

# Laboratory Core Characterization for Fundamental Properties

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U.S. Department of Energy  
National Energy Technology Laboratory  
Resource Sustainability Project Review Meeting  
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# Project Overview

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## – Funding

- Prime Performer: NETL, Morgantown, WV
- 04/01/2018-03/31/2024
- DOE Share \$11.6M; Performer Share: \$0

## – Overall Project Objectives

- To supports recent field efforts by DOE and the National Methane Hydrate Research and Development Program
- To accelerate the determination and realization of methane hydrates' resource potential
- To enhance the current understanding of the role gas hydrates have in the natural environment

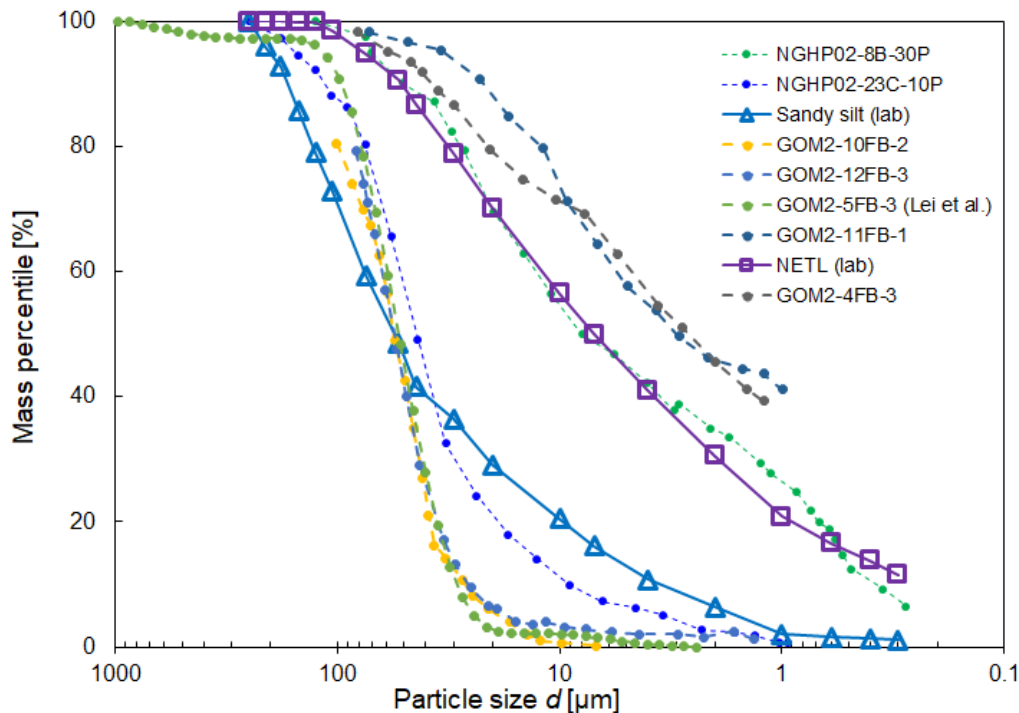
# Project Overview

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- Activities at Georgia Tech
  - Provide high-quality lab data on geomechanical and hydraulic properties
  - Understand and develop novel lab testing methods
  - Enhance the understanding of natural conditions and their impacts to the fundamental properties of hydrate-bearing sediments
  - Develop methods/models to predict the behavior of gas hydrate at various production scenarios

# Technology Background

– Sandy silt (MS) vs. Clayey silt (MC)



## Geomechanical:

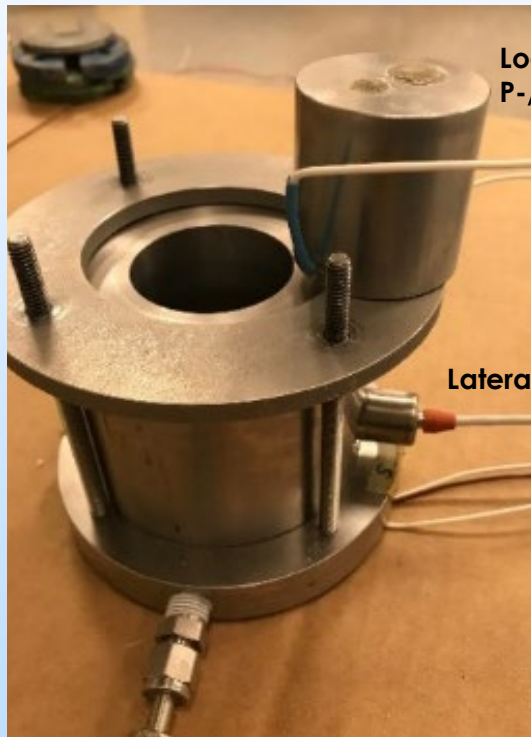
- Stiffness
- Particle crushing

## Hydraulic

- Anisotropy
- Hydraulic gradient
- Capillarity

# Geomechanical Properties: Stiffness

## – Experimental Setup



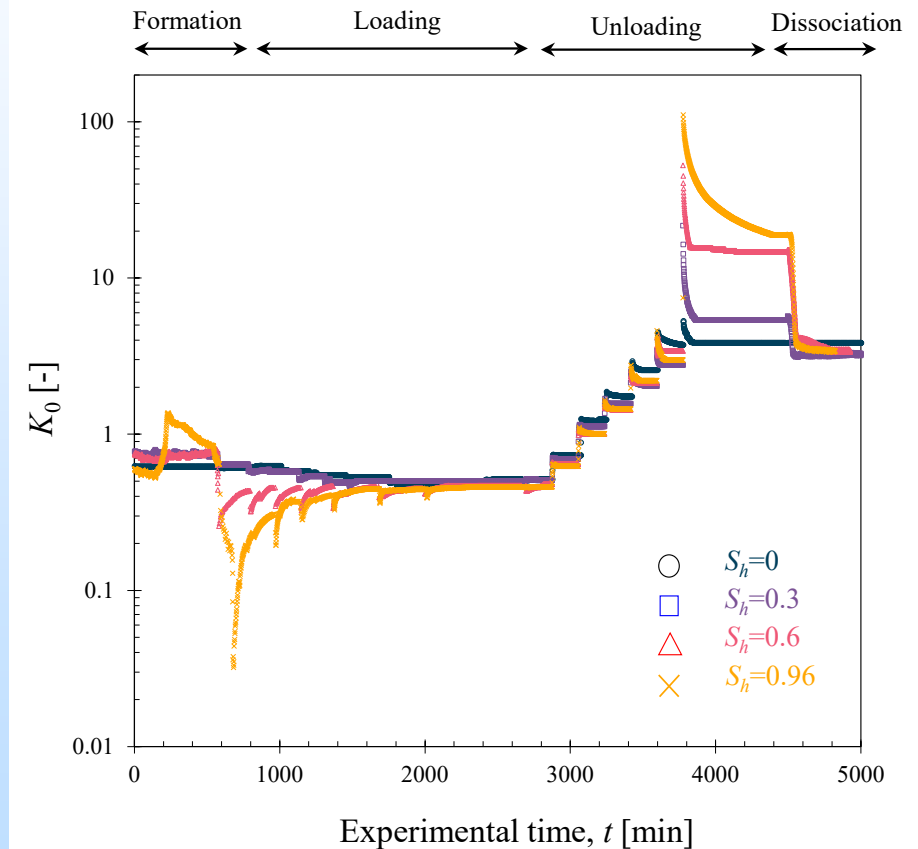
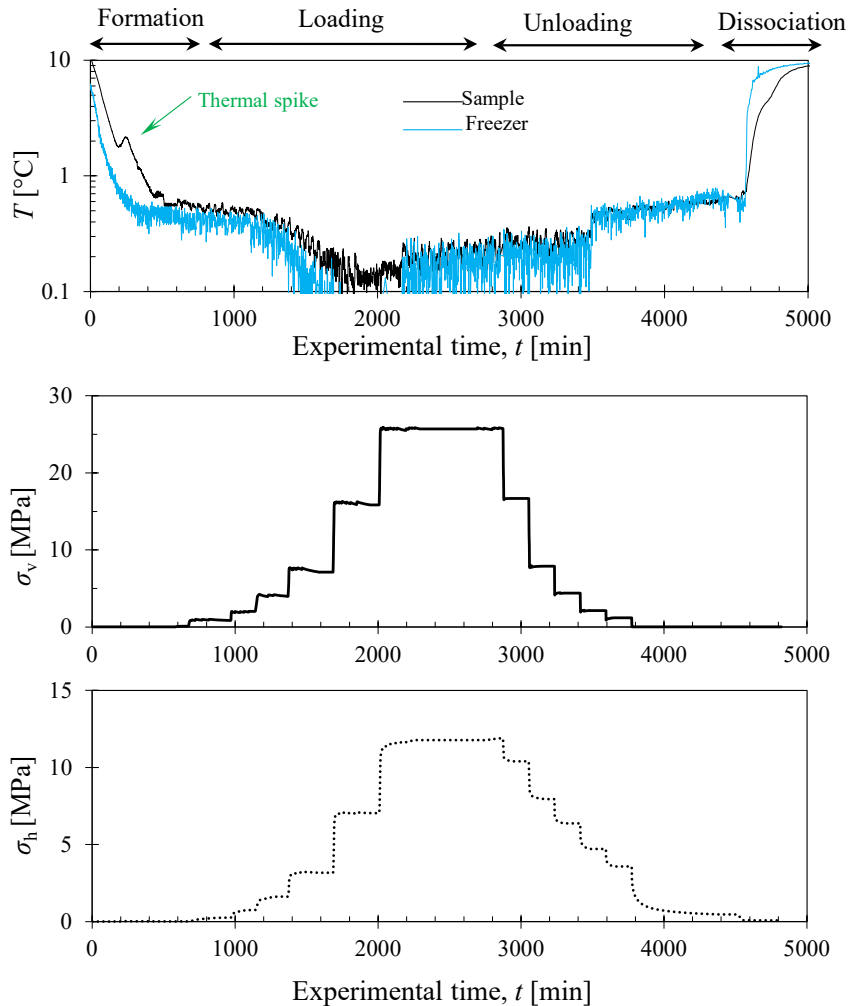
Loading piston with  
P-/S-wave transducers

