Primitive continents suppressed Earth's O_2 cycle during the Archean

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The development of Earth's O_2 cycle 3.0-2.4 Gyr ago is one of the most important geochemical revolutions in Earth's history. Links between the global oxygen cycle and the changing composition of the continental crust have been proposed [*1*]. Such models are potentially very powerful. Crustal evolution during the Archean is nevertheless not constrained well enough that such links can be explored further. A key issue is that only fragments of the Archean crust remain, and many of these are strongly modified and subject to preservational bias. The composition of terrigenous sediments provides a powerful approach to circumvent these issues and constrain average continental composition [*2*,*3*].

In this study, we use Cr/U as a new tracer for (source-) lithology. This ratio varies over several orders of magnitude across the range of known rock types and has a demonstrably strong resolving power for their composition. In addition, both elements are hosted in minerals (i.e., chromite, uraninite) that are similarly robust and behave similarly during weathering under both oxidized and reduced conditions. These features minimize the risk of fractionation within the sedimentary system.

The Cr/U data reveal a striking secular change in the composition of the exposed continental crust between 3.0 and 2.4 Gyr ago at a yet new level of time resolution. Before 3.0 Gyr ago, high-Cr/U (mafic, olivine-baring) rocks were common among the subaerial Earth [*4*]. Their decline was synchronous with oceanic, and ultimately atmospheric, oxygenation. This correlation is caused neither by changing degrees or conditions of alteration, nor by a change in the Fe flux. Instead, the development of the O_2 cycle can be ascribed to the removal of the primitive mafic crust and the cessation of widespread serpentinization—a process that in modern settings causes extreme oxygen scavenging. This model can be tested through experiments and field studies in exposed Archean terranes and their possible modern analogues.

[*1*] Lee et al. *Nature Geosci.* **9**, 417-424 (2016); [*2*] McLennan & Taylor *Nature* **285**, 621-624 (1980); [*3*] Tang et al. *Science* **351**, 372-375 (2016); [*4*] Smit & Mezger *Nature Geosci.* **10**, 788-792 (2017).