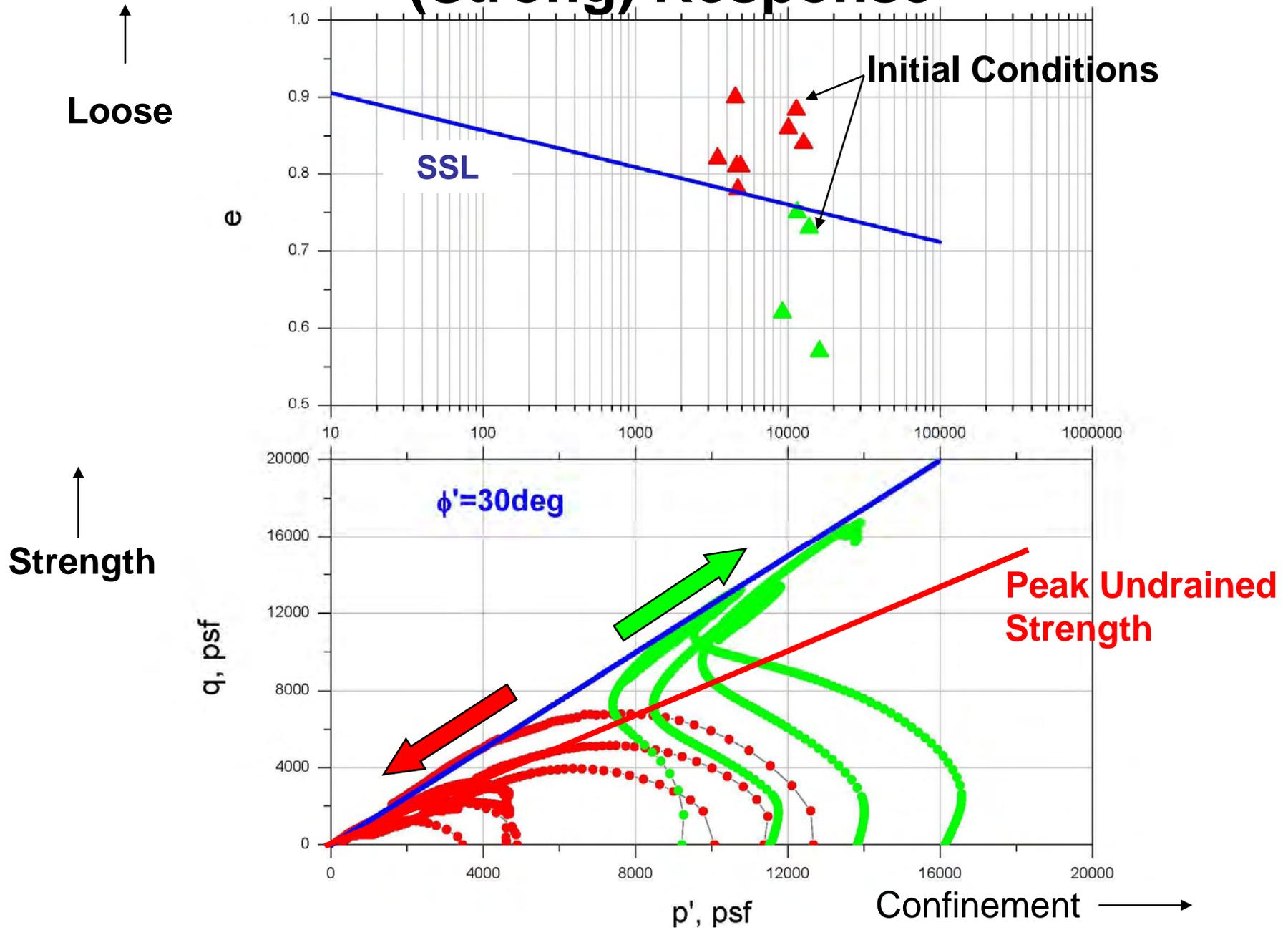
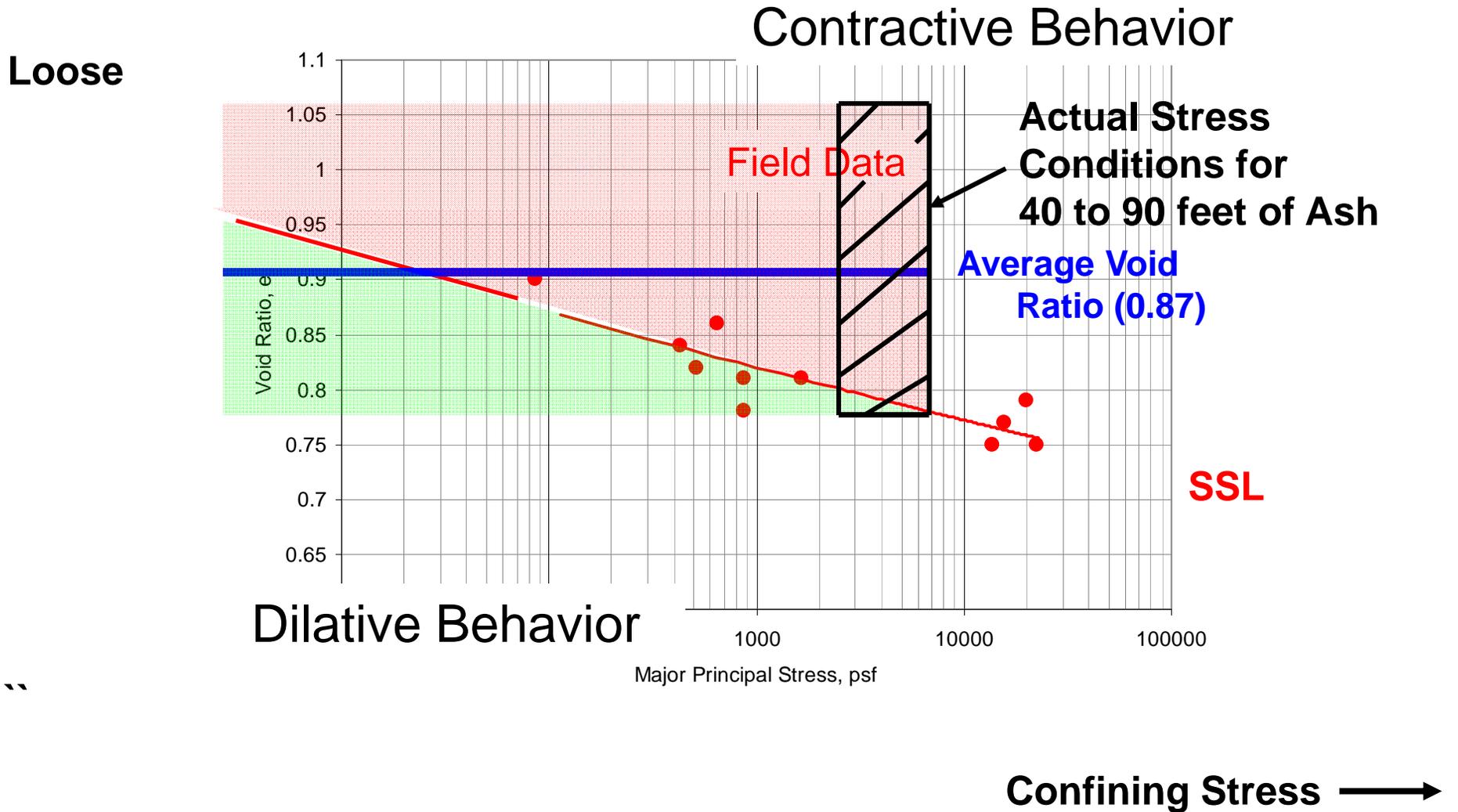


