Measurement of Thin Film Characteristics In Porous Media

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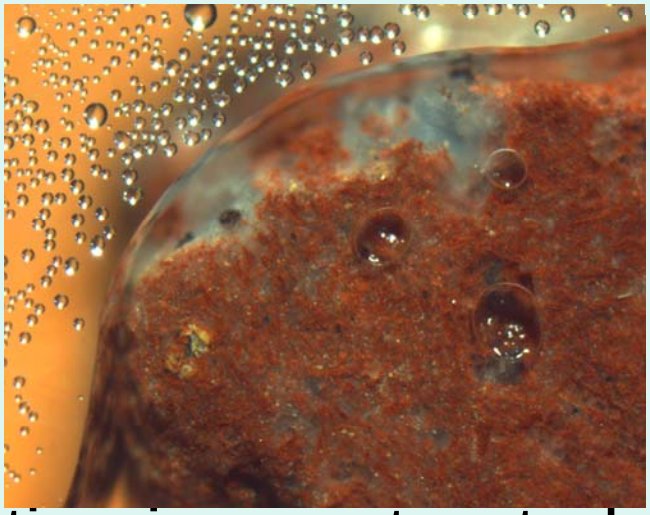
Introduction

- At low saturations water moves in thin films around objects rather than by capillary action



- Liquid film formation in unsaturated porous media is not commonly included in subsurface flow and transport models
- Thin films provide greater areas of air/water interfaces at which a large variety of microbes flourish

The Project

- Construct a virtually 2-D flow cell using Yucca Mountain tuff grains cut to 0.5 millimeter thickness

- The flow cell must incorporate a relative humidity and temperature sensor while remaining a closed system

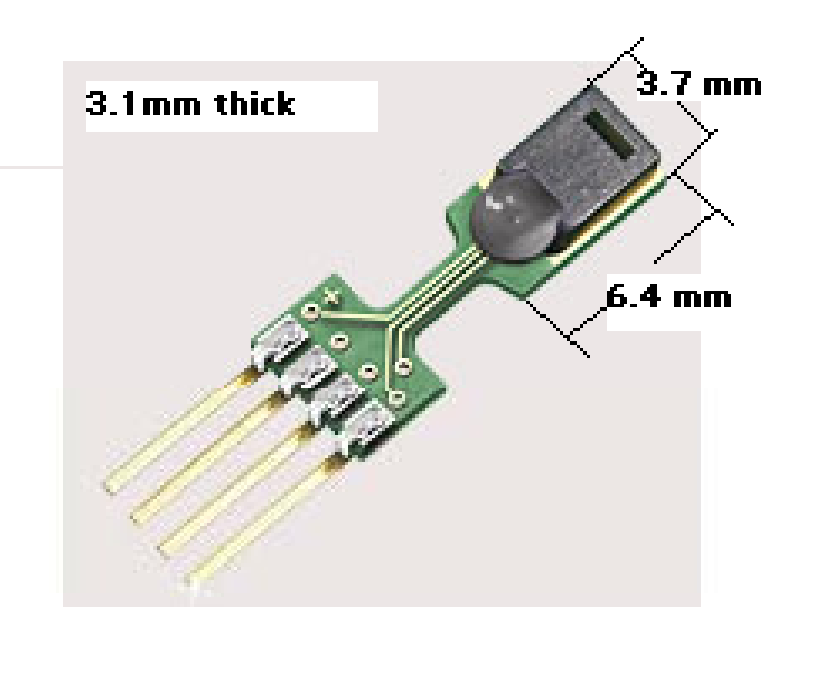
The Project

- The flow cell is wetted and dried while being digitally imaged.

- Saturation levels from images are combined with relative humidity and temperature data to create a model for conditions at which film flow occurs

