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Expanding-contracting Earth

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The Earth was born from a giant impact at 4.56 Ga. It is generally thought that the Earth subsequently cooled, and hence shrunk, over geologic time. However, if the Earth's convection was double-layered, there must have been a peak of expansion during uni-directional cooling. We computed the expansion-contraction effect using first principles mineral physics data. The result shows a radius about 120 km larger than that of the present Earth immediately after the consolidation of the magma-ocean on the surface, and subsequent shrinkage of about 110 km in radius within about 10 m.y., followed by gradual expansion of 11 km in radius due to radiogenic heating in the lower mantle in spite of cooling in the upper mantle in the Archean. This was due to double-layered convection in the Archean with final collapse of overturn with contraction of about 8 km in radius, presumably by the end of the Archean. Since then, the Earth has gradually cooled down to reduce its radius by around 12 km. Geologic evidence supports the late Archean mantle overturn ca. 2.6 Ga, such as the global distribution of super-liquidus flood basalts on nearly all cratonic fragments (>35 examples). If our inference is correct, the surface environment of the Earth must have undergone extensive volcanism and emergence of local landmasses, because of the thin ocean cover (3e5 km thickness). Global unconformity appeared in cratonic fragments with stromatolite back to 2.9 Ga with a peak at 2.6 Ga. The global magmatism brought extensive crustal melting to yield explosive felsic volcanism to transport volcanic ash into the stratosphere during the catastrophic mantle overturn. This event seems to be recorded by sulfur mass-independent fractionation (SMIF) at 2.6 Ga. During the mantle overturn, a number of mantle plumes penetrated into the upper mantle and caused local upward doming of by ca. 2e3 km which raised local landmasses above sea-level. The consequent increase of atmospheric oxygen enabled life evolution from prokaryotes to eukaryotes by 2.1 Ga, or even earlier in the Earth history.

Keywords: Expanding Earth, Mantle overturn, Global unconformity, Nutrients, Eukaryotes