

High Pressure Atomic Force Microscopy Capability

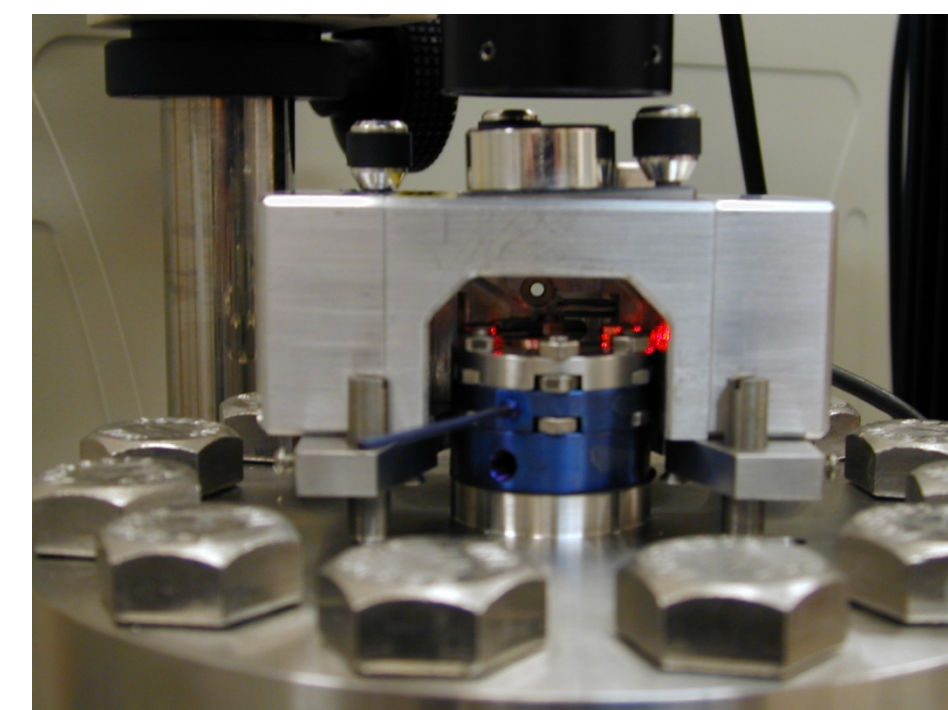
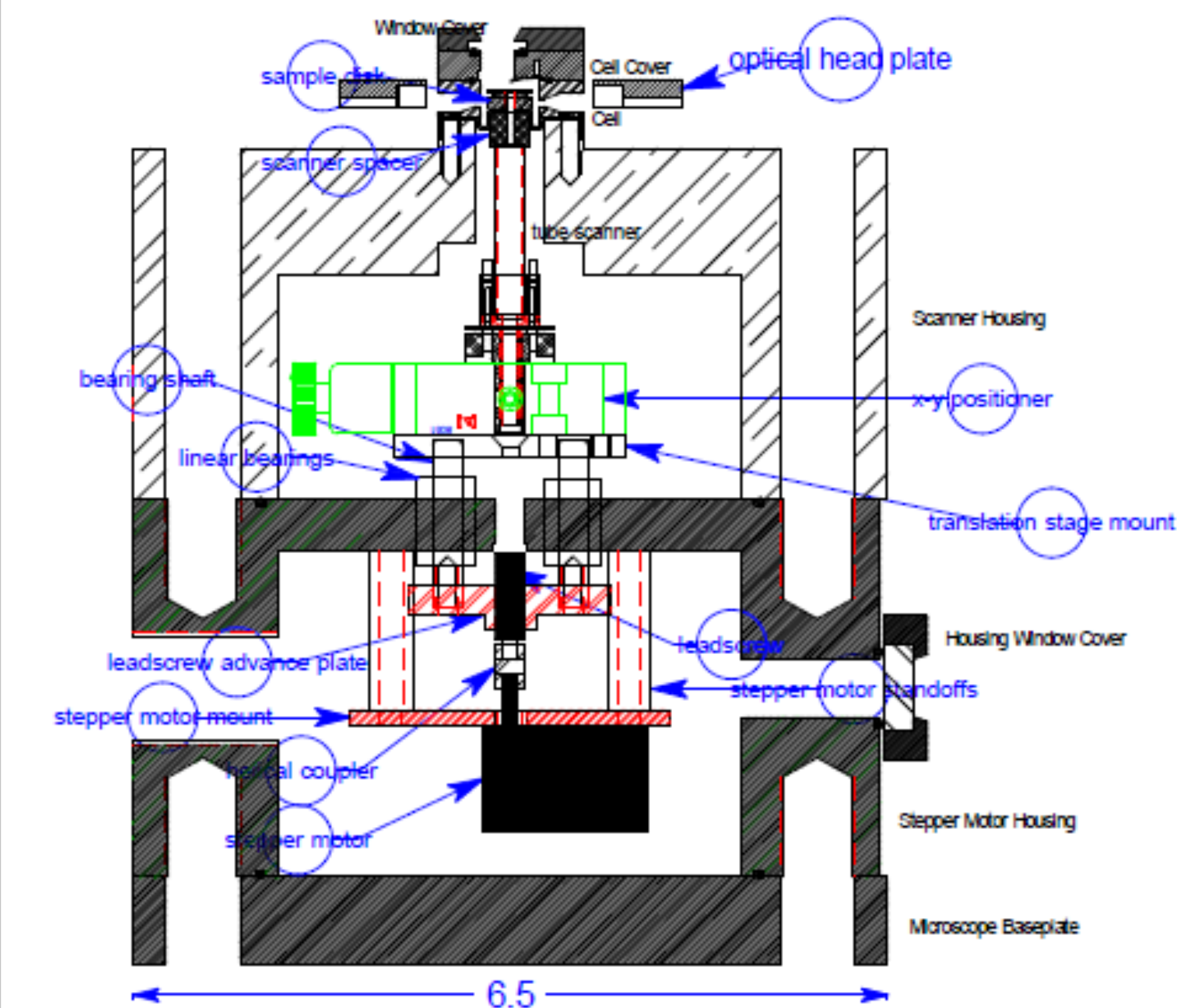
Scott Lea



