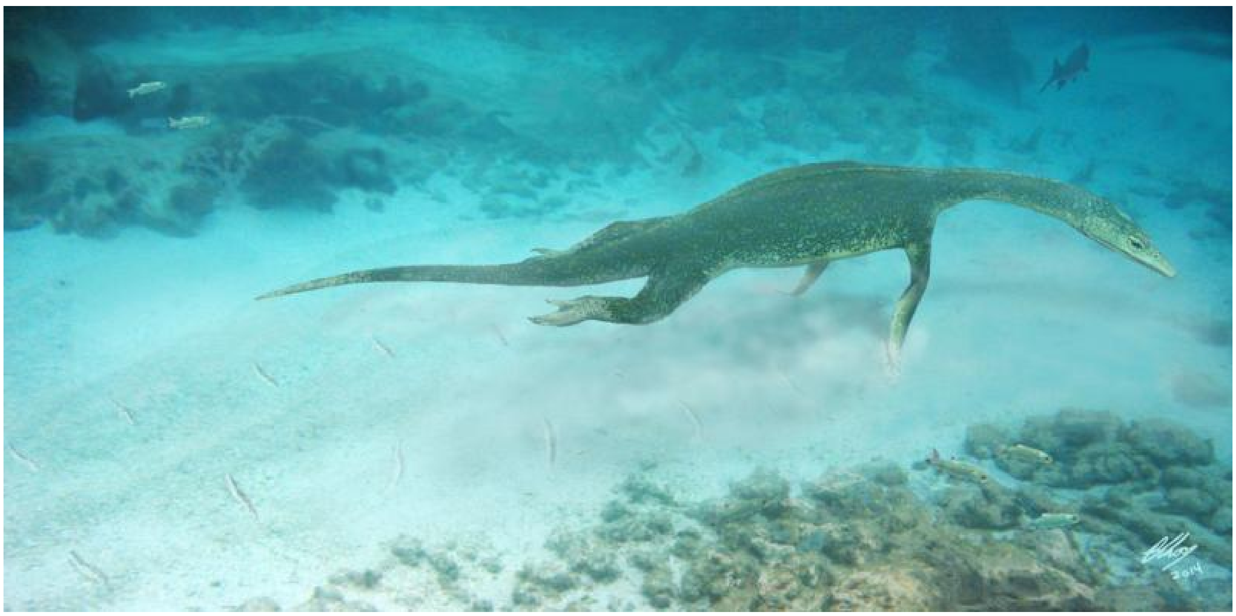
Elementary new theory on mass extinctions that wiped out life

November 5 2015, by John Long And Ross Large



Many marine reptiles like this nothosaur went extinct at the end of the Triassic, one of five major mass extinction events on Earth. Credit: Brian Choo, CC BY-NC

Throughout the past 600 million years there have been five major mass extinction events that devastated life on Earth. While some of these events are very well studied, such as the killer asteroid that wiped out the dinosaurs 66 million years ago, others are more enigmatic and entertain a variety of possible causes.

The first three extinction events took place near the end of the Ordovician Period (around 445 million years ago), end of the Devonian Period (from 385 to 359 million years ago) and at the end of the Permian Period (252 million years ago).

The most devastating of all these events was the end of the Permian period, which wiped out some 96% of all marine species and about 70% of all known species on Earth.

The likely causes are massive volcanic eruptions on a scale never before seen, with other effects that include runaway greenhouse effect triggered by methane release from clathrates on the seafloor. Because the devastation was so severe, recovery took around 10 million years.

The big extinction event at the end of the Ordovician is linked to glaciation and widespread anoxia, or loss of oxygen in the seas. About 57% of all marrine life was wiped out in the oceans, making it the second largest of all extinction events.

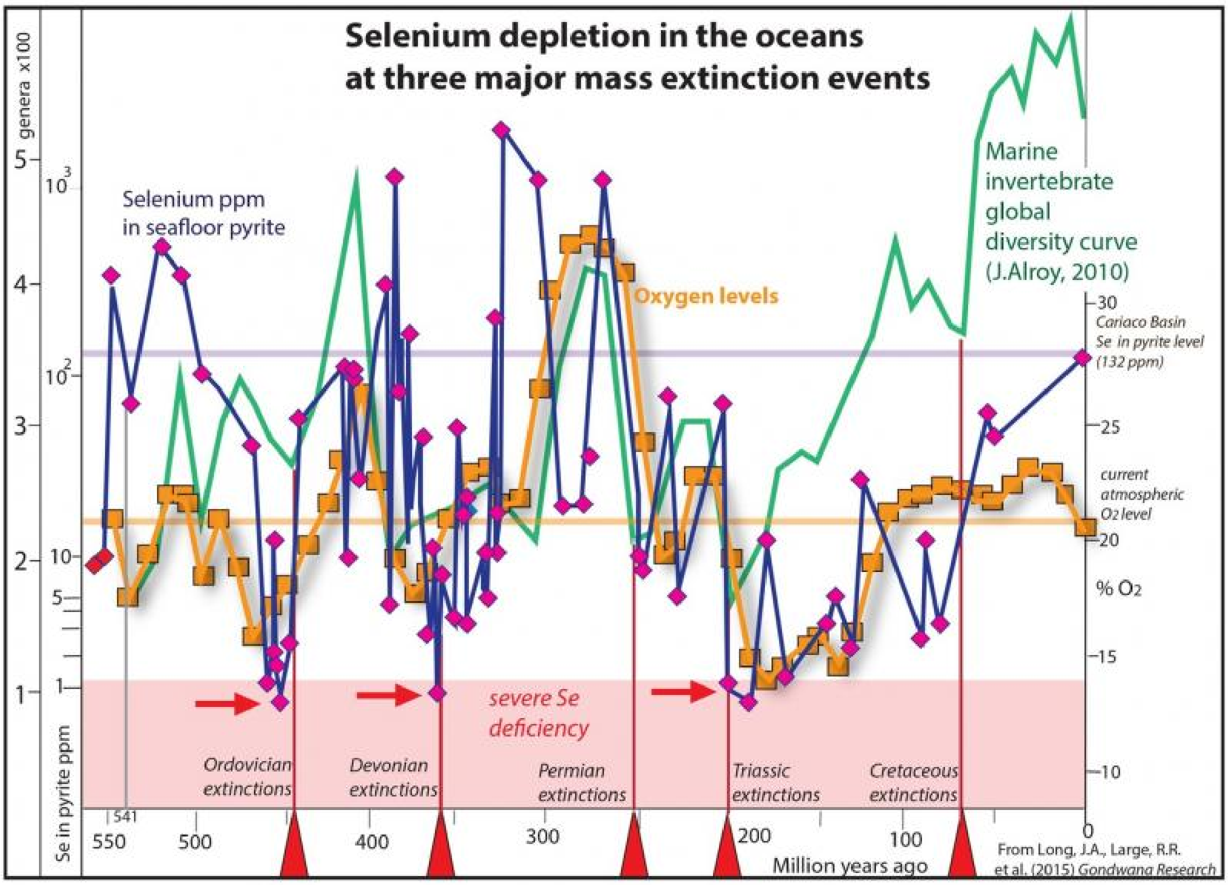
The reliability of interpreting the past oxygen levels of the Earth is key to understanding this event, as perhaps the anoxia was brought on by another cause.

