

# Assessing the structural integrity of marine calcifiers under changing environmental conditions

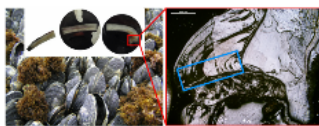
Suzanne Jennions, Daniela N Schmidt, Katrin Linse, Claire Morely, Loren Picco, Tom Scott



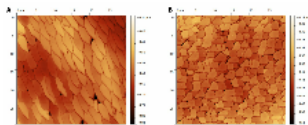
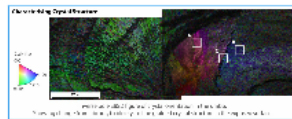
UK Ocean Acidification  
Research Programme

## Characterising Crystal Structure

Cathy Pfister, Sophie McCoy, Tom Scott, Loren Picco



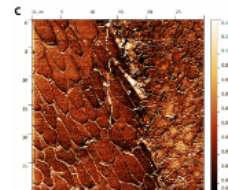
Section of *Alcyonella* through the centre of the shell, exposing the hinge (umbel).



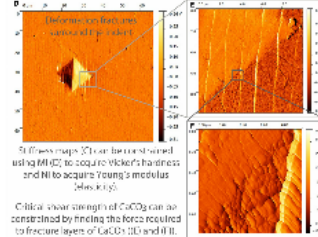
High resolution AFM images revealing the different crystal domains in the umbel.

## Material Properties

Loren Picco, Tom Scott, Zora Zittler



### Quantifying Material Properties



High resolution AFM images can be used to quantify the material properties of the shell, such as the Young's modulus and Poisson's ratio.

Critical shear strengths of CaCO<sub>3</sub> can be constrained by finding the force required to fracture layers of CaCO<sub>3</sub> (I) and II.

## Consequence on Structural Integrity

Claire Morely, Jen Bright, Emily Rayfield

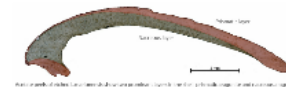
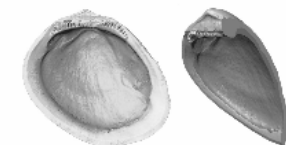
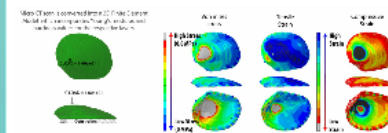


Diagram illustrating the structural integrity of the shell, showing the hinge and the umbel.



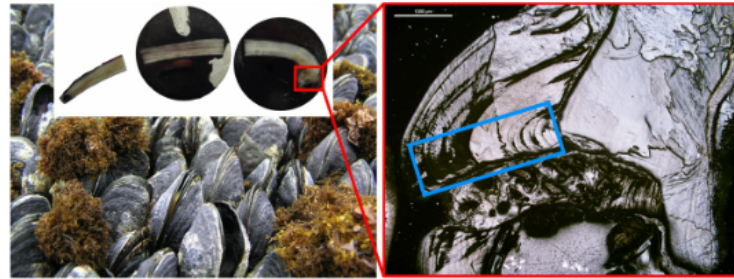
Microscopic images showing the structural integrity of the shell, highlighting the hinge and the umbel.



