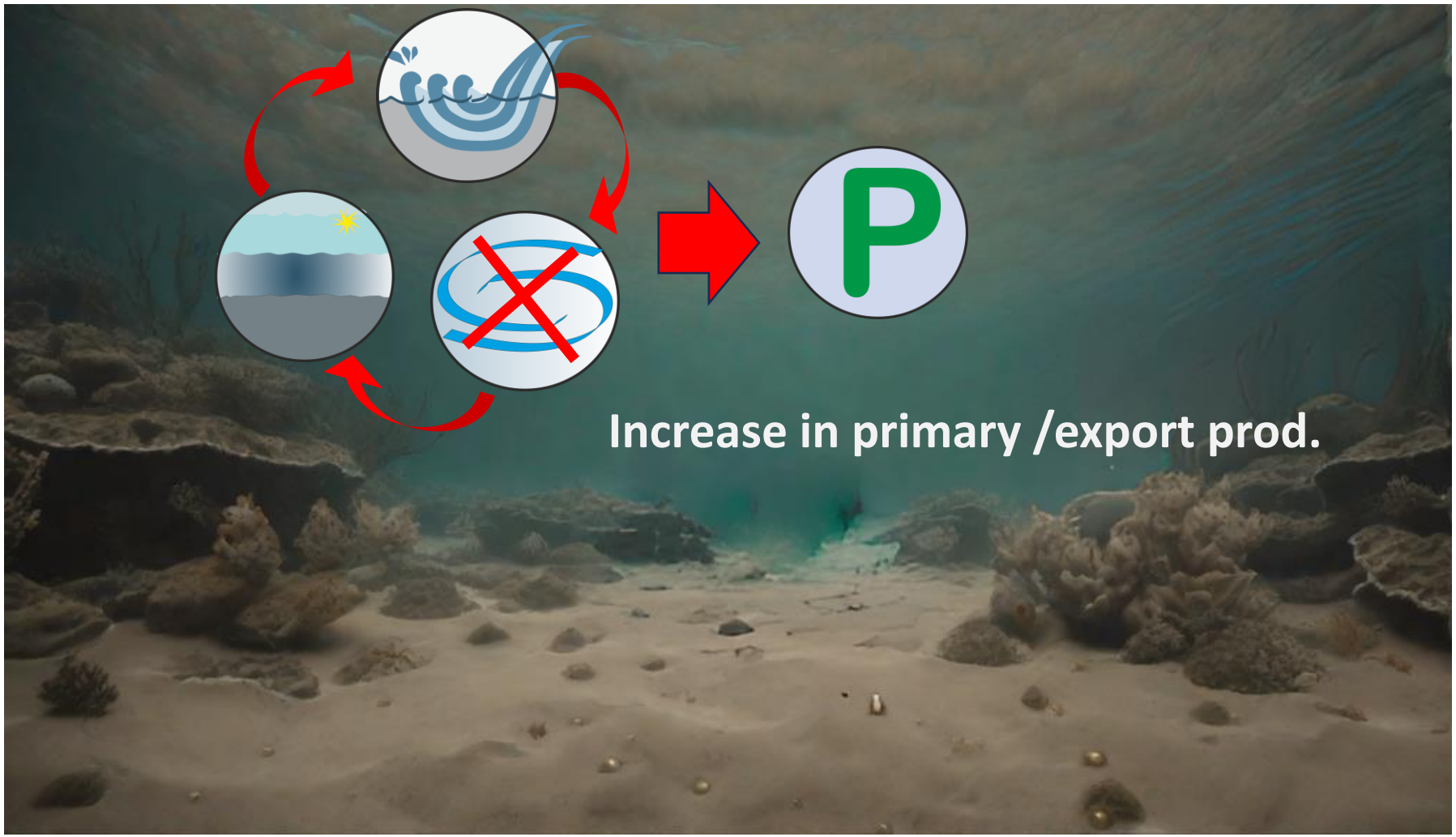

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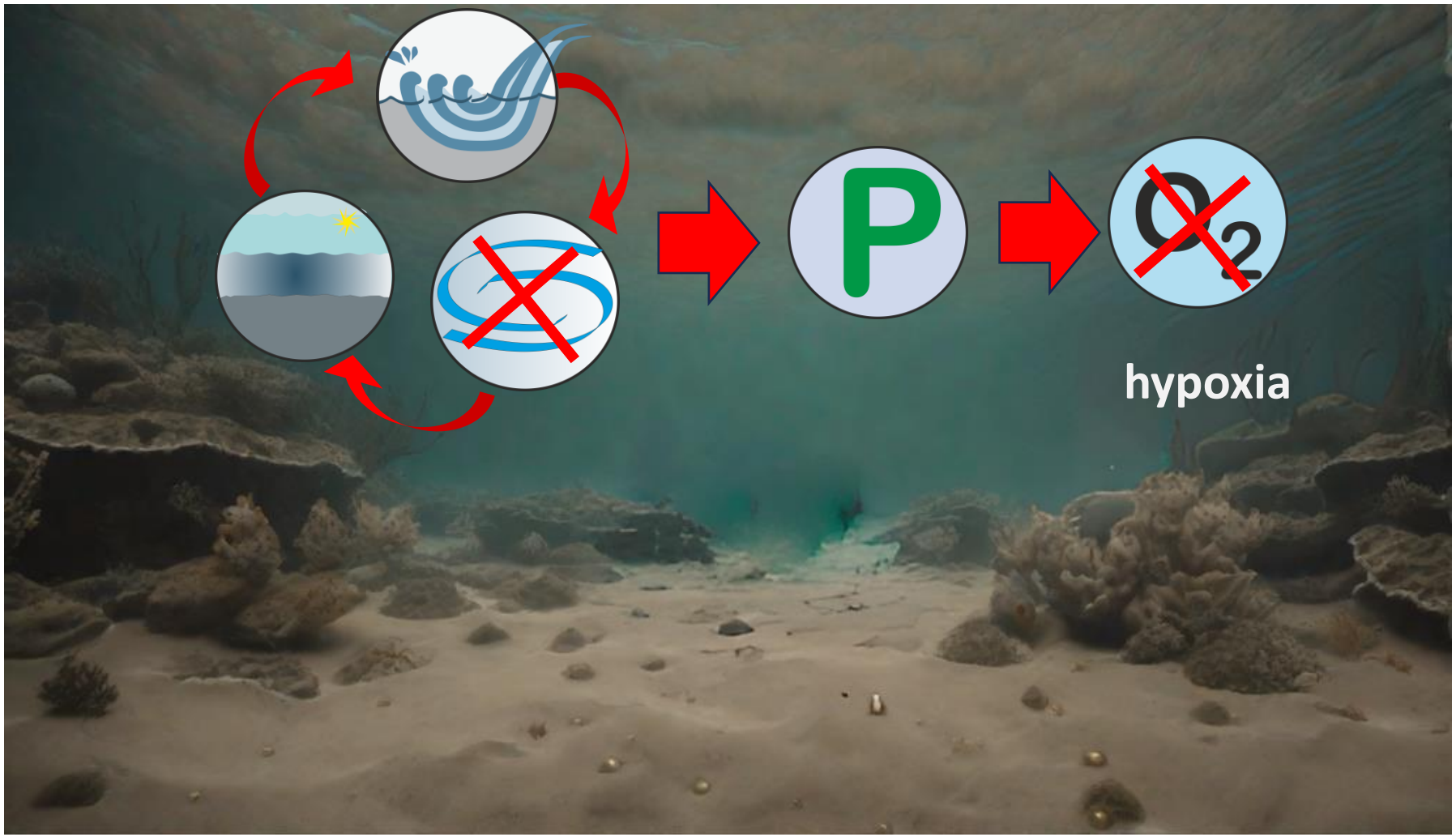

