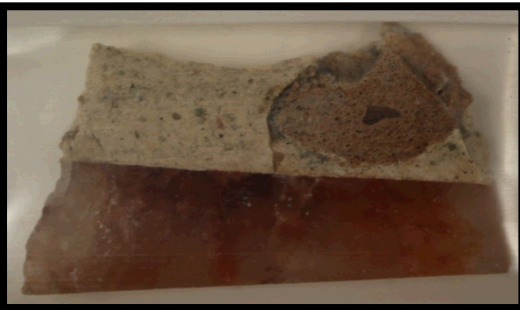


Monitoring the Degradation of Cement at the Cement/Geomaterial Interface using Ultrasonics

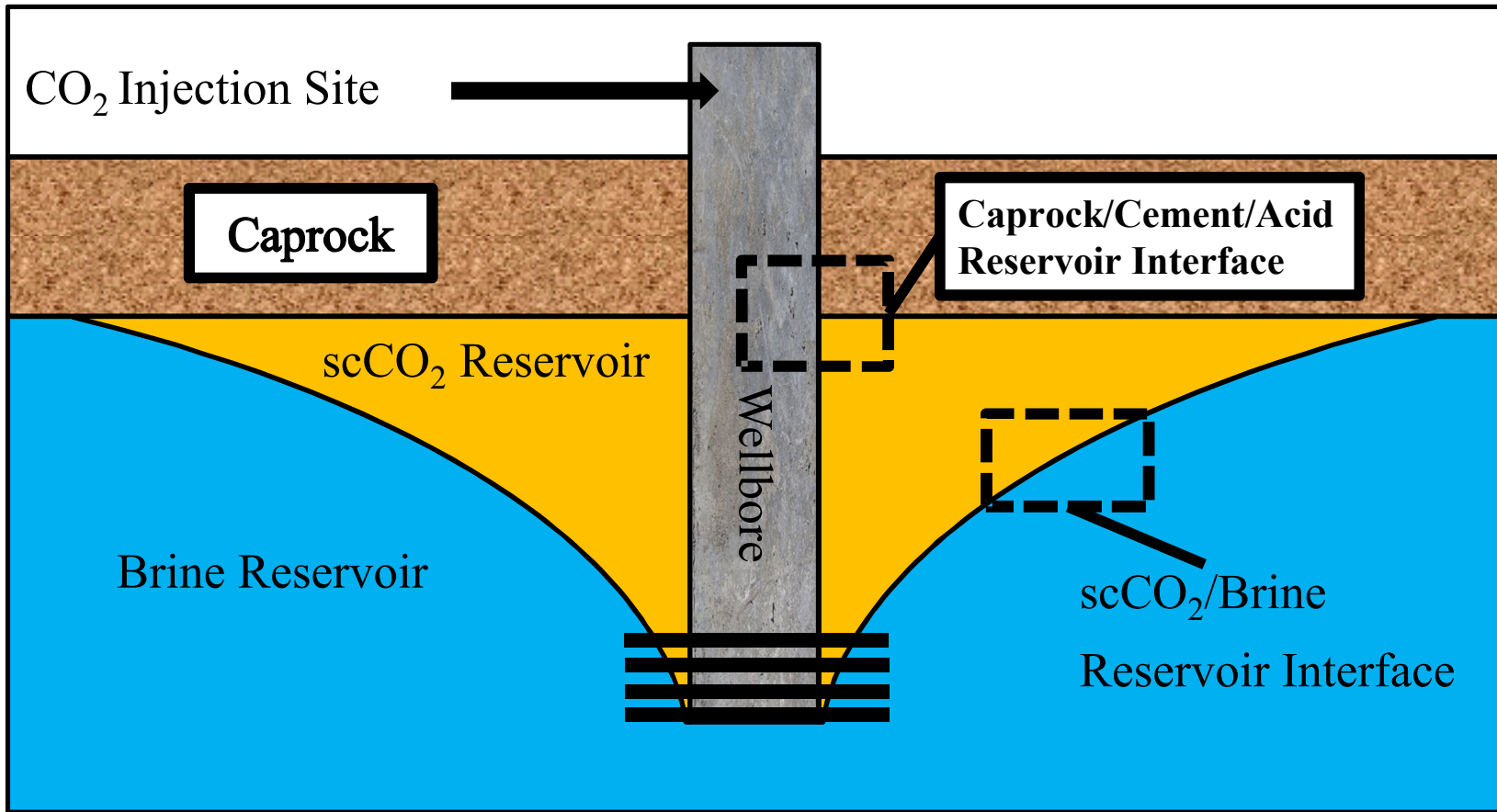
Joseph Mohagheghi

Thesis Proposal

00/00/2018



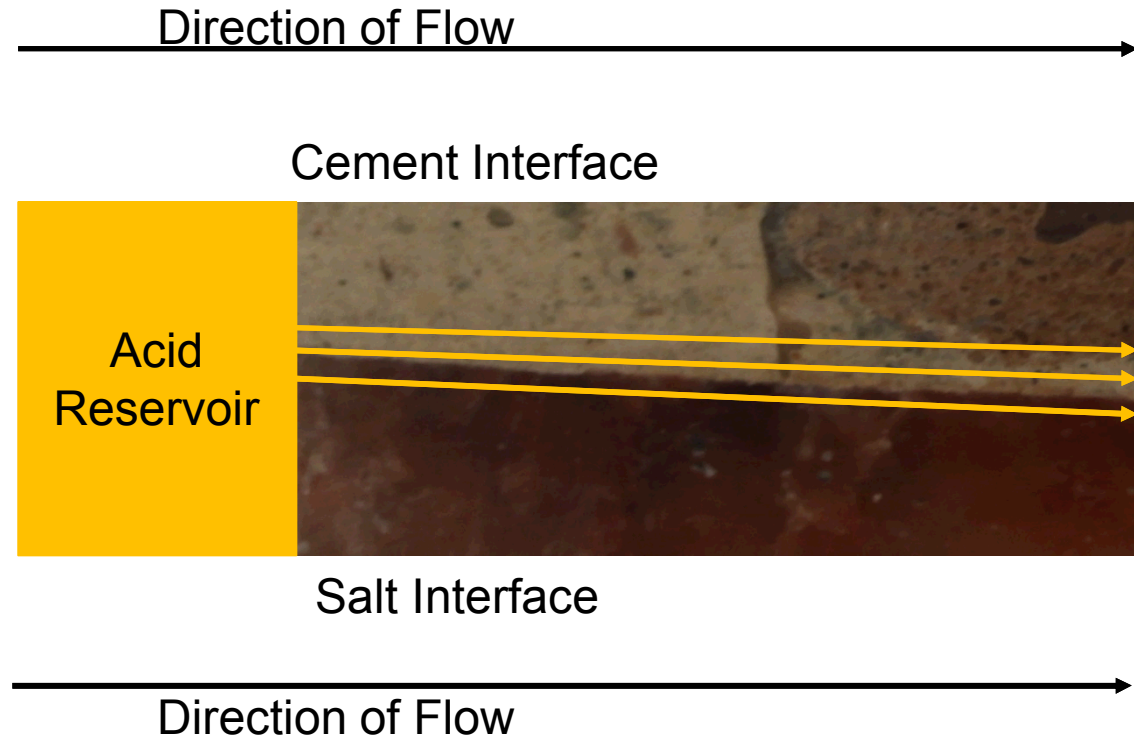
Reasoning Behind the Project



Typical 'Martini Glass' Distribution of Supercritical scCO₂ From a Wellbore Interested in the Caprock/Cement Interface.

