Sedimentology and stratigraphy of the Kettle Point Formation: implications for widespread marine anoxia and the extensive deposition of Upper Devonian black shales in eastern North America

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The Upper Devonian Kettle Point Formation of southwestern Ontario is characterized by intervals of organic-rich interlaminated black shale interbedded with organic-poor greyish green mudstone and rare red beds, separated by metre-scale sequences of non-interlaminated black shale. The formation shows a largely consistent background value for the black shales around 20‰ $\delta^{34}S$, punctuated by a substantial positive excursion of ~32‰ (up to + 12.87‰) coincident with a significant section of greyish green mudstone and red beds. Organic content, in conjunction with the sulphur isotope data, indicate that the black shales were deposited during periods of anoxia with thick intervals of non-interlaminated black shales representing the acme of anoxic conditions. Greyish green mudstones, with their lack of organic-content, increased bioturbation, and higher, more-positive, sulphur isotope values, therefore record deposition in more oxygenated environments. A new 4-stage, 2 cycle depositional model for the Kettle Point Formation is proposed with relative water depth interpreted as the key control on the vertical diffusion of oxygen in the water column, and therefore on the distribution of the Kettle Point lithofacies. Interbedded black shales and greyish green mudstones were deposited in relatively shallow water where minor, short-lived falls in relative sea level promoted dysoxic to oxic conditions and the deposition of organic-poor lithologies. Non-interlaminated black shales are indicative of substantial rises in relative sea level, resulting in widespread anoxia and the deposition of thicker and more laterally extensive packages of organicrich sediment. The sedimentology and stratigraphy of the Kettle Point Formation and other syndepositional black shales, suggests that the extensive deposition of organicrich sediment across eastern North America during the Late Devonian was a product of widespread anoxia related to fluctuating water depth and restricted circulation in intracratonic and foreland basin depositional centers.

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