Lateral stress transducer



# Geomechanical Properties: Stiffness

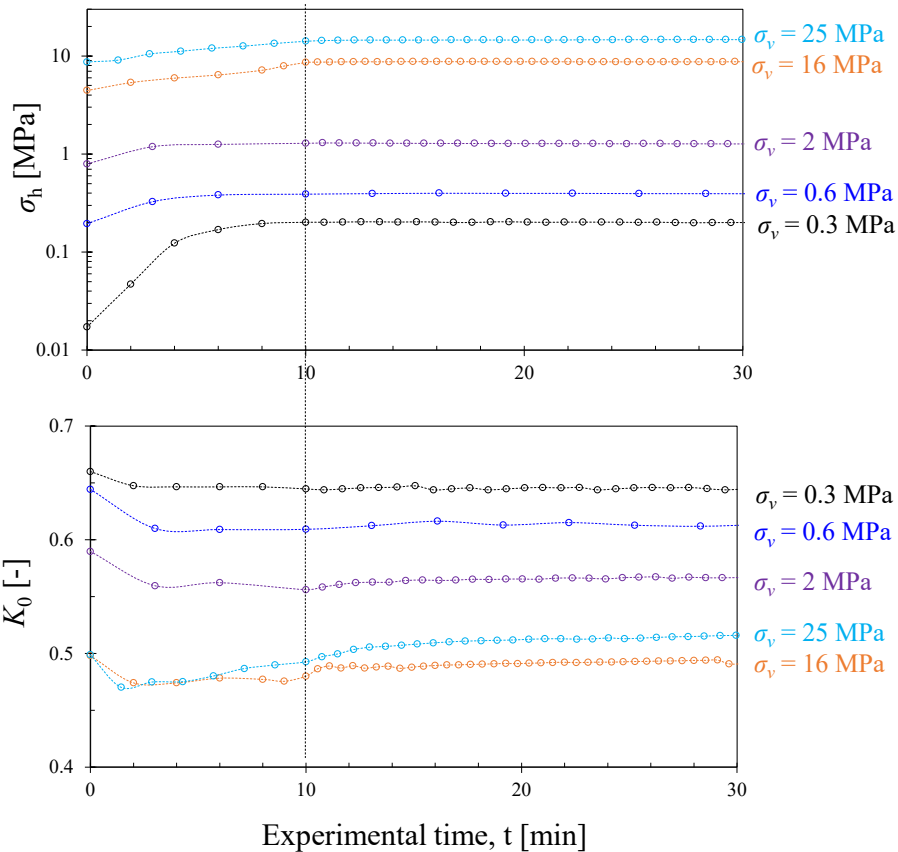
## – Experimental Steps



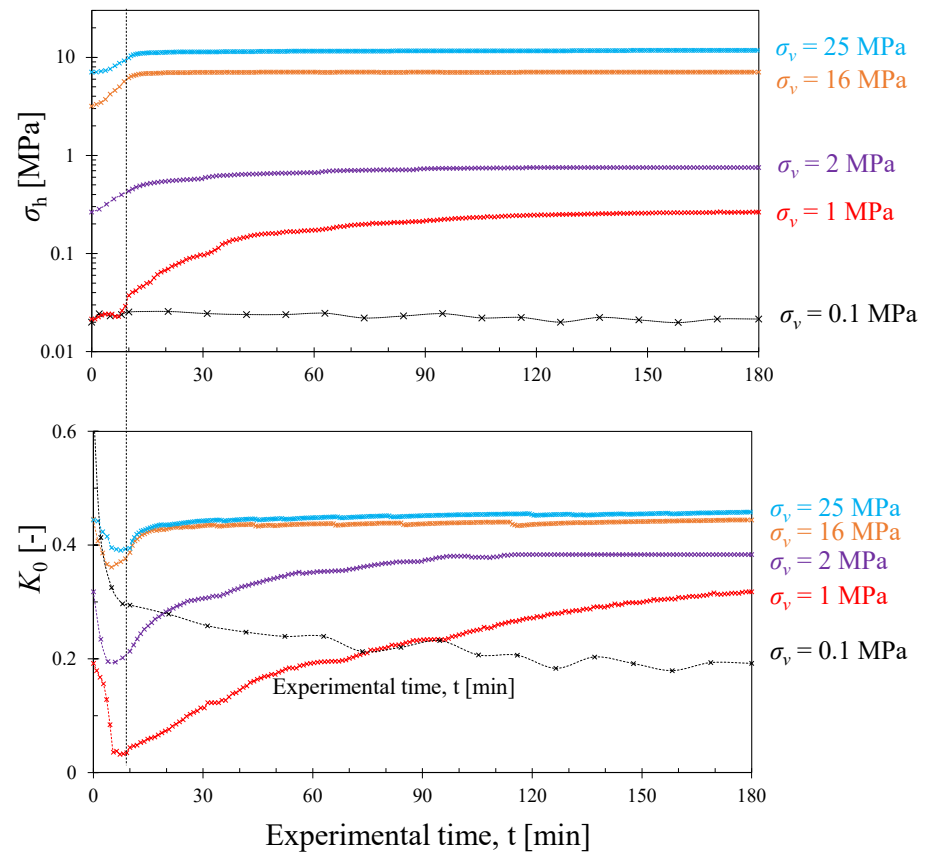
# Geomechanical Properties: Stiffness

## – Experimental Results: Loading

Hydrate-free sediments ( $S_h = 0$ )



