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The hydrocarbon cycle and its role in hyperthermals, ocean anoxic events and mass extinctions

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Release of light isotopic carbon, ocean oxygen deficiency and extinction characterizes the Paleocene-Eocene Thermal Maximum (PETM). The PETM carbon isotope excursion (CIE) has been linked to gas hydrate decomposition and/or methane release due to igneous intrusions in sedimentary basins. In reviewing the published geological and geochemical data it became apparent that the majority of observations are in fact compatible with a different source(s) of the light isotopic carbon, namely, that of fluids trapped in sedimentary basins. Here I make a connection between the drilled paleo-accumulations of oil and gas in the Barents Sea, their burial and tectonic history, and published data of the PETM that may be reinterpreted as to reflect large scale leakage of oil and gas accumulations. I focus on oil, as leaked oil has a preservation potential in the sedimentary record. In contrast, gas from either leaked gas accumulations or exsolution from pore waters has little preservation potential other than contributing to the CIE. Sedimentary records compatible with leaked oil is present in the Arctic Ocean and Spitsbergen as fluorescent bitumen/amorphous organic matter (AOM) with carbon isotope ratios and biomarker signatures similar to those recorded in Barents Sea oil samples. Bitumen/AOM-rich immature sediments are also found in the North Sea and unresolved complex organic matter compatible with highly weathered oil has been found as far south as Walvis Ridge, offshore Namibia. Large scale fluid leakage from sedimentary basins can also explain the increase in radiogenic Osmium and Rhenium that mimic the CIE. Also biological evidence such as the extinction of North Atlantic benthic foraminifera lineages, the A. Augustum bloom and the occurrence of malformed micro/nannofossils may be linked to large scale leakage of oil and diagenetically altered porewaters. The leaked oil and gas was partially re-cycled into an organic rich shale (source rock) suggesting a 'hydrocarbon cycle' exists. Based on previously noted similarities between the PETM, the Toarcian OAE and the Triassic-Jurassic and Permian-Triassic events, it is inferred that also these may have been associated with catastrophic leakage of hydrocarbons trapped in sedimentary basins.