様　式　Ｃ－１９、Ｆ－１９－１、Ｚ－１９　（共通）

# 科学研究費助成事業　　研究成果報告書

令和　３ 年　 ４ 月 ２８ 日現在

機関番号：８２７０６
研究種目：研究活動スタート支援
研究期間：2019～2020
課題番号：１９Ｋ２３４７５

研究課題名（和文）Elucidating organic matter-mineral interactions using amino acid 14C

研究課題名（英文）Elucidating organic matter-mineral interactions using amino acid 14C

研究代表者
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国立研究開発法人海洋研究開発機構・海洋機能利用部門(生物地球化学プログラム)・Young Research Fellow

研究者番号：３０８４７２５７

交付決定額（研究期間全体）：（直接経費）　　2,200,000円

研究成果の概要（和文）：パール川（中国本土）、高平川（台湾島）、カガヤン川（フィリピン）、北米西海岸から採取した堆積物から、プロリン、バリン、イソロイシン、ロイシン、メチオニン、フェニルアラニン、アルギニン、ヒスチジン、グルタミン酸、アラニン、およびスレオニンを抽出・単離しました。それら化合物の炭素同位体分析を実行しました（13Cおよび14C）。これらの化合物の炭素同位体パターンを初めて明らかにし、この結果については今後学会発表や論文投稿をする予定です。

研究成果の学術的意義や社会的意義
This is the first time the radiocarbon signatures of individual amino acids are revealed in nature. Amino acids are the building blocks of life and their fate in the sedimentary record represents the geological legacy of life on Earth. With radiocarbon we can quantitatively understand this.

研究成果の概要（英文）：From sediments collected we have extracted and isolated amino acids and have performed carbon isotope analysis (13C and 14C). These results are revealing carbon isotope patterns in these compounds for the first time and we will interpret and begin to publish the results.

研究分野：Biogeochemistry

キーワード：Radiocarbon　Amino acid　Minerals　Chromatography　organic carbon　carbon cycle　Life

様　式　Ｃ－１９、Ｆ－１９－１、Ｚ－１９（共通）

## １．研究開始当初の背景

Amino acids comprise the largest molecularly characterizable fraction of sedimentary organic matter. These “building blocks of life” are ubiquitous throughout geologic time and space with all known life forms on Earth sharing these. The preservation of amino acids recording the signatures of life is remarkable as they are considered intrinsically labile; nonetheless, they are found in the sedimentary record for reasons that have long eluded researchers (Erdman et al., 1956; Science, 124, p. 1026).

## ２．研究の目的

The goal of this research was to investigate the preservation of amino acids in sediments. Specifically, we tested the following hypothesis: Amino acid preservation in sediments is modulated by organic matter mineral interactions (Fig. 1; Blattmann & Ishikawa, 2020; Frontiers in Marine Science, 7). The origin of this hypothesis lies in the starkly contrasting affinities of different amino acids for different mineral surfaces. In particular, basic amino acids have a high affinity for clay mineral surfaces, thereby theoretically leading to their preferential stabilization via sorption. By testing this hypothesis, we sought to research the basic mechanisms governing the preservation of life’s biogeochemical fingerprint in the geologic record.

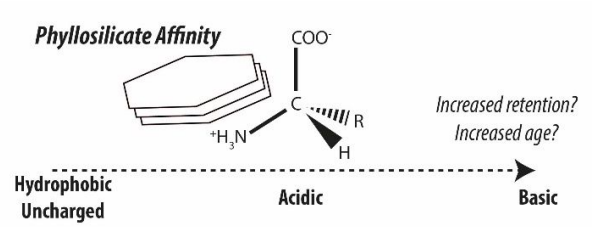


*Figure 1: Amino acid affinity for mineral surfaces with their hypothesized effect on radiocarbon age.*

## ３．研究の方法

In order to test the hypothesis, we have developed and executed a method for measuring the radiocarbon signatures of individual amino acids extracted from sediment (Blattmann et al., 2020; Frontiers in Marine Science, 7). The logic behind choosing radiocarbon is that its decay is time dependent. By exploiting this property, amino acids retained strongly by mineral surfaces would experience slower turnover and would therefore exhibit older ages than other amino acids. This method involved 2- or 3-dimensional high pressure liquid chromatography in order to separate and purify the individual amino acids. These were then evaluated for their purity chromatographically and via elemental analysis and were then prepared for radiocarbon analysis using accelerator mass spectrometry (AMS) at the University of Tokyo and ETH Zurich.

