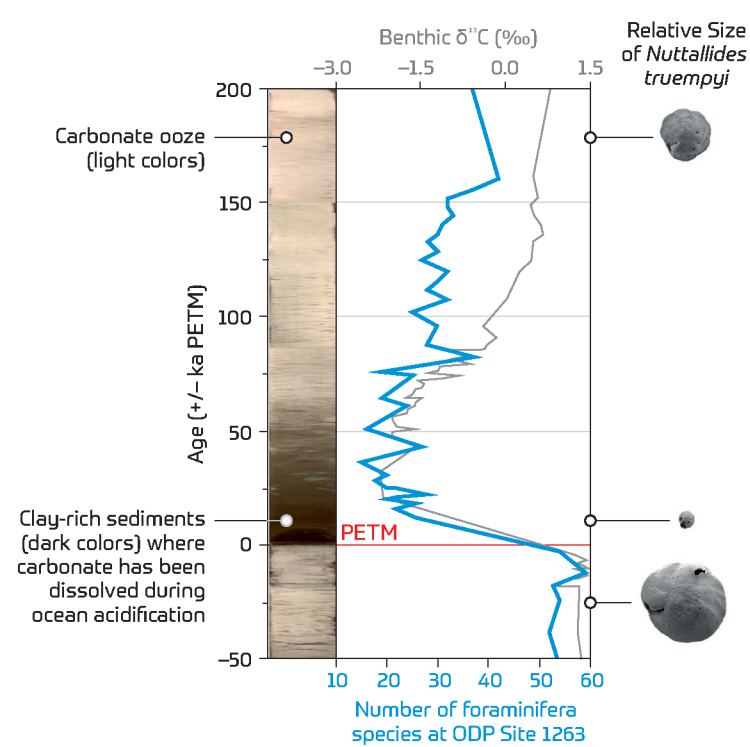

Determining Future Biodiversity Shifts

The Paleocene-Eocene Thermal Maximum (PETM) and the Early Eocene Climatic Optimum (EECO) are excellent intervals to use in investigations of marine biodiversity and ocean health during past "greenhouse" climate states. Scientific ocean drilling cores are replete with fossilized skeletal and molecular remains of past life, whose chemistry, biology, and diversity reveal the health and resilience of ancient ecosystems and food webs. Future scientific ocean drilling could target bleaching episodes, for example, during a relatively brief interval of the PETM, when planktonic foraminifera discarded their algal symbionts in a process similar to what happens in corals exposed to higher temperatures. On longer timescales, larger benthic foraminifera and calcareous algae outcompeted corals during the PETM and EECO, replacing coral-algal reefs with foraminifer-algal banks on a worldwide basis for more than 10 million years. These foraminifer-algal banks dominated coastal ecosystems throughout the tropics and can be found on atolls and guyots in the central Pacific. Deep-time reef records targeted by scientific ocean drilling can show us how long-lasting global warming can flip ecosystems such as coral reefs to an alternate state for millions of years.

The PETM (55.8 million years ago) provides an analogue for exceptionally high rates of ocean acidification and carbonate dissolution in the ocean of a high-CO_2 world. Scientific ocean drilling cores from Ocean Drilling Program (ODP) Site 1263 (Walvis Ridge) reveal a rapid and enormous loss of species of shell-forming foraminifera (blue line) occurs during ocean acidification, coeval with a carbon isotope ($\delta^{13}C$) excursion in shells of deep-sea benthic foraminifera. Surviving species, such as the depicted *Nuttallides truempyi* (all specimens to scale), show a severe reduction of test size. Species diversity eventually recovers, although at a much slower pace over tens of thousands of years. *From Thomas (2012), https://doi.org/10.22498/pages.20.1.37*