Undrained Contractive (Weak) vs. Dilative (Strong) Response



Estimated Critical State Line

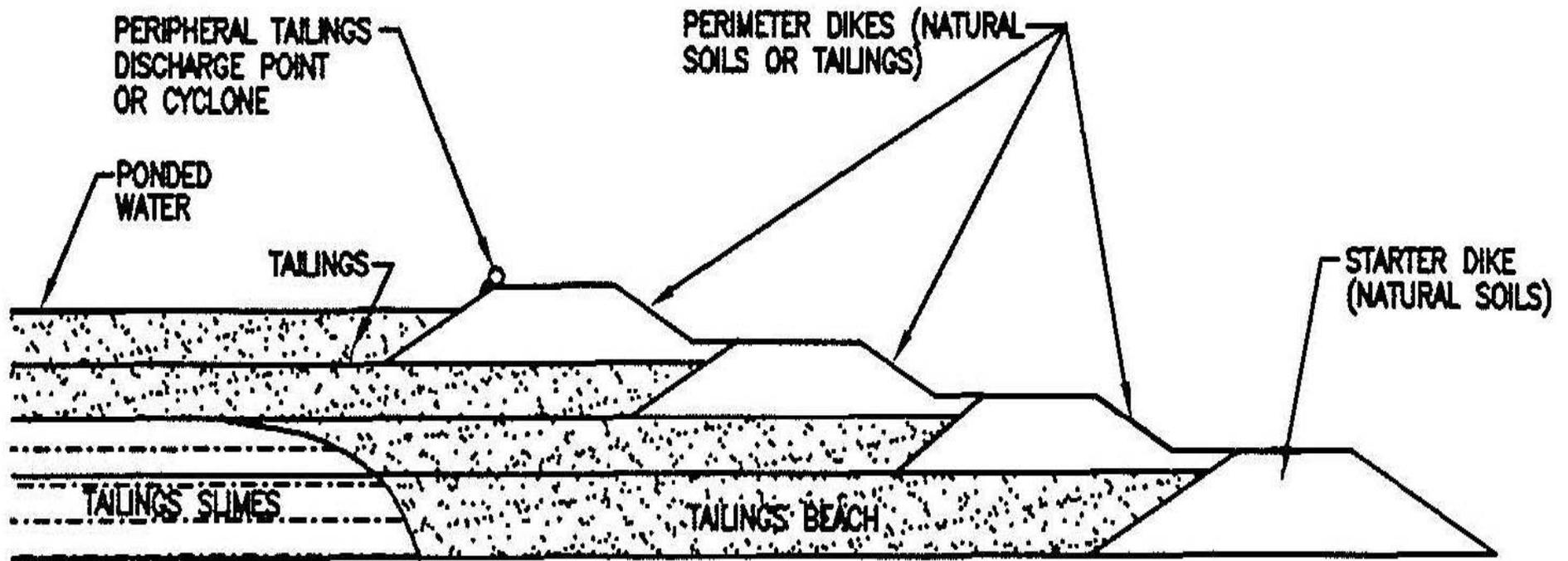


Weak Thin Layer of Silt and Ash Slimes at Bottom of Loose Ash

- Under the Cell 2 and Old Cell 3 there is a layer of high void ratio laminated silt mixed with fine ash that has low undrained shear strength
- The silt and fine ash is sensitive, overconsolidated and behaves in a brittle manner initially, becomes plastic and then softens to low strength
- The silt and ash slime is highly structured and loses strength when disturbed

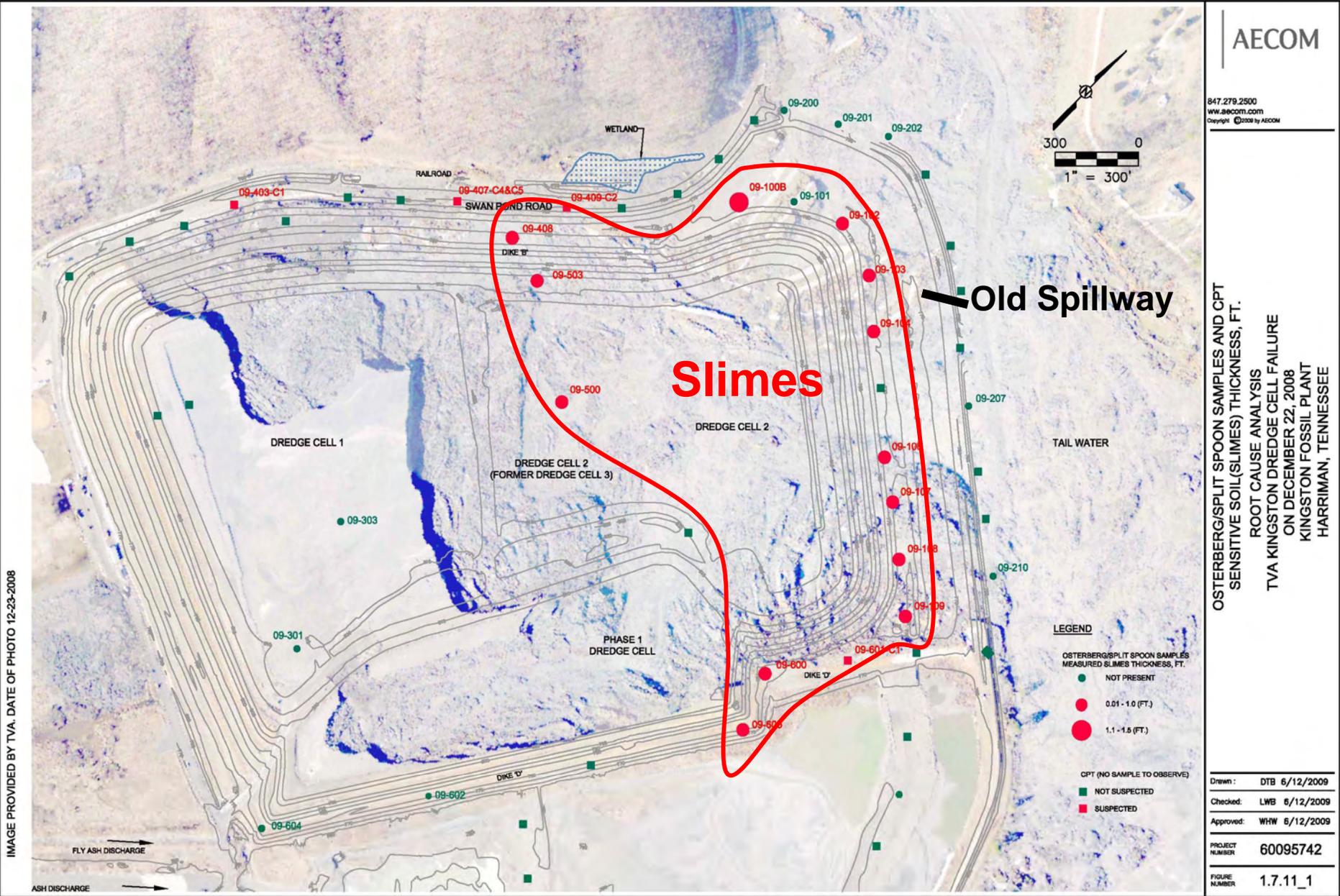
Unusual Latent Condition – Likely Trigger