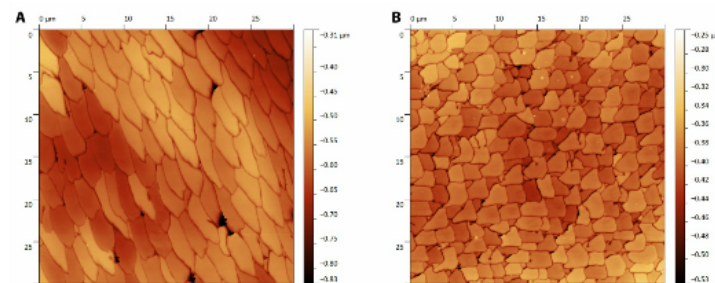
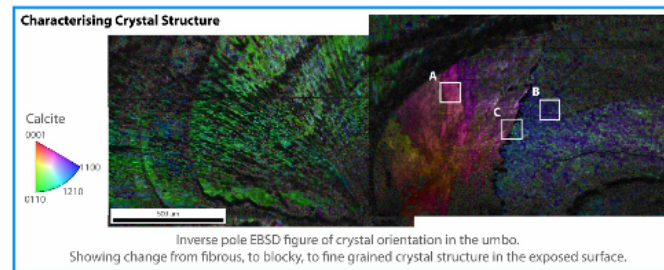
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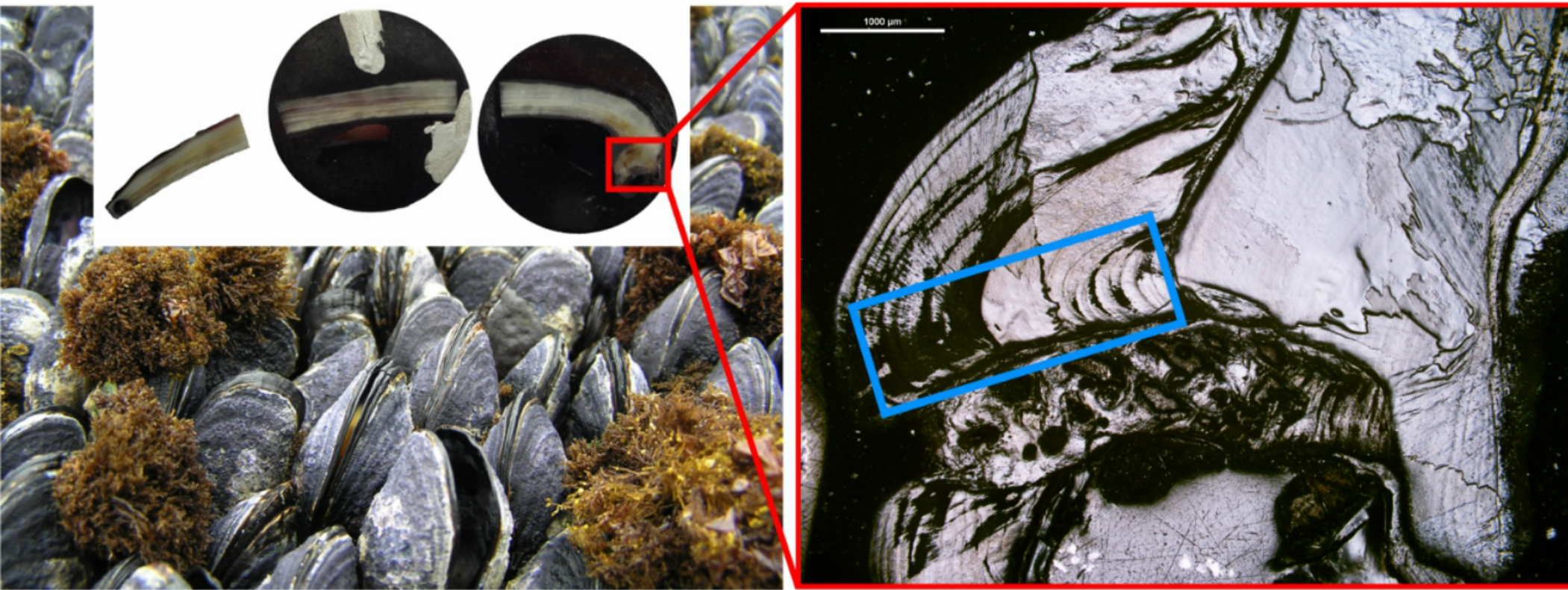
Section of *M. californianus* through the centre of the shell, exposing the hinge (umbo).



High resolution AFM height maps showing two of the different crystal textures in the umbo



