

OAE 1b in the Vocontian Basin, Southeast France

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The Cretaceous was a time of greenhouse climates characterized by at least 15 degree warmer sea surface temperatures than the present one. During the climax of Cretaceous warming, anoxic condition in the oceans globally expanded, resulted in accumulations of organic rich sediments. These events are called Oceanic Anoxic Events (OAEs), and occurred at least 8 times during the Cretaceous period. The study of OAEs is important from three different perspectives: (i) the OAEs acted as the thermostat during the greenhouse climate because they eliminated carbon from atmosphere (CO₂) to sediments (black shales); (ii) the expansions of anoxic condition in the oceans caused mass extinctions of marine biota; (iii) most of source rocks were formed during Cretaceous time under anoxic oceanic environments. Recently, oxygen and carbon isotope data on planktic and benthic foraminifers reveal the development of two types of water-column structure during OAEs. The first type, represented by collapse of the vertical structure of the water column caused by abrupt deep water warming, is recognized in OAE 1a, Fries and Bullois levels of OAE 1b, OAE1d and OAE 2. Such OAEs are characterized by the increased primary production, drawing of carbonate platform and world-wide deposition of black shales. The second type corresponds to intensified vertical water column stratification triggered by an increase in the surface water temperature or a decrease in salinity (e.g., Paquier level of OAE1b). To understand the detailed depositional process and response of marine biota during OAE, we focused on the OAE1b sequence distributed in the eastern part of the Vocontian Basin which contains abundant well-preserved macro- and microfossils.

The OAE 1b interval the Vocontian Basin comprises intercalations of six major black shale beds. These are: the Fries, Bullois and Jacob levels of the late Aptian age, and the Kilian, Paquier and Leenhardt levels of the early Albian age, in ascending order. From the sedimentological and paleontological points of view, these black shale levels are classified into three types. The upper Aptian Fries and Bullois levels (type A) contain few planktic foraminifera and nannoconids but no megafossils, while the black shales of the Kilian and Paquier levels (type B) bear abundant ammonites, planktic foraminifera and nannoconids. Type C, represented by the Leenhardt and Jacob levels, exhibits intermediate characteristics between types A and B. The types A and B black shales were deposited during transgressive periods while the deposition of the Jacob of type C took place during regressive periods. High-resolution sedimentological and micropaleontological records are deciphered from two black shale levels of the type A (Fries level) and B (Paquier level). Sampling resolution is about 1 - 4-cm-interval for each sample. The black shale levels of types A and B commonly exhibit increase in quartz grains just below and/or within the strongly laminated layer, and decrease in benthic foraminifera within the strongly laminated layers. These evidences indicate that oxygen depletion of bottom water was followed by the elevated continental run-off. Within the type A black shale level, the strongly laminated layers contain few planktic foraminifera, radiolarians and nannoconids while the massive parts exhibit increase of these fossils. On the other hand, type B black shale beds bear a lot of planktic foraminifers, radiolarians, nannoconids within the strongly laminated layers while those suddenly decrease in the massive parts. Although black shales of these two types deposited under elevated continental run-off during transgressive periods, distinction of faunal response in the black shale reflects different oceanographic conditions with regard to development of anoxic environment.