Weathering of Ancient Sedimentary Organic Matter in the Geochemical Cycles of Carbon and Oxygen

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Rock reservoirs such as sedimentary rocks and metasediments represent a vast store of 15 million Pg of chemically-reduced carbon which, over geologic time scales, interacts with Earth's Critical Zone through weathering, erosion and transport processes to modulate the CO_2 and O_2 content of Earth's atmosphere. In light of the fundamental role these gases play in defining Earth's surface environment, weathering of sedimentary OM is recognized as a critical component of Earth's coupled biogeochemical cycling of the elements.

Various approaches can help us to better understand weathering of ancient sedimentary OM. Detailed geochemical characterizations of weathering profiles have revealed changes that develop in kerogen composition during weathering. Molecular and isotopic signatures have indicated influences of microbiological activity during OM weathering, showing many parallels with patterns of oil and coal biodegradation, while microcosm and field experiments have demonstrated direct biological assimilation of ancient OM pools. Numerous examples of aged, fossil or petrogenic OC in river POC and DOC pools provide evidence that oxidation of sedimentary OM is incomplete during weathering in many settings, while ^{14}C interpretations suggest that, as river and floodplain heterotrophy lead to assimilation of ancient carbon into modern food webs, caution must be applied to not confound 'ancient' with 'refractory'. Together, these observations inform estimates of sedimentary OM weathering rates at field, regional and global scales, drawing from an emerging range of modeling approaches and geochemical proxies. A goal of current efforts is to better develop and scale-up process-based understanding of the limits, controls and rates of weathering to partition the loss of sedimentary OM from rock reservoirs into oxidative fluxes that directly modify the Earth's atmosphere, and transport/ reburial/recyling fluxes that have limited influence on long-term evolution of atmospheric composition.