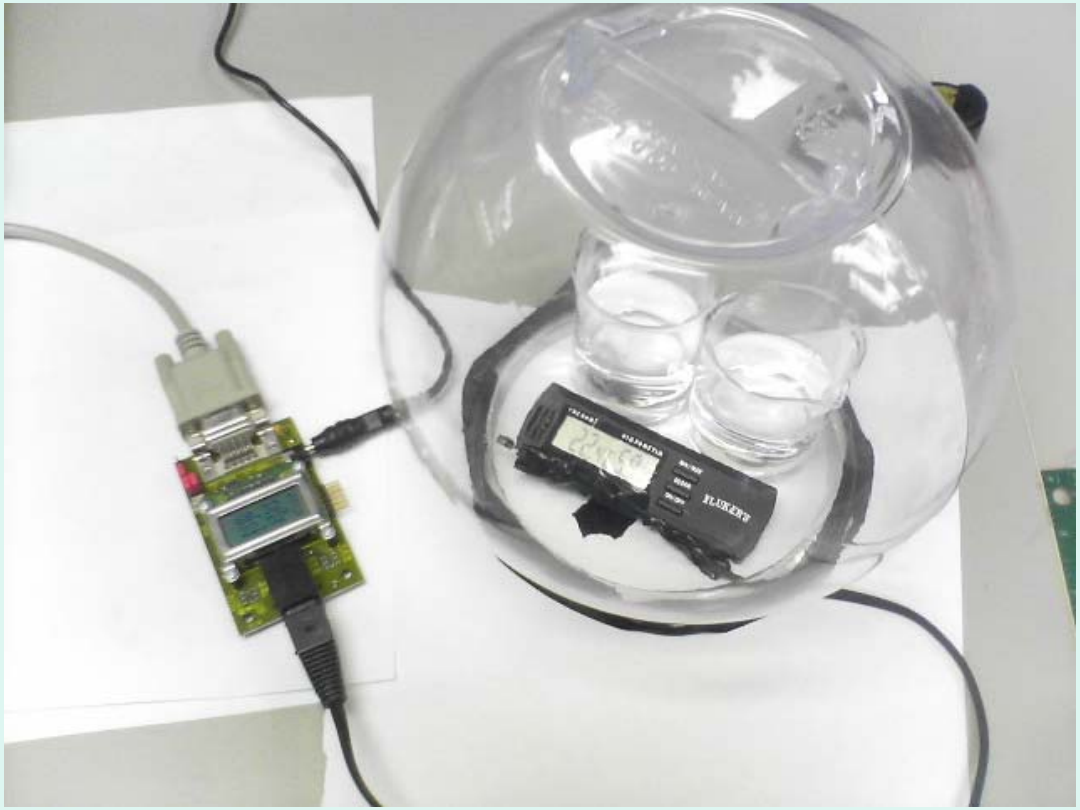
Set Up

- First, I found a digital sensor small and accurate enough to work in such a small space



