Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.25354

A Neoproterozoic to early Paleozoic revolution of continental weathering

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This presentation will propose that there might be very little continental weathering before the Neoproterozoic to early Paleozoic oxygenation of atmosphere. I will present a data assembly that shows decreasing K/Al mudstone since the early Neoproterozoic, which is interpreted to reflect an increasing continental weathering input of aluminum to dilute the hydrothermal addition of K to the sedimentary mud reservoir. A positive feedback loop is invoked to explain the coupling between continental weathering and pO_2 in response to external forcings possibly linked to tectonic activity. The positive feedback loop involves influence of weathering phosphorus input on organic C burial and thus atmospheric pO_2 and the control of pO_2 on efficiency of continental weathering by determining the depth of weathering front generated by oxidative reactions.

The hypothesis can be supported by other records. Felsic regolith with lower Fe content shows higher susceptibility of weathering front propagation to pO_2 changes than the basaltic regolith. A lower continental weathering under lower pO_2 also imply higher contribution of marine weathering (basaltic seafloor alteration and sediment weathering) to maintain a CO_2 consumption required by carbon cycle balance. Thus, weathering lithology must have been shifted dramatically (resulting fine terrestrial sediments that may not represent the contemporary crust exposed). The effect of pO_2 on weathering lithology may contribute partly to rise of seawater $^{87}Sr/^{87}Sr$ and decline of sedimentary εNd during the Neoproterozoic to early Paleozoic. Higher Al/[Ca+Mg] of felsic rocks than basaltic rocks also imply higher clay production in response to shifting weathering lithology under the same CO_2 consumption, which may be responsible for emergency of clay mineral factory, rising frequency of alluvial mudstone, and increasing seawater $^{7}Li/^{6}Li$ in the late Precambrian.

The Neoproterozoic to early Paleozoic revolution of continental weathering may have profound influence on the evolution of Earth system. Increasing terrestrial clay production may influence solid earth dynamics though sediment-lubricated subductions and subduction of water-enriched clays. Clay production facilitates soil formation and water retention on land, a condition that favors colonization of terrestrial plants. Increase efficiency of weathering CO_2 consumption caused by rising of pO_2 even may have initiated Neoproterozoic snowball events.