Petrizzo et al., 2022

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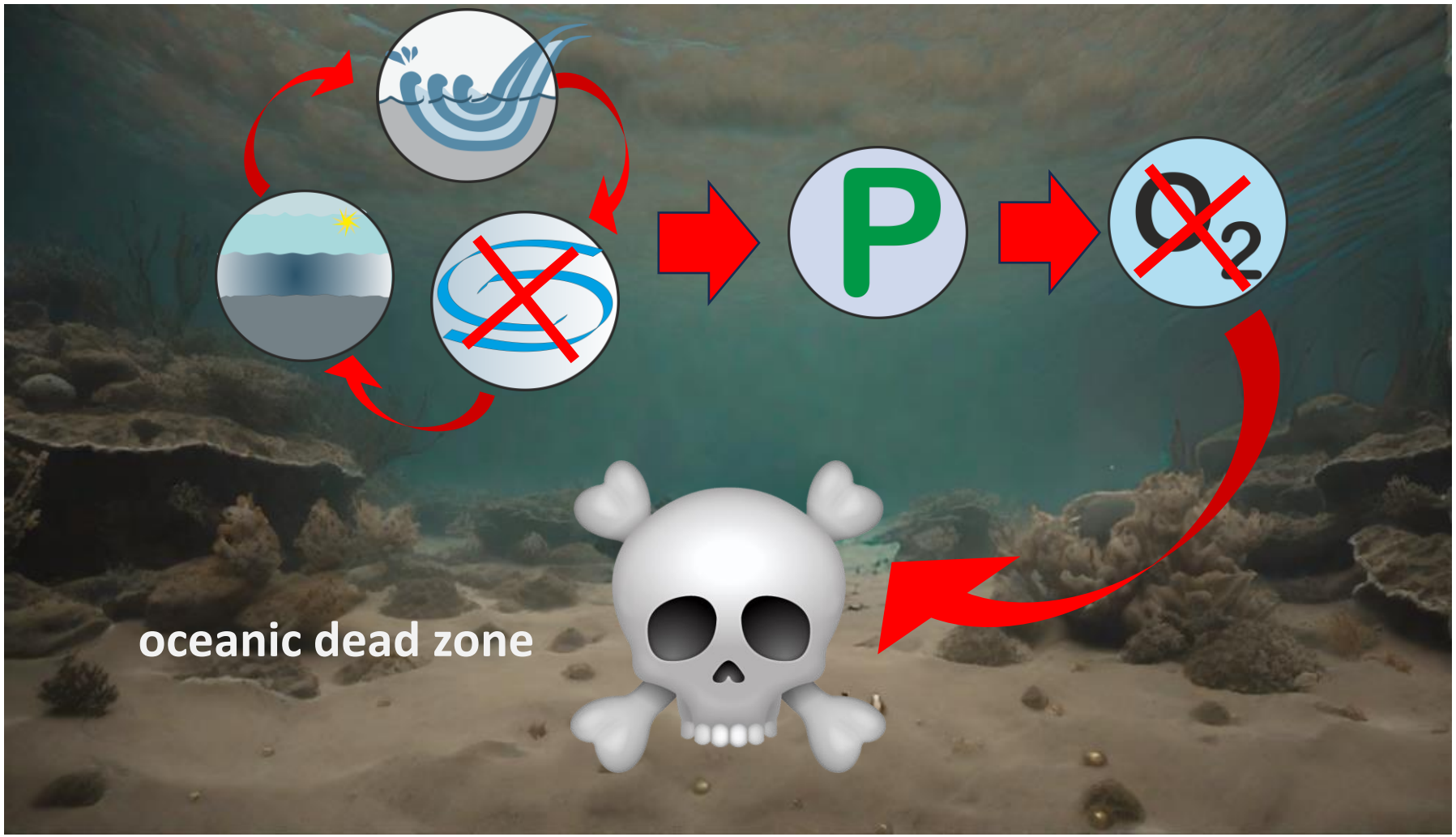

Benthic foraminifera during the Oceanic Anoxic Event 2 in the Mentelle Basin IODP Site U1516