How We are Testing the Boundary Sandia National Laboratories

- Acid Reservoir
- Promote flow through the boundary
- Observe Changes



Pressurized Triaxial Core-Holder

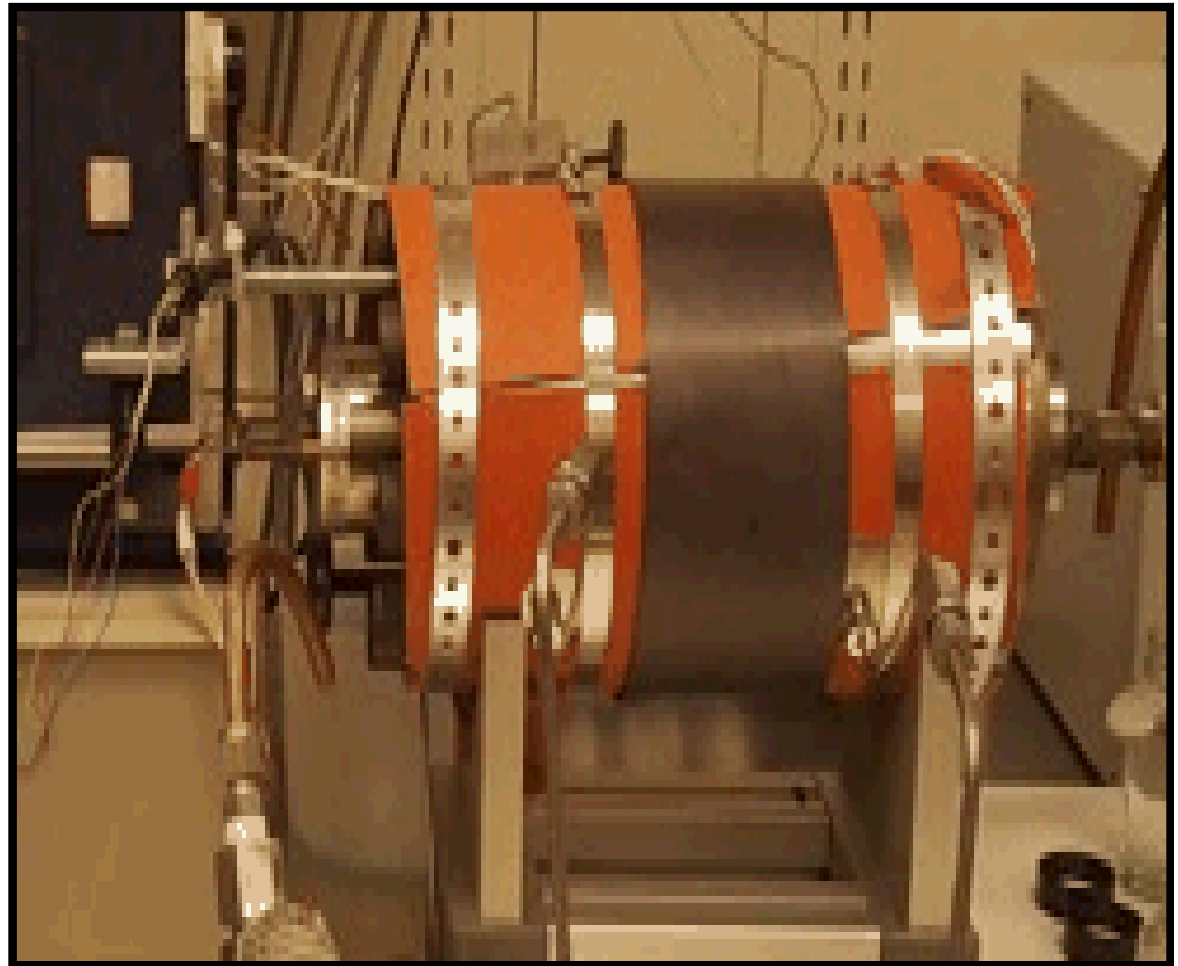


What's Inside:

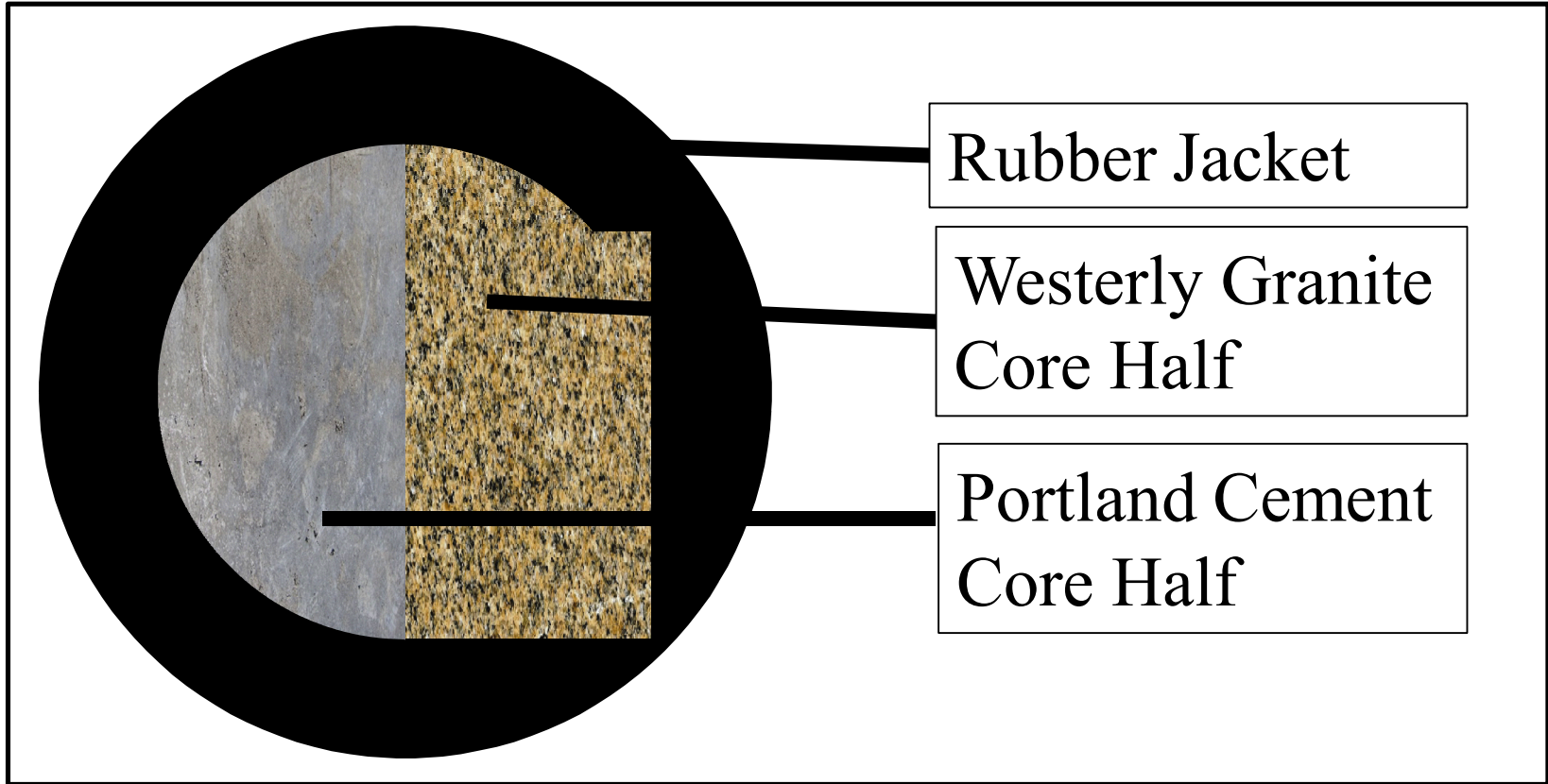
- Cement/Geomaterial Core Sample

Instruments attached:

- Temperature Controller
- Pressure Controller
- LVDT
- Inline pH Probe
- Ultrasonics



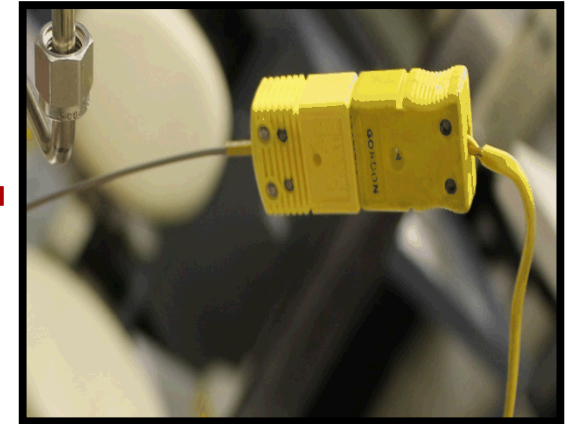
Core Sample Preparation



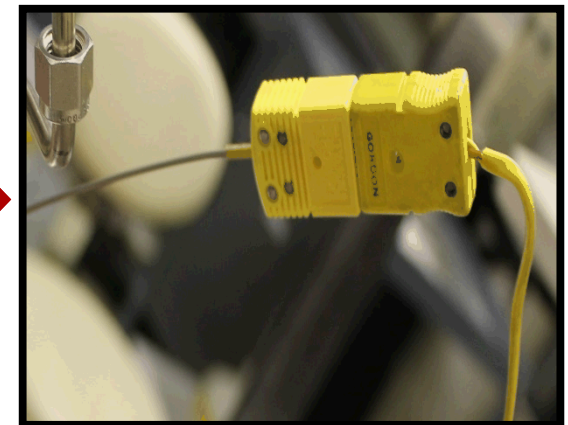
Temperature Controller



Temperature Controller

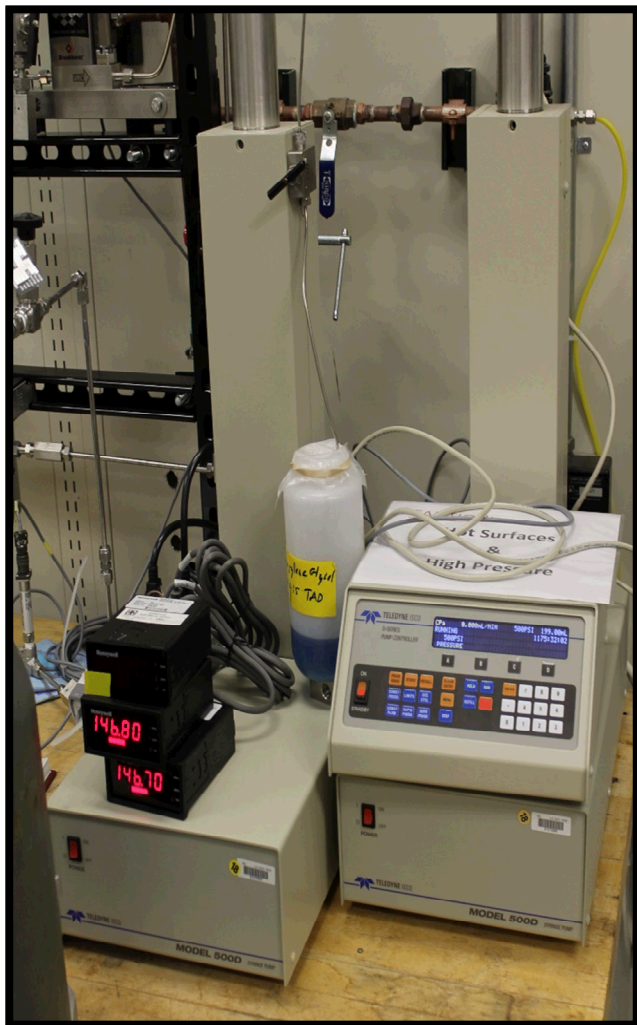


Internal Thermocouple