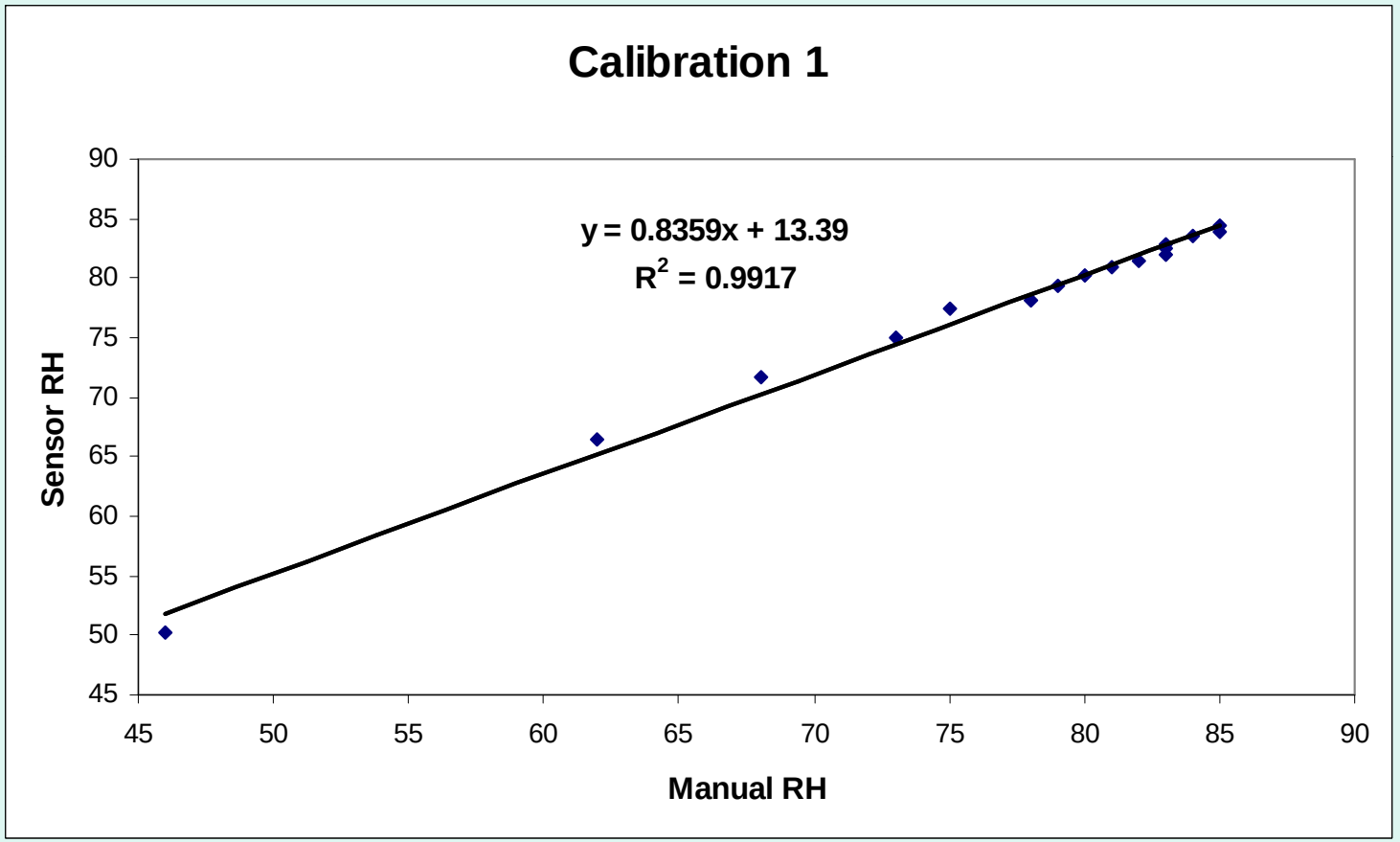
Set Up

- The RH sensor was calibrated using an analog RH sensor

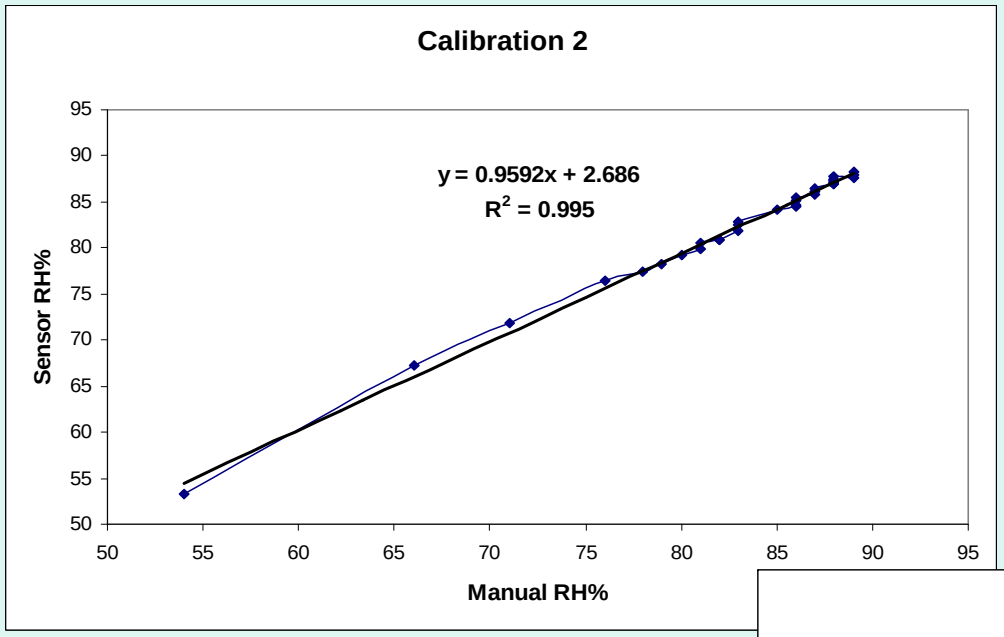


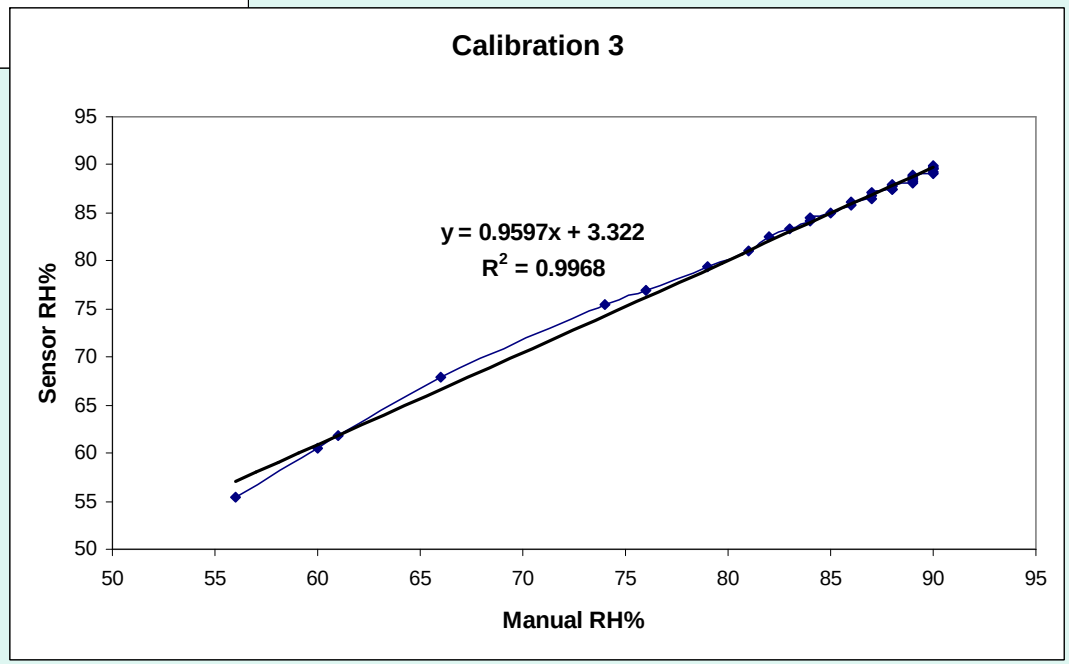
Set Up

- Readings from the two sensors were repeatable and closely correlated



Set Up


Calibration 2
y = 0.9592x + 2.686
R2 = 0.995
Sensor RH%
Manual RH%
95
90
85
80
75
70
65
60
55
50
50
55
60
65
70
75
80
85
90
95


Calibration 3
y = 0.9597x + 3.322
R2 = 0.9968
Sensor RH%
Manual RH%
95
90
85
80
75
70
65
60
55
50
50
55
60
65
70
75
80
85
90
95