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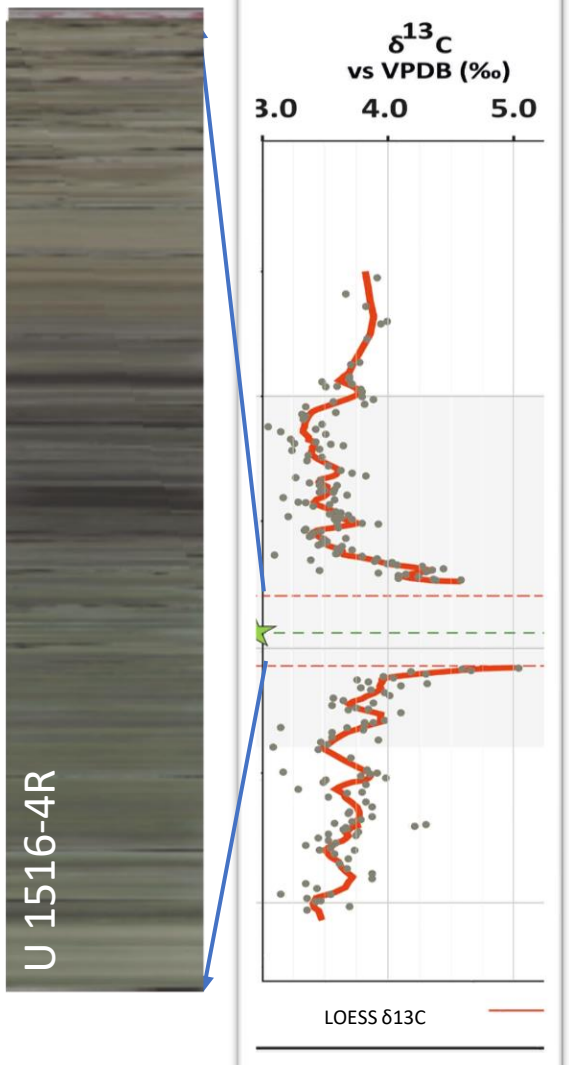
Petrizzo et al., 2022



Wolfgring et al., 2023

- Changes in microfossil assemblages illustrate different palecologic intervals during Oceanic Anoxic Event (OAE) 2
- Numbers of BF decline and reach lowest during the max. δ13C isotope excursion (CIE).
- Rebound of BF numbers in post-CIE and post OAE intervals.

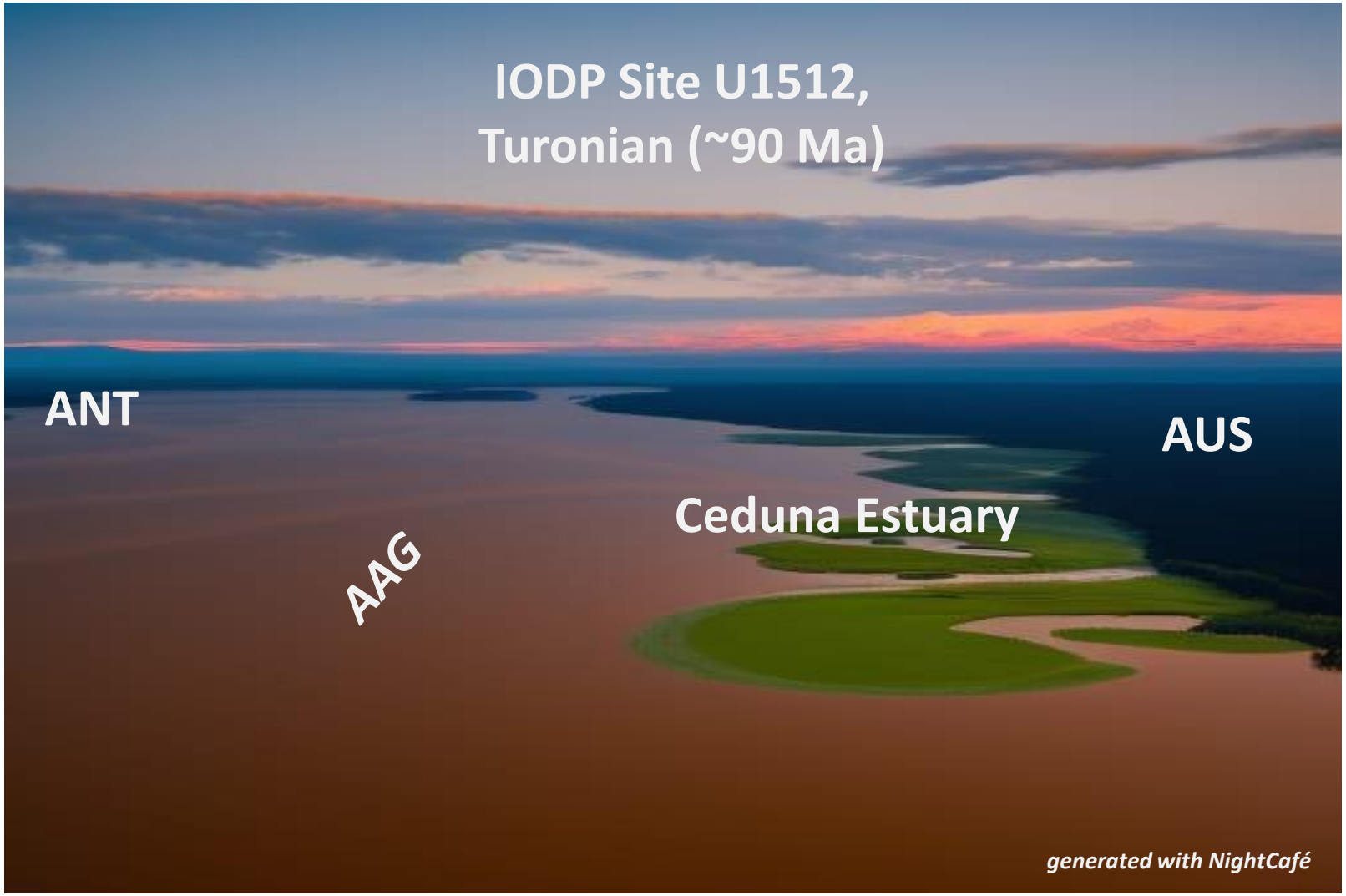
Case study 2:
The Upper Cretaceous record of IODP Site U1512
- a marginal marine/estuarine basin

