Phanerozoic O_2 Cycles

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Previous workers have considered that O_2 content in the Phanerozoic atmosphere was relatively stable compared to the Precambrian. However we present a very different scenario of significant, systematic cycles in atmosphere-ocean O_2 contents, on wavelengths of 70 to 150 Ma, that have had an influence on ocean trace element nutrients, organic productivity, ocean anoxia, petroleum source-rock generation, glaciation events, marine metal deposition and mass extinction events. An integrated Earth-Ocean O_2 cyclic pattern places major marine geochemical and geo-biological events through the Phanerozoic into a systematic framework.

The selenium content of sedimentary pyrite has been demonstrated to be a robust proxy for ocean-atmosphere oxygenation *et al*[1], and is used here as the basis for the recognition of five cycles during the Phanerozoic. Cobalt in sedimentary pyrite is concentrated during periods of low O_2 and exhibits the opposite pattern to Se. Cycle peaks that represent periods of maximum trace metals in the ocean, leading to maximum productivity and O_2 occur around 515, 395, 310, 235, 150 Ma and the present. Cycle troughs that represent periods of trace metal deficiency (but Co enrichment), sulfidic oceans, minimum O_2 and marine extinction maxima occur at 450, 370, 295, 200 and 70 Ma. At present the Earth is at the peak of the sixth cycle, enjoying a period of maximim ocean O_2, nutrient trace elements and organic productivity.

[1] R. R. Large *et al* Trace element content of sedimentary pyrite as a new proxy for deep-time ocean–atmosphere evolution. *Earth. Planet. Sci. Lett.* **389**, 209 (2014).