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Oxygenation of the Proterozoic Earth's surface: An evolving story

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The history of free oxygen (O_2) in Earth's atmosphere and oceans during the Proterozoic Eon is slowly coming into focus. So too are the connections between this history and the history of life. Just a few decades ago, when geochemists' toolboxes were lean, many sedimentary successions had yet to be sampled, and geochronological constraints were few and far between, it was only possible to draw broad and general connections between these two histories. This is no longer the case.

This presentation will briefly summarize a recent review chapter bearing the same title and published in the 3rd edition of the *Treatise on Geochemistry*. In this new chapter we provide an updated synthesis on background O_2 levels and potential short-term O_2 changes during the Proterozoic Eon. We place a focus on the Lomagundi-Jatuli Event, the perhaps not-so-boring Mid-Proterozoic, and an alleged Neoproterozoic Oxygenation Event (NOE). We discuss the O_2 demands of Proterozoic life, and the potential role of oxygenation in Proterozoic animal evolution.

Background Proterozoic atmospheric O_2 levels were stable but low according to the available evidence, up to a few percent of the present atmospheric level. Surface oceans had low and variable O_2, reaching a few 10s of μM in at least some locations, but the deep oceans remained broadly anoxic. Short-termed oxygenation events could have disturbed these low background O_2 levels. None of these alleged events, however, is free from controversy or complication. Each merits continued interrogation. This is especially true for the NOE, where alleged magnitudes of oxygenation oftentimes far exceed the inferred demands of Earth's oldest fossilized animals: the Ediacara biota. While some level of O_2 is needed to permit complex animal life and ecosystems, there is growing evidence that the O_2 requirements of Neoproterozoic animals were first met long before their initial appearance and rise to some level of ecological dominance.