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NEW EVIDENCE FOR A DRAMATIC RISE IN ATMOSPHERE OXYGEN CA. 1,900 M.Y. AGO

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The evolution of the oxygen content of the Earth's atmosphere has been tied closely to the history of the biosphere. Before the advent of life, the O_2 content of the atmosphere must have been vanishingly small. At the beginning of the Phanerozoic, ca. 570 m.y. ago, P_{O_2} must have been at least 10% of the present O_2 level of o.2 atm. During the past 300 m.y. P_{O_2} was almost certainly more than half and less than twice the present level. To date, the O_2 content of the atmosphere between the origin and life and the opening of the Phanerozoic has been very poorly constrained. Several lines of geologic evidence have pointed to a significant increase in P_{O_2} about 2,000 m.y. ago, but the magnitude of P_{O_2} before and after that time has been quite uncertain. The data that we have accumulated recently suggest that P_{O_2} was $\leq 2 \times 10^{-3}$ atm more than 2,000 m.y. ago, and ≥ 0.03 atm more recently than ca. 1,900 m.y. ago.

These estimates are based on the behavior of iron in Precambrian weathering horizons. More than ca. 2,000 m.y. ago Fe^{+2} released during the weathering of basalts was not oxidized to Fe^{+3}, and was removed in ground water from the upper layers of soil horizons. More recently than ca. 1, 850 m.y. ago, Fe^{+2} was oxidized to Fe^{+3} and precipitated as iron oxides and hydroxides in such soil horizons and in the weathering products of a carbonate facies banded iron formation in Griqualand West, South Africa. The O_2 content of the atmosphere must have increased dramatically about 1,900 m.y. ago to explain these observations. The reasons for the increase are still obscure, but are probably related to changes in the biologic productivity of the oceans. Eukaryotes appear to have developed shortly after the increase in P_{O_2}, perhaps in response to the subsequent increase in the supply of nitrate from the atmosphere to the oceans.