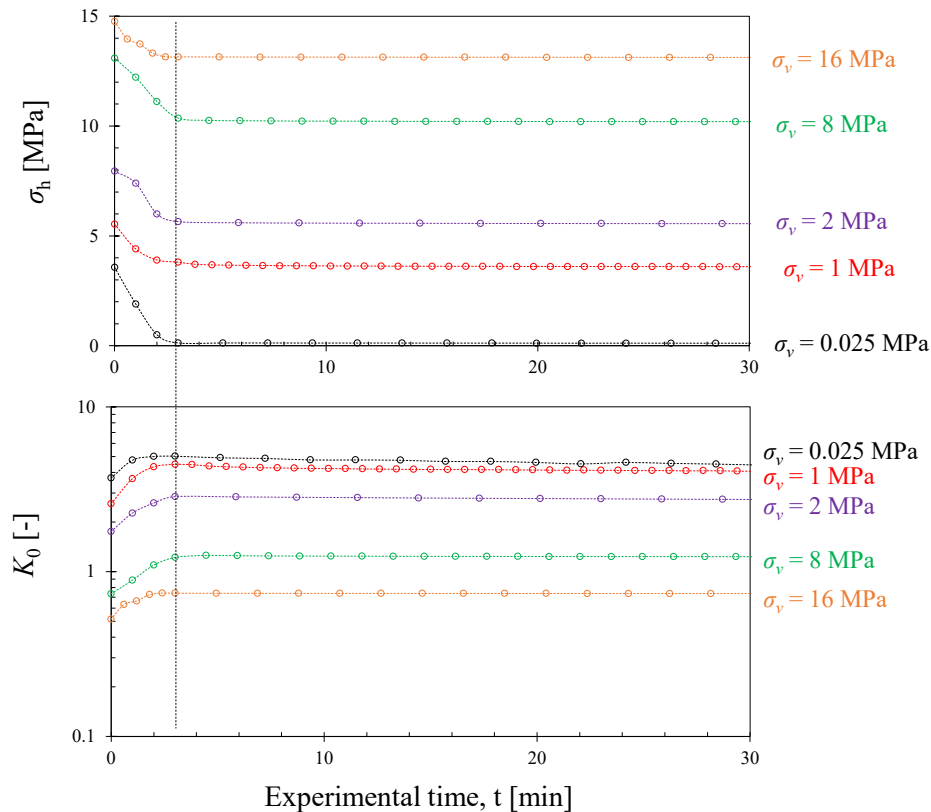
Hydrate-bearing sediments ( $S_h = 0.96$ )



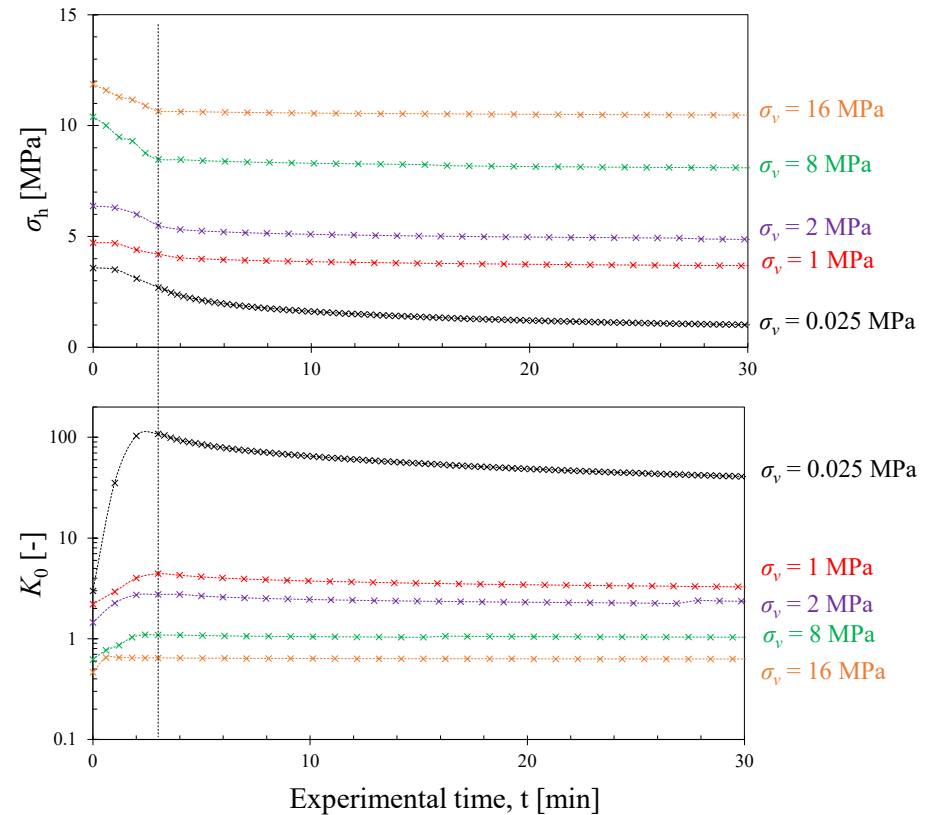
# Geomechanical Properties: Stiffness

## – Experimental Results: Unloading

Hydrate-free sediments ( $S_h = 0$ )



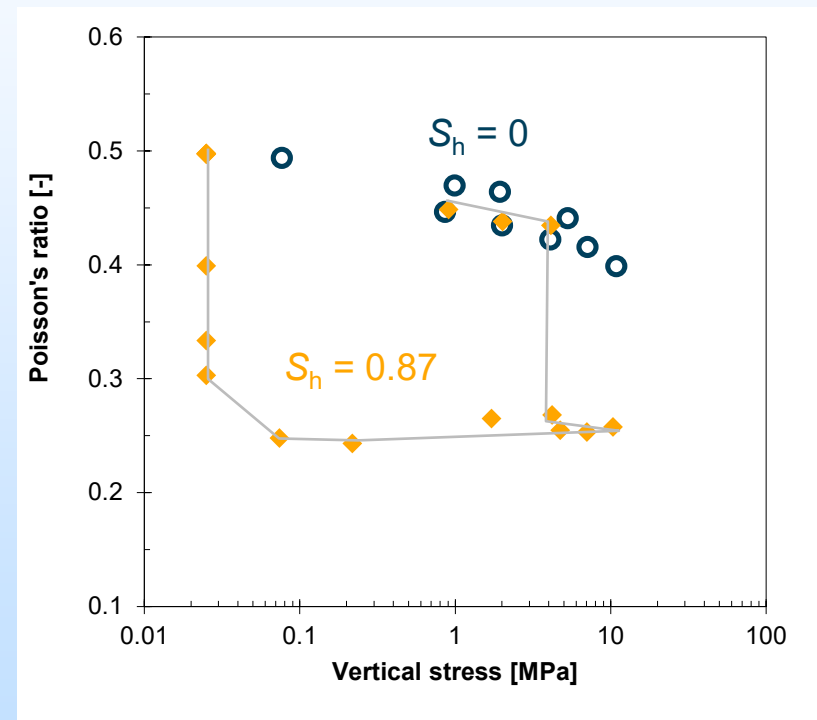
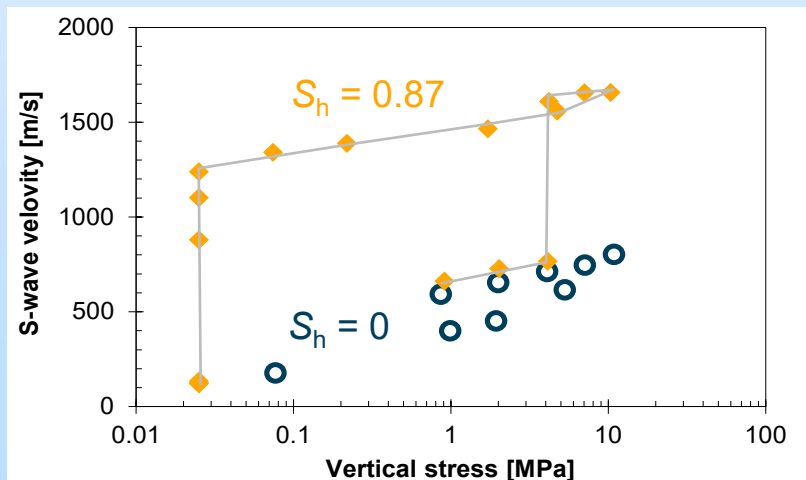
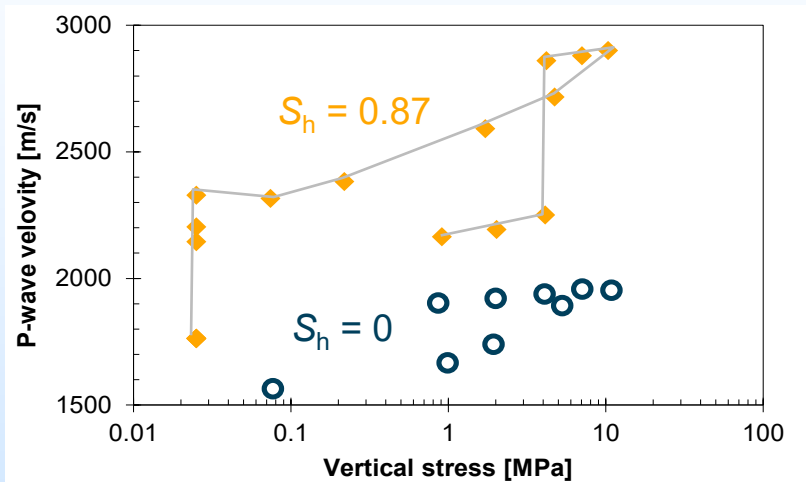
Hydrate-bearing sediments ( $S_h = 0.96$ )





