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Black shale deposition in high latitude, peri-glacial shelf basins during Hirnantian (end Ordovician) deglaciation

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The "run-off" hypothesis describes a relationship between the increased influx of nutrient-rich waters, anoxia and the increased production and preservation of sedimentary organic matter in restricted ocean basins. If this holds then the influx of glacial meltwater into ice margin basins should result in the deposition of organic-rich black shales. The melting of the end Ordovician Gondwana ice sheet provides a test case.

Laminated black shales from Batra Formation (Ordovician to Silurian) in Jordan were deposited in a shelfal basin, $<$ 100km from the ice margin during the deglacial high-stand. Core samples typically contain Type II kerogen. The % total organic carbon (TOC) increases stepwise as a function of height above the base of the formation, from 1 to 10%. HI of the samples have a range of 156 to 402 mg HC/g OC (mean 283 mg HC/g OC). Stable carbon isotope ratios of bulk OM show a range of -30.8 to -29.6‰ with fluctuations of up to 0.4‰ and a gradual positive shift of 1.4‰ up the section. The regular sterane carbon number distributions are such that $C_{29} > C_{27} >> C_{28}$ where the average value of the C_{28}/C_{29} steranes ratio is 0.27 consistent with this ratio being less than about 0.35 for samples older than Silurian. The sterane distributions are thermally immature throughout the section. The 17α-hopane distributions are also immature and again do not vary with changes in burial depth. Maxima in the regular

sterane/17α-hopanes occur at $\sim$ 6.5 m and 12.9 m above the base of the formation and coincide with the stepped increases in TOC suggesting major contributions to the OM from planktonic and benthic algae. Isorenieratane (the saturated hydrocarbon equivalent of isorenieratene) was identified in all of the samples analysed with a δ^{13}C value of -14.7 +/- 0.3$\%_{\circ}$ providing unequivocal evidence for photic zone euxinic conditions during the deposition of these sediments. We conclude enhanced "run-off" was the primary cause of basinal anoxia. Ordovician peri-glacial basins were a major site of carbon sequestration and source rock formation during early deglaciation.