# Cathy Pfister, Sophie McCoy, Tom Scott, Loren Picco

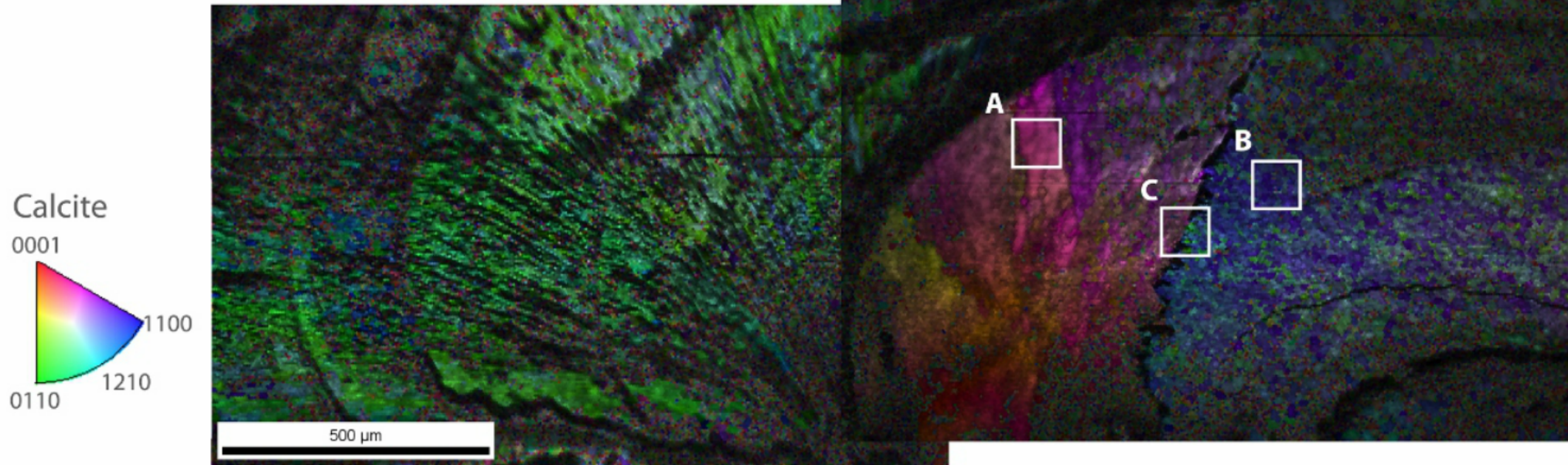


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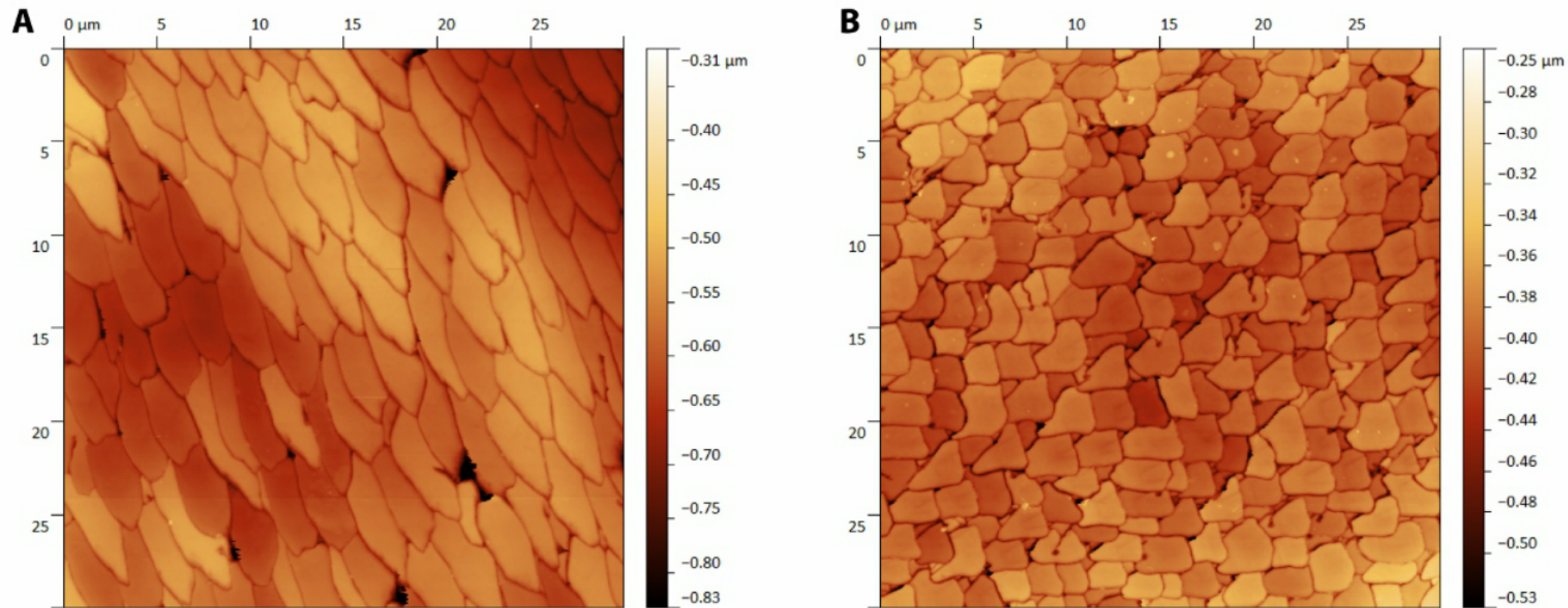
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### Characterising Crystal Structure



Inverse pole EBSD figure of crystal orientation in the umbo.  
Showing change from fibrous, to blocky, to fine grained crystal structure in the exposed surface.

