

Early shale diagenesis: implications for the oxidation state of Neoproterozoic oceans

Supervisors Professor Ian Fairchild and Dr. Rebecca Bartlett



Background: In the Neoproterozoic Era occurred some of the most extraordinary events in Earth history including extreme glaciation and the emergence of animal life in some way associated with increased oxidation of surface environments. Although much of the sedimentary rocks deposited during this interval are shales, these lithologies have been much less studied than carbonates and glacial facies. Where closer investigations have been undertaken startling interpretations have been made, e.g. in terms of changes in oxidation state from the location of iron in the shales, or depositional pH from clay mineralogy, or changes in the carbon cycle from carbon isotope evidence. It is timely to look more closely at shales in classic Neoproterozoic successions, particularly since changes in their character over time, under relatively constant physical conditions, should reveal key aspects of the evolution of the marine chemistry and potentially the whole Earth system.

There is a flourishing cross-disciplinary research culture at Birmingham, including a number of relevant areas within the host School, e.g. carbonate geology, colloid science, rock magnetism, hydrochemistry and palaeoclimate modelling. At Birmingham we also have extensive rock collections from previous fieldwork on classic Neoproterozoic successions in Svalbard and East Greenland and fieldwork continues as we investigate glacial facies within these rocks.

Aims and objectives: A key approach in the study of shales is to marry chemical and mineralogical information across mineral phases. This has been done for iron, using specific analytical techniques now available at Birmingham, and claims of progressive oxygenation of ocean environments have been made on this basis. Such an approach has never been undertaken in the classic successions of the Arctic region. In this studentship we propose to nest such studies within a broader and holistic understanding of the mineralogy and geochemistry of the shale successions to interpret the early diagenetic history and constrain the oxidation state and geochemistry of the ocean environments over time.

Methods: We expect that there will be an opportunity to make new field collections of samples in the Arctic in 2012 or 2013. Hands-on training for specific techniques is available in-house, including iron-speciation determinations, stable isotope analysis, trace elements by ICP-MS, electron microscope techniques. It may also be possible to use relevant national or international facilities, such as the ion microprobe or synchrotron X-ray analysis, with which supervisors are familiar.

Applicants: We are looking for BSc or MSci applicants in Geoscience with particular interests in laboratory techniques, but an interest in fieldwork would be an advantage.

References:

- Fairchild, I.J. and Hambrey, M.J. 1995 Vendian basin evolution in East Greenland and NE Svalbard. *Precambrian Research*, 73, 217-233.
- Fairchild, I.J. and Kennedy, M.J. 2007 Neoproterozoic glaciation in the Earth System. *Journal of the Geological Society, London*, 164, 895-921.

Potential applicants are invited to contact Ian Fairchild (i.j.fairchild@bham.ac.uk)