Tailings Dam Definitions



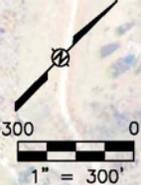
UPSTREAM METHOD (A)

Location of Slimes Under Cell 2



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OSTERBERG/SPLIT SPOON SAMPLES AND CPT SENSITIVE SOIL(SLIMES) THICKNESS, FT.
 ROOT CAUSE ANALYSIS
 TVA KINGSTON DREDGE CELL FAILURE
 ON DECEMBER 22, 2008
 KINGSTON FOSSIL PLANT
 HARRIMAN, TENNESSEE

IMAGE PROVIDED BY TVA. DATE OF PHOTO 12-23-2008

Soft Laminated Silt and Ash Boundary Material (Slimes)

- **Slack Water Deposition from 1954 to 1958, with potential for more slimes between 1958 to mid 1960's due to great distance from delta to spillway in Ash Pond**
- **Thin Laminated Deposit of Silt Size and Rounded Ash Slime Particles in 1/2 to 6 inches thick layers**
- **Highly Structured, Sensitive Slime Material**
- **Slimes are Highly Unusual Material Having Low Shear Strength Properties**

Unusual Properties of Slimes

- High Water Content 40% to 140% ($W_c = W_w/W_s$)
- High Liquidity Indices 3.5 to 7 (Rarely found in nature)
- Relatively low permeability 6.5×10^{-4} feet/day
- Specific Gravity $G_s = 2.2$ to 2.3 , Wet Density is 90 pcf
- CKU'DSS Shear Strengths range from 600 to 1,250 psf with Contractive Undrained Behavior
- CKU'DSS Creep test shows failure at 85% of peak shear strength

Photos and Selected Tests on Tube
Samples of Sensitive Silt and
Failure Slide Plane in 100 Series
Holes at toe of Cell 2