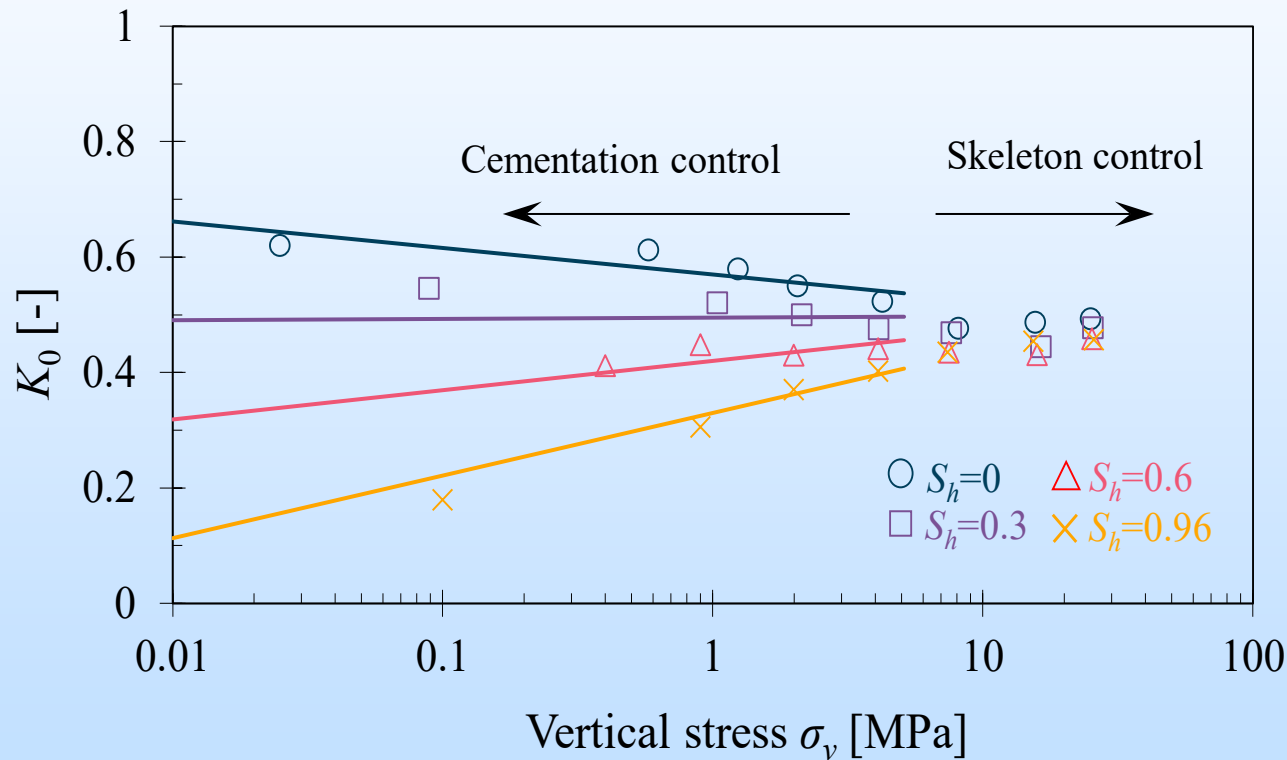
# Geomechanical Properties: Stiffness

## – Experimental Results: Stiffness



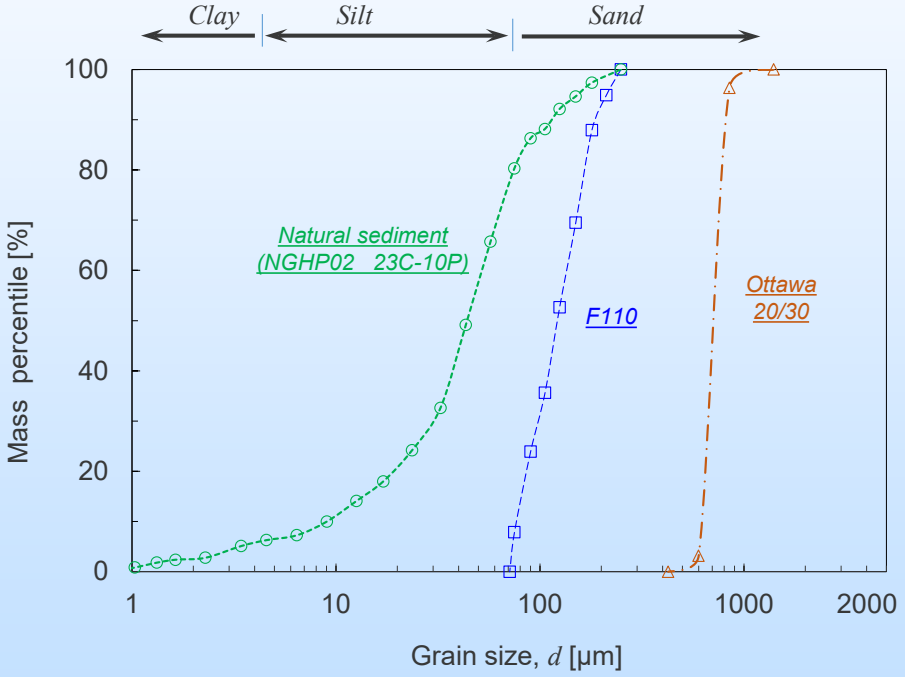
# Geomechanical Properties: Stiffness

## – Experimental Results: Summary



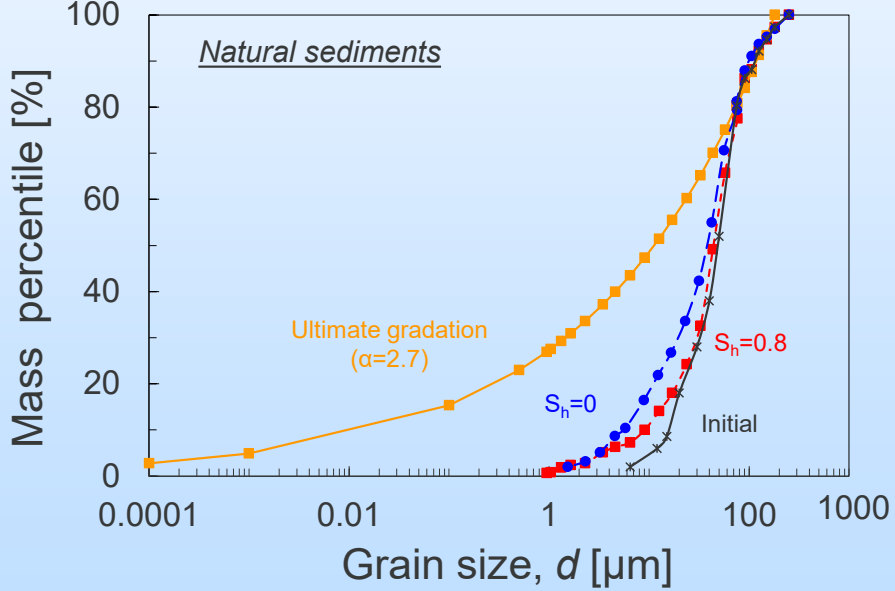