## ４．研究成果

The project has been successfully executed. Amino acids extracted from contrasting environments: freshwater vs. marine, oxic vs. low-oxygen, kaolinite vs. smectite vs. illite and chlorite end members were investigated. One such amino acid is shown in Fig. 2. Preliminary data from amino acids recovered from sediments have revealed contrasting ages. Currently, we have a partial data set and are waiting for further measurement from our AMS partners and data processing to test the hypothesis outlined above. However, with the data we have on hand we have initiated discussions on the patterns of radiocarbon ages that we have obtained. These ages are revealing biogeochemical fingerprints that are raising new questions that are new to science as this represents the first data set of its kind.

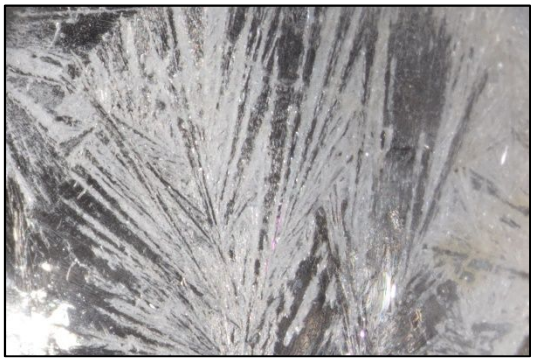

*Figure 2: Phenylalanine extracted from marine sediment and chromatographically purified.*

５．主な発表論文等

〔雑誌論文〕　計2件（うち査読付論文　1件／うち国際共著　2件／うちオープンアクセス　1件）

| | |
|---|---|
| １．著者名<br>Blattmann Thomas M.、Montlucon Daniel B.、Haghipour Negar、Ishikawa Naoto F.、Eglinton Timothy I. | ４．巻<br>7 |
| ２．論文標題<br>Liquid Chromatographic Isolation of Individual Amino Acids Extracted From Sediments for Radiocarbon Analysis | ５．発行年<br>2020年 |
| ３．雑誌名<br>Frontiers in Marine Science | ６．最初と最後の頁<br>1-8 |
| 掲載論文のDOI（デジタルオブジェクト識別子）<br>10.3389/fmars.2020.00174 | 査読の有無<br>有 |
| オープンアクセス<br>オープンアクセスとしている（また、その予定である） | 国際共著<br>該当する |

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|---|---|
| １．著者名<br>Blattmann Thomas M. | ４．巻<br>319 |
| ２．論文標題<br>Comment on carbon dioxide emissions by rock organic carbon oxidation | ５．発行年<br>2019年 |
| ３．雑誌名<br>American Journal of Science | ６．最初と最後の頁<br>903～904 |
| 掲載論文のDOI（デジタルオブジェクト識別子）<br>10.2475/10.2019.03 | 査読の有無<br>無 |
| オープンアクセス<br>オープンアクセスではない、又はオープンアクセスが困難 | 国際共著<br>該当する |

〔学会発表〕　計3件（うち招待講演　2件／うち国際学会　1件）

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|---|
| １．発表者名<br>Thomas M. Blattmann |
| ２．発表標題<br>Rethinking the sedimentary flow of carbon due to organic matter-mineral interactions |
| ３．学会等名<br>Global Scientist Interdisciplinary Forum2020 at Southern University of Science and Technology (SUSTech)（招待講演） |
| ４．発表年<br>2020年 |

| |
|---|
| １．発表者名<br>Thomas M. Blattmann |
| ２．発表標題<br>Rethinking the flow of carbon from chemical weathering: And some “Hsu-ian” thoughts on science in East Asia |
| ３．学会等名<br>The University of Tokyo-Tongji University Joint Workshop on Geosciences among Graduate Students |
| ４．発表年<br>2019年 |

| |
|---|
| １．発表者名<br>Thomas M. Blattmann |
| ２．発表標題<br>Amino acid-specific radiocarbon from complex environmental matrices: Towards new insights in sediments |
| ３．学会等名<br>International Symposium on Isotope Physiology, Ecology, and Geochemistry (IsoPEG’19)（招待講演）（国際学会） |
| ４．発表年<br>2019年 |

〔図書〕　計0件

〔産業財産権〕

〔その他〕

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６．研究組織

| | 氏名<br>（ローマ字氏名）<br>（研究者番号） | 所属研究機関・部局・職<br>（機関番号） | 備考 |
|---|---|---|---|

７．科研費を使用して開催した国際研究集会

〔国際研究集会〕　計0件

８．本研究に関連して実施した国際共同研究の実施状況

| 共同研究相手国 | 相手方研究機関 | | | |
|---|---|---|---|---|
| スイス | ETH Zurich | | | |
| デンマーク | Denmark Technical University (DTU) | | | |
| 米国 | University of Washington | | | |
| 中国 | Ocean University of China | | | |
| その他の国・地域 | National Taiwan University | | | |