Nanostructure of *Arctica islandica* shells: Implications for formation pathways

D. E. JACOB[1], R. WIRTH[2], S. PIAZOLO[1] AND P. TRIMBY[3]

[1]Department of Earth and Planetary Sciences, Macquarie University, North Ryde NSW 2009, Australia (dorrit.jacob@mq.edu.au)

[2]German Research Centre For Geosciences GFZ, Telegrafenberg, 14473 Potsdam, Germany

[3]The Australian Centre for Microscopy & Microanalysis, The University of Sydney, NSW 2006, Australia

Marine *Arctica islandica* shells are important paleo-environmental recorders in the northern hemisphere. Shells are entirely aragonitc and display a so-called Homogeneous Microstructure [1]. This microstructure is a complex arrangement of oriented granular and prismatic grains with variable grain sizes arranged in domains. Largest units consist of a granular area towards the outside of the shell just under the periostracum and a complex predominantly prismatic area towards the inside of the shell. Both areas are distinct in trace element composition [2], and present difficulties for deciphering this critical paleoclimate proxy archive.

We carried out a detailed *in situ* study of *Arctica islandica* shells using Focussed Ion Beam supported Transmission Electron Microscopy (FIB-TEM), Electron Backscattered Diffraction (EBSD) and Transmission Kikuchi Diffraction Analysis (TKD, [3]). We show that at the nano-scale all areas in the shells consist of porous mesocrystals with individual crystal sizes as small as 5 nm. They share many characteristics with *Unionoida* shells for which a formation pathway via amorphous precursor phases is established [4], suggesting a similar formation mechanism.

EBSD and TKD show strong crystal preferred orientation and extensive twinning over scales from nano to micro. We carried out TKD on FIB foils of the granular layer cut from different locations along the grrowth direction of the shell. The results show that over the mm scale away from the youngest part of the shell grain sizes in the granular layer increase significantly as the texture matures. This is interpreted as an Ostwald ripening effect and shows that shell formation is a dynamic process that does not cease with the precipitation of $CaCO_3$.

[1] Ropes et al. (1984) *Fish. Bull.* **82**, 1-19. [2] Shirai et al. (2014) *GCA* **126**, 307-320. [3] Trimby (2012) *Ultramicroscopy 120*, 16-24. [4] Jacob et al. (2011) *J. Struct. Biology* **173**, 241-249.