# Geomechanical Properties: Crushing

## - GSD



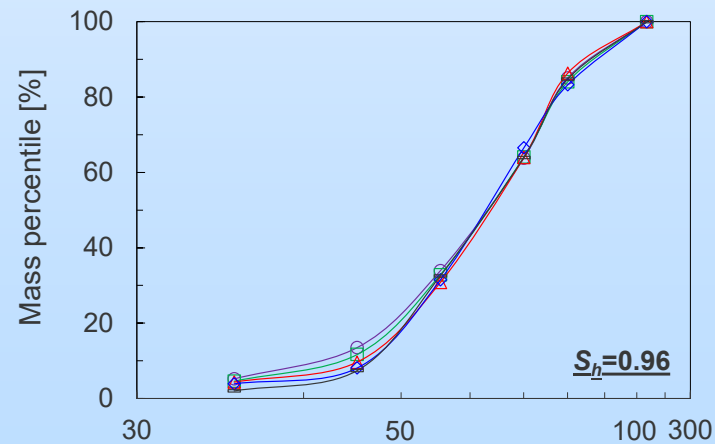
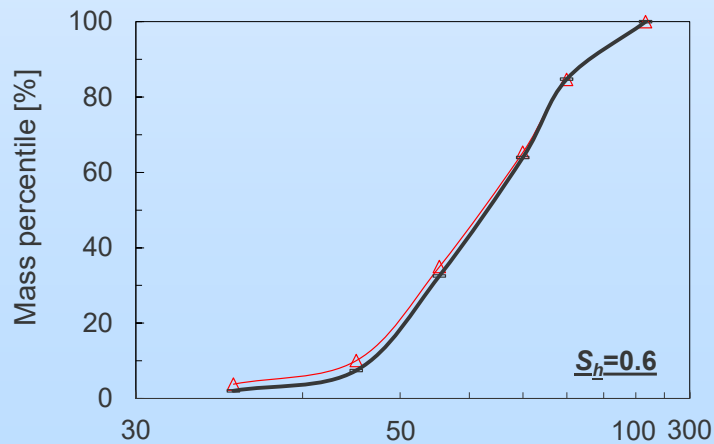
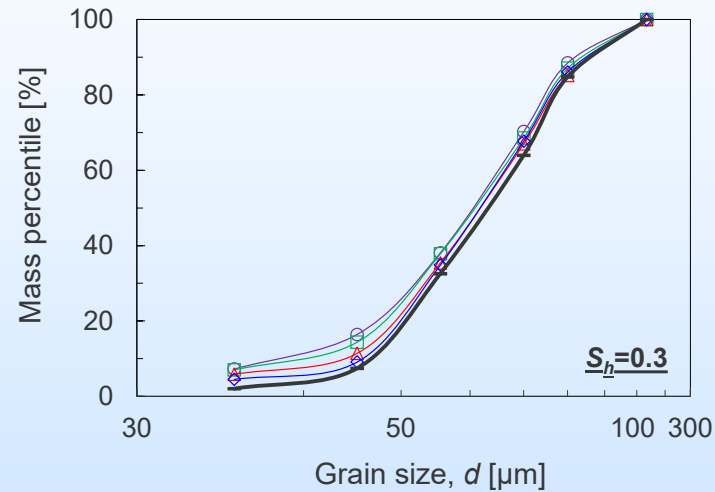
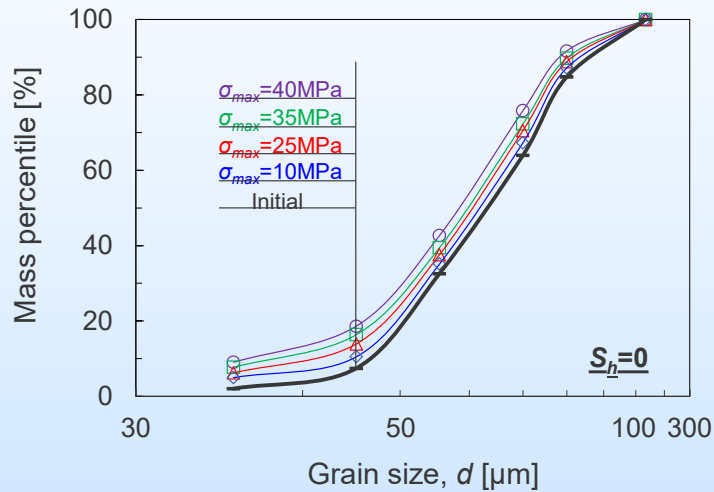
Ultimate gradation  $U_g$

