Volcanic activation of biogeochemical cascade regulates Oceanic Anoxic Event 2

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Several lines of geologic and geochemical evidence suggest that Cretaceous oceans experienced discrete, short-lived (<1 Ma) episodes of widespread anoxia. These episodes, termed oceanic anoxic events (OAEs), record significant increases in organic carbon burial and are marked by positive carbon isotope excursions in both marine carbonate and organic carbon. While it is widely held that these events were driven by enhanced primary production within surface waters, the details underpinning the initiation, maintenance and termination of OAEs remain equivocal. In the present study, we provide sulfur isotope measurements (sulfate and sulfide) from rocks deposited in the Cretaceous Western Interior Seaway of North America and the proto-North Atlantic Ocean (ODP Site 1258 at Demerara Rise) before, during and after OAE2 (~94.5 Ma)—one of the more pronounced and studied Cretaceous OAEs. Our results are consistent with previous studies and demonstrate that Cretaceous seawater sulfate concentrations may have been low relative to modern levels and that massive volcanism triggered OAE2. We argue that the actual mechanism was increased sulfate levels, which enhanced nutrient recycling and primary production in surface waters. Changes in sulfate concentration provide an effective mechanism to regulate nutrient recycling, which although indicated by increased C/P ratios in sediments during OAE2, has remained unexplained.

Past ocean temperature and radiocarbon values from deep-sea corals

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Interest in deep-sea corals for paleoclimate reconstructions is motivated by several intrinsic advantages to this archive. The uranium rich, aragonitic skeletons of these benthic filter feeders are not bioturbated and show potentially annual density bands. Tracer information recorded in the corals provide ~100 year long records of ocean behavior at decadal or better resolution. Unfortunately many tracers show large overprints from the effects of biomineralization. At Caltech we have been developing two tracers that overcome these vital effects. Paired U-series and radiocarbon dates provide a direct measure of the past C-14 content of deep waters and clumpy isotope values are directly related to the temperature in which the coral grew. Together these data can place strong constraints on the rate of past ocean circulation. We will present new data from the deglacial intermediate depth North Atlantic where all tracers are measured in the same corals.

One obstacle to more widespread use of deep-sea corals in paleoclimate is their perceived scarcity on the seafloor. We have mounted several expeditions specifically designed to collect fossil corals in the North Atlantic and the Southern Ocean. Using AUVs, ROVs, and manned submarines we have over 15, 000 individual D. dianthus specimens in the Caltech collection. To survey the age range of this sample set we have collaborated with the group at NOSAMS to screen 500 corals for their radiocarbon age. The resulting distributions of corals in space and time show correlations between population density and both climate change and bottom water chemistry.