Intact Interfaces of Laminated Slimes & Ash

Microscope
Photograph

09-100B S5 33.0-35.5 ft



UNFAILED ASH

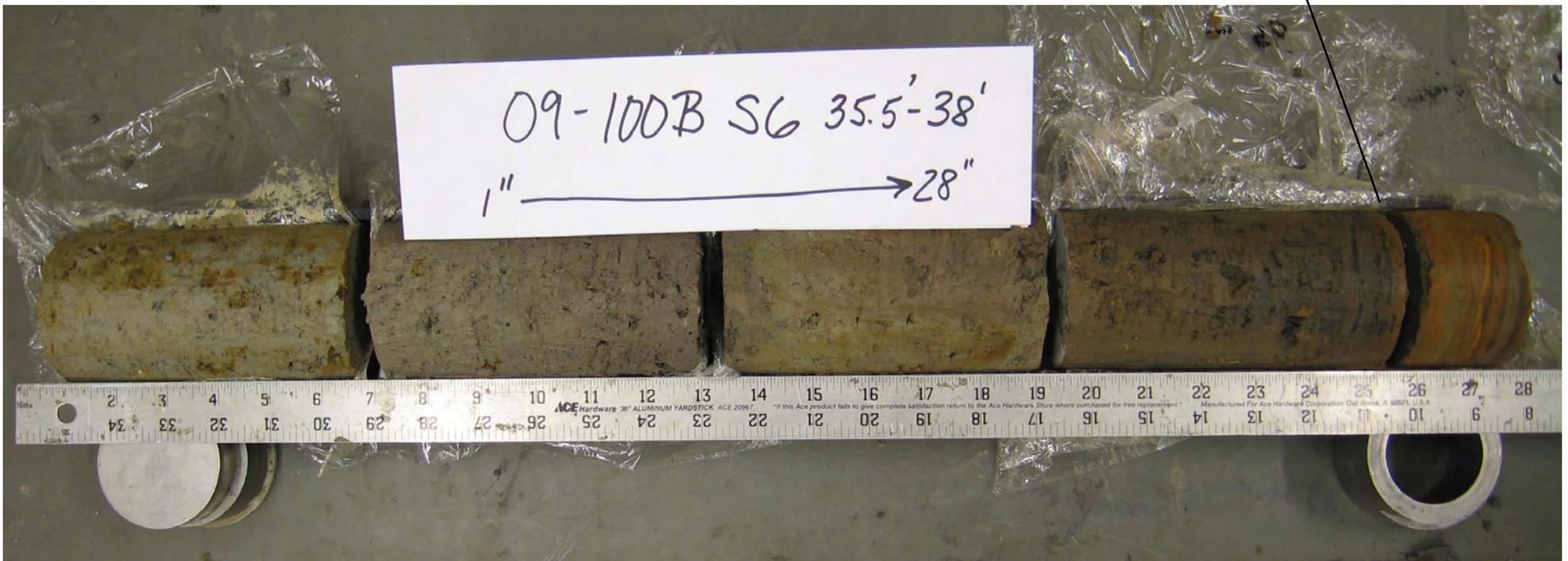
FAILED ASH

LAMINATED HIGH WATER CONTENT SLIMES

Unfailed Clay and Laminated Slimes Interfaces at 09-100B

NATIVE CLAY

LAMINATED
SLIMES



09-100B S6 35.5 to 38.0 ft



DSS G357 on 09-100B S6 (w = 119%)
– oven dry test specimen split open

University of Kentucky Electron Microscope Scan of 09-503B Slimes

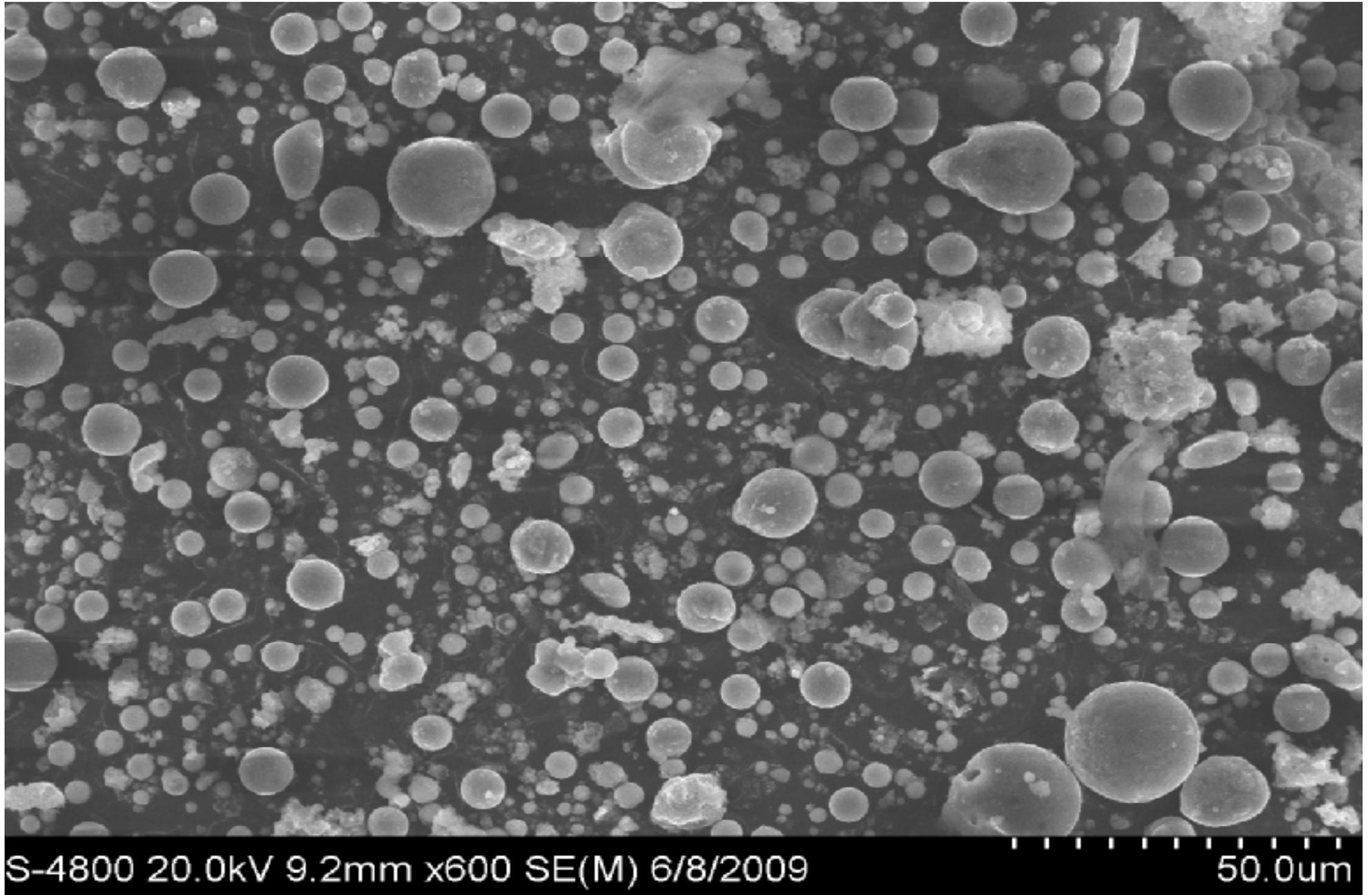


Photo of Laminated Slimes at 09-103B



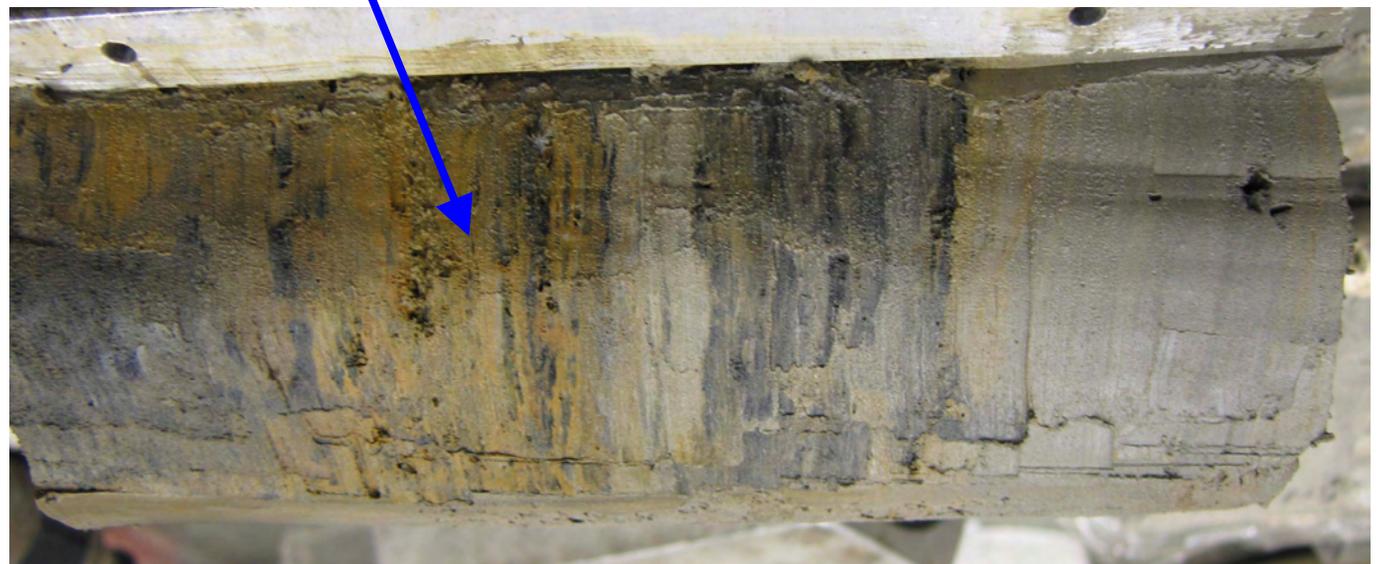
Photos of Unfailed Clay and Failed Laminated Slimes/Ash Interfaces at 09-104B