$$U_g = \left( \frac{d}{d_{\max}} \right)^{3-\alpha}$$



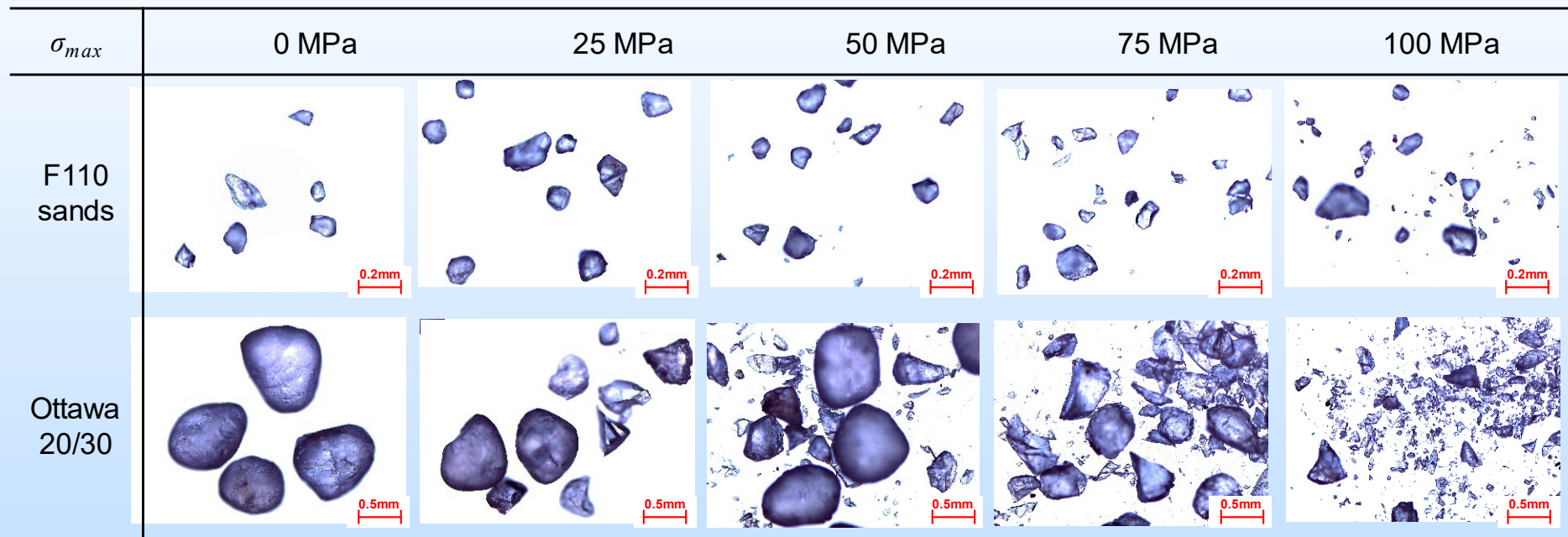
# Geomechanical Properties: Crushing

## – Experimental Results: F110



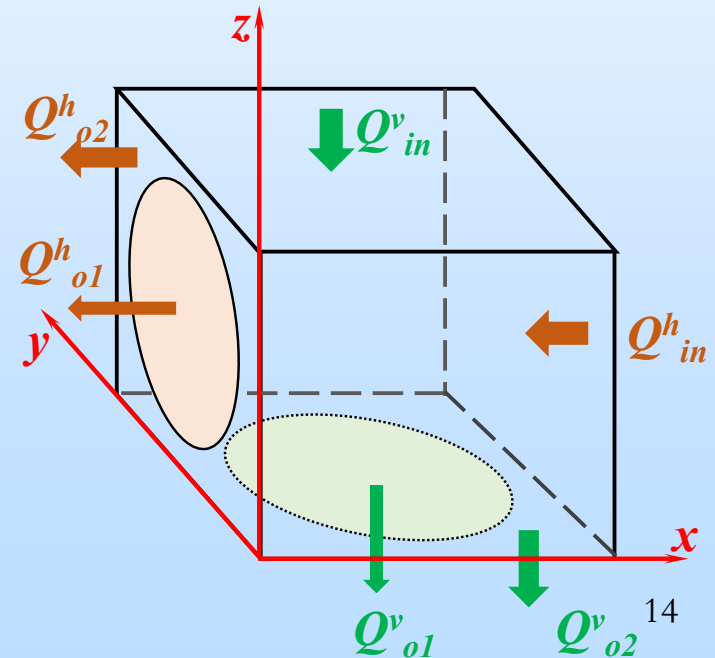
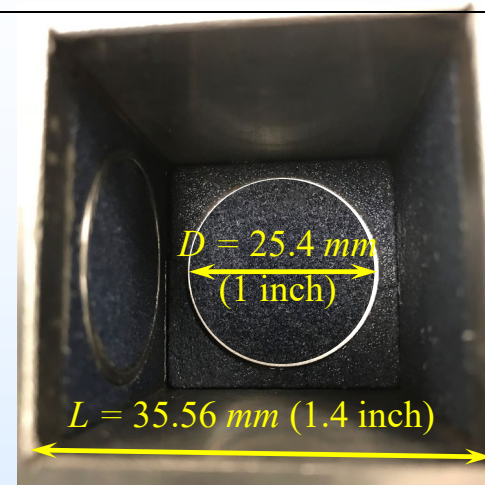
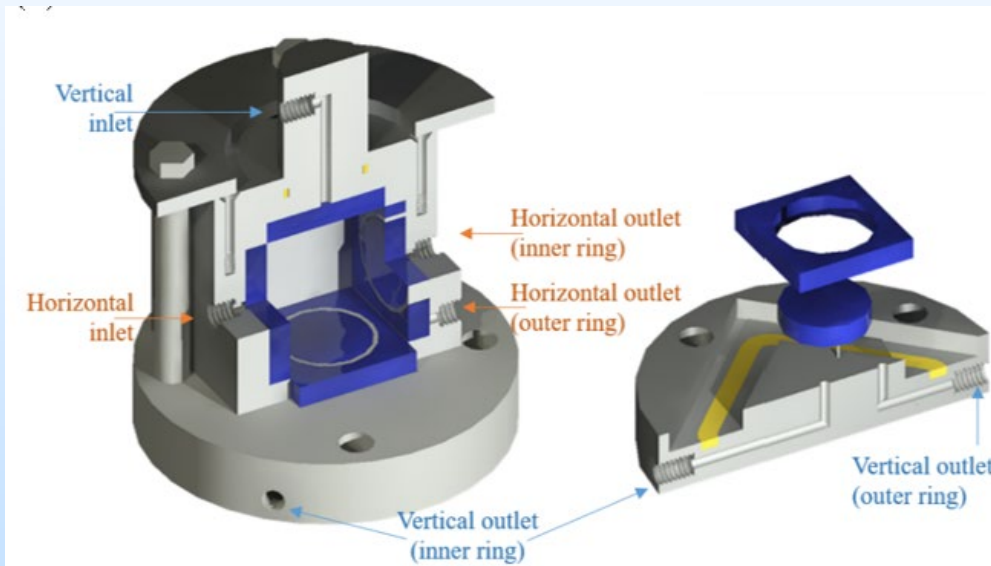
# Geomechanical Properties: Crushing

– Experimental Results: Fine sands vs. Coarse sands



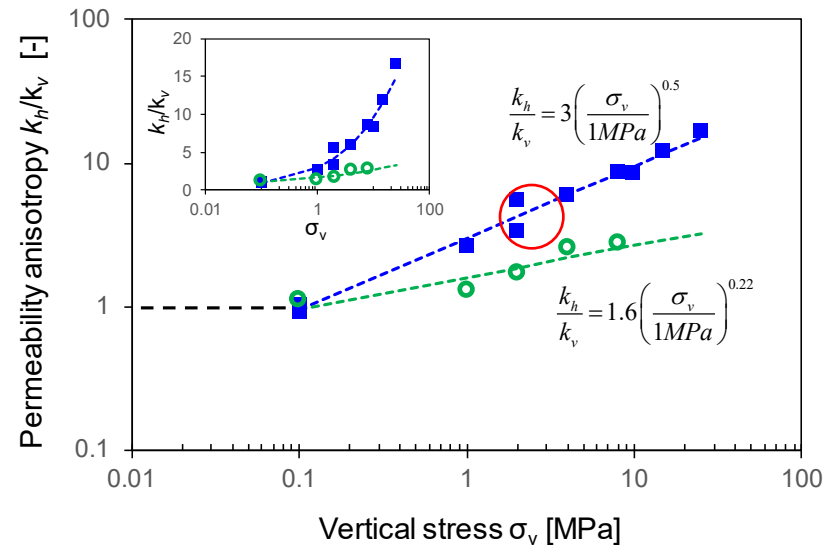
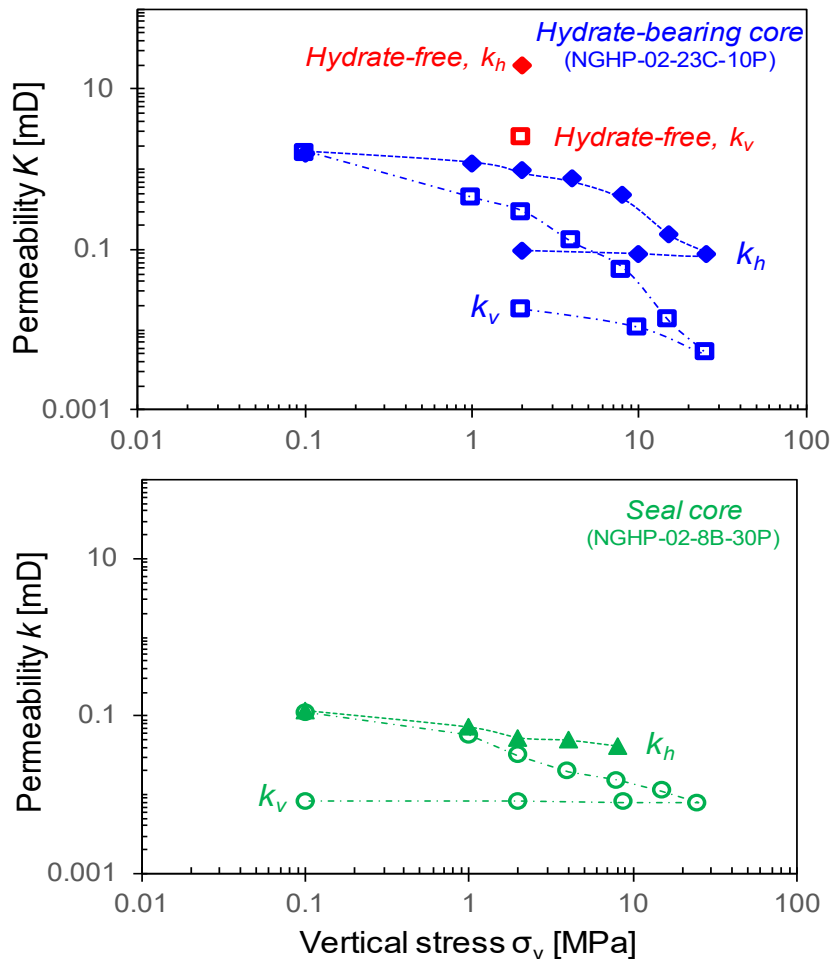
# Hydraulic Properties: Anisotropy

