# 冥王代生命学の創成

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研究成果報告書

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**はしがき**

本研究領域は、生命がいつ、どこで、どのように誕生したかを明らかにすることを目的とし、宇宙物理学、地球科学、化学、生命科学、情報科学など多様な領域の研究者により、世界に先駆けて「冥王代生命学」を創成した。

生命の起源研究は、有名なミラーの「化学進化」実験や、その延長上にあるオパーリンの「干潟誕生説」に端を発する。近年では、中央海嶺の「深海熱水系」で、原始的な超好熱細菌が発見されたため、生命誕生場として注目されている。しかし、深海熱水系環境ではアミノ酸やヌクレオチドの重合以上の高次構造体の合成は困難であることが実験によって明らかとなっている。一方で、生命は宇宙から飛来したとする「パンスペルミア説」がある。太陽系外から生物が飛来した可能性は否定できないが、その生物の進化段階に適した環境を、その時期の地球がたまたま提供できる確率は極めて低いと考えられる。

本研究領域では「冥王代生命学」を確立し、地球惑星科学と生命科学の真の学際融合研究により、冥王代地球の「生命誕生場」を解明した。得られる知見は、自らの存在の根拠を問い続ける人類の知的探求心が生み出した「我々はどこから来て、どこへ行くのか？（ポール・ゴーギャン）」といった問いかけに解を与え、人類の文明の進歩に大きく貢献する。また、本研究領域が推進する物質科学に基づいた総合的モデルの構築と検証という手法は、複雑系科学研究の重要な方法論を具現化したものである。このような具体的手法を示すことは、日本の学術水準のみならず、世界の研究水準向上を牽引する最たる例となる。

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| 平成27年度 | 224,510,000円 | 172,700,000円 | 51,810,000円 |
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| 平成29年度 | 226,070,000円 | 173,900,000円 | 52,170,000円 |
| 平成30年度 | 228,410,000円 | 175,700,000円 | 52,710,000円 |
| 総計 | 1,198,730,000円 | 922,100,000円 | 276,630,000円 |

**研究発表**

本領域では、生命の起源研究の成果を発表するため２つのジャーナル（計 5 冊）で特集が組まれ論文を発表した。

（１）Geoscience Frontiers; Frontiers in Early Earth History and Primordial Life- Part I

（２）Geoscience Frontiers; Frontiers in Early Earth History and Primordial Life- Part II

（３）地学雑誌「特集号：冥王代の世界（Part I）-ハビタブルトリニティ惑星の誕生-」

（４）地学雑誌「特集号：冥王代の世界（Part II）―生命誕生場の準備―」

（５）地学雑誌「特集号：冥王代の世界（Part III）―生命誕生と初期進化―」

**成果論文（合計 324 報）**

以下は計画研究班および公募班から発表された主要論文のリストである。また、特集号に掲載された論文も含め、主要論文の内容をまとめた専門書は、「冥王代生命学」として 2022 年に出版予定で、新たに確立された学術分野としての知見を体系的に整理し、最前線の内容をいち早く関連研究者らに還元するものである。

**計画研究班**

**2014**


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**ホームページ**
領域ウェブページ, http://hadean.jp/

**主催シンポジウム**
1. キックオフシンポジウム, 東京都港区, 2014 年 9 月 19 日.
2. 第 2 回シンポジウム, 長野県白馬村, 2015 年 3 月 13, 14 日.
3. 第 1 回合同班会議, 東京都目黒区, 2015 年 6 月 11 日.
4. 新学術横断合同ワークショップ with「π 造形科学」, 東京都目黒区, 2016 年 3 月 9 日.
5. 中規模ワークショップ、東京都目黒区、2016 年 7 月 2 日
6. 新学術横断合同ワークショップ with「ゆらぎと構造の協奏」, 東京都港区, 2016 年 10 月 22 日
7. キックオフワークショップ、東京都港区、2017 年 5 月 15 日
8. 冥王代生命学の創成　国際シンポジウム 2018、東京都千代田区、2018 年 11 月 22 日～23 日
9. その他合同 WS 合計 49 回. Origins of Life meeting, 合計 33 回.