- **documenting ~10 Ma of the opening of the Australo-Antarctic Gulf**
- **terrestrial, estuarine and/or marine influence**
- **~700 core meters of greyish-blackish siltstone**

The Upper Cretaceous record of IODP Site U1512 - a marginal marine/estuarine basin

Mays, et al., 2014
Wolfgring et al., 2019

Petrizzo et al., 2022



The Upper Cretaceous record of IODP Site U1512 - a marginal marine/estuarine basin

Mays, et al., 2014
Wolfgring et al., 2019

Petrizzo et al., 2022

Inoceramid bivalve from Site U 1512

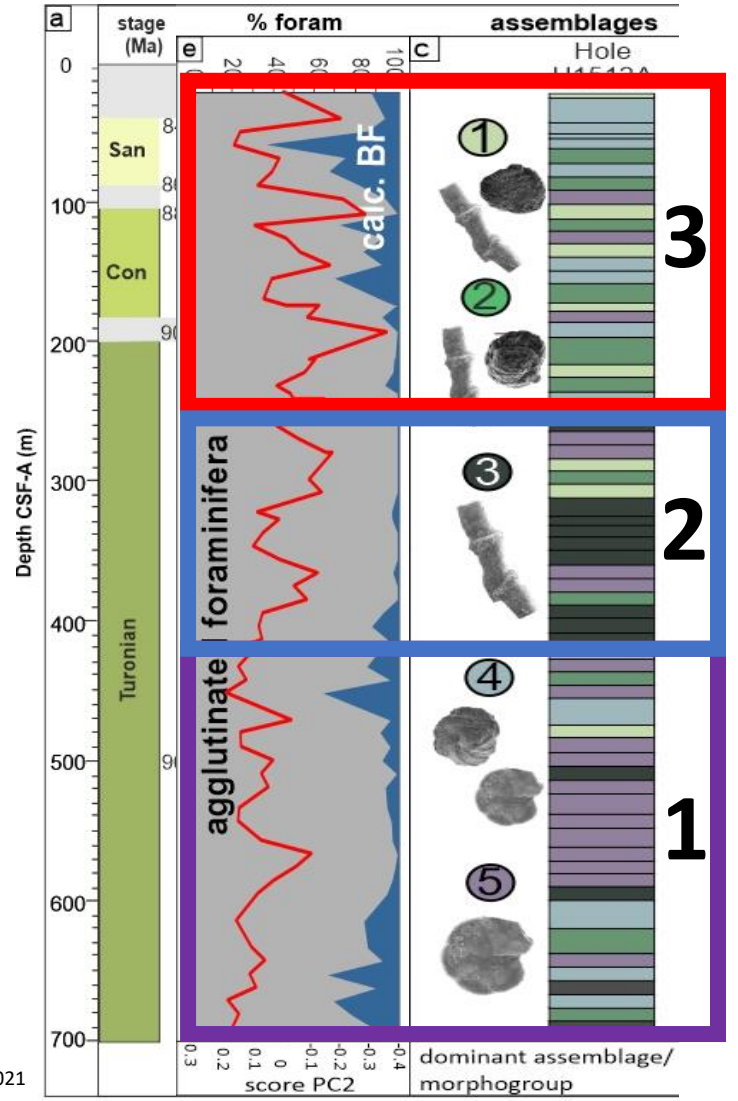
- Taxa tolerant to brackish environments (foraminifera, radiolaria, inoceramids)
- Terrestrial and marginal marine, thick clay/siltstone packages
- opening of the Australo-Antarctic Gulf to Indian Ocean evident vs. Santonian (top of the section)

The Upper Cretaceous record of IODP Site U1512 - a marginal marine/estuarine basin

Mays, et al., 2014
Wolfgring et al., 2019

Petrizzo et al., 2022

- environmental reconstructions based on variations in of benthic organisms
- gradual process of opening of the AAG, Alternating marine and terrestrial influence recorded in benthic foraminiferal assemblages
  1. terrestrial & estuarine
  2. transgressive high org. matter
  3. marine influence



Wolfgring et al., 2021

Case study 3:
Cooling in the Santonian – how do fauna in bottom waters react?