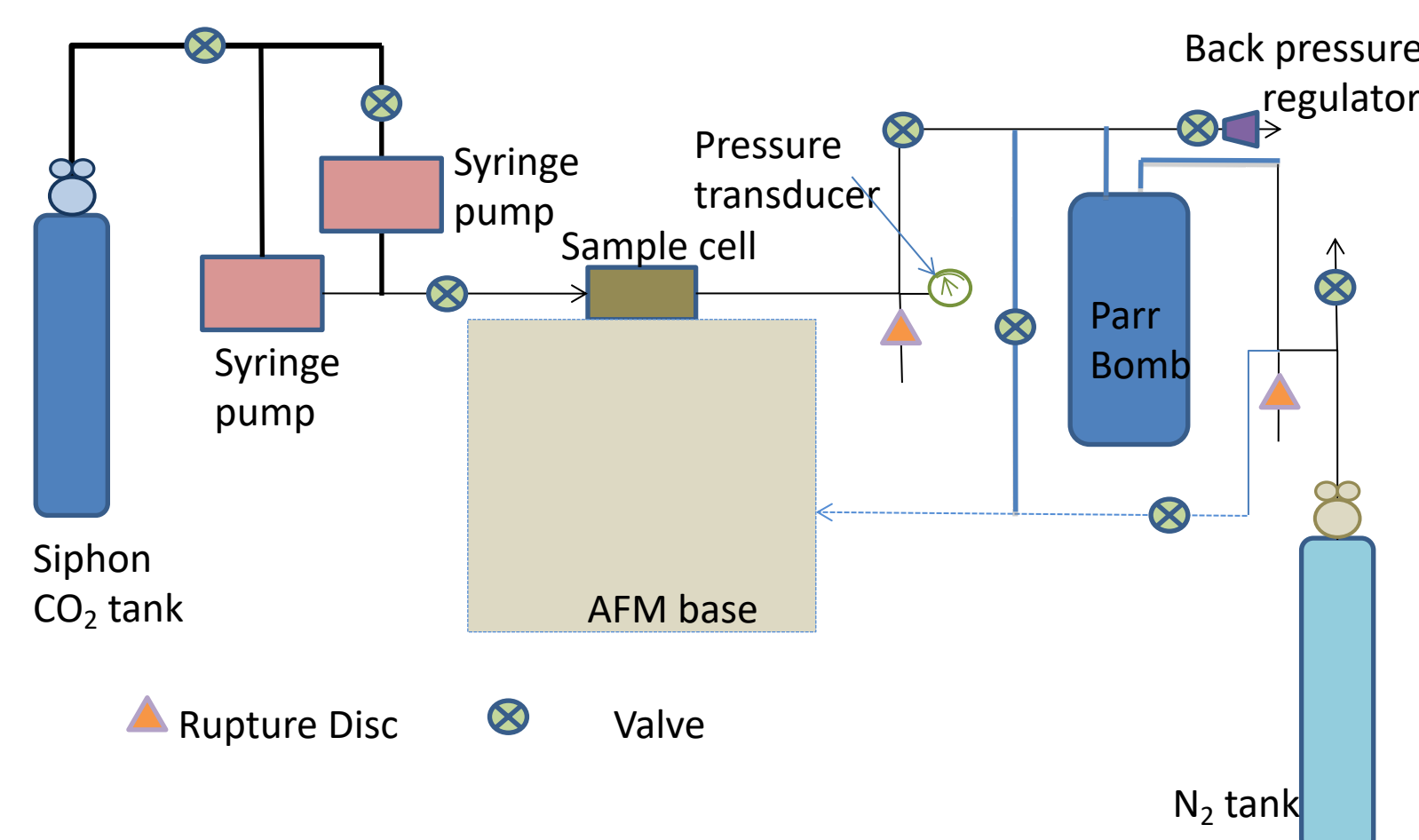
Pacific Northwest
NATIONAL LABORATORY

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Capability Description



Design Considerations:
The high pressure scCO₂ AFM includes +/- 2mm xy translation stage, stepper motor engagement, and a 40μm scan area



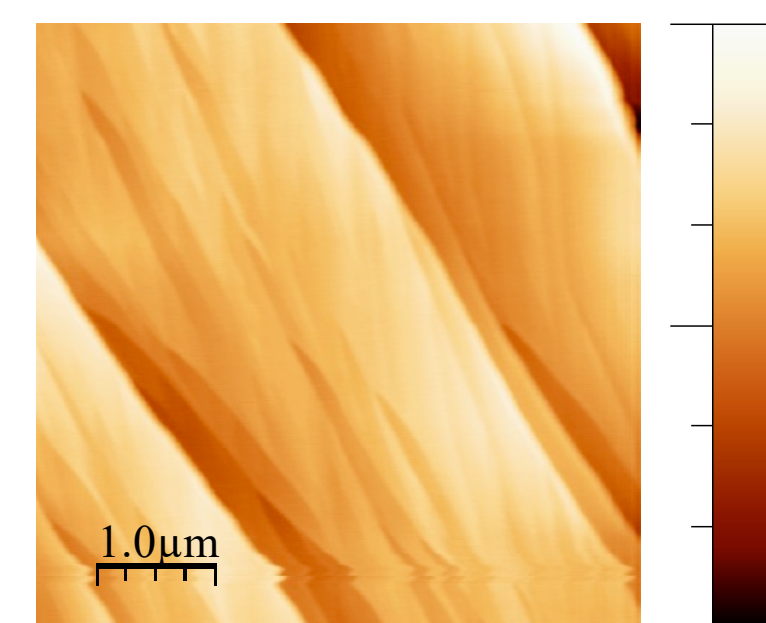
Key Features

- Designed for *in-situ*, dynamic imaging of mineral surfaces during exposure to scCO₂ fluids
- Atomic scale measurements of metal carbonate nucleation and growth rates on mineral surfaces in contact with hydrated scCO₂ fluids