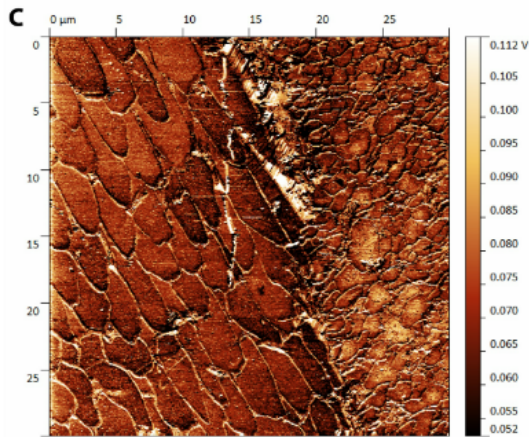




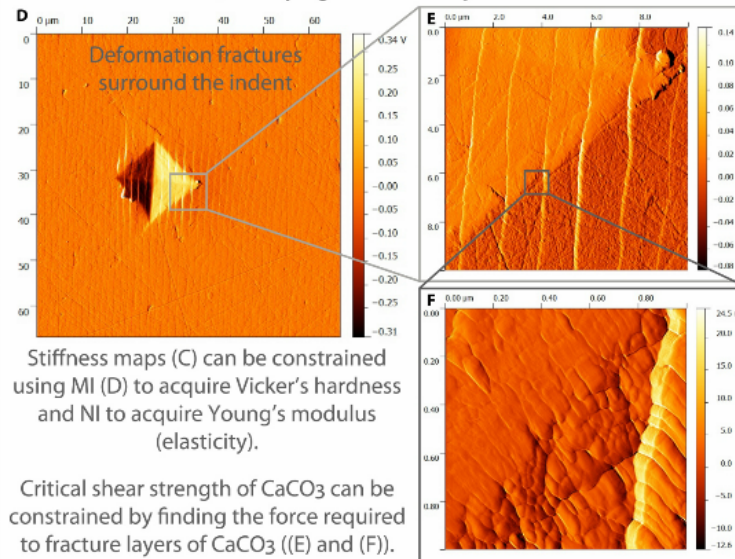
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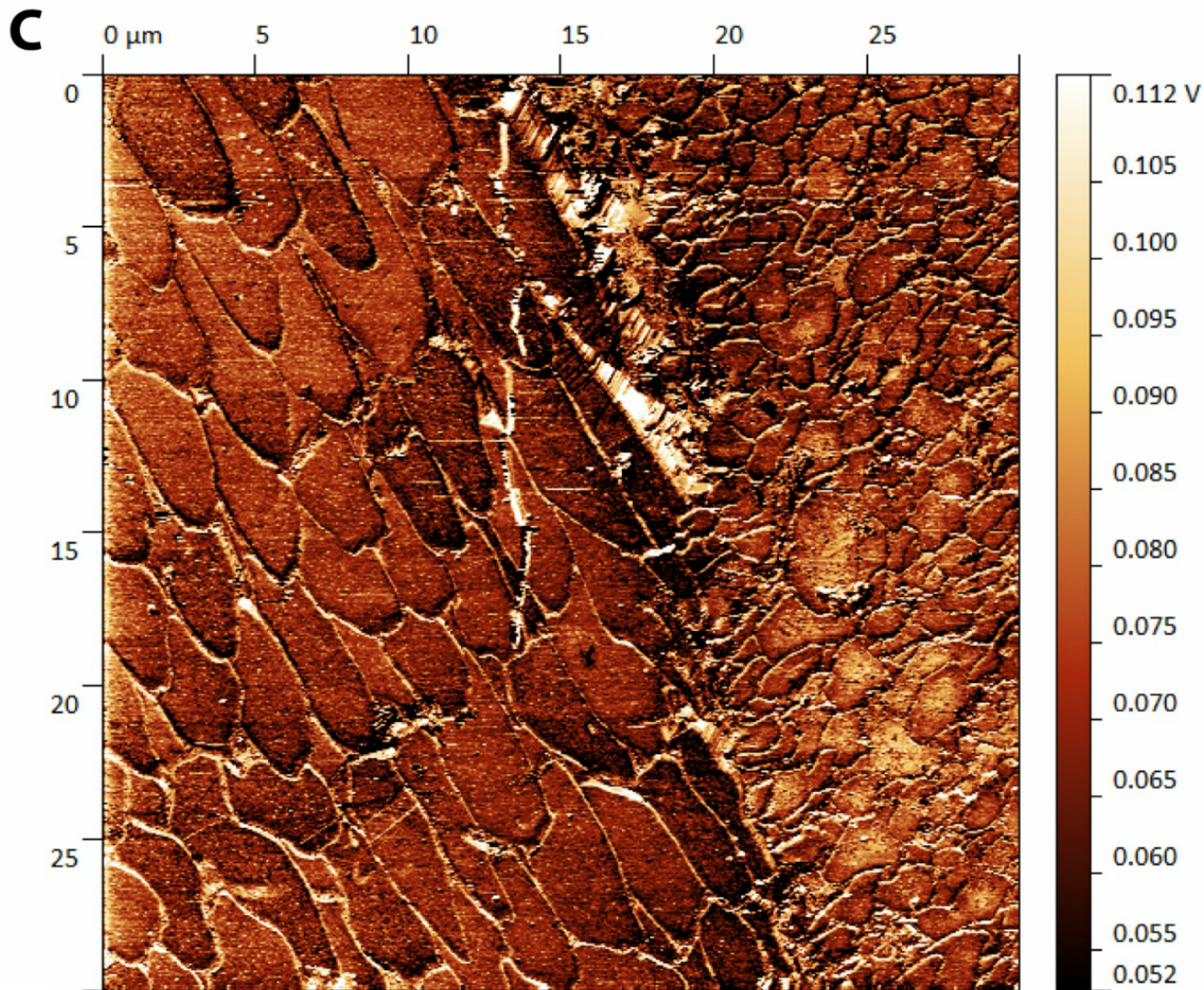
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## Quantifying Material Properties