## – Experimental Setup



# Hydraulic Properties: Anisotropy

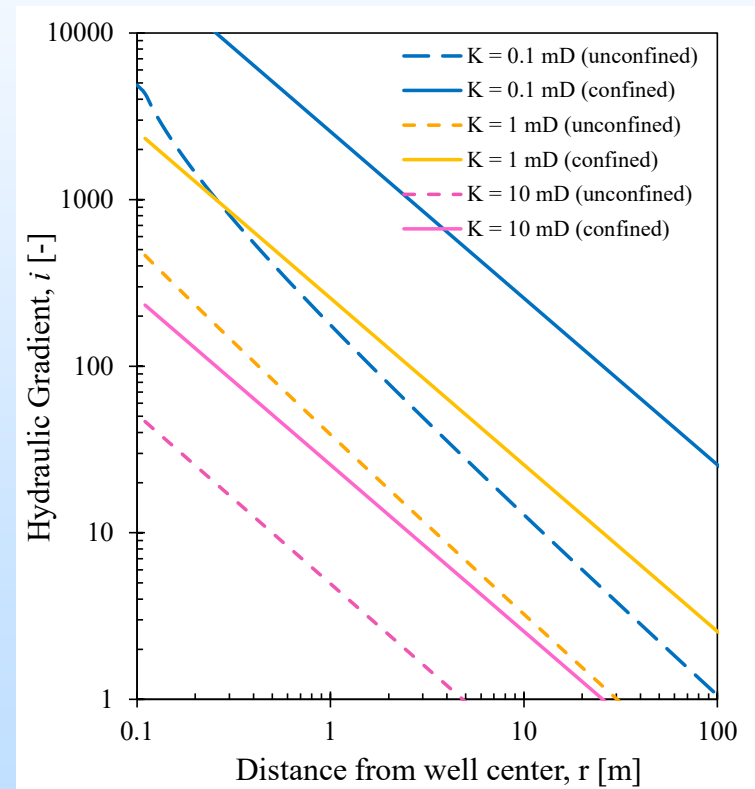
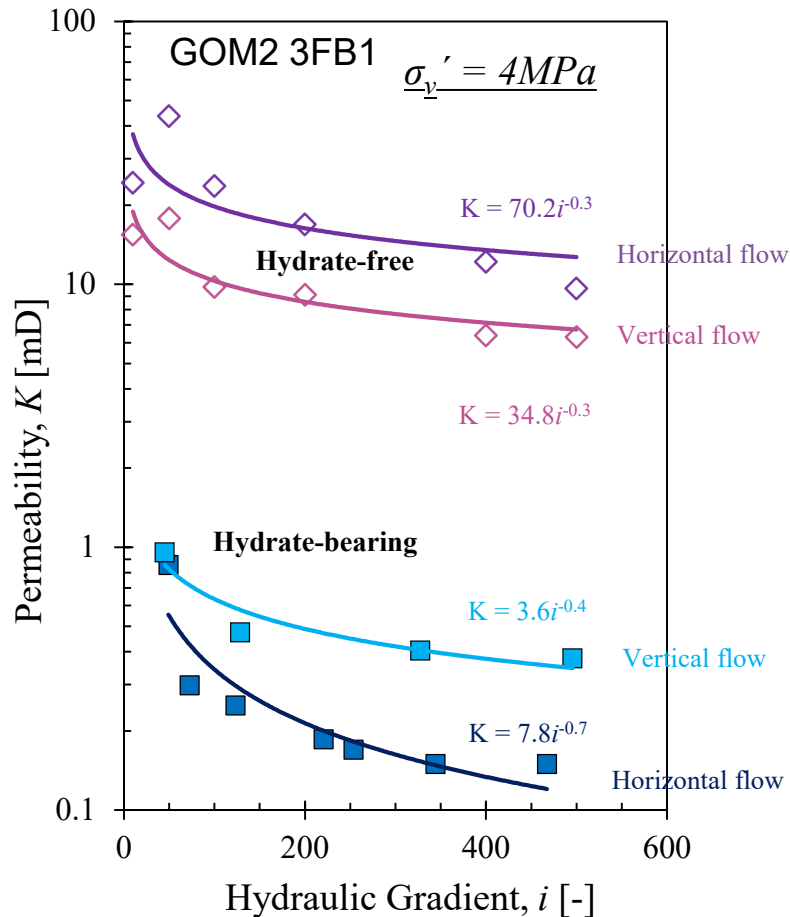
## – Experimental Results



