Global scale uniformitarianism and catastrophism dictated by crust-to-core volatile cycles

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Recent theoretical and experimental studies have revealed dramatically altered chemistry at the high pressure-temperature lower-mantle conditions that can produce a highly oxidized form of FeO_2 by pressure-induced decomposition of goethite (FeO_2H) and releasing free hydrogen (Hu *et al*, 2016). Generalization of this reaction indicates that in the presence of iron or iron oxides, the water cycle in the lower mantle deeper that 1800 km turns into a water-down-hydrogen-up cycle (Hu *et al*, 2017). When the subducted plates continuously supply water to meet the inexhaustible reservoir of iron in the core, hydrogen will be released and make the core-mantle boundary (CMB) a gigantic hydrogen generator, that provides a constant source for formation of hydrocarbons and other biochemical ingredients. Meanwhile, the oxygen will be left to form FeO_2 that amasses in oxygen-rich patches at the CMB (Mao *et al*, 2017). The anomalous seismic behaviors of the D" layer above the CMB are consistent with the elastic properties of FeO_2 (Liu *et al*, 2017).

Sustained accumulation of the metastable oxygen-rich patches through geological time would eventually reach a critical point of massive oxygen outburst at the CMB. Impacts of the oxygen outbursts offer a singular, unified theory for multiple global, environmental, biological, geodynamic, and volcanic catastrophes during the Earth's long history. The surge of oxygen is obviously a convenient new explanation for the great oxidation event (GOE), as well as the five mass extinctions and snowball Earth that are closely correlated with large fluctuations of oxygen in the geological records. The oxygen outbursts add chemical driving force and perturb the steady-state thermally driven mantle convection, leading to super plumes and catastrophic formation and rifting of supercontinents. The additional hydrogen, oxygen, and associated volatile components could also lower the mantle rock melting point and cause massive magma generation to feed into the large igneous provinces (LIP) and flood basalts and to trigger catastrophic environmental changes. Interdisciplinary collaborative efforts are needed to test these grand hypotheses.

References

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