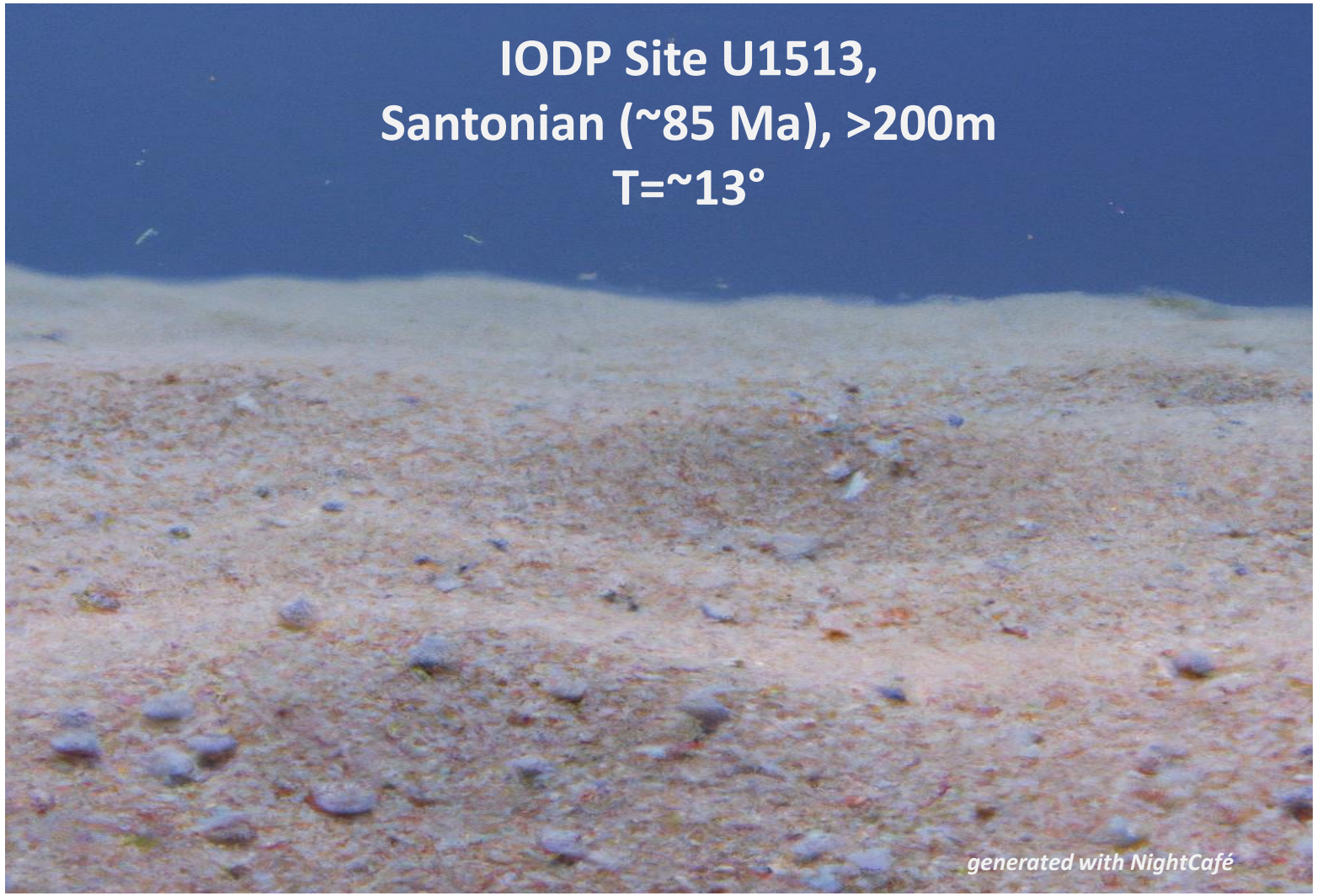
- **The onset of the Late Cretaceous cooling**

- **Isotopic data from surface dwelling planktonic foraminifera suggest a large increase in in δ18O values (implying cooling by ~5°C)**

Cooling in the Santonian – how do fauna in bottom waters react?

Mays, et al., 2014
Wolfgring et al., 2019

Petrizzo et al., 2022



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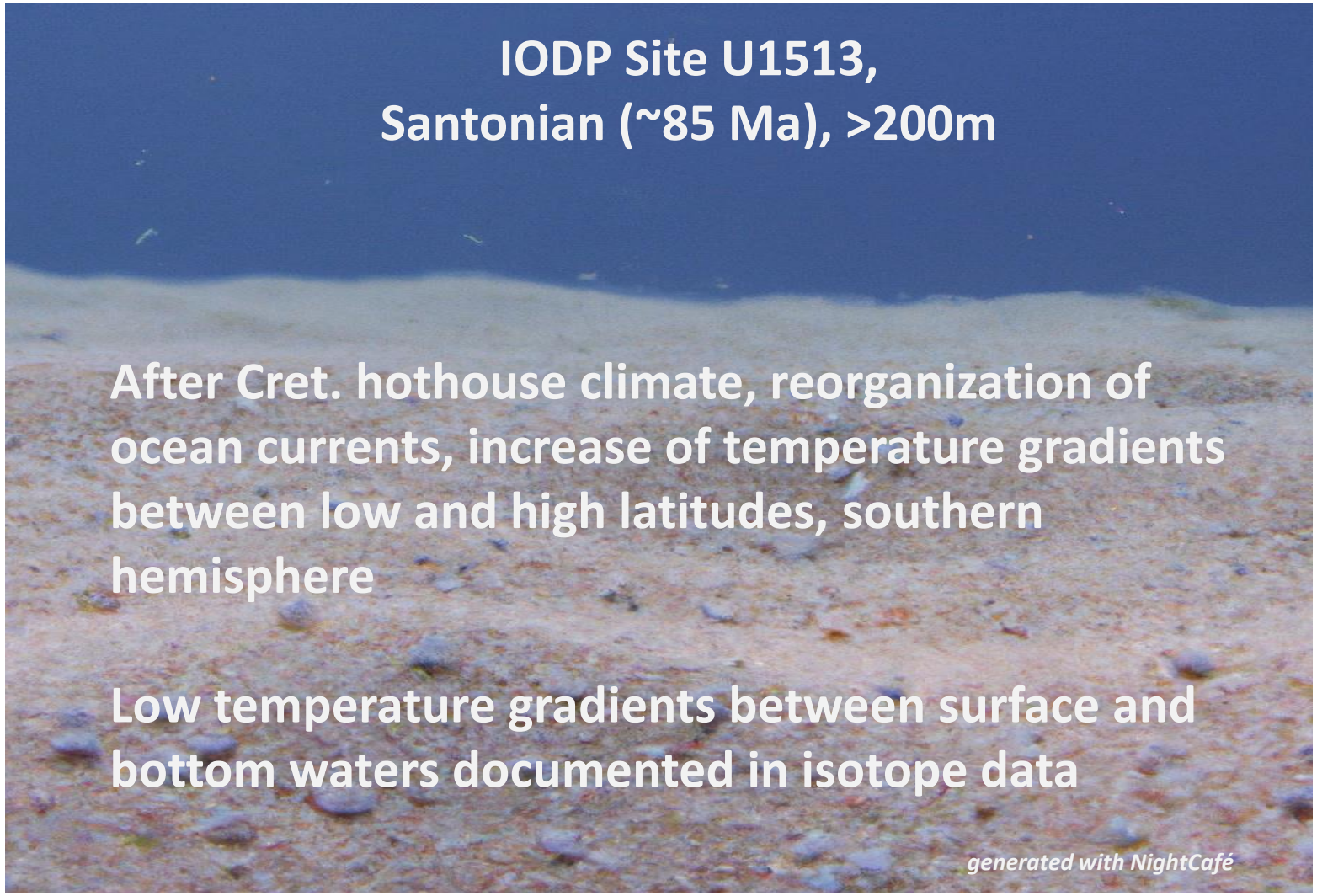
Petrizzo et al., 2022



