Australia's ancient oceans: toxic and purple

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Ancient oceans in Australia's north were toxic seas of sulfur, supporting coloured bacteria that made the seas appear purple and unlike anything we know of in the Earth's history, according to new ANU research.

These oceans existed 1.6 billion years ago, at a time when very little is known today about the structure of the planet's seas — scientists debate whether at this time the oceans became more oxygenated, in parallel with the Earth's atmosphere, or whether they remained oxygenless, as isotopic evidence suggests before 1.8 billion years ago.

Dr Jochen Brocks, from the Research School of Earth Sciences, found evidence in the world's best preserved rocks of the time, in northern Australia near the present Gulf of Carpentaria, that this sea was inhabited by purple and green sulphur-loving organisms which depended on light to live, in a paper published in the latest edition of Nature.

"They provide significant new clues into the mystery of the oceans of Earth's 'middle age', which have been difficult to study because certain types of rocks disappeared from the geological record about 1.8 billion years ago," Dr Brocks says. "So we know quite a lot about the very early oceans, but their 'middle age' is still a mystery."

Understanding the world's oceans at this time is an important factor in determining why complex forms of life, such as modern algae and animal life, arose so late in the planet's history. It is argued that if the oceans had more oxygen 1.6 billion years ago, multi-cellular oxygen-breathing organisms would have developed much earlier in Earth's

history. The first animal embryos, still mere clusters of cells, only appeared around 0.6 billion years ago.

Dr Brocks found evidence of the unusual 1.6 billion-year-old organisms in ancient lipids, in this case crude oil, in the rock sample from the McArthur Basin in northern Australia. In the oil, he found the molecular remains of green and purple coloured carotenoid pigments that were used by the bacteria to conduct photosynthesis.

Dr Brocks says the presence of the green and purple sulfur bacteria, types of which still exist today, showed that the ocean needed to be sufficiently sulfidic close to the surface where light could penetrate for the bacteria to survive.

“Finding these ancient pigments was breathtaking. You take a 1.6 billion year old grey, carbonate rock, squeeze black oil out of it and then use the biochemical information in the oil to reconstruct the rainbow colour of a sea that existed thousands of millions of years ago,” Dr Brocks said.

“You discover a new molecular fossil of purple bacteria — the first and only evidence for purple sulfur bacteria in the geological record, representing a powerful new environmental marker of the biology of the mysterious oceans at this time.”

Dr Brocks said the purple and green bacteria also provided the first evidence independent of isotopic findings that the oceans remained oxygen-starved and sulfur-choked, even while oxygen in the Earth’s atmosphere was increasing. He added that evidence of organisms more complex than bacteria was conspicuously absent from the sample.

“If indeed the oceans were sulfidic during this middle period of Earth’s history, it would rewrite much of what we’ve believed about a fifth of the planet’s history. Geochemical cycles would have been fundamentally

different and many life-essential elements, such as nitrogen and copper would have been rare," Dr Brocks said.

"It would seem that this is the reason why the world was ruled by bacteria for such a long time.

"When the oxygenless and toxic waters finally retreated about 800 million years ago, complex eukaryotes, such as algea, finally conquered the world's open oceans. Their development culminated in the Cambrian Explosion 542 million years ago, the sudden appearance of most groups of animals as we know them today."

Source: The Australian National University