# EARTH'S MIDDLE AGE: THE PALEOPROTEROZOIC-MESOPROTEROZOIC TIME SLICE

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**ABSTRACT:** The Paleoproterozoic and Mesopoterozoic was a period of dramatic developments and responses in the Earth's lithosphere, oceans, atmosphere and biosphere. These included the assembly and dispersal of the first true supercontinents, oxygenation of the surficial environment, and changes in ocean circulation that led to feedbacks with the biosphere and responses in the type and frequency of mineral and hydrocarbon deposits. The volume of continental crust during this time period was similar to today (range of 75-85%), and in combination with an evolving mantle thermal regime enabled a lithospheric response that resulted in the supercontinents Nuna and Rodinia and development of their associated orogenic systems.

The Archaean – Paleoproterozoic transition was one of the most profound in Earth's evolution. It was defined by planetary oxidation throughout the geosphere, hydrosphere, biosphere, and atmosphere. Chemical deposition of banded iron formation was replaced by physical sedimentation of granular iron formation ca. 2.45 Ga. This facies became restricted to a deep-water, tectonically-sequestered niche ca. 1.9 Ga, before disappearing altogether from Earth's rock record for more than a billion years.

Staged transition of Earth's rock record is mirrored by its paleo-biochemistry: bacterial consortia utilising the photosystem II pathway became widespread, proteins built around trace metals radiated through prokaryotic lineages, and free di-oxygen became relatively abundant in Earth's atmosphere, generating an ozone layer that ended mass-independent fractionation of sulphur isotopes. Later, eukaryotic lineages radiated and the oceans also became mostly oxygenated.

Earth experienced its first global glaciations (known as the 'Huronian' ice ages) between 2.45 and ~2.2 Ga, and large continental platforms were established. By 1.8 Ga, Earth's continental plates had assembled into the first supercontinent, Nuna, along collisional belts with regional tectonic patterns resembling those of modern Earth's great orogens (a pattern repeated with Rodinia). Over the intervening time, the global carbon cycle experienced its earliest and largest perturbations: an extreme and prolonged, positive carbonate C-isotopic excursion ca. 2.1 Ga termed the Lomagundi-Jatuli Event, and the development of a supergiant oil field, the ca. 2.0 Ga Shunga Event. These suggest wholesale re-organization of carbon reservoirs coincident with episodic changes in Earth's plate tectonic, sedimentary, and biospheric regimes.

Although the oxygenated Earth system is a direct consequence of the cyanobacterial metabolism, the reason why the so-called 'Great Oxidation Event' occurred in Earth's middle age, rather than earlier, and the direct cause-and-effect relations accompanying transitions in different components of the Earth system remain a subject of lively debate. Some workers advocate biology alone (i.e. evolution of cyanobacteria) as responsible for changing Earth's oxidation state, while others consider the crucial dynamic to have been passing of a tipping point at which the rate of oxygen production via oxygenic photosynthesis outpaced the rate of consumption by reduced volcanic gases and rocks as oxygen sinks. Altogether, our planet's transition to becoming oxygen-rich was an evolutionary progression as much as a revolutionary event.