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Time-resolved evolution of short- and long-range order during the transformation of amorphous calcium carbonate to calcite in the sea urchin embryo CHANTEL TESTER, CHING-HSUAN WU, MINNA KREJCI, LAURA MUELLER, ALEX PARK, Northwestern University, BARRY LAI, SI CHEN, CHENGJUN SUN, MAHALING BALASUBRAMANIAN, Argonne National Laboratory, DERK JOESTER, Northwestern University — The biological use of amorphous mineral precursors is thought to be directly related to the ability to create single crystalline, yet composite materials with complex shapes that are beyond our synthetic capabilities. Despite considerable effort in recent years, it has not been possible to capture the mechanistic detail of the disorder-to-order transformation that is a key element of this process. This is largely due to lack of sensitivity, lack of temporal and spatial resolution, and artifacts of sample preparation. To overcome these challenges we use strontium as a probe for X-ray absorption spectroscopy (XAS). In pulse-chase experiments, sea urchin embryos incorporate Sr2+ from Sr-enriched seawater into small volumes of the developing endoskeleton. During the chase, the transformation of the newly deposited amorphous mineral is characterized by Sr-Kα XAS of cryo-frozen whole embryos. We find that the initial mineral has short-range order resembling hydrated amorphous calcium carbonate. Within 3h, the short-range order of calcite is adopted, with long-range order developing over the next 20h. Pulse-chase experiments combined with heavy element labeling can be used in numerous mineralizing systems to study phase transformations during biological crystal growth.

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