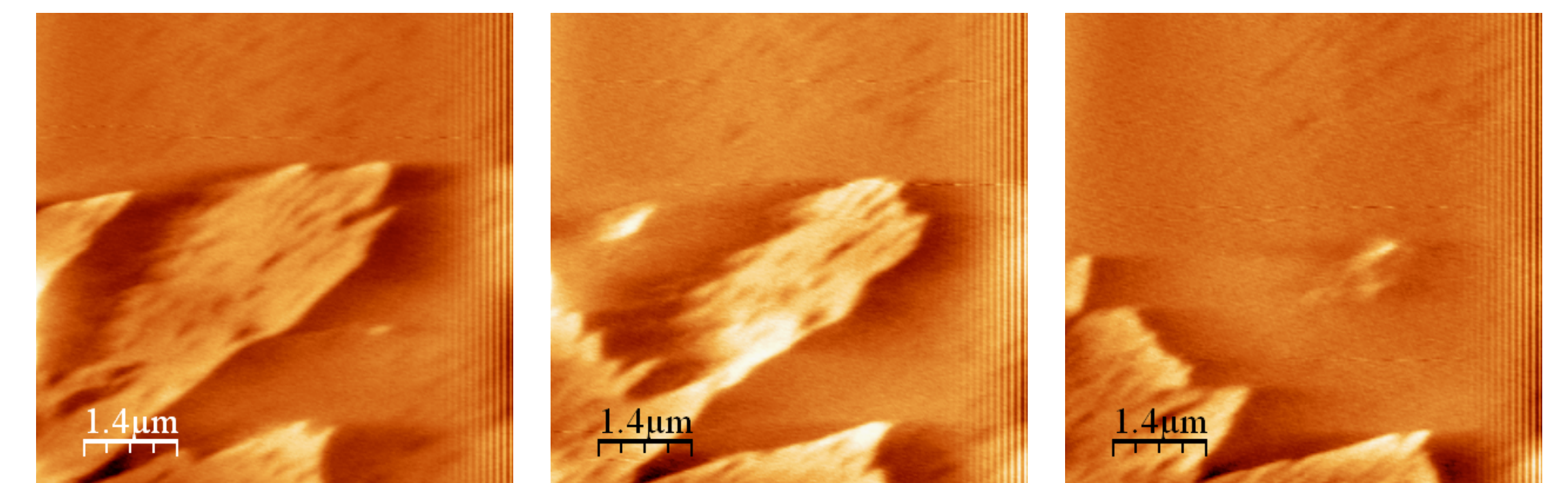
Application

Proof-of-Concept

Experimental Approach: Calcite, when exposed to humid air, forms a hydrated layer on the surface. Dry scCO₂, a dehydrating agent, decomposes the hydrated layer which is visible in the high pressure AFM.

