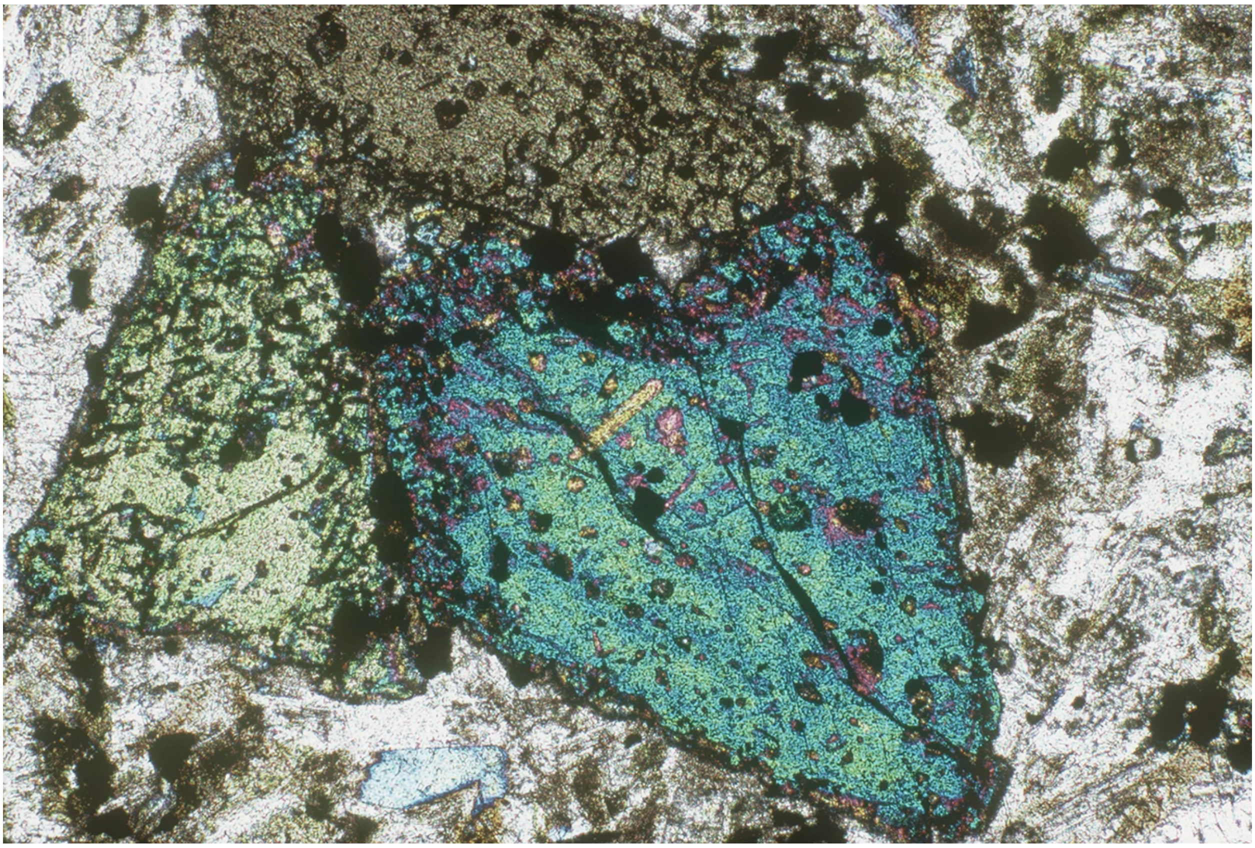
Rocks, not bacteria, triggered Earth's oxidation

Changes in the planet's crust paved the way for an oxygen atmosphere and the evolution of complex life, writes Andrew Masterson.



Olivine basalt. When the highly reactive olivine became less common in Earth's crust, the oxygen produced by cyanobacteria transformed the atmosphere.
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The Great Oxidation Event – the period 2.4 billion years ago when the Earth's atmosphere suddenly became rich in oxygen, thus catalyzing the evolution of aerobic life – was caused by geological, rather than biological, change, new research has found.

Geologists Matthijs Smit from the University of British Colombia in Canada and Klaus Mezger from Switzerland's University of Bern set out to trace the cause of the oxidation event, which saw the amount of oxygen in the oceans increase 10,000 times in just 200 million years – an incredibly rapid rise.

At the time, cyanobacteria were already in existence and producing oxygen as a byproduct of photosynthesis. Some studies have suggested that this process was solely responsible for the sudden rise in available oxygen, but there has been **little data to support the contention <http://www.pnas.org/content/110/5/1791.short>** .

Smit and Mezger decided to take a different approach and looked to rock formations for a possible answer. During the Great Oxidation Event the rocky composition of the continents also underwent significant chemical change.

At the start of the event, most shales and igneous rock types around the world comprised high levels of magnesium and low levels of silica. This is a similar composition to rocks found today in volcanically active areas such as Iceland.

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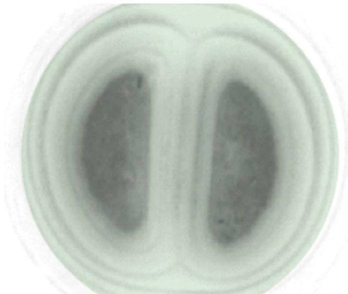

Bacteria's evolution sheds light on great oxygenation event

BIOLOGY

These ancient formations, however, also contained another very plentiful mineral called olivine, a type of magnesium iron silicate. When it comes into contact with water, it catalyses chemical reactions that lock away oxygen, meaning it is not freely available as a gas – which is essential for aerobic respiration.

Indeed, the scientists calculate that olivine was plentiful enough that it would have tied up all the oxygen produced by cyanobacteria, neutralising its effect.

However, at the same time as the oxidation event was occurring, the continental crusts were evolving. Their composition changed – in particular, olivine became very rare.

As a result, fewer olivine reactions meant that oxygen produced by cyanobacteria was gradually able to accumulate in the oceans without being tied up. Eventually it saturated the water and began to leach out into the atmosphere.

"It really appears to have been the starting point for life diversification as we know it," says Smit.

"After that change, the Earth became much more habitable and suitable for the evolution of complex life, but that needed some trigger mechanism, and that's what we may have found."

The research is **published in the journal <http://dx.doi.org/10.1038/ngeo3030>** ***Nature Geoscience* *<http://dx.doi.org/10.1038/ngeo3030>*** .

***ANDREW MASTERSON** is news editor of Cosmos.*