HORIZON 2020

Probing the Memory of Earth Anoxia: New Stable Isotope Constraints on the Rise of Oxygen

Berichterstattung

Projektinformationen

ANOXIA-MEM

ID Finanzhilfevereinbarung: 708117

DOI
10.3030/708117

Projekt abgeschlossen

EK-Unterschriftsdatum
8 März 2016

Startdatum
1 April 2016

Enddatum
31 März 2018

Finanziert unter
EXCELLENT SCIENCE - Marie Skłodowska-Curie Actions

Gesamtkosten
€ 185 076,00

EU-Beitrag
€ 185 076,00

Koordiniert durch
UNIVERSITE DE BRETAGNE OCCIDENTALE
France

Periodic Reporting for period 1 - ANOXIA-MEM (Probing the Memory of Earth Anoxia: New Stable Isotope Constraints on the Rise of Oxygen)

Berichtszeitraum: 2016-04-01 bis 2018-03-31

Zusammenfassung vom Kontext und den Gesamtzielen des Projekts

"The evolution of the Earth surface environment is marked by the Great Oxidation Event (GOE), circa 2.5 to 2.3 billion years ago, when atmospheric oxygen concentrations increased above 0.001% with key evidence for this found in sulfur isotopes in the rock record. Anomalous sulfur isotope signals that can only be explained by extremely low oxygen levels before 2.5 billion years ago and disappear thereafter. However, these sulfur isotope signals slowly disappear over more than 100 million years of time and this feature has been described by a possible ""memory effect"", as described by Reinhard et al. (2013), where weathering of older anomalous sulfur in rocks is redeposited in newly formed rocks. The result of this scenario is that a signal of no atmospheric oxygen, with respect to anomalous sulfur isotopes, may be indicated in the rock record even though there is oxygen present in the atmosphere. A test of this ""memory effect"" would strengthen our understanding of the history of Earths' atmospheric oxygen and therefore its relationship to the evolution of life on Earth, with which it is inextricably linked, and may help us understand the potential for atmospheric oxygen on other planets in our solar system and beyond.

Sulfate is an excellent archive of sulfur and oxygen isotope signals in the rock record due to its widespread occurrence and strong preservation and suitable sulfate from around the time of the GOE can be used to test for the presence of the weathering ""memory effect"". Direct evidence for the ""memory effect"" would show up in sulfate records with significant sulfur isotope anomalies that run in parallel to coexisting sulfide records, and sulfate oxygen isotope compositions that indicate the origin of the sulfate from oxidative weathering of older sedimentary sulfides on the continental surface. Such sulfate was recovered in the form of trace barium sulfate (barite) from drill cores from the Turee Creek Group sedimentary sequence from western Australia, circa 2.45 to 2.21 billion years old, in the critical time window of the GOE."

Arbeit, die ab Beginn des Projekts bis zum Ende des durch den Bericht erfassten Berichtszeitraums geleistet wurde, und die wichtigsten bis dahin erzielten Ergebnisse

"For this Marie Curie postdoctoral project, barite was measured for multiple sulfur and triple oxygen isotopes from a Turee Creek Group drill core that has been dated to younger than 2.31 billion years old, at a time when no significant anomalous sulfur isotope signals should exist in the rock record.

The work performed for the barite measurements included crushing of rock samples into powder, chemical treatment of rock powders to extract barite, purification of the extracted barite, and then subsequent measurement of quadruple sulfur (32S, 33S, 34S, 36S) and triple oxygen (16O, 17O, 18O) isotope compositions of the barite during three separate measurement sessions. The isotope measurements for sulfur and oxygen have different sample preparation and analytical requirements.