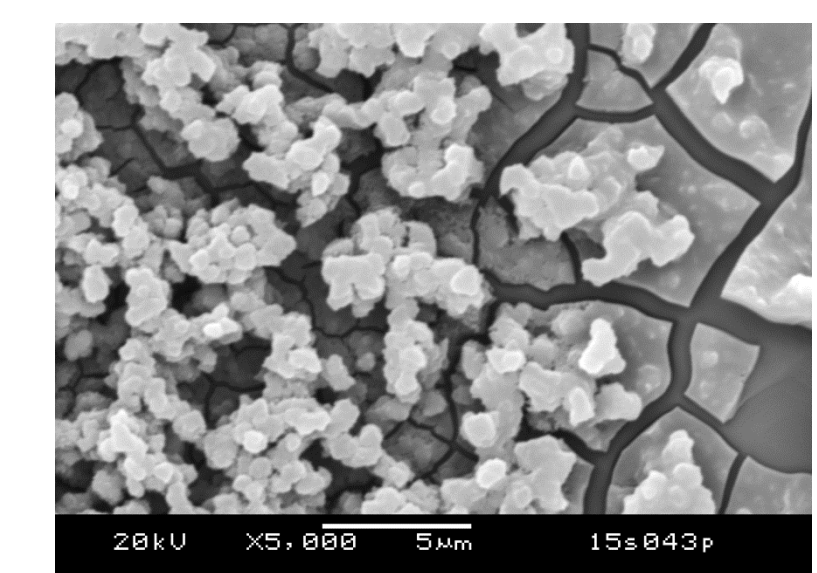
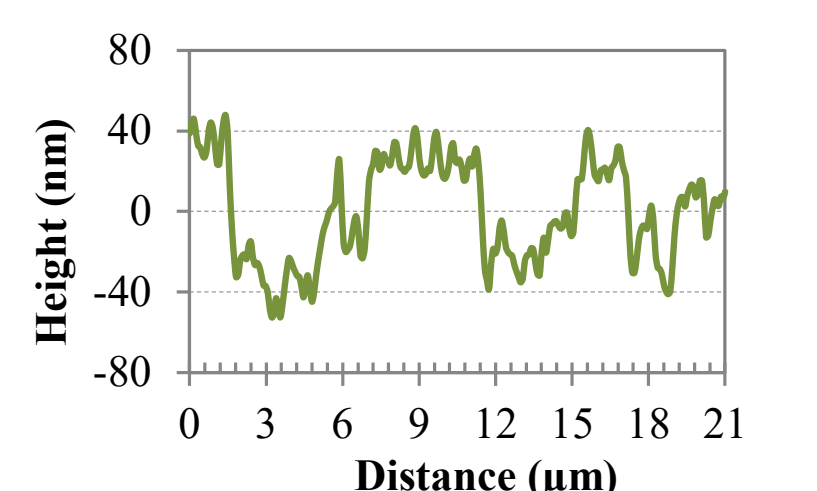
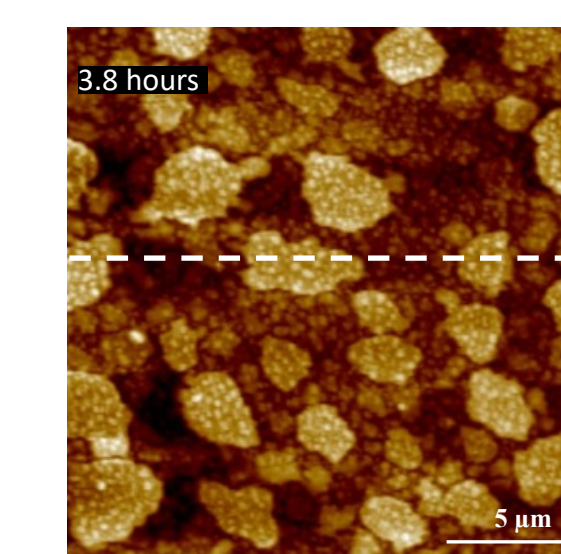
