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Press release

MARUM - Zentrum für Marine Umweltwissenschaften an der Universität Bremen
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01/03/2018
http://idw-online.de/en/news687029

Cooperation agreements, Research results
Geosciences, Oceanology / climate
transregional, national

Nutrient surplus causes the oceans to suffocate

Combination of Earth orbit and biomass causes Devonian extinction event What favoured the Devonian extinction about 300 million years ago? Based on rock samples, a team of scientists from Germany, Belgium, China and the USA identified the so-called rhythmic climate cycles and found out why the oceans could become so hostile to life so quickly at that time. Their results have now been published in the journal Nature Communications, led by Dr. David De Vleeschouwer from MARUM - Center for Marine Environmental Sciences at the University of Bremen.

In whole Earth's history, geologists distinguish five mass extinction events that were particularly severe. The Devonian mass extinction event is one of those five and occurred 374 million years ago, more than 300 million years before the meteorite impact that wiped out the dinosaurs. The Devonian was a very peculiar period: large fish reigned the oceans and coral reefs were flourishing, but there were no large land animals yet. "The Devonian climate can be best described as an extreme greenhouse climate, with much more CO_2 in the atmosphere compared to today," says Dr. David De Vleeschouwer, geologist at the MARUM – Center for Marine Environmental Sciences at the University of Bremen. Despite the intriguing aspects of the Devonian world, scientists did not know exactly how fast the Earth became inhospitable for life across Devonian mass extinction event.

For reasons still debated by scientists, the ocean water turned low in oxygen during the Devonian mass extinction event. "This event suffocated the majority of life in the ocean, and the extremely diverse Devonian reef-builders were among the major victims," explains Anne-Christine Da Silva from Liège University in Belgium. The main cause of the extinction is a hot topic in geology, as there is no smoking gun that can be identified as the trigger of this underwater-massacre. In fact, oxygen levels in the ocean water dropped twice across the course of the extinction. Geologists know that by virtue of two levels of black shale in the worldwide rock record, marking the extinction interval. These two levels of black shale are rich in organic components because there was no sufficient oxygen for the organic material to rot, nor for under-water organisms to breath.

As a geologic clockwork, David De Vleeschouwer and his team used a technique called cyclostratigraphy. "We combined information from geologic sections spanning the Devonian extinction event, from Belgium, Poland, China, Canada and the USA. In all sections, we found the effects of cyclical changes in the eccentricity of the Earth's orbit around the Sun." When eccentricity is low, the Earth rotates around the Sun on an orbit that is very close to a perfect circle; but, when eccentricity is high, the Earth's orbit around the Sun is much more elliptical, allowing for very strong differences in the amount of solar energy the Earth receives during winter and summer. Changes in eccentricity are very rhythmical, with fixed periods of 100 and 405 thousand years. The authors used these cycles to constrain the duration between the two black shales, and found that the second episode of low oxygen levels commenced 600,000 years after the first. This result is the first precise time measurement of this essential episode in the evolution of life on Earth, and turned out to be much shorter than expected. What is more, is that the team noticed that the main pulse of extinction coincided with a prolonged period of low eccentricity. This means the Earth's orbit was close to circular for several ten- to hundred thousands of years, giving way to quite steady climates. These invariable climates gave way to sluggish ocean circulation and stratification of the water column, both favouring low oxygen levels in the world's oceans.

Yet, the authors do not claim that they unmasked the so-called “smoking gun”. The authors believe land plants are the most likely culprits of the devastating Devonian die-off. During the Devonian, land plants developed deep root systems and woody tissues, giving them the evolutionary advantage to colonize different environments. The success of land plants came at a cost though: when a plant dies, its biomass get washed into waterways and into the ocean. “In other words, the Devonian seas got smothered with nutrients from rotting plants, a process during which oxygen is absorbed and other life is starved out,” explains David De Vleeschouwer. “However, the evolution of land plants is a slow and gradual process. Only when the eccentricity configuration of the Earth’s orbit favoured sluggish ocean circulation, all factors aligned to push the Earth’s system beyond its tipping point, causing the Devonian mass extinction.”

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MARUM aims at un-der-stan-ding the role of the oce-ans in the Ear-t-h’s sys-tem by em-ploy-ing sta-te-of-the-art me-thods. It ex-ami-nes the si-gni-fi-can-ce of the oce-ans wi-t-hin the frame-work of glo-bal chan-ge, quan-ti-fies in-ter-ac-tions bet-ween the ma-ri-ne geo-s-phe-re and bio-s-phe-re, and pro-vi-des in-for-ma-ti-on for sustainable use of the oce-an. MARUM com-pri-ses the DFG re-se-arch cen-ter and the clus-ter of ex-cel-lence "The Oce-an in the Earth Sys-tem".

URL for press release: http://www.marum.de/en/Discover/Nutrient-surplus-causes-the-oceans-to-suffocate.html

Steinbruch Schmidt (Bad Wildungen): The geological expression of the Late Devonian mass extinction event which is displayed by a level of black shales interrupting the succession of limestone layers.
MARUM, David De Vleeschouwer