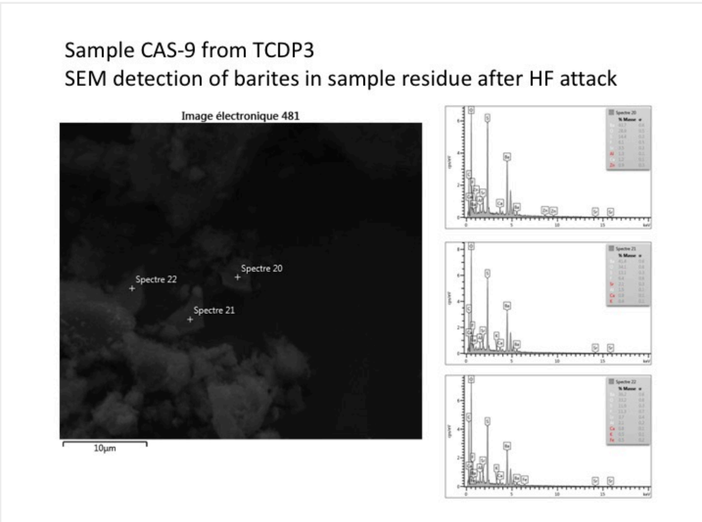
In the barite measured for this project, its anomalous sulfur isotope compositions indicate a source of sulfur from when atmospheric oxygen was less than 0.001% but its oxygen isotope compositions reveal that sulfate was being generated by oxidative weathering on the continent in the presence of meteoric waters. Thus, the presence of the ""memory effect"" is revealed.

Due to the Marie Curie project directly, the recipient of funding, Bryan Killingsworth, has already contributed to a Nature Communications submission (presently in review), and is prepping one new first-author manuscript for imminent submission to a top science journal, with another one to follow.

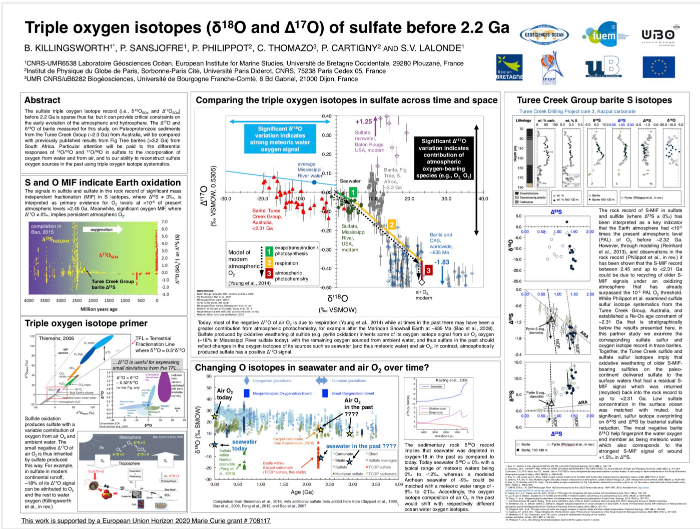
Furthermore, Bryan Killingsworth has shared results of this Marie Curie project at important scientific meetings, including talks at Goldschmidt 2017, AGU 2017, and the Gordon Geobiology Research Seminar 2018, and poster presentations at the Geobiology Meeting in Banff in 2017, Gordon Geobiology Research Conference 2018, the Primitive Earth workshop in St. Etienne 2016."

Fortschritte, die über den aktuellen Stand der Technik hinausgehen und voraussichtliche potenzielle Auswirkungen (einschließlich der bis dato erzielten sozioökonomischen Auswirkungen und weiter gefassten gesellschaftlichen Auswirkungen des Projekts)

The project has already contributed to important interpretation of sulfur isotopes from pyrites (not measured for this project) in a submission to Nature Communications, and is expected to place 2 first-author publications in high-impact peer-reviewed scientific journals. This project was successful in making predictions that it could test in the rock record, with outcomes that are certainly significant for our understanding of the evolution of Earth atmospheric oxygen and how this atmospheric evolution is reflected by variations of geochemical isotopic signals in the rock record.



<2.31 billion year old barite from the Turee Creek Group seen in scanning electron microscopic image



Poster of project results that was presented at the Gordon Geobiology Research Conference 2018

Letzte Aktualisierung: 1 April 2019