Did respiration in soils drive atmospheric O_2 levels up during the Mid-Paleozoic?

SUSANNE ARENS[1] AND TAIS W. DAHL[2]

[1]GLOBE Institute, Øster Voldgade 5-7, 1350 Kbh. K University of Copenhagen, susanne.arens@sund.ku.dk

[2]GLOBE Institute, Øster Voldgade 5-7, 1350 Kbh. K University of Copenhagen, tais.dahl@sund.ku.dk

It has been suggested that evolving microbial respiration below ground caused an increase in atmospheric O_2 during the Neoproterozoic [Kump 2014]. The largest absolute increase in atmospheric O_2 may have occurred during the Paleozoic due to increased organic carbon burial. This broadly coincided with the evolution and spread of vascular land plants. Here, we investigate if increased soil respiration associated with the evolution of roots during the Mid-Paleozoic would also have contributed to a substantial O_2 increase.

Traditionally, the global balance between burial and oxidation of sedimentary organic carbon and pyrite is considered the main control of atmospheric O_2. Periods of excess organic carbon burial are considered the main cause of increases in atmospheric O_2. Oxidative weathering of sedimantary organic carbon and pyrite is considered the primary long term sink for atmospheric O_2. Whether this sink is primarily controlled by a direct sensitivity of oxidative weathering to atmospheric O_2, or if tectonic recycling of sedimentary organic carbon and pyrite sets the pace of oxidative weathering, is still an open question. Within this framework, the hypothesized effects of soil respiration invites further investigation.

We extended an established model of oxidative weathering with soil respiration to find that soil respiration can stave off below ground oxidative weathering to an extent that results in substantial atmospheric O_2 build-up. The combined effects of initial atmospheric O_2 and uplift rates on the resulting atmospheric O_2 increase are non-trivial. We conclude that the effect is large enough to warrant inclusion in global mass balance models of the carbon and oxygen cycles.

Kump (2014), *PNAS* 111 (39) 14062-14065.