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Carbon-isotope records of sedimentary organic matter through a high-frequency Carboniferous sea level cycle: Implications for the delivery of organic matter to ancient shallow water shelves

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Carboniferous mudstone successions that were deposited on broad, relatively shallow water-shelves across northern England and Scotland are significant organic carbon repositories. Silt-bearing and sand- and silt-bearing clay-rich mudstones, with 1.8-2.8% total organic carbon, were deposited from erosive hyperpycnal flows and are dominated by terrestrial plant-derived material including terrestrial palynomorphs and phytoclasts (including equant fragments and sheet-like cellular material). This material has high (less negative) carbon-isotope values (averaging -22.8±0.3). These samples contain up to 50% silt grains and therefore Zr, found primarily in the heavy mineral zircon, is also abundant (averaging 159.2±42.2 ppm). In contrast, clay-rich mudstones, with a marine macrofauna indicating normal salinities, were more likely to have been deposited from suspension settling when biological productivity in the water column was high. The organic matter is mainly amorphous organic matter (AOM), typical of marine algae, although the occasional detrital grains or terrestrial plant fragments were probably deposited from dilute suspended sediment plumes or wind blown material. These mudstones contain 2.3-5.2% total organic carbon and are characterised by lower (more negative) carbon-isotope values (averaging –24.5±0.3). Lower abundances of Zr (99.5±7.5 ppm) reflect the very low silt content. Differences in the sedimentary processes that deliver sediment to these shelves therefore result in changes in the proportions of terrestrial and marine organic matter. These changes can be tracked using carbon-isotope values of sedimentary organic matter due to the large differences that exist between carbon-isotope values in terrestrial and marine organic matter and corresponding changes in Zr abundance. Here we show that the systematic lithofacies changes observed through a complete sea-level cycle; from one maximum flooding surface through a sea level fall to a renewed sea-level rise depositing a second maximum flooding surface, demonstrates that different depositional processes operate during given periods of time and suggest that changes in sea-level were probably responsible for the changes in facies types.