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Ocean chemistry controls trends in foraminiferal mineralogy

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Foraminifera are unicellular marine protists of which many produce a calcium carbonate shell of either aragonite or calcite. Since they are responsible for a large part of open ocean calcium carbonate precipitation, it is necessary to understand their response to changes in ocean chemistry. On geological time scales, the ratio of Mg over Ca in seawater played an important role in controlling marine aragonite versus calcite mineralogy. Here we reconstructed occurrences of aragonite and low- and high-Mg calcite producing foraminifera through the Phanerozoic. We discovered a two-step impact of seawater chemistry and mass extinction events on the evolution of foraminifera. Seawater Mg to Ca ratios favor production of either calcite, or of high magnesium carbonate and aragonite shells. However, mass extinction events controlled the timing of shifts in dominance from one mineralogy to the other. This observation suggests that ongoing ocean acidification may have important consequences for foraminiferal calcification. Although reduced carbonate saturation state increases dissolution rates of high-Mg calcite and aragonite compared to low-Mg calcite, the current high Mg/Ca of the ocean kinetically favors precipitation of high-Mg calcite and aragonite. Contrary to the differential effects of dissolution, we argue that ongoing ocean acidification is likely to particularly impact calcite producers (e.g. planktonic foraminifera, coccolithophores) compared to those precipitating high-Mg calcite and aragonite (e.g. corals).