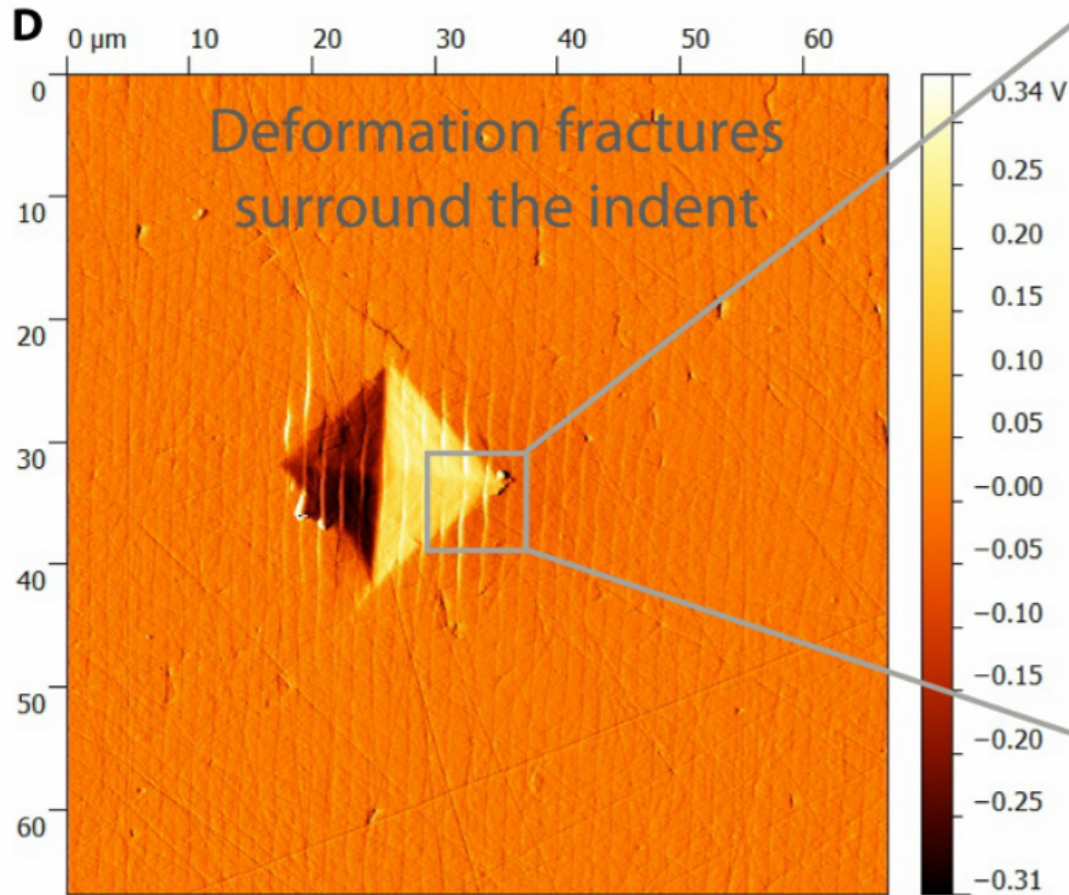






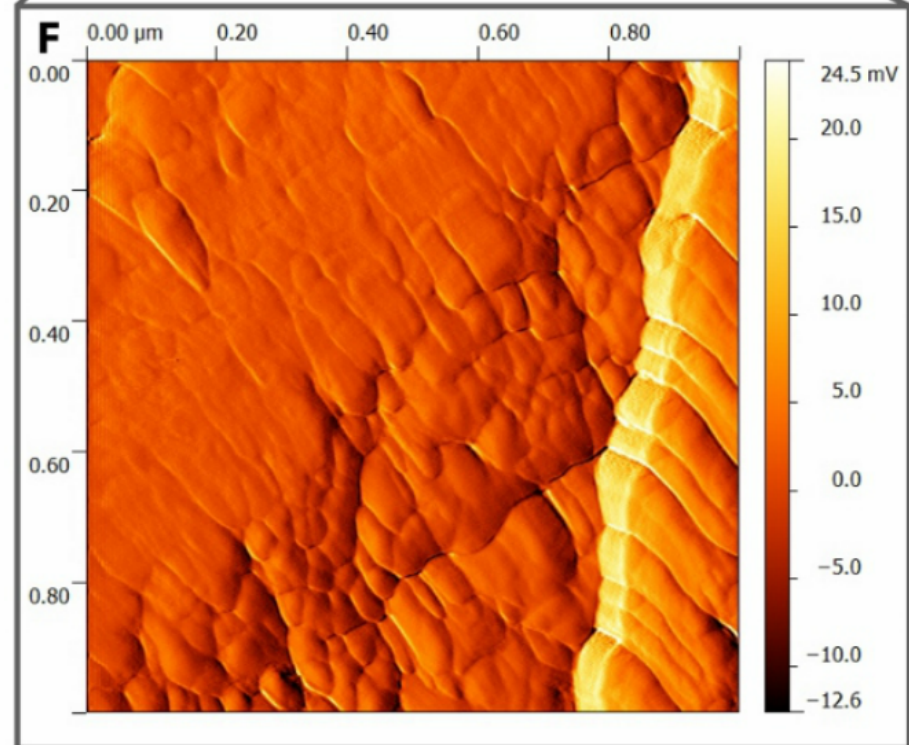
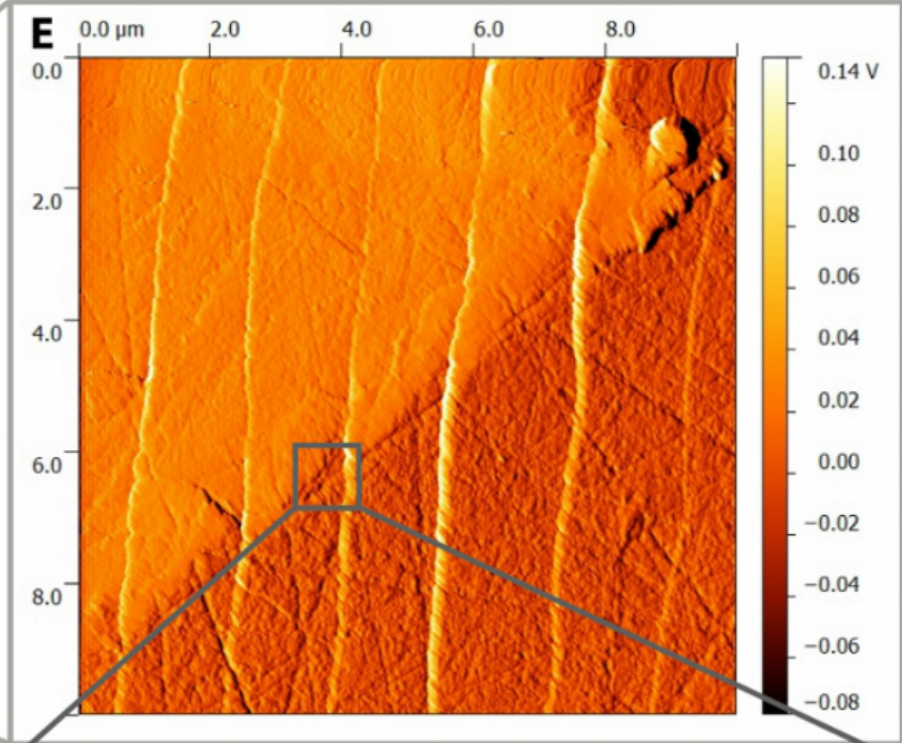


# Quantifying Material Properties



Stiffness maps (C) can be constrained using MI (D) to acquire Vicker's hardness and NI to acquire Young's modulus (elasticity).