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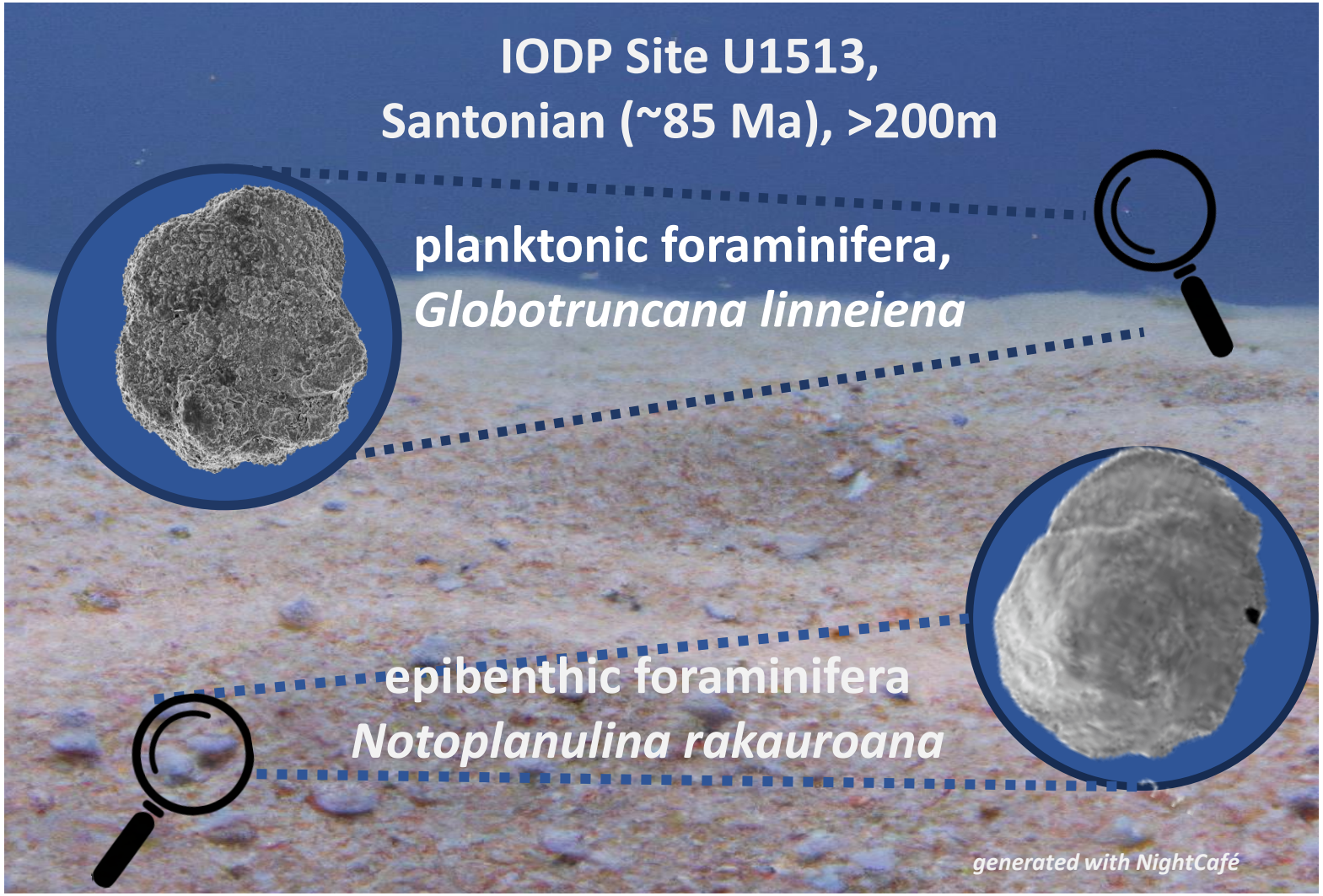
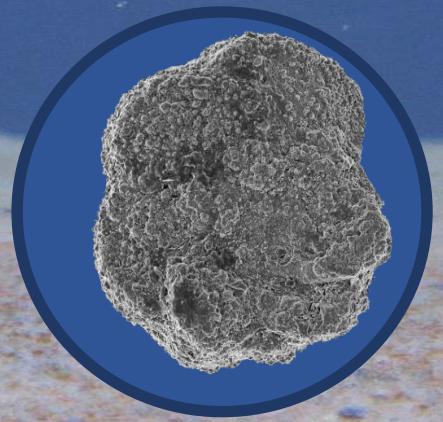


Cooling in the Santonian – how do fauna in bottom waters react?

