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"ACID WEATHERING, CLAY TRANSPORT AND ENHANCED PHOSPHATE SUPPLY TO EARLY PALEOPROTEROZOIC OCEANS FOLLOWING THE GREAT OXIDATION EVENT"

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It was previously hypothesized that following the Great Oxidation Event at ca. 2.5 billion years ago, oxygenation of the atmosphere led to unprecedented acid production from biological oxidation of crustal pyrite, leading to enhanced levels of nutrient transport to the oceans[1]. Higher levels of terrestrial phosphate supply would then have facilitated marine primary production, the burial of more organic carbon than any previous time in Earth's history, a rise in atmospheric oxygen, and a large increase in the $\delta^{13}C$ value of marine carbonates; these events are collectively known as the Lomagundi Event (LE) between ca. 2.22 and 2.06 Ga[2]. Although phosphate was initially sourced from dissolution of crustal pyrite by acidic soil pore- and ground-waters, the mechanisms by which the phosphate was transported to the oceans and then concentrated into P-rich deposits is unclear. Here we show that phosphate is readily adsorbed onto kaolinite particles under freshwater conditions (pH 6, ionic strength=0.01 M) but that phosphate is released in marine aquatic environments (pH 8, ionic strength=0.56 M). Phosphate sorption is significantly increased when the pH is further dropped to pH 4, conditions mimicking acid rock drainage. We suggest that during post-GOE terrestrial weathering, P was carried by suspended clay particles to estuarine and coastal environments, where P was desorbed, released into seawater as ionic phosphate species and then utilized by photosynthetic plankton. Our research provides new perspectives on the mechanisms that link the rise in atmospheric O_2 with the evolution of aerobic chemoautotrophy on land to the LE.

1. Konhauser, et al., 2011. Aerobic bacterial pyrite oxidation and acid rock drainage during the Great Oxidation Event. Nature, 478:369–373.
2. Bekker, A. and Holland, H.D., 2012. Oxygen overshoot and recovery during the early Paleoproterozoic. EPSL, 317:295–304.

Dr. Konhauser (left) Two-billion-year-old shungite (right), a type of sedimentary rock exposed in north-western Russia, records evidence for oxygen-rich conditions on the early Earth. Photo courtesy of K. Paiste.

Kurt O. Konhauser (Ph.D. University of Western Ontario) is a professor in the Department of Earth and Atmospheric Sciences, University of Alberta. His current research interests include: surface reactivity of biomass, microbial silicification, modern microbialites, sediment diagenesis and the effects of infaunal burrowing, understanding the mechanisms for Precambrian banded iron formation, using Precambrian sediments as paleo-seawater proxies, and Neoproterozoic environment and evolution of animal life.

Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta, T6G 2E3 (kurtk@ualberta.ca)