# Large Accumulations of Sulfide-rich "Organic Oozes" in Archean Seas

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Organic carbon- and sulfide-rich black shales are frequently associated with banded iron formations (BIFs) of all geologic age. Here we report the results of elemental and isotopic analyses of drill core samples from two major black shale formations: the 2.7 Ga Jeerinah and 2.55 Ga Mt. McRae Shale Formations of the Hamersley Basin, Australia. Our data, together with those from previous studies, suggest that before these sediments were subjected to a long history of alteration by diagenetic, hydrothermal, and metamorphic processes, they were essentially 'organic oozes', which were typically comprised of 20-50% in mass by remnants of microbes (including cyanobacteria, eukarya, sulfate reducers, methanogens, and methanotrophs), 1-15 wt% by biogenic pyrite, and 30-80 wt% by detrital/aerosol minerals (clays and quartz); in volume, organic matter was >50% of the original sediments. Both formations are ~100 m in thickness and >100,000 $km^2$ in aerial distribution, which make them two of the largest accumulations of organic matter in Earth's history. The high productivity and preservation of organic matter may be linked to a prolonged history of large-scale submarine hydrothermal activity, which also produced BIFs, in the Hamersley Basin. Geochemical data of these black shales (e.g., the contents and ratios among C, S, Fe, Mo and N; the $\delta^{13}C$ and $\delta^{15}N$ of kerogen; $\delta^{34}S$ of sulfides) also suggest the concentrations of Fe, S, Mo and N in the oceans, and their geochemical cycles through the atmosphere-hydrosphere-biosphere-lithosphere system, have been basically the same as today since at least 2.7 Ga ago.