Authigenic carbonate and the history of the global carbon cycle: Why diagenesis matters even more.

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Since the observation of isotopic fractionation of stable isotopes of carbon during photosynthesis more than 60 years ago, the contrast in isotopic composition between organic carbon and calcium carbonate has been used to reconstruct the history of the global carbon cycle and to infer a connection to the oxidation state of the planet, including the rise of atmospheric oxygen. The input of carbon to Earth's surface reservoirs, primarily in the form of carbon dioxide associated with volcanism and metamorphism, is balanced by the burial of carbon either as organic carbon, which is depleted in ^{13}C relative to dissolved inorganic carbon in seawater (DIC), or as calcium carbonate, which has a similar isotopic composition to DIC. Changes in the isotopic composition of marine carbonate in the geologic record have been interpreted as changes in the fractional burial of organic carbon relative to carbonate carbon. Last year, we proposed a new framework for relating the carbon isotopic composition of calcium carbonate to the history of the carbon cycle that adds a new degree of freedom to the isotopic mass balance described above, and requires a major reinterpretation of the carbon isotope record throughout Earth history.[3] In particular, we proposed that authigenic carbonate, produced in sediments during diagenetic reactions associated with sulfate and iron reduction has played a major role in the carbon cycle over Earth history, although it represents a minor component of the modern carbon isotope mass balance due to high levels of atmospheric oxygen in the modern world. We will present new evidence that supports this hypothesis, and reexamine critical events in Earth history in this context. We will discuss specific diagenetic mechanisms that cause a transition between a modern state with relatively minor authigenic carbonate and an ocean state with high authigenic carbonate burial. We will also discuss a variety of environmental conditions that can promote much higher authigenic production.

[1] Schrag, DP, Higgins, JA, Macdonald, FA, and Johnston, DT. *Science,* **339**, 540-543, 2013.