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Possible Methane Release during the Middle Devonian: A New Carbon Isotope Record from the Mimerdalen Subgroup near Pyramiden, Svalbard

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The Devonian Period (419-359 Ma) encompasses a critical transition within the Paleozoic, during which land-plants evolved from low-lying sporophytic organisms into the first forests, establishing the base of the terrestrial trophic structure that persists today. The Middle to Late Devonian (394-359 Ma) was a time of many biotic crises, with two severe mass extinctions during the Late Devonian. We present a high-resolution terrestrial carbon isotope record from Givetian (389-383 Ma) terrestrial sediments from the Mimerdalen Subgroup near Pyramiden (Svalbard). Our 109-point record reveals a baseline carbon isotope value of $-25.9 \pm 0.8\%$, with several excursions of magnitude $\sim 4.0\%$ toward lower values, near 140 m stratigraphic height. Sudden methane release events have been proposed as key drivers of climate and evolutionary crises at many points during geologic time (e.g., PETM, the end-Permian). From a mass-balance perspective, the isotope excursions in the Mimerdalen section are best interpreted as driven by methane release, due to the low carbon isotopic value observed within methane hydrates, relative to carbon derived from volcanoes, wildfires, continental drying or sea-level decrease. A chaotic series of methane release is also consistent with observations of widespread oceanic anoxia during the Givetian. Our sampled sediments contain some of the best-preserved terrestrial organic carbon of the Middle Devonian, and are linked to the Taghanic crisis (381 Ma), a second order global extinction event possibly related to greenhouse overheating. The methane release that we hypothesize based our observed carbon isotope excursion coincides with the Taghanic crisis and may have resulted, like other methane-release events, in very rapid warming and/or oceanic anoxia. These results suggest a methane-driven mechanism for dramatic carbon cycle perturbation within the Middle Devonian, and substantiate the view of the Taghanic crisis as a particularly volatile time in Earth's climatic history.