Manchester Geological Association
Broadhurst Lectures
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Speakers' Abstracts

Continent formation and the early Earth plate tectonic enigma

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New continental crust is mostly created in volcanic arcs on the modern earth as a consequence of plate tectonics. However, the applicability of such processes to the early Earth is very uncertain as it is not clear that modern style plate tectonics could operate on an earlier, hotter planet. The ongoing debate of when plate tectonics started is inherently linked to the unclear definition of what plate tectonics is and how it may have controlled the earliest continents on Earth. Numerous models presented for early continent formation range from magmatically-driven thickening of crust through to arc settings identical to the modern Earth. If the earliest continents formed via processes other than plate tectonics then a question remains regarding when and how the earth switched to a modern tectonic regime.

A world of microbes: exploring early life on Earth

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Microbial organisms provide the earliest physical, geochemical and genetic traces of life on the planet, stretching back at least 3.4 billion years. For 70% of its existence, the world was microbial, and metazoan animals, including our own species, are only recent arrivals – and perhaps we are just guests on a microbial world. Microbes have adapted to dramatic environmental changes on early Earth, and their diversity constitutes a true success story. Their evolutionary inventions, including the development of oxygenic photosynthesis, changed the surface of the Earth forever and paved the way for our own success.

Here, we will explore the spectacular and subtle traces of microbial life on early Earth, and how microbes interacted with the dramatic environmental changes on the planet. This research has direct applications to the search for life on other planets.

The Great Oxidation Event

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Over half a century ago evidence began to emerge that suggested that Earth's atmosphere (and oceans) may not have always contained free oxygen (O_2) in the concentrations present in the modern atmosphere (i.e. ~21 %). Field and petrographic evidence constrained the disappearance of redox-sensitive detrital minerals and banded iron-formations, and the first appearance of red beds, sulphates, and phosphates, to ~2.4 to 2.3 billion years ago. It was argued that fluctuating (probably rising) O_2 concentrations were the cause. In the past twenty years, geochemical studies employing sulfur, carbon, oxygen, and metal isotope systems (and trace element concentrations) have been used in conjunction with improved geochronological constraint to further pin down Earth's first oxidation, commonly known as the Great Oxidation Event (GOE).

However, many challenges remain. Great debate still remains surrounding what combination of biological, chemical and tectonic events finally triggered the GOE. Uncertainty exists surrounding the isotope systems used to closely monitor ancient oxygen levels – what processes do they actually record? Other problems persist: was the oxygen rise unidirectional, or reversible? What are the relationships between oxygen pulses and global ("snowball") glaciations? What evolutionary control (if any) does atmospheric oxygen concentration exert of the complexity of life, and how should we therefore think about exoplanet habitability?

This talk will give an overview to the GOE, outlining many aspects of the work conducted to date, our current understanding and the challenges we face, and where GOE research may be headed.