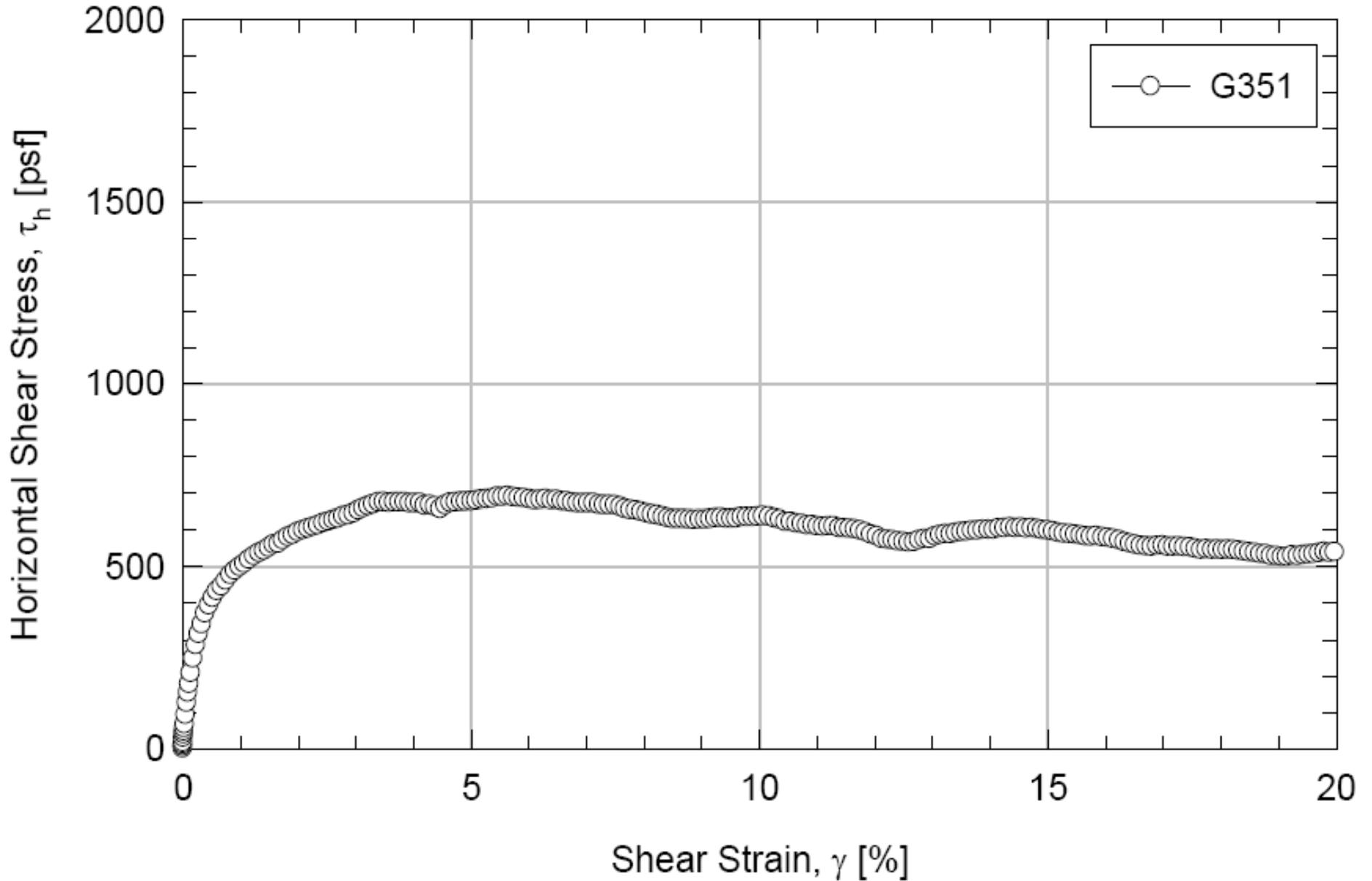
Laminated Silt/Ash Interface at 09-108B



09-108B OST 2
23.5 to 26.0 ft



DSS at 09-108B, $S_u = 690$ psf



CKUDSS Creep Test on Slimes

Creep Failure at 85% of G357 in G361

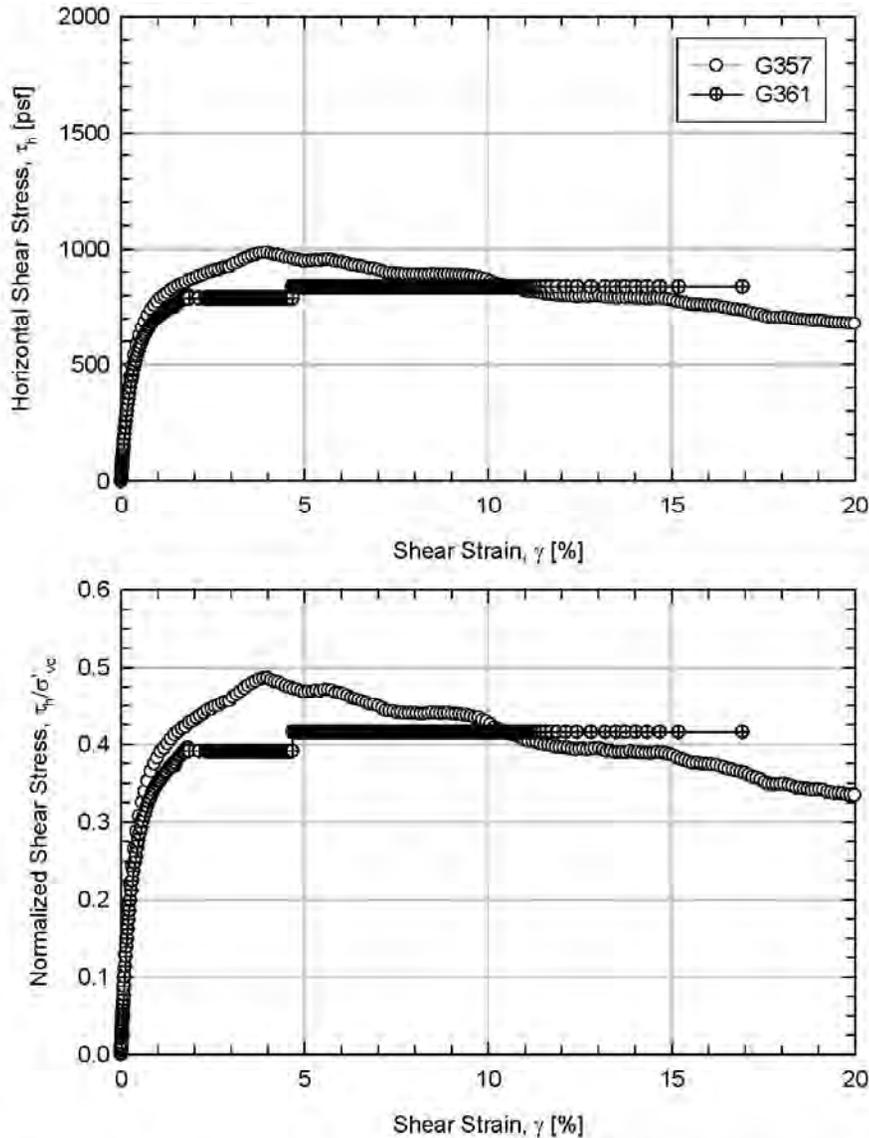


Figure 5.4.62 Horizontal shear stress and normalized shear stress versus shear strain for test DSS G357 and creep test G361 on sample 09-100B S6 35.5-38.0 ft