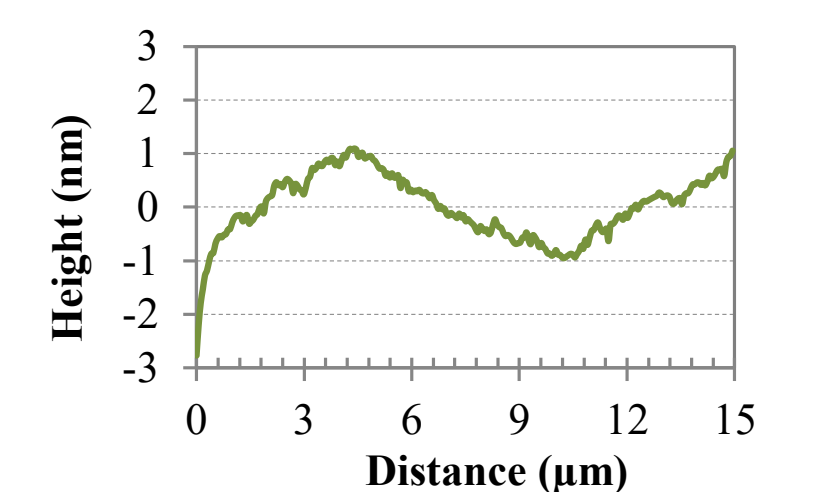
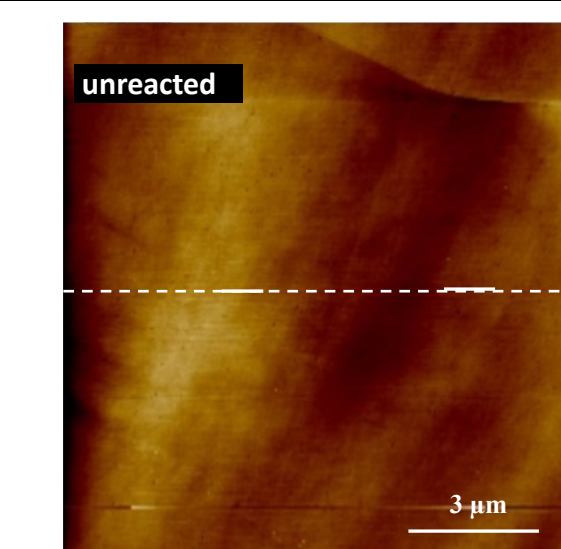


