Links between the sedimentary redox cycle and marine acid-base chemistry

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The redox state of Earth's surface over geological timescales is controlled by the flow of electrons through the sedimentary rock cycle, mediated by the weathering and burial of C-S-Fe phases. These sedimentary processes act to buffer atmospheric pO_2 [1]. At the same time, it is appreciated that CO_2 influxes and carbonate burial control seawater acid-base chemistry and climate over long timescales via the silicate weathering feedback [2]. However, redox and acid-base processes operating on the fluid Earth are mechanistically linked and impact each other via charge balance in the hydrosphere [3,4]. We have developed a simple numerical model of the sedimentary rock cycle and marine carbonate system designed to interrogate a subset of these connections, with a focus on net redox balance in the sedimentary rock cycle. Model calculations of end-member scenarios illustrate an important hysteresis in carbonate burial rates attendant to protracted imbalances in the redox budget of Earth's crust and sediments. We apply this approach to the Neoproterozoic sedimentary record associated with the low latitude glaciation, including deposition of "cap carbonates". We find that these linkages may be able to explain, at least in part, both the signal feature of this event—strongly pulsed carbonate burial—as well as it's striking sedimentary redox character, including iron formation and unusual sulfur cycling.

[1] Kump & Garrels, *AJS*, (1986) [2] Walker *et al JGR* (1981) [3] Higgins *et al EPSL* (2009) [4] Tziperman *et al PNAS* (2011)