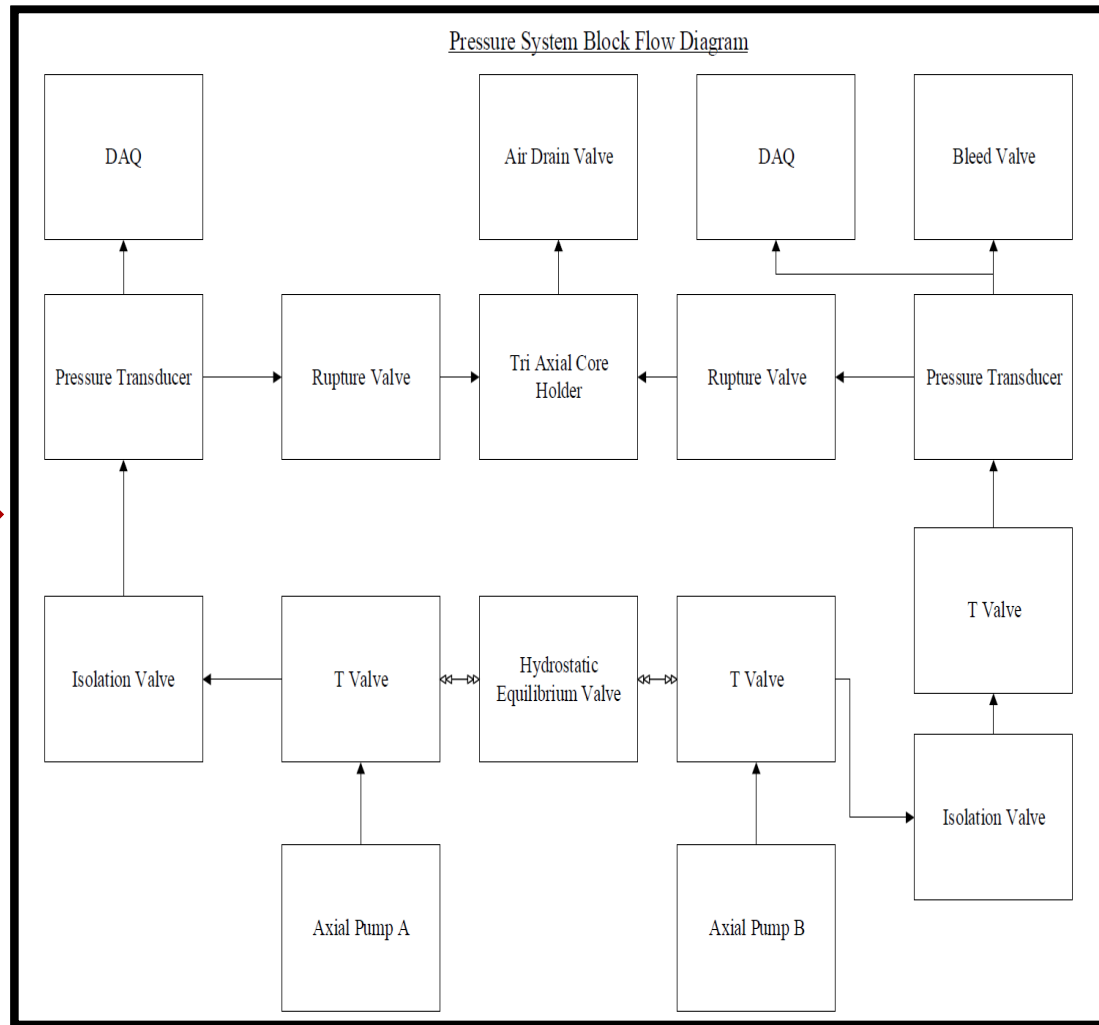


External Thermocouple

Pressure Controller



Pressure Pumps



Pressure Block Flow Diagram

Linear Variable Differential Transformer



Compression Displacement Unit

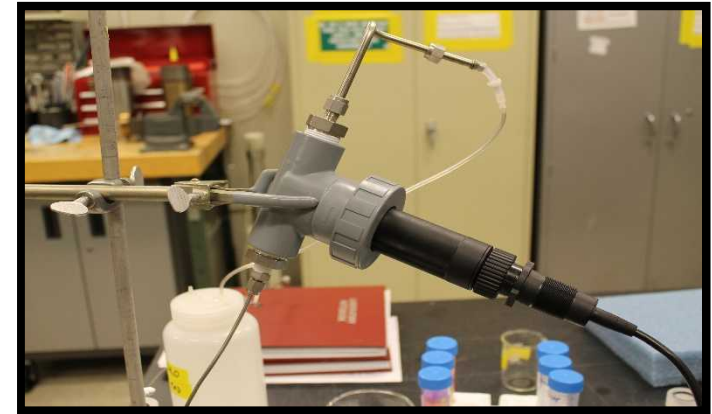


LVDT Meter

Inline pH Probe



Syringe Pump

