UNIVERSITY of TASMANIA

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Earth's atmosphere subject to dramatic oxygen cycles, new research finds

New research by a team of Australian earth scientists indicates that oxygen in the atmosphere has varied greatly over geological time, far more than previously thought.

Current scientific understanding is that oxygen increased in two major leaps at about 2.3 and 0.8 billion years ago, but was fairly flat between and after. Today, the Earth's atmosphere contains 21 per cent oxygen.

The new research, by a team led by Professor Ross Large of the University of Tasmania, has used changes in the composition of a group of trace metals in the ocean to predict changes in atmosphere oxygen.

It has identified a series of dramatic oxygen cycles over the last two billion years where oxygen rose to very high levels at periodic intervals (to greater than 25 per cent oxygen) and fell to very low levels in between (less than 10 per cent oxygen).

Instead of the two steps, the team has nominated eight steps, that they term 'oxygen cycles'. Each time atmosphere oxygen dropped below 10 per cent at the end of a cycle, there was a mass extinction event (ME).

The research has shown major correlations with the evolution of life and with times of accumulation of giant deposits of copper and lead-zinc-silver on the ocean floor.

The eight major peaks in the cycles of atmosphere oxygen occurred at 210, 320, 390, 525, 750, 1400, 1800 and 2300 million years ago. The dramatic drops in oxygen below 10% correspond with major mass extinction events at 450, 370, 250 and 200 million years ago.

Based on their research, the team predicts that much older extinction events occurred in the oceans at 560, 1000 and 1600 million years ago due to a combination of low oxygen and very low concentrations of bio-essential nutrient trace elements, especially selenium.

“It is now becoming clear that the oxygen cycles were driven by the supercontinent cycles of drifting and colliding continents that lasted hundreds of millions of years,” Professor Large said.

When continental collision occurred, major mountain chains fed the oceans with trace elements via erosion. Trace element nutrients from this erosion stimulated life and biological change.

Their theory predicts that continent collisions led to increased atmosphere and ocean oxygen which stimulated evolution, whereas long periods of static continents eventually led to a drop in atmosphere oxygen which ended with mass extinctions. Thus, increasing-decreasing cycles of oxygen during Earth history have been the norm, resulting in cycles of evolution, each ending in a mass extinction event.

The team at the Centre for Ore Deposits and Earth Science (CODES) at the University of Tasmania has revealed that the oxygen cycles had a major influence on mineral deposit formation.

The very large lead-zinc-silver deposits in northern Australia, such as Mt Isa and Century, formed during periods of decreasing atmospheric oxygen, facilitating extensive black shale sedimentary basins that trapped the metals.

In comparison, copper deposits require elevated oxygen for their formation, and thus formed during periods of much higher atmospheric oxygen.

The relationship between oxygen and ore deposit cycles will be the focus of a new industry-funded international research project by Professor Large and his team.

“The picture is now emerging that nearly all major Earth processes in geological history were cyclical in nature, with several orders of cycles superimposed. Supercontinent cycles led to mountain building cycles, which stimulated nutrient cycles, oxygen cycles, evolutionary cycles, climate cycles and mass extinction cycles.”

The paper is published by Springer Nature in *Mineralium Deposita* and can be viewed online.

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