Still another difficulty in using foraminifera to reconstruct secular paleohistories

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Oxygen isotopes have been used to infer climate change in sediments and sedimentary rocks. The ratio of $^{18}O/^{16}O$ depends on several variables, especially temperature and/or global ice volume.[1,2] It is common to measure oxygen isotopes in the carbonate skeletons of the marine zooplankton, foraminifera (figure 1). Oxygen isotope analysis is one of the main methods secular researchers use to study thousands of deep-sea cores. Oscillations or variations in the oxygen isotope ratio are measured down the cores. It is from these measurements that researchers concluded there were 50 ice ages of variable sizes during the 2.6 Ma of the Quaternary.[3] Therefore, it is important to understand the biology and taxonomy of foraminifera and be certain there was no contamination.

Foraminifera commonly altered

It has long been known that foraminifera can easily be subtly altered by carbonate dissolution or the addition of carbonate.[4] Within a range of depths, the rate of carbonate dissolution exceeds the rate of calcite deposition. Hence, the shells can dissolve in the bottom water while sinking or within the top layers of the sediment on the bottom. Likewise, inorganic carbon dissolved in interstitial pore fluids is also thought to precipitate onto buried shells.

So, researchers have attempted to analyze what they think are pristine-looking shells. These pristine-looking,

believed well-preserved, shells can be translucent or opaque. To the consternation of the researchers it has been discovered by carbon-14 dating that the opaque shells are 'older' than the translucent shells by a considerable amount. Opaque shells have dated the last glacial maximum 8,000 to 15,000 years earlier than expected, and the deglaciation period 14,000 to 22,000 years earlier than expected. The 'frostiness' of the opaque shells is thought to be due to the post-depositional addition of calcite to the shells. This age offset is bad news for secular paleoceanographers, as the opaque shells are common in ocean bottom sediments and have been used for years to date climate events, since both types of shells look pristine. The frostiness in the opaque shells is visible in microscope images, but early diagenesis (changes leading to it becoming rock) can be missed:

> "To complicate matters, early diagenesis is easily overlooked as it occurs on sub-micrometer scales without visibly altering the foraminiferal shell microstructures (Sexton *et al*., 2006)."[5]

This post-depositional alteration of the foraminifera shells was discovered in 'older' sediments about two decades ago.[6,7,8] This solved what was called the 'cool tropics paradox' in which the Cretaceous and early Cenozoic high-latitude climate, based on oxygen isotopes, was judged very warm while the tropics were relatively cool. This does not make meteorological sense, so secular scientists needed to find a solution.

The change in the oxygen isotope ratio is thought to be due to burial compaction that causes interstitial fluids to diffuse upwards. This fluid contains bicarbonate ions with a higher oxygen isotope ratio which would bind with the foraminifera shells. Since higher oxygen isotope values are thought to indicate cooler temperatures, this effect 'fooled' researchers into thinking that the tropics were cooler than they 'really' were. However, a reanalysis showed that the tropics were warm during this period, and in some cases quite hot, thereby apparently resolving the paradox. However, researchers assumed that late Quaternary sediments would have been unaffected, as any alteration would have been negligible, due to a lack of time for such effects to occur:

> "The prevalence of post-depositional diagenesis [alteration] among foraminiferal shells in geologically older sediments is well established … but alteration of younger (late Pleistocene to Holocene) foraminifera is often considered negligible owing to their brief depositional history and shallow burial depths."[5]

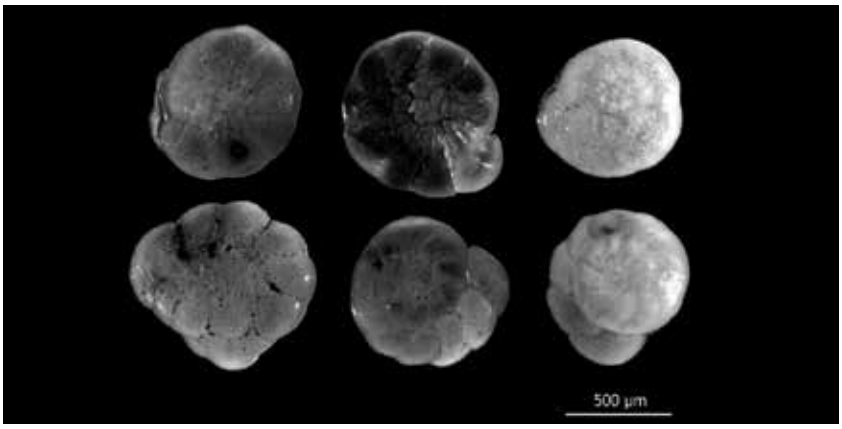

Figure 1. Binocular micrographs of benthic, near-bottom, foraminiferans

However, this new research shows that this effect can show up even in 'younger' sediments.

So, now researchers avoid the opaque shells, and use translucent shells, believed to remain uncontaminated by being surrounded by clay. But what about all the previous research that used opaque shells for past climate analysis?

Creationist implications

The implications of this research for creation scientists are that without accurate oxygen isotope ratios on foraminifera, some of the uniformitarian climate deductions for the Quaternary are bound to be skewed in some unknown way or outright wrong. At this point, it is unknown what far-reaching effect this new research may have.

It also calls into question the assumption that the late Quaternary was too young to be significantly contaminated with carbonate having a heavier oxygen isotope ratio. This could imply that there is actually very little real age difference between late Quaternary and the rest of the Cenozoic and Cretaceous.

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