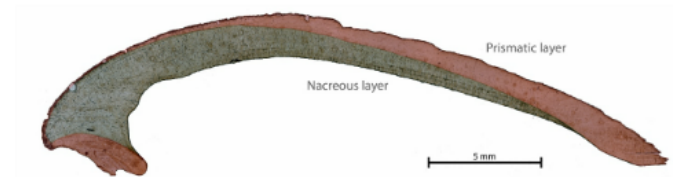
Critical shear strength of  $\text{CaCO}_3$  can be constrained by finding the force required to fracture layers of  $\text{CaCO}_3$  ((E) and (F)).



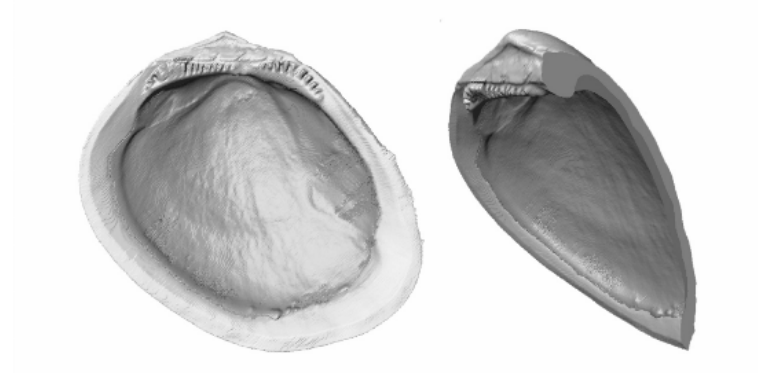


# Consequence on Structural Integrity

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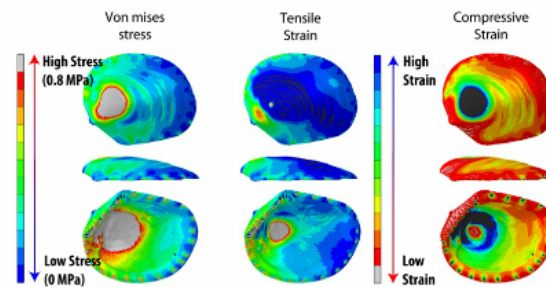
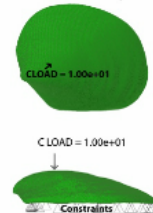


Acetate peels of etched *L. marionensis* show two prominent layers in the shell: prismatic aragonite and nacreous aragonite.

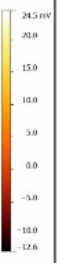


Micro CT scan of *L. marionensis* incorporating the nacreous (dark grey) and prismatic (light grey) layers, derived from acetate peels produced at known increments across the shell.

Micro CT scan is converted into a 3D Finite Element Model which incorporates Young's modulus and hardness values for the respective layers

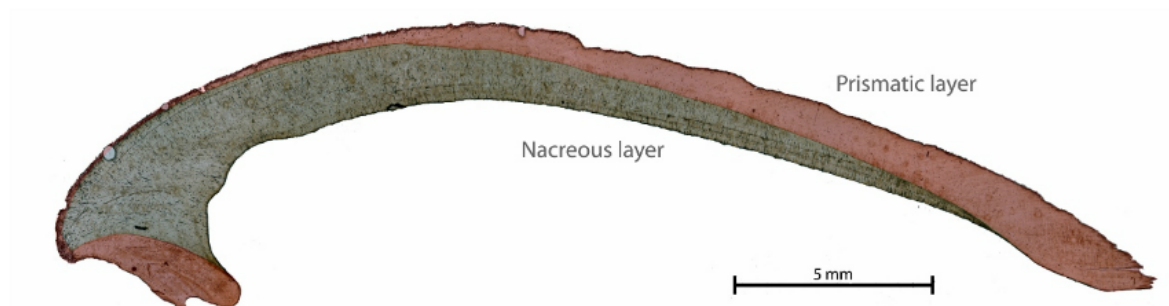


The model is constrained as if the shell were closed, a load is applied to the exterior of the shell to mimic biologically and environmentally relevant forces.



