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The geologic history of seawater DOC from marine iron oxides

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Marine dissolved organic carbon (DOC) is a major reservoir in the global carbon cycle, with a mass today comparable to atmospheric carbon dioxide. Small imbalances in DOC production and consumption can cause significant changes in the reservoir's size, which can impact global biogeochemical cycles and climate. However, despite this crucial role, there is currently no quantitative proxy to reconstruct DOC concentrations in the geologic past. Modeling studies have attempted to reconstruct DOC concentrations but with drastically diverging results, particularly during the Neoproterozoic era, where model-predicted DOC concentrations range from near-modern to ~1,000 times greater than modern. Our ongoing efforts aim to develop iron-oxide ooids as a DOC proxy to build the first empirical record of past marine DOC concentrations. We will show that carbon incorporated within iron-oxide minerals is quantitatively proportional to the parent fluid DOC concentration, and we will discuss the complexities involved. Subsequently, we will present a high-fidelity record of carbon content and $\delta^{13}C$ values in iron-oxides formed in shallow marine settings throughout geologic time. Our record suggests that seawater DOC concentration increased by a factor of ten during the transition from the Precambrian to the Phanerozoic eon, opposite of most existing models. Additionally, seawater DOC $\delta^{13}C$ value remained constant from the Mesoproterozoic to the early Paleozoic era. However, through Phanerozoic time, seawater DOC $\delta^{13}C$ has risen by up to 20‰. Finally, we will discuss potential explanations for these observed long-term trends.