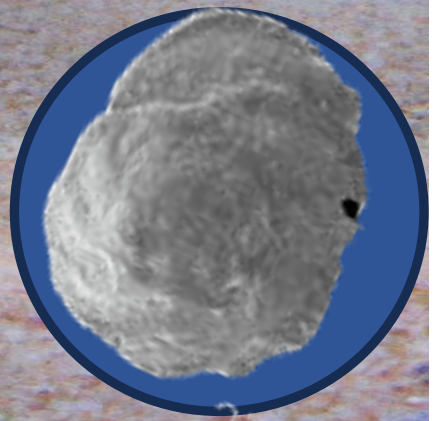
Mays, et al., 2014
Wolfgring et al., 2019

Petrizzo et al., 2022

IODP Site U1513, Santonian (~85 Ma), >200m



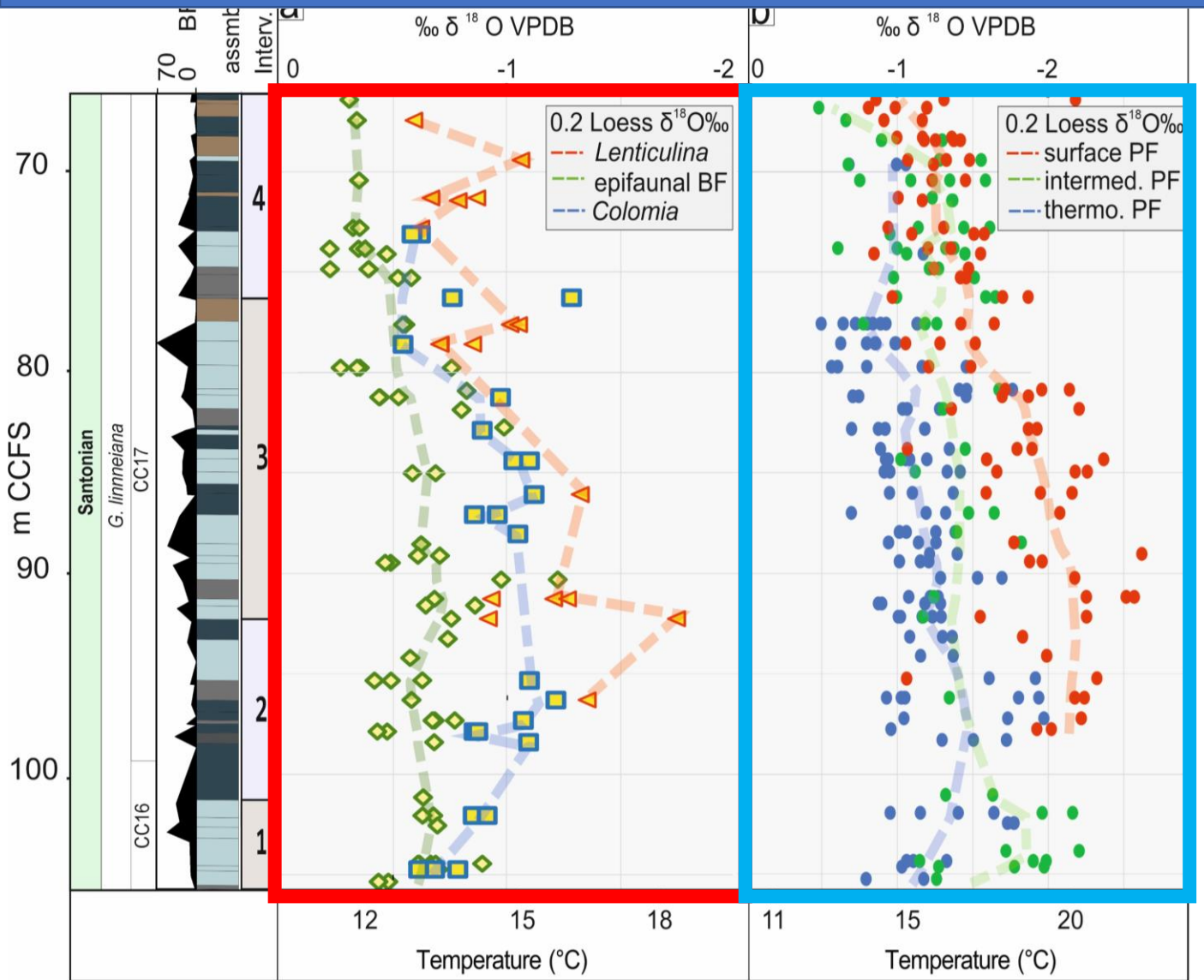
planktonic foraminifera record the largest increase in δ18O values (cooling by ~5°C),



epifaunal benthic foraminifera only register a moderate decline by ~2°C

generated with NightCafé

The Upper Cretaceous record of IODP Site U1513 – different strategies in changing bottom waters