**映像ライブラリ**
本領域の研究成果を映像ライブラリとして日英両言語で制作し、DVD を配布した。2016 年から YouTube 上で公開を開始し、2019 年 6 月にシリーズ全編が完了した。2019 年 6 月時点での総視聴数 30 万回を超えた。
1. 全地球史アトラス vol. I（地球誕生、プレートテクトニクス、原始生命誕生）
2. 全地球史アトラス vol. II（生命進化の第 1 ステージ、生命進化の第 2 ステージ、生命進化の第 3 ステージ）
3. 全地球史アトラス vol. III（生命大進化の夜明け前、カンブリア紀の生命大進化、古生代）
4. 全地球史アトラス vol. IV（中生代から人類の誕生まで、人類代：人類の誕生と文明の構築、地球の未来）

**アウトリーチ**
1. 教育講演会「白馬とカガクの奇跡」(後援:長野県教育委員会, 白馬村), 長野県白馬村, 2015 年 3 月 15 日.
2. 銀座 NAGANO 白馬イベント, 東京都中央区, 2015 年 9 月 14 日.
3. 高校での出張講義、自由研究課題等, のべ 4 校.
4. 教育講演会「白馬とカガクの奇跡 2」(後援:長野県教育委員会, 白馬村), 長野県白馬村, 2017 年 10 月 15 日.
5. 教育講演会「白馬とカガクの奇跡 3」(後援:長野県教育委員会, 白馬村), 長野県白馬村, 2018 年 10 月 20 日.
6. 公開講座「地球生命の起源と進化～ヒトの誕生と現在から近未来の課題まで～」（主催：東北大学東北アジア研究センター）, 東京エレクトロンホール

（宮城県民会館）， 2019 年 2 月 23 日
7. 蒲郡市生命の海科学館開館 20 周年記念特別展「カンブリアン・キングダム」，2019 年 7 月 13 日~11 月 24 日.

**メディア**
1. 天然水素の長野・白馬八方温泉, 2015 年 9 月 21 日（毎日新聞電子版）
2. 白馬八方温泉で「溶存水素」を確認, 2015 年 10 月 23 日（フジサンケイビジネスアイ）
3. 東工大・黒川教授白馬高校で講義 「白馬で探る生命のルーツ」, 2015 年 10 月 29 日(信濃毎日新聞)
4. 蛇紋岩 八方は貴重な研究地, 2015 年 10 月 29 日（大糸タイムス）
5. 自然科学の魅力 専門家に学ぶ，2017 年 12 月 24 日（大糸タイムス）
6. 生物史の最新研究 CG 動画「全地球史アトラス」新作「カンブリア紀の生命大進化」など， 2018 年 7 月 19 日（IT media NEWS）
7. 「“科学”からの招待状～地球と生命の誕生～」， 2018 年 10 月 6 日（再放送 2018 年 10 月 7 日、2018 年 10 月 27 日、2019 年 5 月 18 日）（放送大学 BS231 チャンネル）
8. 「“科学”からの招待状～人類につながる生命進化～」， 2018 年 10 月 13 日（再放送 2018 年 10 月 14 日、2018 年 10 月 28 日、2019 年 5 月 18 日）（放送大学 BS231 チャンネル）
9. 「原始生命」探り白馬巡る，2018 年 10 月 26 日（大糸タイムス）
10. 「吉岡里帆　神秘のハワイ　宇宙と地球をつなぐ島」，2019 年 1 月 18 日（BS-TBS）
11. 「チコちゃんに叱られる！」， 2019 年 2 月 1 日（NHK 総合）
12. 「ウェークアップ！ぷらす」，2019 年 2 月 23 日（読売テレビ）

**研究成果**

多様な研究分野を融合し、生命誕生場は自然原子炉間欠泉を中核とする物質・エネルギー循環系であり、生命は 3 つの段階を経て誕生したとする「生命誕生の 3 段階モデル」を導いた。主要な成果は、(1)自然原子炉間欠泉モデルの提案および化学進化実験による実証:自然原子炉が安定的に供給する高密度の非熱的エネルギーにより生命誕生プロセスが進行したとするモデルを提案した。自然原子炉間欠泉を模したγ線照射実験により、ワンポットで、ヌクレオチド前駆体のアンヒドロシチジン、グリコルアルデヒドとグリセルアルデヒドや、2-アミノオキサゾールの合成に成功した。(2)ABEL モデルの提案:地球は 45.6 億年前に無大気・無海洋で誕生し、その 1.9 億年後に小さな氷惑星の飛来によって大気・海洋が生まれたとする 2 段階形成モデルを提案し、タンデム惑星形成論により理論的に実証した。(3)冥王代類似環境微生物のゲノム解析:冥王代類似環境で発見した難培養細菌 Hakuba OD1 や WS2 のドラフトゲノム解析により、Hakuba OD1 が原始生命の性質を色濃く残している微生物であることを明らかにした。(4)冥王代ジルコンの大規模分離:新規装置開発により 43

億年前の 10 粒を含む約 200 粒の冥王代ジルコンを分離し、世界最大量の冥王代ジルコンを保有するに至った。(5)タンデム惑星形成モデルの構築:古典的な力学計算の手法に太陽系円盤磁場の要素を組み込み、新たな惑星形成論を導くとともに、ABEL モデルや、太陽系小惑星帯の存在を理論的に支持することを明らにした。