Permeability anisotropy:  
 $k_h/k_v \approx 4$  at in situ stress

# Hydraulic Properties: Gradient

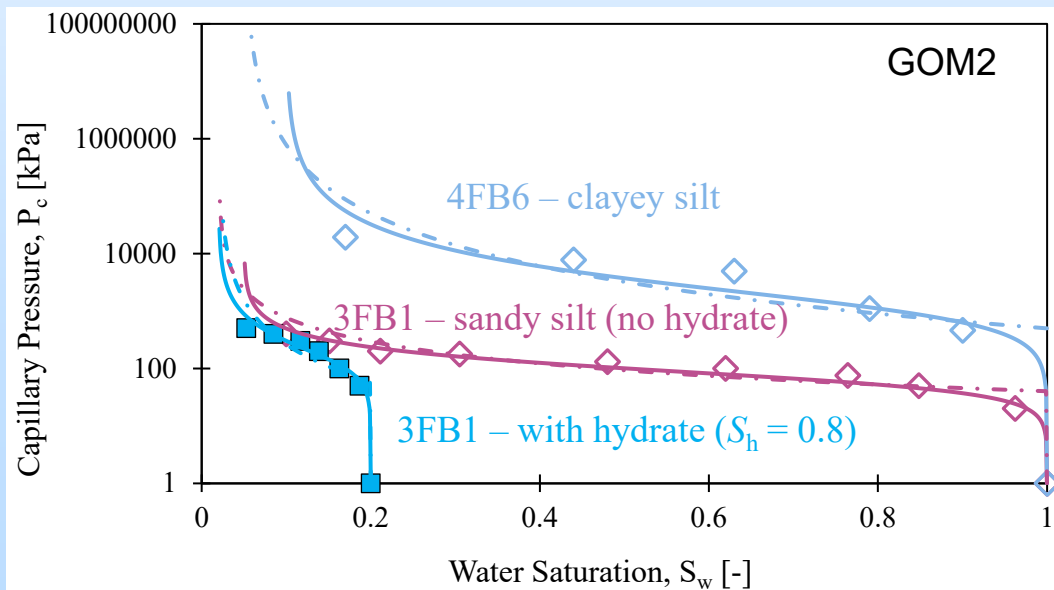
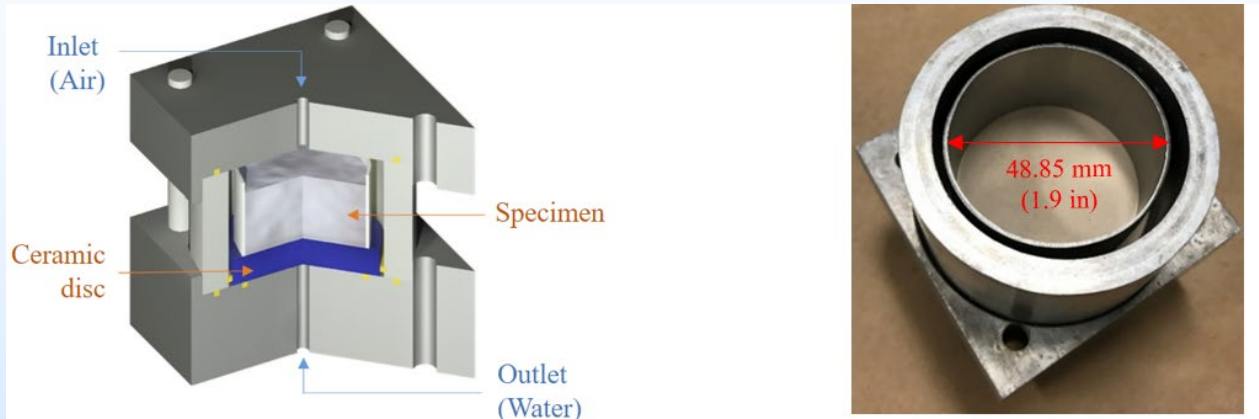
## – Experimental Results





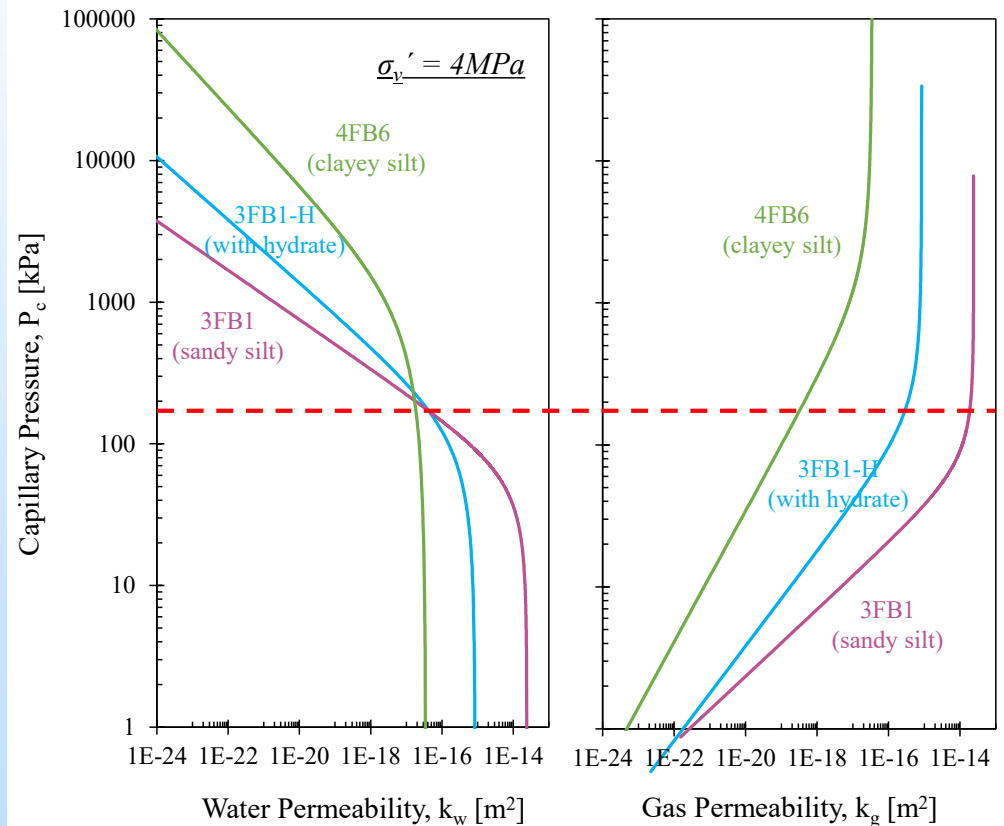
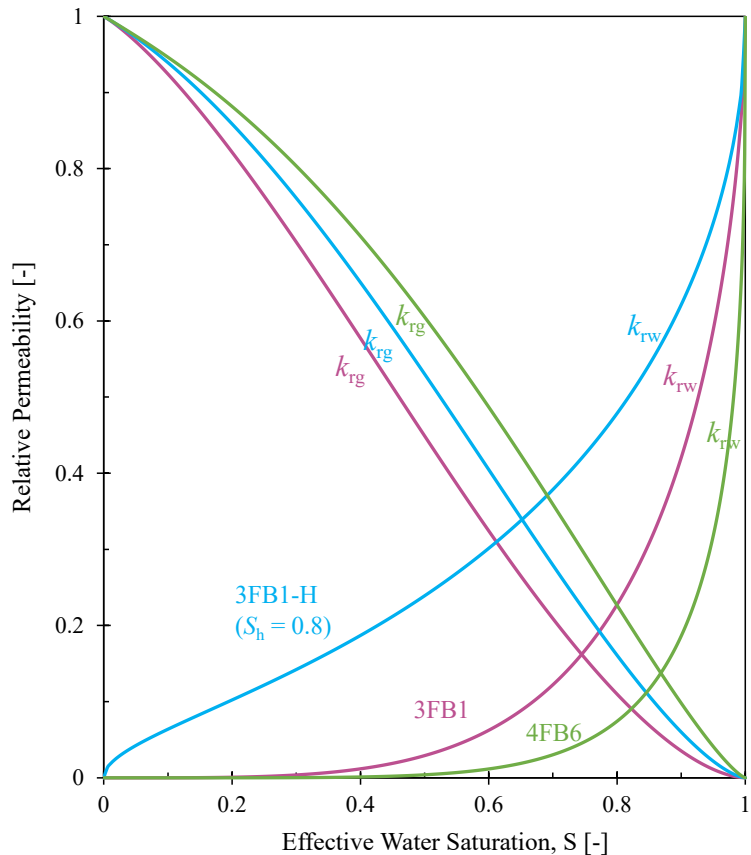
# Hydraulic Properties: Capillarity

## – Experimental Results



# Hydraulic Properties: Capillarity

## – Experimental Results



# Summary

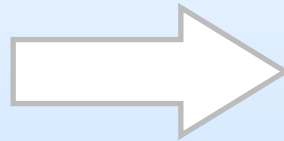
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## Geomechanical:

- Stiffness
- Particle crushing

## Hydraulic

- Anisotropy
- Hydraulic gradient
- Capillarity



– Interbedded

– Particle migration

– Scales

# Appendix

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- These slides will not be discussed during the presentation **but are mandatory.**