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# Low oxygen bottom waters in the Devonian ocean through a combined biological and geochemical approach

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Devonian black shales of the Appalachian basin preserve a range of bottom-water oxygen conditions within the epeiric seaway and provide an opportunity to investigate temporal redox variation on a microstratigraphic scale. Two black shale intervals were analyzed using an integrated paleontological–geochemical approach. Data for trace and body fossil abundance and size suggest generally low oxygen conditions. The strata are frequently dominated by laminated sediments that are traditional indicators of anoxic/euxinic bottom waters. The addition of parallel geochemical results, however, further refines this perspective. The use of well-established iron proxies for depositional redox tells us that anoxic conditions were intermittent and short-lived, if present at all. Trace metals including molybdenum point to very low oxygenated bottom waters with high pore-water concentrations of hydrogen sulphide in close proximity to the sediment–water interface. These elevated sulphide concentrations under iron-limited diagenetic conditions varied with organic content and may have further inhibited benthic colonization and an active infaunal community more specifically. Anoxia/euxinia, if present, occurred briefly and intermittently, perhaps on seasonal time scales tied to cycles in primary productivity and/or climatically induced variation in water column stratification. The study confirms the strength of the combined biogeochemical and palaeoecological perspective, revealing a refined fabric of redox variation that would be missed otherwise.