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Investigation of the calcification response of foraminifera and pteropods to high CO_2 environments in the Pleistocene, Paleogene and Cretaceous

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Ocean acidification is regarded as a current problem and there is an extensive literature on how various organisms are responding to changes in oceanic pH: the result of increasing atmospheric pCO_2. Acidification is, however, not just a recent phenomenon and there are times in the geological record where pCO_2 has been higher than present day levels (especially in the Cretaceous and Paleogene). Understanding the response of various microfossil groups to the changes in oceanic pH is on-going as part of a major investigation of ocean acidification in both modern and 'fossil' environments.

Extensive carbon dioxide vents have recently been described in the Wagner Basin (northern Gulf of California, Mexico), which cause dramatic changes in carbonate chemistry. The pHT decreased from 7.88 to 7.55 near the most active vents where the lowest saturation states of aragonite (ΩArag) and calcite (ΩCalc) were 0.95 and 1.47 respectively. Foraminifera (unicellular protists) present in the top 2 cm of the sediment (both living and dead individuals) had a range of mainly calcareous taxa (including Bolivina acuminata, B. acutula, Bulimina marginata and Nonionella basispinata). This is a normal composition for these water depths. The lack of dissolution features and the generally good preservation of the tests, even when viewed under a scanning electron microscope, were striking. With no evidence of breakage caused by transportation, it is assumed that this composition is representative in terms of numbers of individuals and taxa represented. Benthic foraminifera from CO_2 vents around the island of Ischia (Italy) have shown dramatic long-term effects of ocean acidification. The foraminifera of the Wagner Basin appear to be surviving in high CO_2 environments comparable to those that occurred during the Cretaceous–Paleogene "greenhouse" world where atmospheric pCO_2 was much higher, but with calcareous foraminifera apparently thriving.

In the Pleistocene, pCO_2 levels are known to have fluctuated in parallel with δ18O during the glacial/interglacial cycles that characterise this interval. Calcification of pteropods through the last 250,000 years shows how this has also fluctuated as a response to the changing oceanic pH. The changes seen in the pteropod assemblages of the Caribbean Sea are mirrored by changes known from the Gulf of Mexico, Mediterranean Sea, Red Sea, Indian Ocean and the South China Sea – all records that confirm the variations in calcification as a global signal.