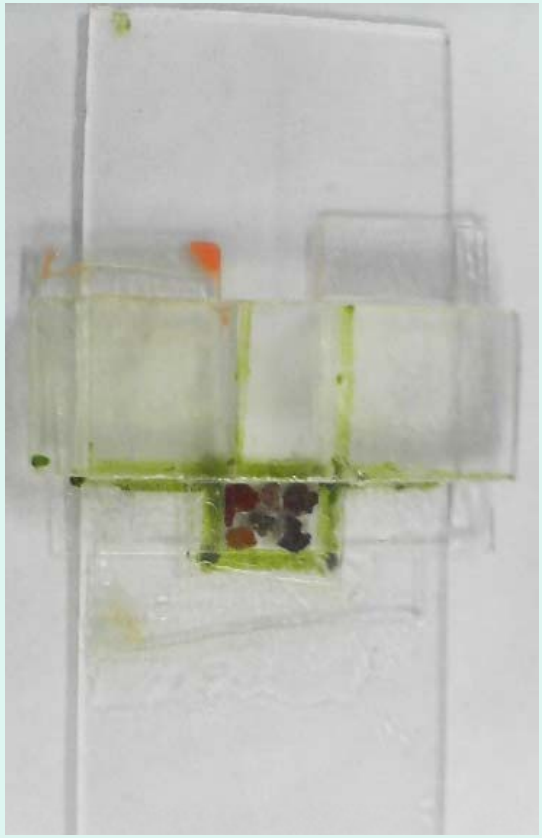
Set Up

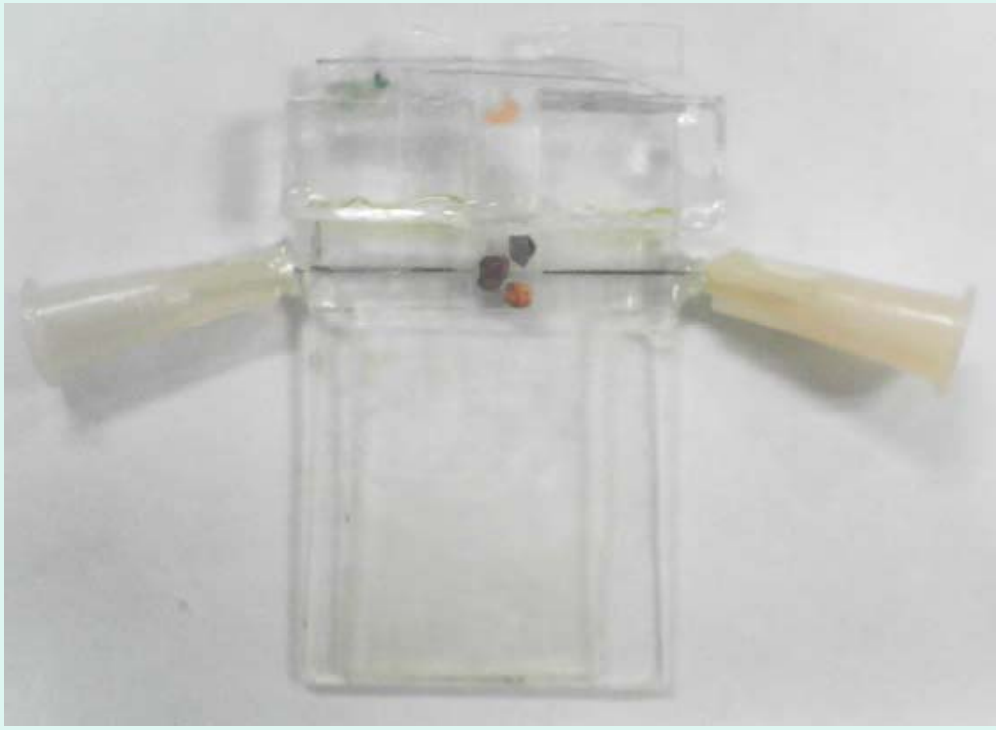
- Next, I constructed flow cells using glass slides and epoxy. These incorporated a housing for the RH sensor.

- Glass inside of the cells were treated to be made hydrophobic.

Experiments

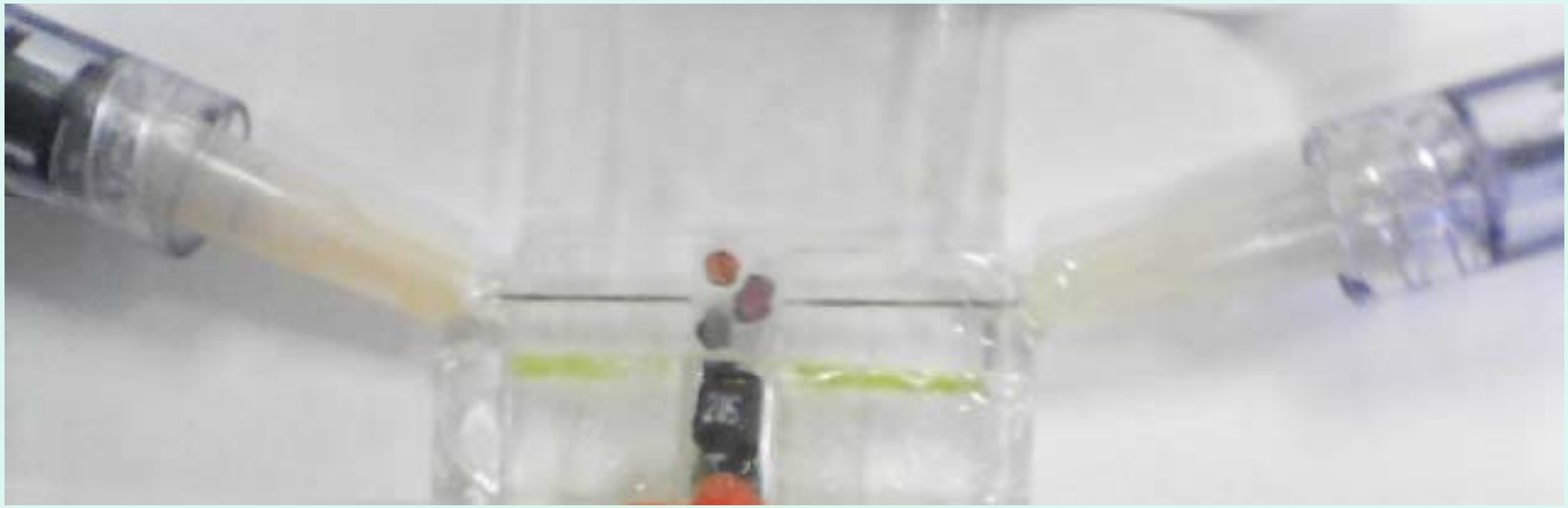
- A few versions of the flow cell have been created due to leakage and other issues





