

ERC: Le sfide dei progetti europei

Donato Giovannelli¹
1 University of Naples Federico II

ERC Starting Grant 2020

CoEvolve: Coevolution of Life and Planet: role of trace metal availability in the evolution of biogeochemically relevant

Life and planet have significantly coevolved over time, influencing each other stability trajectory and ultimately maintaining our planet habitable over most of the last 4 billion years. Elemental cycling plays a vital role in this mechanism, with microbes controlling a large portion of the biogeochemical cycles. The majority of the key reactions that control biogeochemistry are carried out by a small set of microbially-encoded proteins containing a redox-sensitive transition metal as core catalytic center. Different metal centers (such as Fe, Co, Ni, Zn, Mo, W, V, Cu) are used by biology to access diverse redox couples, utilizing more oxidized compounds as they became available during the planet's evolution. Despite the importance of this process, the relationship between metal availability and metabolic innovation and diversity has not been investigated in detail. The project COEVOLVE will elucidate the impact of transition metal availability on microbial functional diversity in deep time, combining fieldwork, laboratory experiments, and computational approaches. The ambitious aims of the COEVOLVE project are: 1) To investigate the relationship between the availability of trace metals and microbial functional diversity in extant ecosystems and organisms; 2) To link metabolic diversity and metal availability to the different geochemical, mineralogical and geological settings under investigations; 3) To link the metabolic diversity and dependence on metal availability to the emergence and evolution of metabolic innovation; and 4) To determine the timing of major steps in metabolic evolution and link them to geochemical proxies of planetary surface redox change. Understanding the role of trace metal availability and distribution in the environment in influencing the microbial functional diversity might hold the clue to understanding the co-evolution of life and our planet, unlocking a number of important discoveries influencing diverse fields like earth sciences, astrobiology, microbial ecology, and biotechnology.

ERC Consolidator Grant 2025

AQUA: The evolution of biological hydrogen oxidation as a key mechanism to prevent planetary water loss

Water is essential to planetary habitability, and Earth's long-term water stability depends on mechanisms preventing hydrogen escape to space. Hydrogen on Earth is continually produced through geological and biological processes. While hydrogen production from water photolysis in the upper atmosphere is largely prevented by Earth's magnetic field and atmospheric cold traps, hydrogen generated in the crust or near the planetary surface would escape to space unless oxidation processes act on it quickly. AQUA hypothesises that biological hydrogen oxidation is one of the major processes preventing planetary water loss and that it played a key role during Earth's evolutionary history. Biological hydrogen oxidation is an ancient and ubiquitous metabolism that spans all major branches of life and is prominent across Earth's environments. Simple calculations suggest that without biological hydrogen oxidation Earth would have lost a significant fraction of its oceans over time. By integrating microbiology, evolutionary biology, geochemistry, and planetary science, AQUA aims to unravel the role of biological hydrogen cycling in Earth's water retention and its implications for the search of life in the universe. The project will focus on: (1) Quantify hydrogen oxidation in microbial communities using novel in situ and laboratory methods; (2) Decipher biological imprints on geological hydrogen across diverse settings; (3) Trace the evolution and biochemical basis of microbial hydrogen metabolism; and (4) Model biological hydrogen cycling's role in planetary water retention and its potential as a biosignature for extraterrestrial life. Fieldwork in diverse geological settings, cutting-edge analytical techniques, and computational modeling will allow AQUA to reconstruct Earth's biological hydrogen cycling history. Insights from this project promise transformative advances in understanding Earth's redox balance, microbial ecology, clean energy prospects, and planetary sciences.

EIC Accelerator 2023

Nano-Tech C-Preg-400

The aerospace industry is currently experiencing profound changes due to increasing environmental awareness and regulatory policies that penalize the low recyclability of aircraft and their components. The International Civil Aviation Organization has set a target of reducing aviation emissions by 50% by 2050, and achieving this goal



will largely depend on reducing the weight of aircraft through the use of lighter materials, replacing metals with composites. However, manufacturers still rely on traditional materials for several reasons: i. Lightweight composite materials have been developed over the past decade, but their limited recyclability and inferior mechanical properties have hindered their widespread use; ii. Introducing new materials to the aerospace market is a time-consuming and expensive process due to the lengthy and costly certification procedures. As a result, the aerospace industry has struggled to produce innovative solutions and has often resorted to outdated technologies. The sector currently relies on materials that have several drawbacks: they are made from toxic starting materials such as phenolic and cyanate ester resins, which have proven to be harmful; they generate environmentally hazardous waste; they are difficult to recycle; and their manufacturing process is energy intensive. C-PREG 400 is an exceptional high-temperature composite developed by NanoTech, utilizing a patented inorganic resin formulation. This composite is inherently non-flammable and stable at high temperatures, making it heat-resistant. It is the first market-ready inorganic composite that can withstand working temperatures of up to 400°C in an oxidant environment and short-term exposure to 500°C. The material can be processed using the same methods as other common prepregs, including compression molding, hot plate presses, or vacuum bagging techniques. This reduces the investment costs for aerospace component manufacturers. With the introduction of C-PREG 400, Nano-Tech is disrupting the aerospace composites market by offering the first and only eco-sustainable composite material that combines superior mechanical and thermal properties with its recyclability and low environmental footprint.