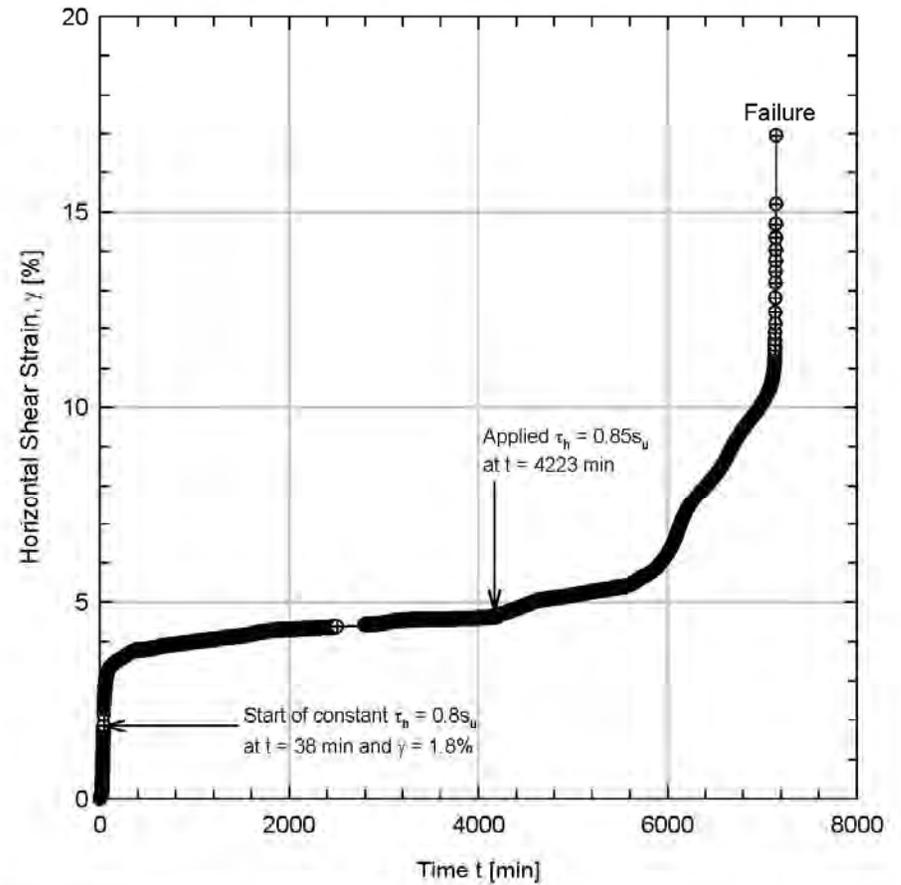
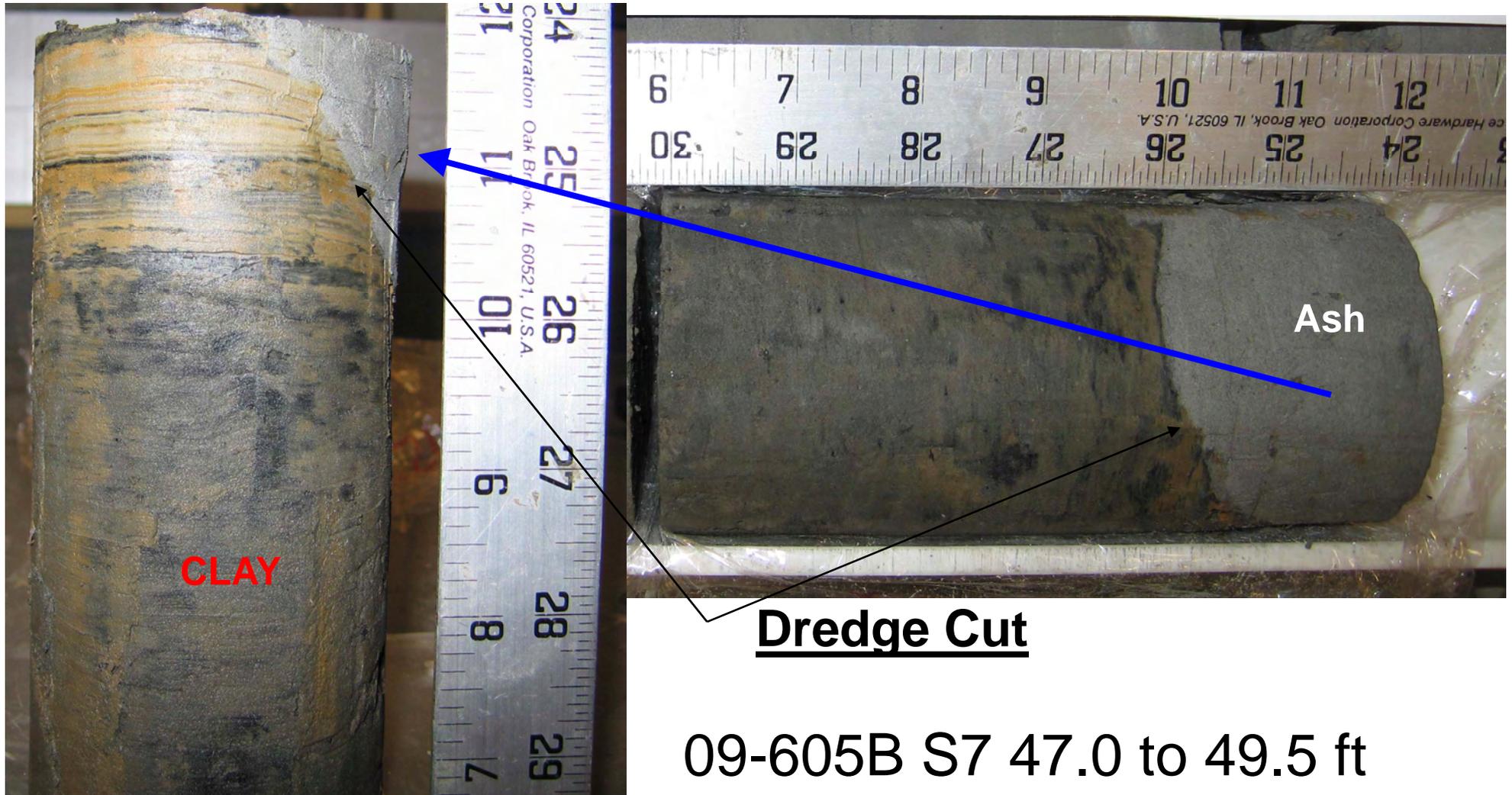


Figure 5.4.65 Horizontal shear strain versus time for DSS creep test G361 on sample 09-100B S6 35.5-38.0 ft

