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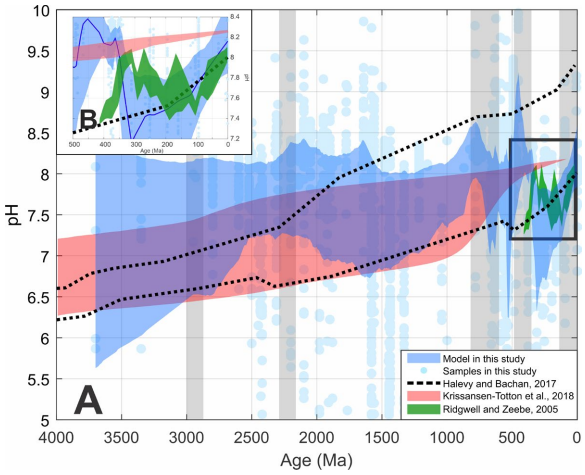
Acidification of Earth's Early Oceans

DR. DARWINAJI SUBARKAH, PHD[1,2], ALAN S. COLLINS[1,2], ANDREW S. MERDITH[2], MORGAN L. BLADES[2], JURAJ FARKAS[2], GEORGINA M. VIRGO[2], DR. STEFAN LÖHR[2] AND DR. JARRED C. LLOYD, PHD[2]

[1]MinEx CRC
[2]Adelaide University

A consequence of increasing anthropogenic CO_2 into our atmosphere and its absorption by the oceans is the decrease in seawater pH over time, with significant ramifications for marine ecosystems. The geological record provides an important archive for predicting the modern ocean's response to changing atmospheric CO_2 levels, as our planet has experienced multiple periods of ocean acidification and global warming since its inception. This study aims to reconstruct the evolution of the Earth's ocean pH for the last 3 billion years (Fig. 1) from rare earth element signatures preserved in carbonate rocks (Lin and Catling 2024). Ocean palaeo-pH constraints from this study were also used to predict past atmospheric CO_2 levels (Fig. 2). Our results indicate elevated pH and subsequently inferred lower CO_2 levels coincide with known icehouse conditions, including the Huronian and Cryogenian glaciations as well as the Ordovician cooling. Outside of these intervals, ancient oceans had a lower pH for most of the Earth's history in comparison to modern-day, particularly during hothouse climates. Beyond the Archean, ocean acidification events occurred during the Mesoproterozoic, the early Cambrian, and the Cretaceous Thermal Maximum (Fig. 1), where atmospheric CO_2 levels may have approached 10,000 ppm.



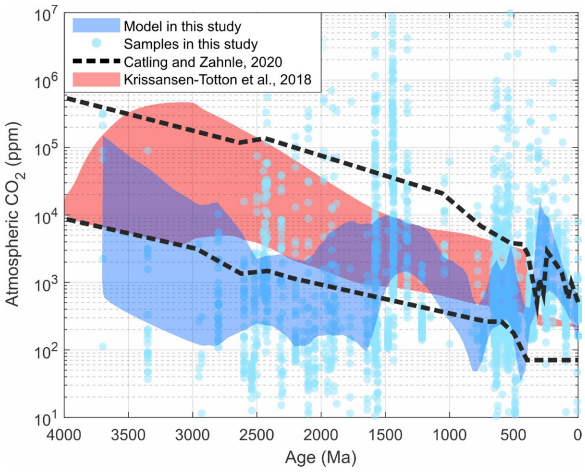


Figure 1. Estimates of past ocean pH from this study and literature (Halevy and Bachan 2017; Krissansen-Totton, Arney, and Catling 2018; Ridgwell and Zeebe 2005). Major glaciations are indicated in grey.

Figure 2. Inferred past atmospheric CO_2 from this study and literature (Krissansen-Totton, Arney, and Catling 2018; Catling and Zahnle 2020).

References

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