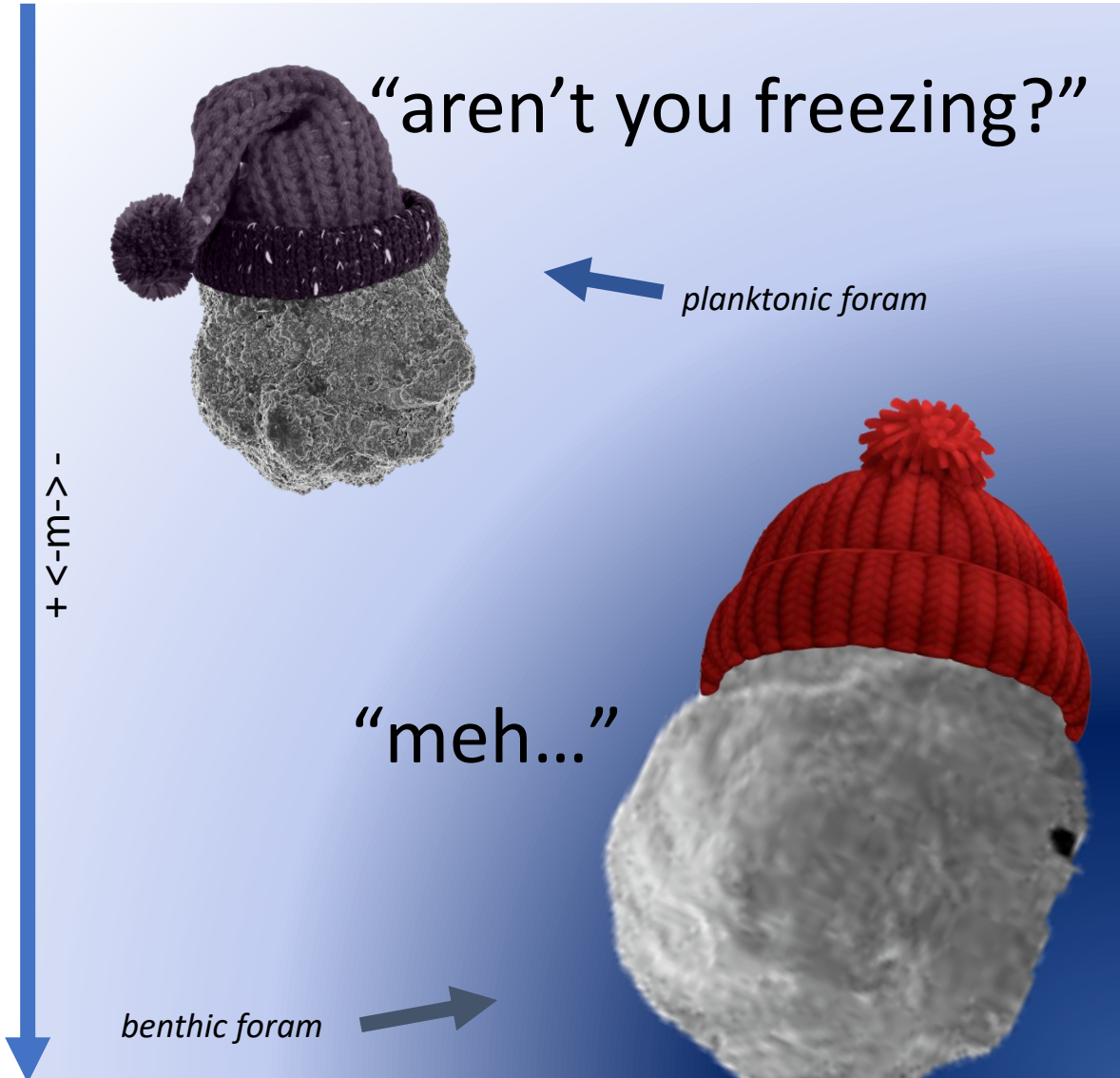


- surfacewater cooling of 5°C, from ~17-15°
- the seafloor at Site 1513 cooled by maximally 2°C (from ~14-12°)

Wolfgring et al., 2022

The Upper Cretaceous record of IODP Site U1513 – the onset of cooling in the Santonian

- The onset of the Late Cretaceous cooling is a surface water signal
- Surface dwelling planktonic foraminifera record the largest increase in δ18O values **(cooling by ~5°C),**
- Whereas epifaunal benthic foraminifera only register a moderate **decline by ~2°C**



Concluding remarks

- **The "Cretaceous Hothouse" climate and Gondwana breakup (re)shaped the Austral-Antarctic realm for the remainder of the Mesozoic.**

- **Opening of the Austral-Antarctic Gulf transformed the basin from a passage with terrestrial and estuarine influence to a broad seaway.**

- **Despite Cretaceous anoxia and global Oceanic Anoxic Events, benthic microfossil communities in the southern high latitudes display impressive resilience, recovering without any extinctions.**

- **The Santonian cooling primarily affected surface waters and circulation patterns/current regimes, with less impact on bottom waters.**

Thanks go to

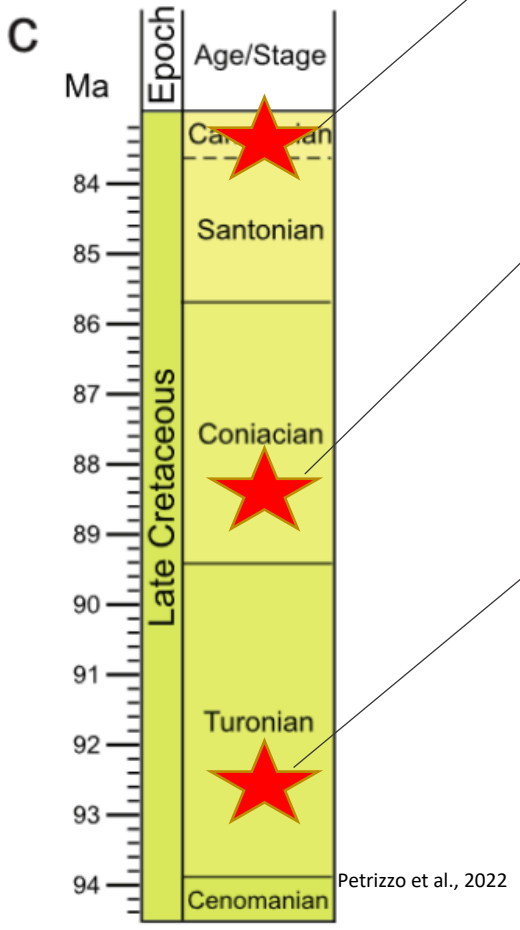
IODP
INTERNATIONAL OCEAN DISCOVERY PROGRAM

GRZYBOWSKI FUNDACJA im. Józefa Grzybowskiego FOUNDATION est. - r.zał. 1992

FWF
Der Wissenschaftsfonds.
P-J4444

Giulia Amaglio, Petra Heinz, Brian Huber, Michael A. Kaminski, Eun Young Lee, Kenneth G. MacLeod, Maria Rose Petrizzo, Carmine C. Wainman, Anna Waskowska, David K. Watkins, the IODP Expedition 369 scientists

The Upper Cretaceous record of IODP Site U1513 – some important contributions of FWF J4444



Petrizzo et al., 2022

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Biotic and Paleoceanographic Changes Across the Late Cretaceous OAE 2 in the Southern High Latitudes. Petrizzo et al. (2023),Paleoceanography and Paleoclimatology, 37, e2022PA004474

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***Buzasina antarctica* n. sp., a new lituolid from the Upper Cret., Great Australian Bight.** Kaminski et al. (2023), Micropaleontology, 66, 2, pp. 139-142

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Biostraitgraphy of the Albian in the Southern High Latitudes, IODP Site U1513, Indian Ocean. Wolfgring et al. (2023), subm.