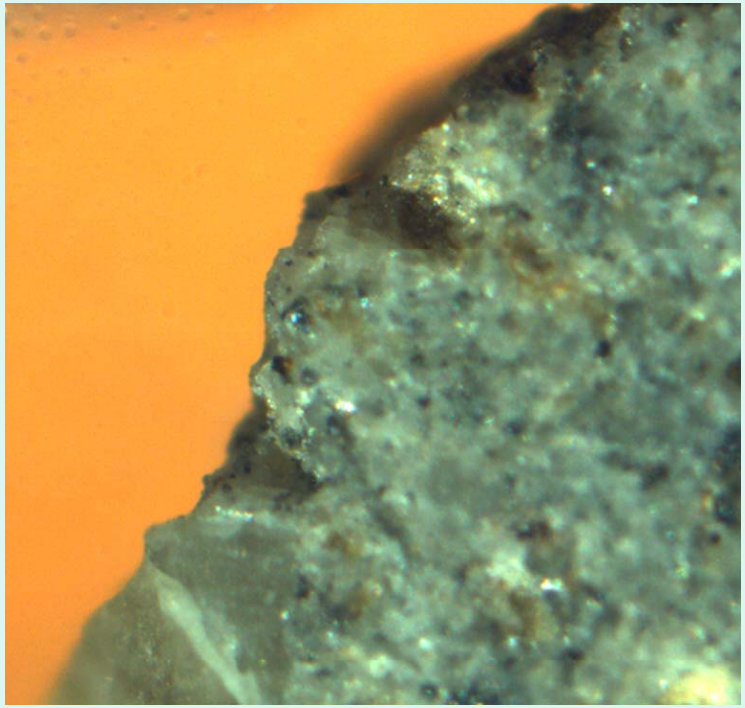
Experiments

- Tests were done using different flow cells and a digital microscope while monitoring relative humidity and temperature.

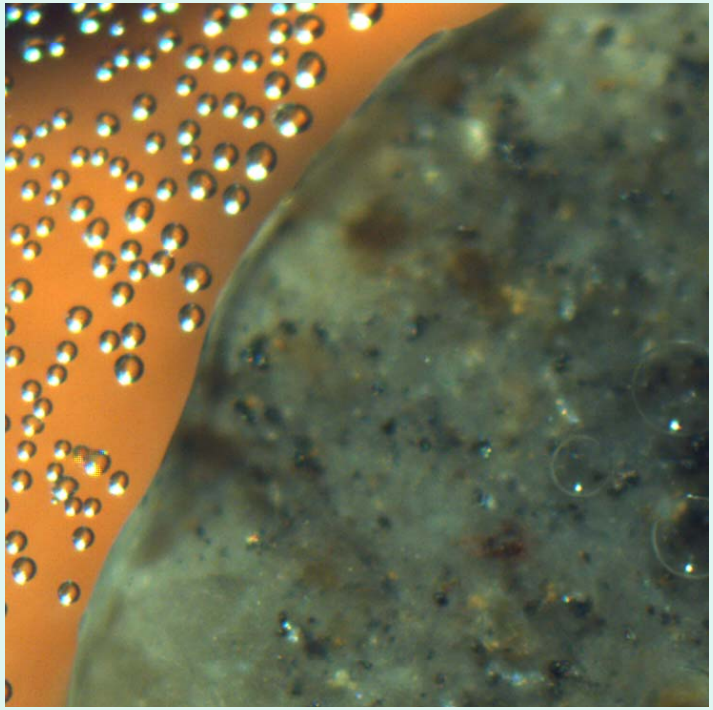


Results

- Images capturing thin film flow have been obtained



Dry Grain Surface



Wetted Grain Surface

Results

- Progress has been made in image optimization

Results

- Further experimentation is being done to optimize flow cells
- Possibilities for use of a polymer called Poly-dimethyl Siloxane (PDMS) in flow cell construction instead of glass are being explored
- Once these problems have been corrected, the data can be used to model thin film flow

Conclusions

- Further experimentation is needed to optimize imaging and flow cell construction techniques
- Once a thin film flow model is achieved, the aspect of this project may be applied to include microbial growth and transport models

Acknowledgements

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