Do clay-rich environments bias the early fossil record?

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Key words:	clays, early life, fossilisation, taphonomy
Research theme(s):	• Oceanography, Climate and Palaeoenvironment • Palaeobiology and Evolution
Eligible courses for this project:	• DPhil in Earth Sciences • Environmental Research (NERC DTP)

Overview

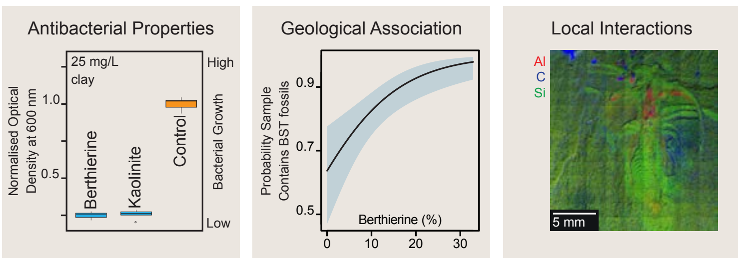
Eukaryotic life today plays a central ecological role on our planet, accounting for most visible biodiversity, most biomass, and most primary productivity. However, the initial diversification of eukaryotes in the Proterozoic Eon remains poorly understood.

The principal challenge is the rarity of fossils with which to track early eukaryote evolution. Given they lacked biomineralized hard shells and skeletons and were microscopic, early eukaryotes required unusual conditions for their preservation. Palaeontologists don't know in which precise rocks to look for these important fossils. Nor do we know how the early fossil record is biased in space and time by the processes of preservation.

Recent research suggests rocks rich in antibacterial clay minerals may hold the key. These minerals, like the aluminium-rich kaolinite and iron-rich berthierine, may be toxic to heterotrophic bacterial degraders, or may bind directly to decaying organics, aiding the fossilisation of early eukaryotes.

This DPhil will:

(1) Experimentally examine the effect of clays on degrader growth.
(2) Determine the prevalence of strata rich in these minerals across space and time.
(3) Determine the extent to which early eukaryote fossils are preserved in direct association with clays.



Methodology

Microbiological experimental work will assess the growth of microbial degraders with different metabolisms in the present of clay minerals.

X-ray diffraction data from samples already collected, will be combined with elemental data in the *Sedimentary Geochemistry and Palaeoenvironments Project*, using machine learning techniques to track mineralogy, and thus favourable fossilisation conditions, across the Neoproterozoic.

Microanalytical techniques (e.g., electron microscopy, infrared spectroscopy) will determine mineralogy at a micron scale adjacent to fossil material, testing whether the type of organism fossilised, or the hosting-formation affected clay-organic interactions.

Timeline

Year 1: Experimental work to examine clay effects on degrader growth. Geochemical data collection: X-ray diffraction, infrared spectroscopy, and electron microscopy.

Years 2 and 3: Mineralogical database development and integration with the *Sedimentary Geochemistry and Palaeoenvironments Project*.

Year 4: Data analysis, thesis completion, papers for international journals/conference presentation.

Training & Skills

Training in geochemical techniques such as X-ray diffraction, infrared spectroscopy, scanning transmission X-ray microscopy, and electron microscopy.

Skills developed will include geochemical data collection, database management, quantitative analysis of databases, writing, and forming logical arguments.

References & Further Reading

McMahon, S., Anderson, R.P., Saupe, E.E., Briggs, D.E.G., 2016. Experimental evidence that clay inhibits bacterial decomposers: Implications for preservation of organic fossils. *Geology* 44 (10), 867–870.

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Further Information

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