Why trace elements matter

New research by our team published this week in Gondwana Research has shown that a depletion of trace elements in the oceans could be another major factor in this extinction and two other major extinction events.

In an earlier article we explained the natural cycle of nutrients caused by plate tectonics, as increased erosion of the Earth's crust supplies nutrients such as trace elements to the oceans.

Trace elements such as zinc, copper, cobalt, manganese and selenium, in particular, are required for life in doses that have a very specific tolerance range. Too much or too little selenium can be toxic.



Selenium abundances in the oceans over the past 550 million years. Note severe depletion of this vital trace element at three major extinction events (red triangles), suggesting this was a possible factor in these extinctions. Credit: John Long & Ross Large

Tolerance levels of selenium for phytoplankton, molluscs, fish and many land plants and animals are very well known. Recently, selenium deficiency in large parts of China and Africa has been linked to major outbreaks of diseases such as AIDS, SARS, Ebola and Avian flu (H1N1). This is because lack of selenium impacts on the immune systems.

Such dangerously low levels of certain trace elements, such as selenium, could be a new factor in three major mass extinction events. But how could this occur?

Could selenium depletion cause mass extinctions?

If the oceans rapidly dropped their levels of selenium by around two orders of magnitude, would food chains likely be effected? This is precisely what happened at or near the end of the Ordovician, Devonian and Triassic Periods.

We suggest that critically low levels of selenium in past oceans would have affected the survival of plankton, eventually leading to collapse of the food chains, and extinctions. Selenium has recently been found to play a vital role in photosynthesis in phytoplankton.

Glaciation and lack of oxygen in the oceans are common explanations for the death of some 60% of all marine invertebrate species. But our data shows a severe selenium depletion event happened before the onset of extinctions, allowing suitable time for the collapse of food chains.

The end of the Devonian period around 359 million years ago saw the extinction of major groups like the placoderm fishes. This period includes four biotic crises, including two major extinction events for which global anoxia in the oceans is often blamed.

Our new data indicate a prolonged period of selenium depletion occurred at least 10 million years before oxygen reached its lowest point.

Some Australian researchers also show that lack of oxygen in late Devonian seas was restricted to local basins and not necessarily a global phenomenon.

The extinction event at the end of the Triassic, about 201 million years ago, mostly affected life in the oceans, with some 34% of marine species declining including the extinction of conodonts, a major invertebrate group.

Placoderm fishes, like this six metre long Dunkleosteus, were one of the major groups to go extinct at the end of the Devonian period. Credit: John Long

Some reptile groups also went extinct on land. It has been shown that selenium uptake in the oceans by plankton effects transmission of selenium by gases to the atmosphere, so oceanic depletion of selenium could in theory effect levels on land.

Another question is whether selenium, which seems to be a very good proxy for determining past oxygen levels, was the prime driver for the loss of oxygen in the oceans which caused the extinctions, or was itself the main cause of extinctions.

One issue with our preliminary study is the dating of our samples does not always match the precise timing of the extinction events. This is purely an artefact of the sampling. Additional samples dated closer to extinction times are currently being analysed for the follow up study.

The bright side of mass extinctions

The cycle of nutrients from the supply of essential trace elements that begin the food chains for all life in the oceans is driven by plate tectonics. The uplift of mountains at plate margins causes erosion of crustal surfaces enabling trace elements to wash into rivers and end up in the seas.

When erosion is prolonged and tectonics is slow, the supply of these nutrients slows down, and depletion of certain elements begins. Only activation of Earth's engine, to drive more mountain building, seems to set the cycle back to normal again.

Yet mass extinctions have their bright side. Without them new life couldn't emerge and take priority place. The early tetrapods survived the end of the Devonian extinction event, a time when many prominent vertebrate groups went extinct.

Without this line of vertebrates surviving, the reptiles and mammals would not have had a chance to evolve. Mammals rose to prominence after the decline of the dinosaurs, and thus we are here today, thanks mainly to these mass extinction events many millions of years ago.

Source: The Conversation

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