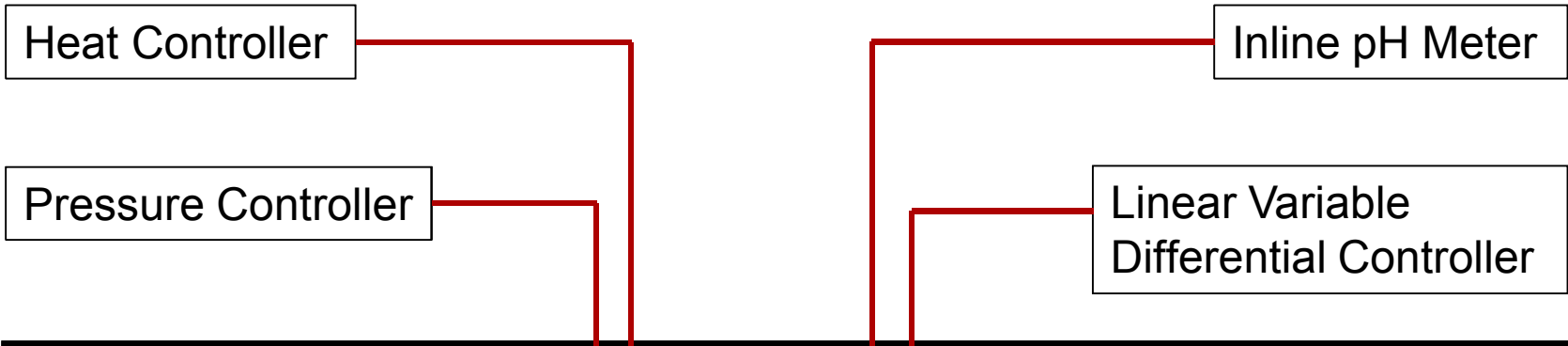


pH Probe



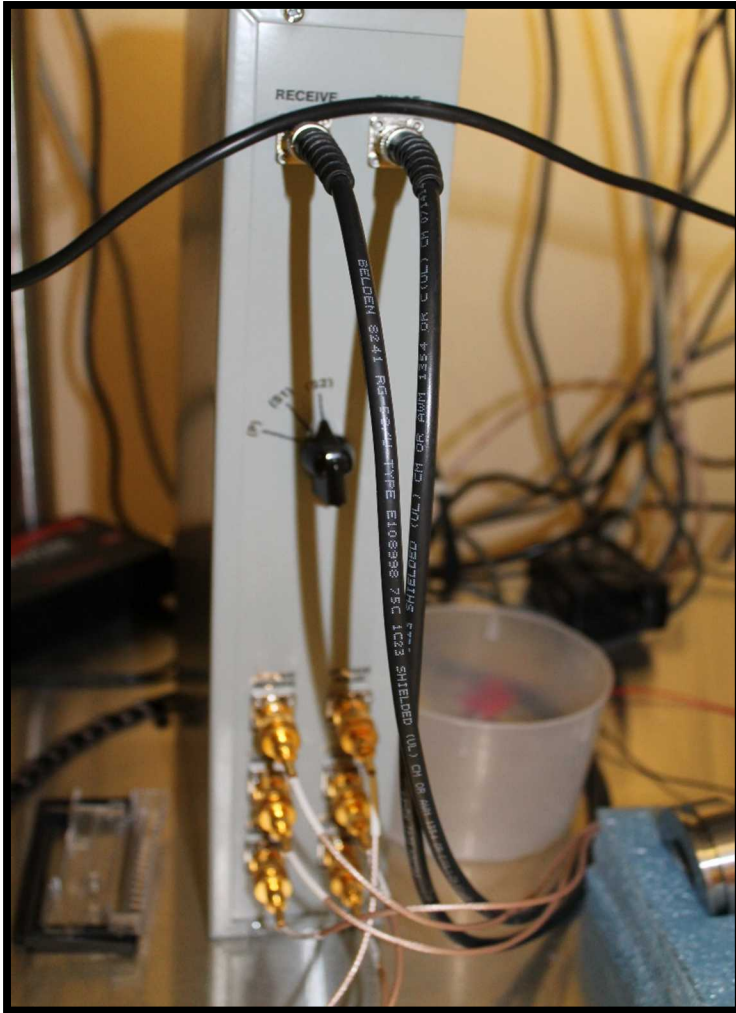
pH Meter

The dataTaker

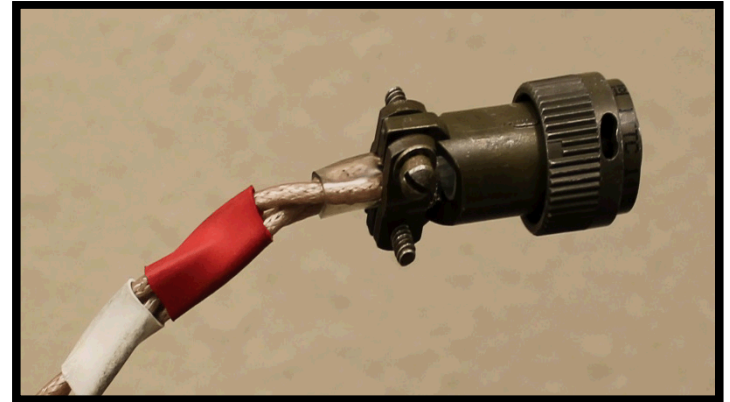


The Data Logger Unit

Ultrasonics



P&S Wave Generator



P&S Wave Transmitter



P&S Wave Receiver

What are the Ultrasonics Doing?

