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Understanding the mechanisms and dynamics of the Neoproterozoic carbon cycle remains an important target within in the field of Precambrian geobiology, especially in light of the potential link to the emergence of complex life in the form of metazoa [1]. During the Neoproterozoic Era, Earth witnessed several severe stable carbon isotopic anomalies that are recorded in carbonates and organic matter [e.g. 2] and which cannot be explained with modern carbon cycle models. Particularly the observation of decoupled isotope signals in co-occurring and syngenetic carbonates and kerogens [3] has resulted in much speculation on its mechanistic origins, such as authigenic carbonate production in sediment pore fluids during early diagenesis [4], remineralization of detrital organic carbon [5] and the oxidation of a massive deep-marine DOC pool [6]. Yet a satisfactory explanation remains absent.

We here present an alternative view on the Cryogenian marine carbon cycle by comparing stable carbon isotope values obtained for carbonates, kerogens, alkyl and phytyl lipids with molecular biomarker distributions, compound-specific hydrogen isotopes, as well as microfossil content and redox sensitive trace metals. For this study we have analyzed a comprehensive sample set from a carbonate and shale succession deposited prior to the Sturtian glaciation that has experienced only mild thermal alteration. We find a substantial heavy $\delta^{13}C$ anomaly expressed in the kerogen, which is not followed by co-occurring carbonates, suggesting a decoupling between source DIC pools, probably located in deeper waters or the sediment *vs.* the upper water column. The behavior of alkyl and phytyl lipids in $\delta^{13}C$ space, relative to the bulk organic phase, can be closely linked to changing microbial ecological associations and redox conditions—likely driven by eustatic environmental factors and primary productivity. In this presentation we will explain our observations in terms of different pools of OM productivity and selective preservation, and hypothesize on tentative extrapolations to carbon isotope anomalies during the later Neoproterozoic.

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