The carbon isotope composition of
global marine authigenic carbonate

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The removal of carbon from the surface of the planet is a
critical component of the long-term carbon cycle; this
removal is through the deposition and subsequent burial of
carbon-minerals in the ocean. Sedimentary, post-depositional
processes play a key role in the global carbon cycle because
much of the organic carbon in sediments is microbially
oxidized back to dissolved inorganic carbon. Most anaerobic
respiration in sediments consumes protons, raising pH, and
leading to some of the dissolved inorganic carbon
precipitating as \textit{insitu}, or authigenic carbonate. Because this
authigenic carbonate has a different carbon isotope
composition to marine carbonate, it may influence the overall
carbon isotope balance at Earth’s surface and critically, our
interpretation of global shifts in the carbon cycle over
geological time. In today’s ocean the two main processes that
produce alkalinity and drive authigenic carbonate formation
are the organiclastic reduction of sulfate and the anaerobic
oxidation of methane, coupled to microbial sulfate reduction.
However, each of these produces authigenic carbonate with a
different carbon isotope composition, and it is unclear how
important these processes were in past oceans with limited
sulfate concentrations.

To identify the processes that are linked to the
precipitation of authigenic carbonate we have utilised the
global ODP/IODP pore fluid database. Here we concentrate
on the relative change in alkalinity, methane and sulfate
concentrations to predict regions of anaerobic methane
oxidation versus organiclastic sulfate reduction and the
relative decrease in calcium concentration to predict the
amount of authigenic carbonate formed. Idealized carbon
isotope profiles for dissolved inorganic carbon then allow us
to determine the global $\delta^{13}$C of the authigenic carbonate sink
today. We use a neural network tuned with chlorophyll,
temperature, water depth and distance from the coast to
predict the extent of anaerobic methane oxidation versus
organiclastic sulfate reduction to extend the sites with
observations to those areas that have none. This knowledge is
then applied to a simple steady-state model to discuss how the
formation of authigenic carbonate would have been impacted
by the lower sulfate and higher calcium concentrations found
in Cretaceous seawater.