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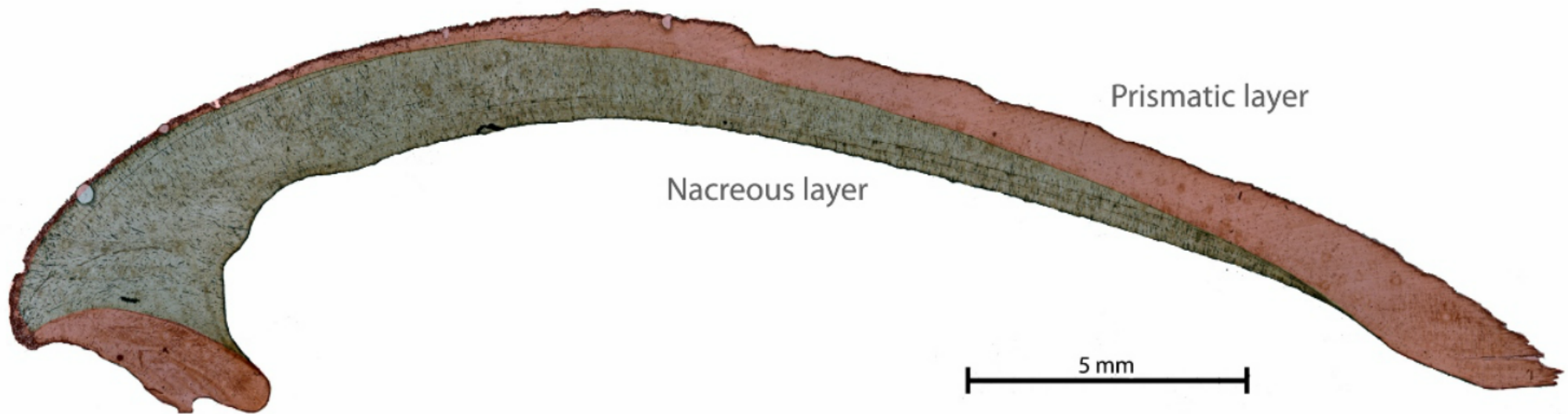
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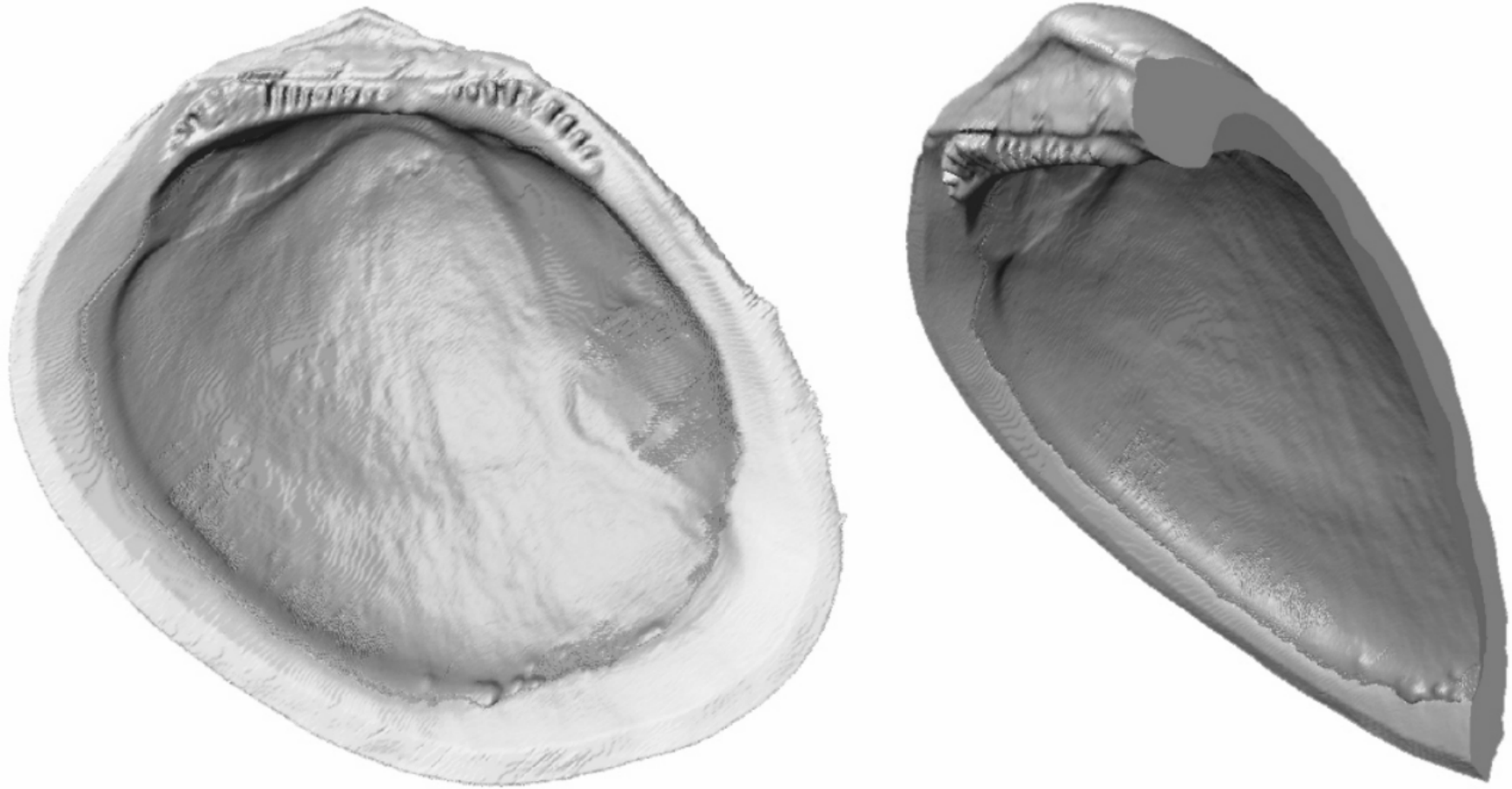
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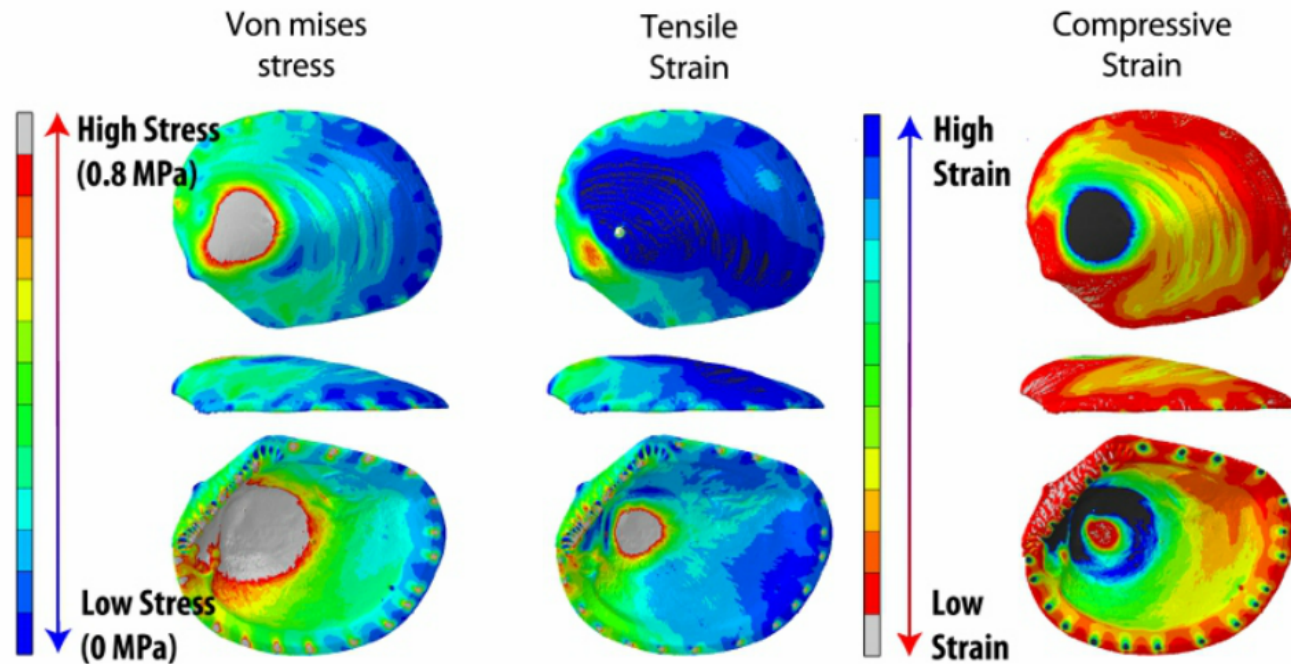
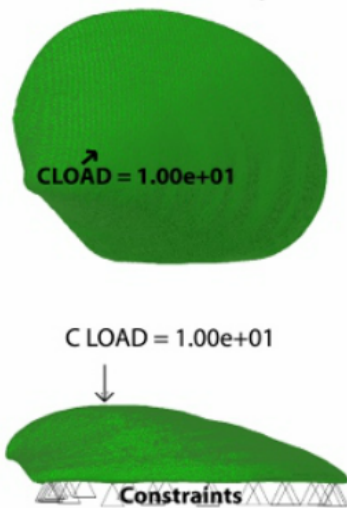
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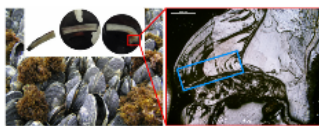
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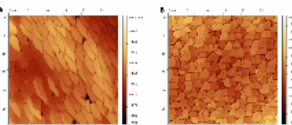
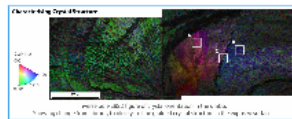
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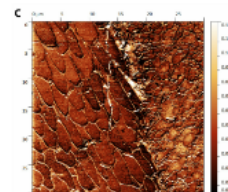
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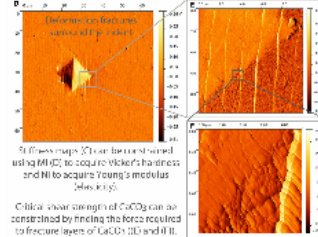
Left: Apatite crystals (AP) in the shell, showing the different crystal orientations in the umbel.

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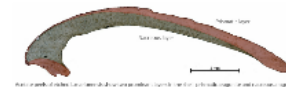
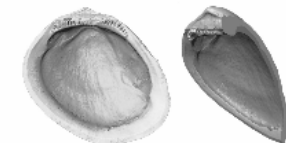
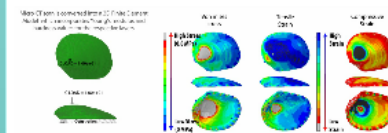


Diagram illustrating the structural integrity of a shell, showing the hinge and the umbel.



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