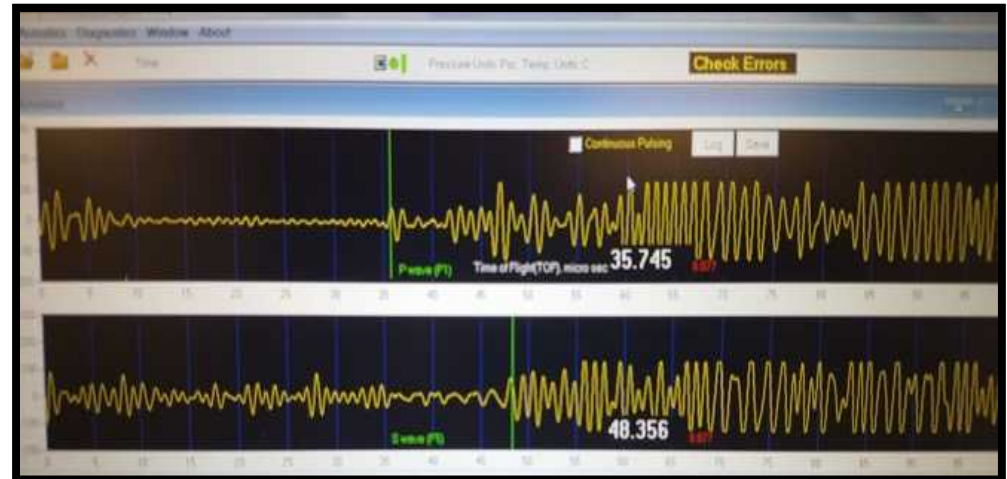
What does this tell us?:

- Initial Primary and Secondary Wave Location

What can we do with this?

We can extract material properties such as:

- Shear Modulus
- Bulk Modulus
- Poisson's Ratio
- Hardness



Unreacted Cement Core



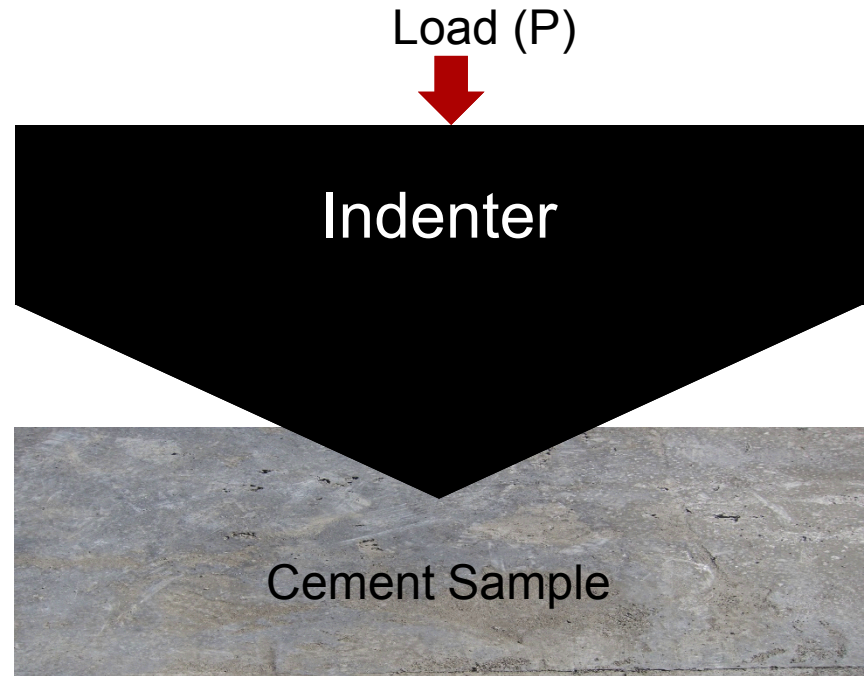
Reacted Cement Core

Nanoindentation

Hardness is a measure of a material's resistance to being dented.

Hardness Testing will let us give a way to validate the results from the acoustics.

Verification for future models with cement.