Interface of Laminated Slimes and Unfailed Flyash at 09-6005B

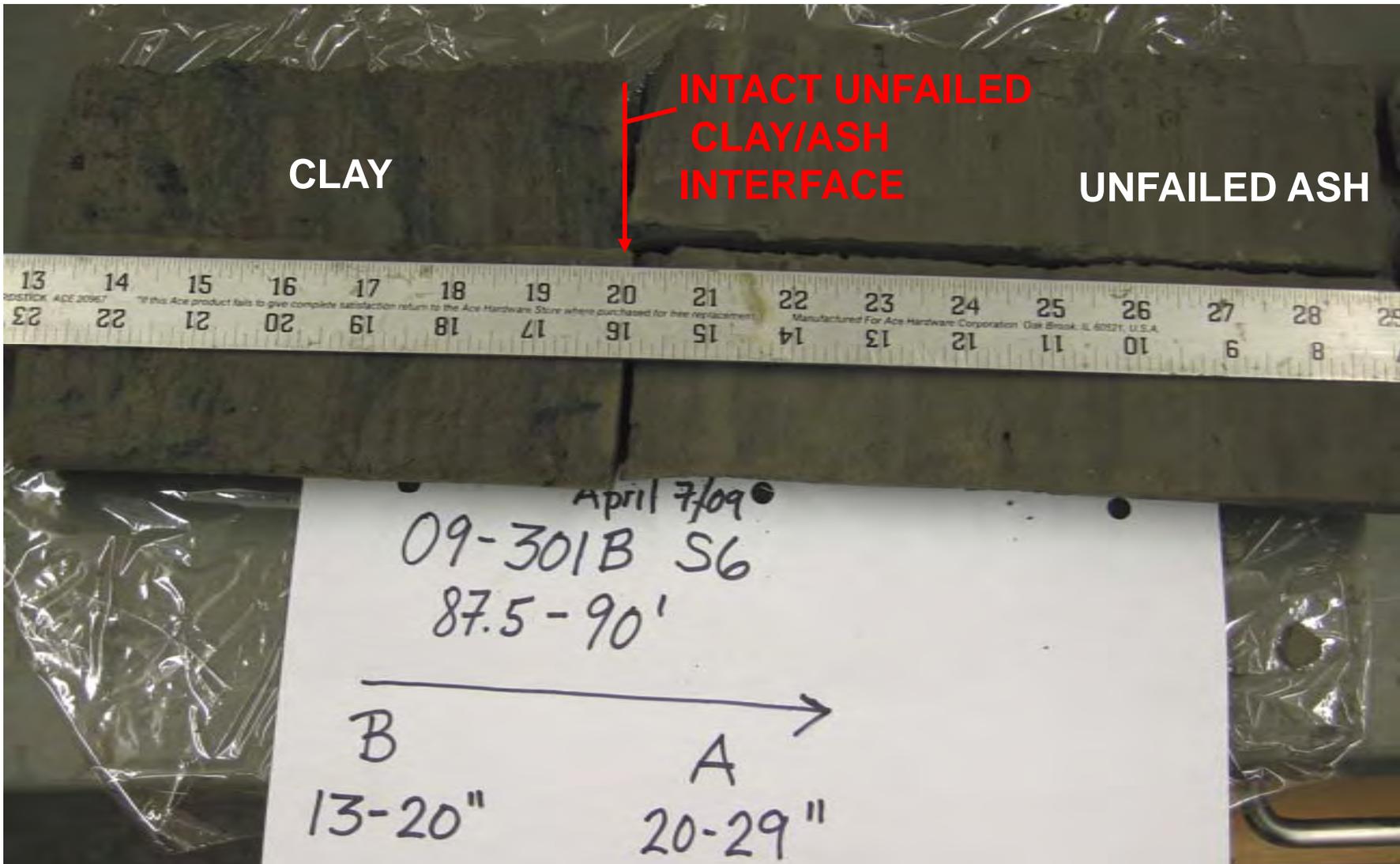


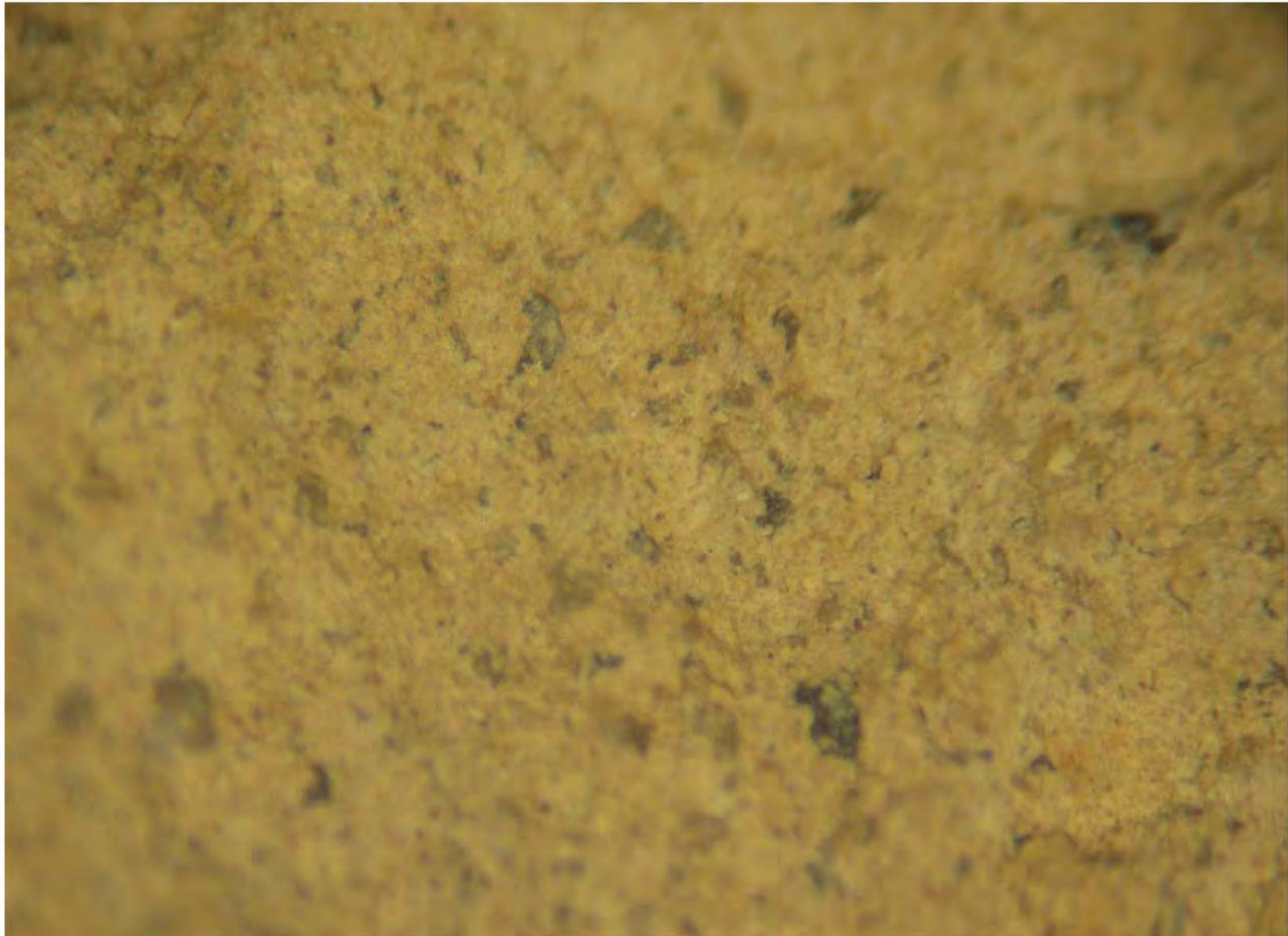
Medium to Stiff Alluvial Silts & Clay

- Found Below Sensitive Silts and Ash
- Soft, Medium, Stiff to Very Stiff Silty Clay
- Medium Plasticity
- Moderate to High Sensitivity
- Relatively low permeability $k_v=4 \times 10^{-3}$ ft/day
- Overconsolidated due to Desiccation
- Specific Gravity 2.65 to 2.72
- Detected in >90% of the Borings and Probes
- Undrained Shear Strength from Vanes can be correlated to CPTu tip resistance using N_k