AFM image of freshly cleaved calcite under dry scCO₂ at 34.9°C and 99.3 atm using a flow rate of 500 μL min⁻¹.



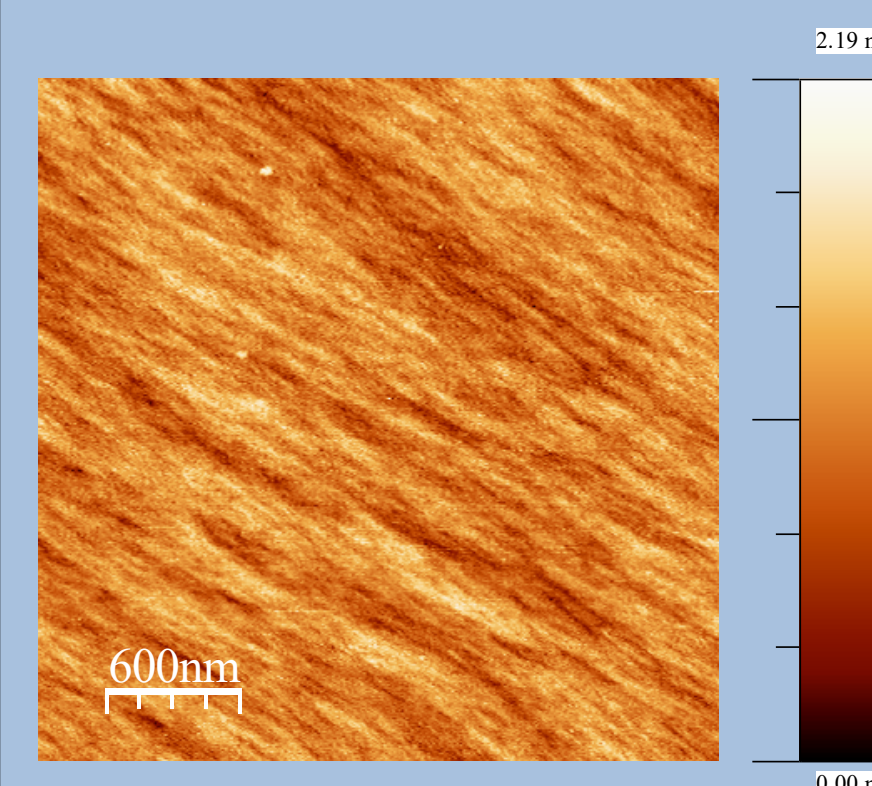
AFM images of calcite exposed to air for ~20 hrs under scCO₂ at 35°C and 82.0 atm as a function of time. Images, taken 6 minutes apart, show dynamic processes occurring on the mineral surface.

Mineral Carbonation: *in-situ* AFM images of brucite surface, 1) unreacted, and after contact with wet scCO₂ for 2) 3.8 hours (50 °C, 90 bar), and a complementary SEM.



Visualizing Forsterite Carbonation

Experimental conditions: AFM image of cleaned, polished natural forsterite under fully hydrated scCO₂ at 35°C and 90 atm using a flow rate of 500 μL min⁻¹.



Forsterite surface imaged in dry scCO₂ prior to exposure to scCO₂ containing water.

Precipitates formed on the surface of forsterite after 2 hours of exposure to water saturated scCO₂.

