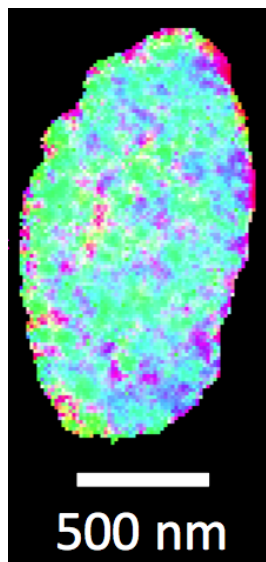


Mapping the amorphous-to-crystalline transitions in CaCO₃ biominerals with 20-nm resolution

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One of the most fascinating aspects of calcite biominerals are their intricate and curved morphologies, quite different from the normal rhombohedral crystal habit of geologic calcite. These morphologies are achieved via amorphous precursor mineral phases [1]. In this talk we will show that in sea urchin larval spicules two distinct phase transitions occur, 1→2 and 2→3 [2]. The 1→2 transition is regulated by inhibiting proteins, while the 2→3 is thermodynamically driven, and occurs spontaneously [3].

Figure 1: Cross-section of a 48-h sea urchin larval spicule, caught in the act of transforming from ACC (type 1 = red, type 2 = green) to crystalline calcite (type 3 = blue), and with imaged XANES-PEEM spectromicroscopy.

[1] Y Politi, RA Metzler, M Abrecht, B Gilbert, FH Wilt, I Sagi, L Addadi, S Weiner, and PUPA Gilbert. (2008) Mechanism of transformation of amorphous calcium carbonate into calcite in the sea urchin larval spicule. *Procs. Natl. Acad. Sci. USA* **105**, 17362-17366. [2] AV Radha, TZ Forbes, CE Killian, PUPA Gilbert, and A Navrotsky. (2010) Transformation and crystallization energetics of synthetic and biogenic amorphous calcium carbonate. *Procs. Natl. Acad. Sci. USA* **107**, 16438-16443. [3] YUT Gong, CE Killian, IC Olson, NP Appathurai, RA Metzler, AL Amasino, FH Wilt, PUPA Gilbert. Phase Transitions in Sea Urchin Larval Spicules. In preparation.

Natural and artificial noble gases as tracers of injected CO₂ migration within a deep reservoir

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CO₂ capture and subsequent geological storage of CO₂ is gaining momentum as a means of economically abating anthropogenic CO₂ emissions from point sources. For the technology to be universally deployed it is essential that a robust, reliable and inexpensive means to trace the migration of CO₂ within the subsurface exists. Monitoring during injection will increase confidence that the site characteristics were correctly determined and met. Furthermore, should migration and subsequent surface leakage occur, the ability to track origin and ownership of CO₂ at near and ground surface will be critical for remediation purposes.

As an analogue for tracing CO₂ migration within an engineered storage site, this presentation will examine both natural and artificially injected noble gases at the SECARB early project at Cranfield in MS, USA. Natural CO₂ rich in mantle derived noble gases was injected into a portion of the reservoir via a deep injection well and samples were collected via U-tube sampling equipment from two nearby observation wells. Additionally, two separate injections of artificial Kr and Xe tracers injected with the CO₂ were undertaken.

Noble gases are conservative tracers within the subsurface, proving to be invaluable in determining both the origin of CO₂ and how it is stored in natural CO₂ reservoirs [1,2]. This presentation will compare measurements of the natural ³He/⁴He, CO₂/³He, ³He, ⁴He, Ne and Ar concentrations within the reservoir prior to CO₂ breakthrough with those after CO₂ arrival at the observation wells. We show that a component of the He fingerprint observed in the injected CO₂ can be clearly traced in both observation wells. Additionally, we see a clear spike in Kr and Xe concentrations following CO₂ breakthrough. Our results show that CO₂ can be traced within a storage site using noble gases, illustrating significant potential for monitoring CO₂ migration in future engineered storage sites.

[1] Gilfillan *et al.*, (2008) *GCA* **72**, p.1174-1198. DOI:10.1016/j.gca.2007.10.009 [2] Gilfillan *et al.*, (2009) *Nature*, **458**, p.614-618. DOI:10.1038/nature07852