

The University of Glasgow is pleased to offer a fully-funded PhD studentship in the following area:

**The role of the environment in the evolution of biomineralisation**

**Supervisors:** Dr Uwe Balthasar

**Background:** Biomineralisation is a fundamental link between the biosphere and the inorganic earth and the vast majority of biomineral hard parts are composed of the main polymorphs of  $\text{CaCO}_3$ , aragonite and calcite. Through Earth history, ocean chemistry oscillated to favour either aragonite or calcite as the main stable polymorph. It is believed that the shifts between aragonite and calcite seas influenced the evolution of biocalcification in marine organisms. The main driving force behind the switching between aragonite-calcite sea intervals is widely believed to be the ratio of dissolved marine  $\text{Mg/Ca}$ ,  $\text{CO}_2$ , and  $\text{SO}_4^{2-}$  (Stanley 2008; Zhuravlev & Wood 2009; Mackenzie et al. 2008; Bots et al. 2011).

The extent to which such changes in ocean chemistry influence the evolution of biocalcification is currently poorly constrained. The most convincing link between aragonite-calcite seas and shell mineralogy exists for organisms that evolved biocalcification from a non-biomineralising ancestor (Porter 2010). Shifts in mineralogy within established calcifying lineages only weakly correlate with aragonite-calcite seas for organisms that have a poor control over their calcification (e.g. sponges, corals, or algae), whereas there is no apparent correlation for more complex organisms (Kiessling et al 2008).

However, while previous work has generally treated aragonite/calcite seas as globally homogenous phenomenon, recent work suggests that, due to the largely ignored role of temperature on  $\text{CaCO}_3$  polymorph selection (Morse et al. 2007), aragonite and calcite sea conditions should have co-existed, separated by temperature gradients with warm waters favouring aragonite and cold waters favouring calcite formation (Balthasar et al. in press). This PhD project aims to determine the environment-specific influence on the evolution of biocalcification in the context of temperature.

Two complementary approaches will be used in this project:

1. Lab experiments with extant organisms will be used to determine the influence of temperature on calcification in extant organisms
2. Since we currently have an aragonite sea, fossils that lived in a calcite sea will be studied

Drawing immediately on the recent methodological/analytical advances that led to the discovery of the oldest known preserved aragonite (Balthasar et al. 2011) and combining the study of fossils with growth experiments on extant organisms in our modern cutting-edge laboratories with training being provided in a range of analytical techniques, provides the potential to launch an excellent interdisciplinary research career.

## References:

- Balthasar, U, Cusack, M, Faryma, L., Chung, P., Holmer, L.E., Jin, J., Percival, I.G., and Popov, L.E., 2011, Relic aragonite from Ordovician-Silurian Brachiopods - implications for the evolution of calcification: *Geology*, v. **39**, p. 967–970.
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- Kiessling, W., Aberhan, M., and Villier, L., 2008, Phanerozoic trends in skeletal mineralogy driven by mass extinctions: *Nature Geoscience*, v. **1**, p. 527–530.
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- Morse, J.W., Arvidson, R.S., and Lüttge, A., 2007, Calcium carbonate formation and dissolution: *Chemical Reviews*, v. **107**, p. 342–381.
- Porter, S.M., 2010, Calcite and aragonite seas and the de novo acquisition of carbonate skeletons: *Geobiology*, v. **8**, p. 256–277.
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- Zhuravlev, A.Yu., and Wood, R.A., 2009, Controls on carbonate skeletal mineralogy: Global CO<sub>2</sub> evolution and mass extinctions: *Geology*, v. **37**, p. 1123–1126.

**About you:** We are seeking a dynamic and independent candidate with a strong background in either earth sciences or biology and an interest in interdisciplinary work. Strengths/experience in analytical chemistry and/or palaeontology would be an advantage.

**About us:** In Glasgow, you will join a friendly and vibrant interdisciplinary research group with PhD students, junior and senior scientists of different scientific backgrounds including chemistry, biology, and geology. At the School of Geographical and Earth Sciences you will be part of a thriving post-graduate research community (up to 20 new PhD students starting in autumn 2011). Our research group is part of the larger Glasgow Earth Systems Research Group (ESRG) which provides a vibrant environment with weekly meetings and one or two research ‘away-days’ annually. ESRG is supported by state-of-the-art laboratories on the Glasgow campus and at the Scottish Universities Environmental Research Centre in Glasgow’s southern suburbs.

**How to apply:** In the first instance please contact Dr Uwe Balthasar ([Uwe.Balthasar@glasgow.ac.uk](mailto:Uwe.Balthasar@glasgow.ac.uk)) to discuss your interest in this project; please include a CV with this initial contact, showing us your relevant skills and experience.

## Application procedure and deadlines

To be considered for PhD studentships to be held in the School of Geographical and Earth Sciences (GES), suitably qualified candidates should apply via the website of the College of Science and Engineering

(<http://www.gla.ac.uk/colleges/scienceengineering/graduateschool/prospectivestudents/essentialinformation/>). Closing dates for University and research council funded studentships will be in early in the new year, as stated on the GES studentships page:

<http://www.gla.ac.uk/schools/ges/research/postgraduate/>.

Non- English speakers must meet the University’s English language requirements. Candidates for NERC studentships should also meet the NERC's requirements for both academic qualifications and residential eligibility. For more information go to <http://www.nerc.ac.uk/funding/application/studentships> and please note that *non-UK European Union citizens will be awarded fees only by NERC.*

For informal enquiries about the research projects please contact the relevant supervisors. Information on the GES graduate school and the application process can be obtained from Mrs Jean McPartland, the assistant to head of the School: [Jean.McPartland@glasgow.ac.uk](mailto:Jean.McPartland@glasgow.ac.uk)