EXPLORING THE LIMITS OF THE MICROBIAL WORLD USING BIOGEOCHEMICAL SIGNATURES

Roger E. Summons

Australian Geological Survey Organisation, GPO Box 378 Canberra ACT 2601

Microscopic organisms are often overlooked as agents of global change. Microbes are geologically significant in that they have helped shape and reshape the Earth's external surface continuously for 3.5 billion years or more. They are essential for maintaining this planet in a habitable state and yet we are only just discovering the true extent of their domain. Most microbes leave no visible record of their presence and we can only infer their involvement in geological processes from chemical clues left in the ocean, the atmosphere and rocks. Molecular methods are providing new ways to track microbiologically driven geological processes. DNA cloned from living microbes is one component of this and analyses of diagnostic lipids of living and dead organisms is another way as well as providing a means to step back in time. Biological marker compounds, or molecular biosignatures, tell us about the inhabitants of today's extreme environments – for example, hydrothermal vents and sediments kilometres deep below the seabed. Biomarkers are also proving an effective means to learn about microbes that inhabited the early Earth and whose remains are found trapped in rocks as old as 2.7 billion years.

Mass spectrometry is the essential analytical tool for studying molecular and isotopic fossils. This talk will show how GC-MS with quadrupole, sector and hybrid mass spectrometers has been used for both structure elucidation and quantitative analysis of hydrocarbons from geological samples. Compound-specific isotope analysis via gas chromatography-combustion-isotope ratio mass spectrometry (GC-C-IRMS) has been another important innovation since it allows individual hydrocarbons to be matched to the carbon metabolism of the source organisms. This has created a much firmer connection between the microbes that we can study in the laboratory and those which we recognise as living deep within the Earth or in the geological past.