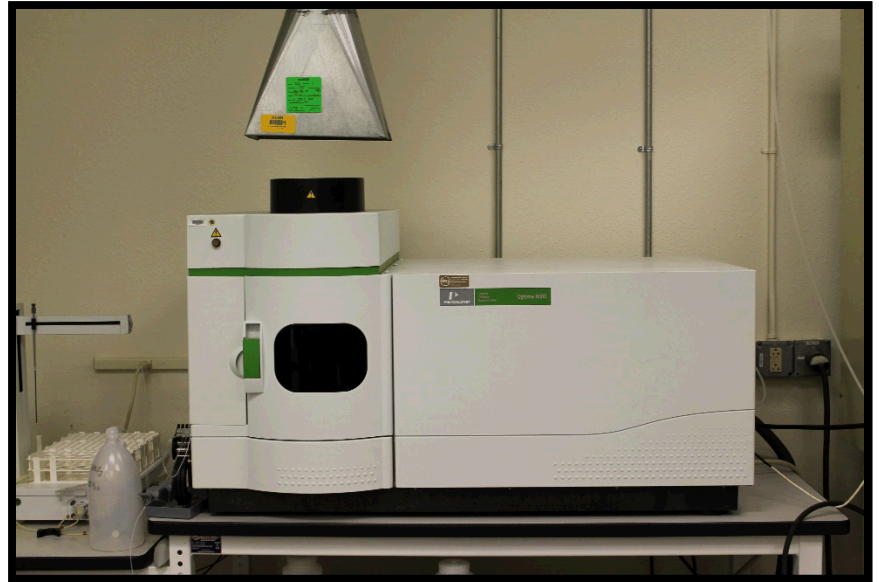


$$\text{Hardness} = (\text{Load}) / (\text{Residual Indentation Area})$$

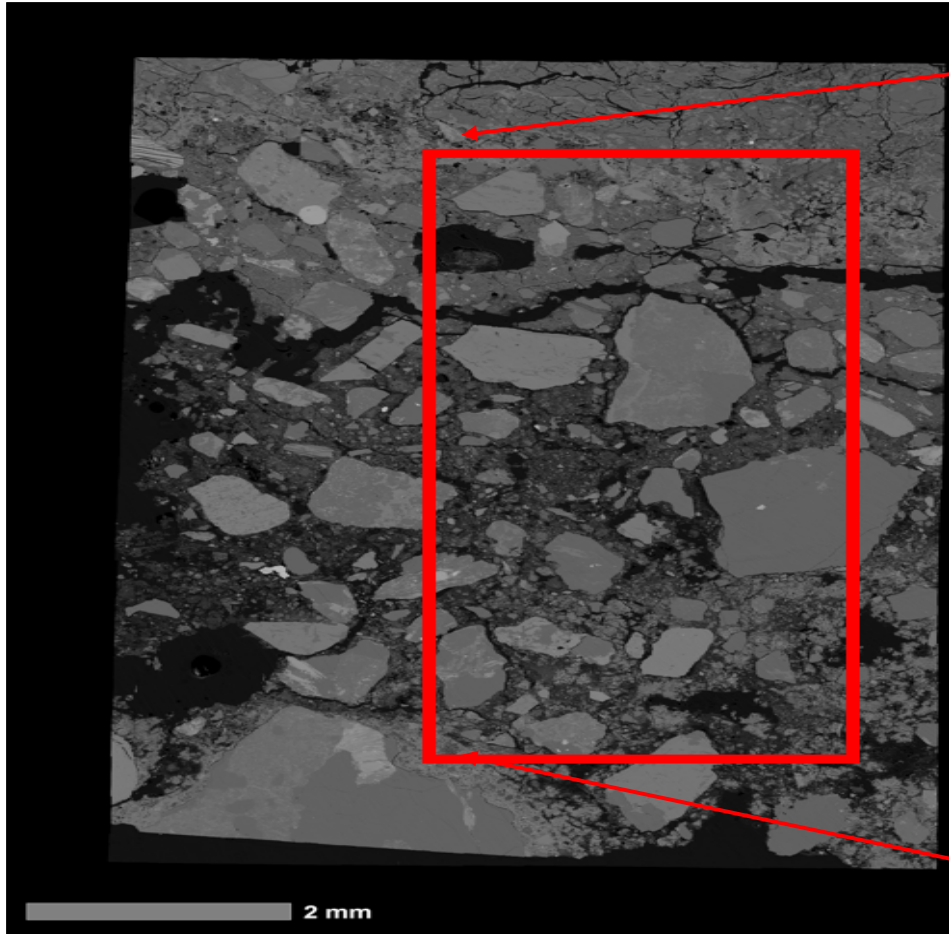
Monitoring Calcium Concentration

Atomic Emission Spectroscopy

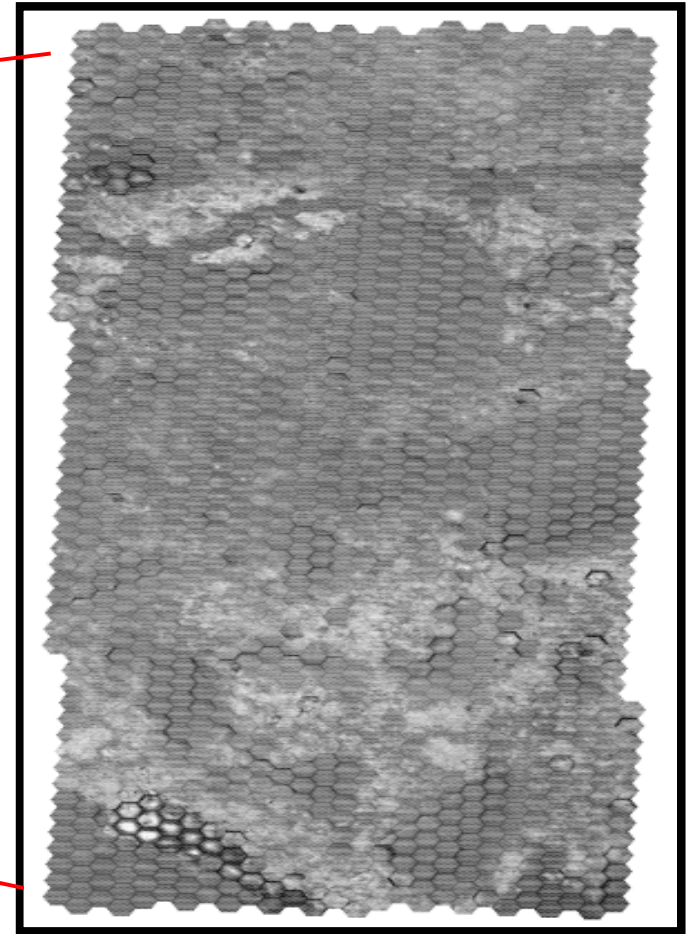
- Monitor the Calcium Concentration with time
- Tell us how fast the cement is degrading with time
- Relate loss of material properties to loss of calcium



Multibeam-SEM Analysis



Cement/Geomaterial region to be scanned



Results to be analyzed for porosity