# The Suffocation of an Ocean

**Jochen Erbacher,** Marine Geology and Deep Sea Mining, Federal Institute for Geosciences and Natural Resources, Germany; **Brian T. Huber,** Smithsonian Institution, USA; **Richard Norris,** Wood Hole Oceanographic Institution, USA

Sedimentary records from the Cretaceous period (140-65 million years ago (Ma)) reveal several dark, laminated, carbon-rich intervals, known as black shales, indicating that the ocean floor was prone to oxygen-poor (anoxic) conditions.

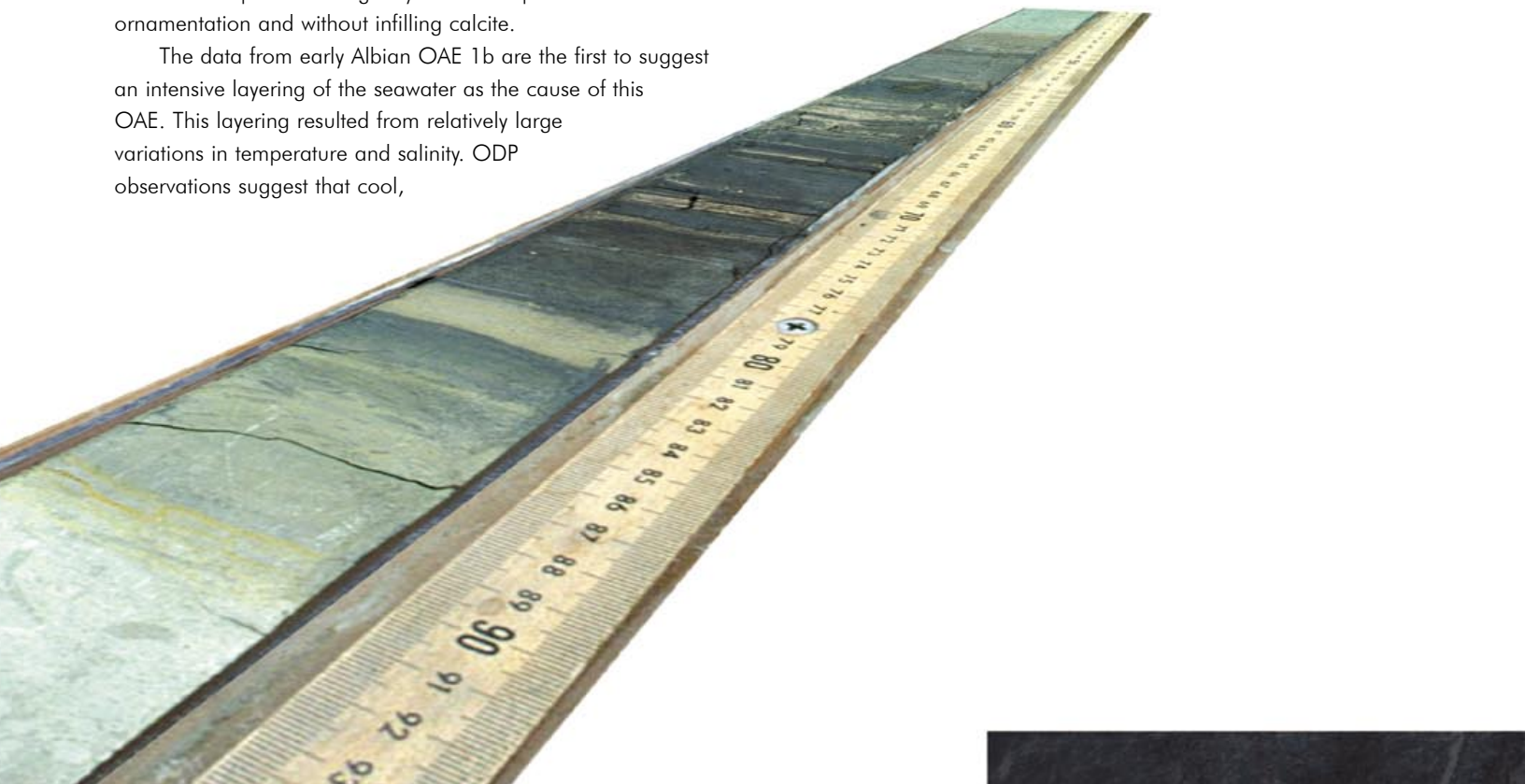
Data from the Deep Sea Drilling Project and Ocean Drilling Program show that many of these black shales occur simultaneously in the world's oceans. Such intervals of concurrent black shale deposition on a super-regional to global scale are called Ocean Anoxic Events (OAEs) and are typical for the mid-Cretaceous time period (120-85 Ma).

The Cretaceous OAEs are periods of high carbon burial and drawdowns in atmospheric carbon dioxide ($CO_2$) during the mid-Cretaceous greenhouse climate and, in many cases, they caused significant biological turnover. Most OAEs are attributed to high ocean biological productivity and export of carbon that led to preservation of organic enriched dark shales. However, the primary factors triggering OAEs remain uncertain. During Leg 171B, ODP drilled mid-Cretaceous black shales in the western subtropical Atlantic off Florida. Scientists recovered sediments that include a 46 cm thick succession of laminated black shale, representing an OAE that occurred 112 Ma, known as early Albian OAE 1b. This record of OAE 1b is unusual for most OAE sediments because the foraminifera are extremely well preserved and can be used to study the geochemical record of the event. Both planktic and benthic species have glassy shells with preserved surface ornamentation and without infilling calcite.

The data from early Albian OAE 1b are the first to suggest an intensive layering of the seawater as the cause of this OAE. This layering resulted from relatively large variations in temperature and salinity. ODP observations suggest that cool, oxygen- and salt-rich surface waters rapidly experienced warmer, oxygen-poor and less saline conditions. No synchronous modifications are observed for the bottom-water. These differences between surface and bottom caused an intensive layering of the ocean. They are documented by the large differences of $\delta^{18}O$ between planktic and benthic foraminifera and suggest that black shale deposition was triggered by a reduction in ventilation of the water column. The termination of OAE 1b was caused by a gradual reduction of the differences between surface and bottomwater and enabled oxygen to be transported into the deeper waters.

Although the OAE has many similarities with the Plio-Pleistocene Mediterranean sapropel record, the geographical extent of the OAE is much larger. This feature together with a ~46,000 year history of deposition, notably at least four times longer than any of the Quaternary sapropels, suggests that the entire North Atlantic and western Tethys constitute a considerable carbon sink.

Analysis from the cores indicate that up to 80 percent (by weight) of sedimentary organic carbon deposited during OAE 1b is derived from a type of single-celled organism, the so-called *Archaea,* that obtains food through chemical reactions. These microbes underwent a massive expansion during this Oceanic Anoxic Event that may have been a response to the strong stratification of the ocean described above. Indeed, the sedimentary record suggests that OAE 1b marks a time in Earth history at which many groups of microbes adapted from high-temperature environments, such as the white and black smokers of the deep-sea, to low temperature environments.



# Early Albian Oceanic Anoxic Event 1b

## Blake Nose, ODP Site 1049C