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Oxidation or Recycling? Characterizing Petrogenic Organic Carbon from Source to Sink in Modern Arctic Sediments

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The carbon cycle links the biosphere, atmosphere, hydrosphere, and geosphere [1]. It begins with photosynthesis, where photosynthetic organisms convert CO_2 into O_2 and organic carbon (OC). This OC is either oxidized to CO_2 or preserved in sediments. [1, 2]. OC buried and lithified within (meta)sedimentary rocks transforms into matured petrogenic carbon (OC_{petro}). When OC_{petro} is re-exposed to weathering it can become reoxidized to CO_2 [3, 4], where oxidation efficiency most likely depends on maturity [2] and O_2 availability, and time in an oxidizing environment. Thus, while OC_{petro} oxidation consumes atmospheric O_2 and influences Earth's redox balance [5], oxidation is often incomplete [2]. It is predicted that under low O_2, more OC_{petro} is unoxidized to be transported to and reburied in marine sediments. Therefore, OC_{petro} recycling is both a control on carbon budgets and a potential proxy for past atmospheric O_2 levels [3].

However, the efficiency of OC_{petro} oxidation during weathering remains poorly quantified; even under high O_2, a significant fraction escapes oxidation and is recycled into marine sediments [2]. Quantifying this recycling in modern complex sediment matrices is challenging. This project investigates OC_{petro} oxidation and recycling in modern Arctic riverine and marine sediments on Svalbard to determine whether erosion releases it as CO_2 or promotes its reburial in fjords.

We quantify OC_{petro} in sediments using TOC analysis and ^{14}C dating, and develop an extraction method to isolate OC of different maturities from sediments. Raman spectroscopy is then used to characterize OC_{petro} heterogeneity [2], distinguishing maturity populations, sources, and degrees of recycling [6] in both sediments and source rocks. Together, this enables a source-to-sink assessment of OC_{petro} oxidation and recycling into riverine and marine sediments on Svalbard.

This research improves understanding of OC_{petro} cycling, refines carbon cycle and climate models, and informs interpretations of past atmospheric O_2.

References:

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