Minor Impact – Retards Drainage of Silts and the Clay is Stronger than the Slimes

09-301B OST 6 87.5 to 90.0 ft

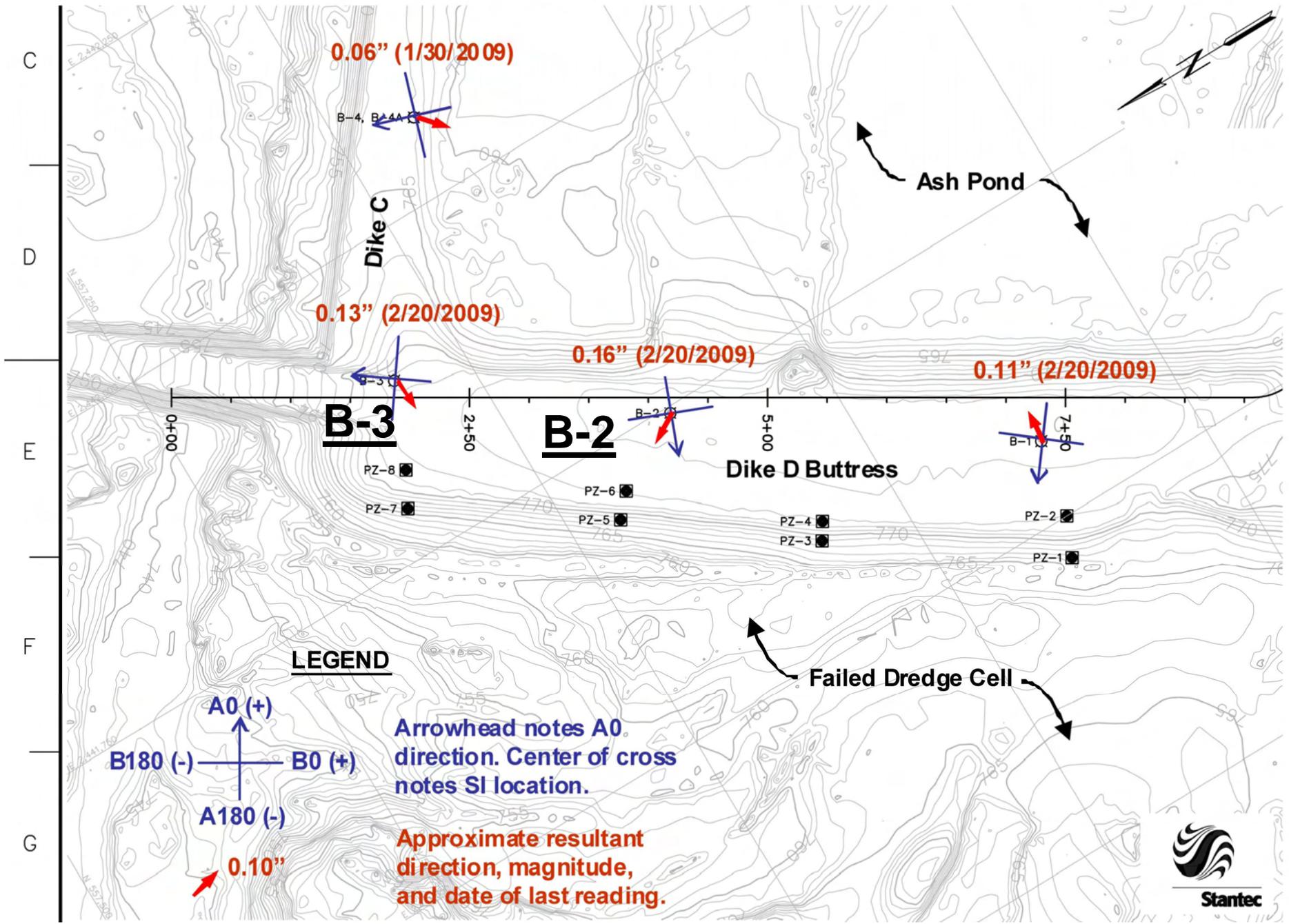




CLAY DSS G349 on 09-301B S6 ($w = 22\%$)
oven dry test specimen split open

LOCATION OF SLIDE PLANE

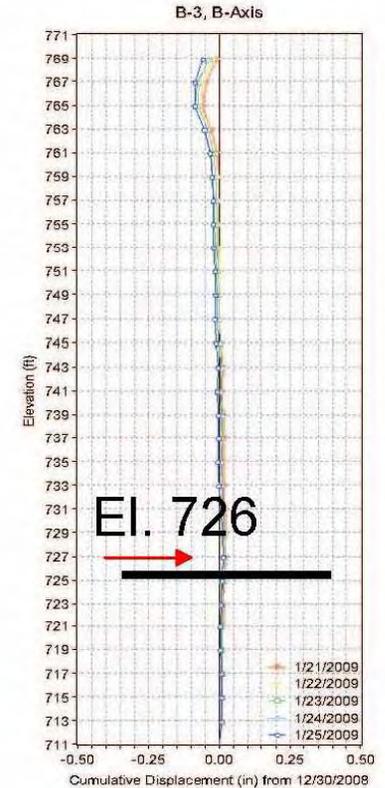
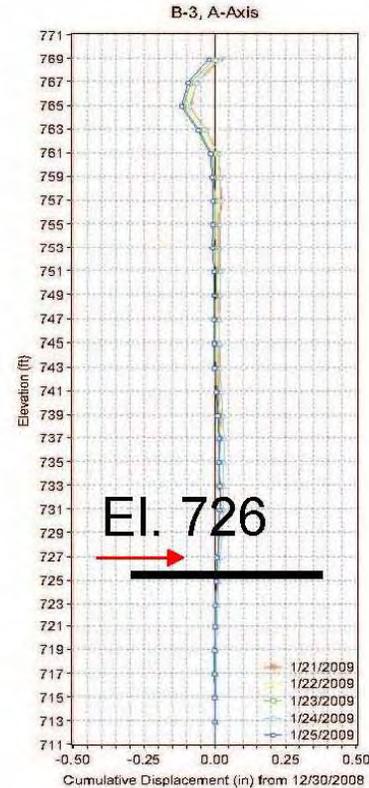
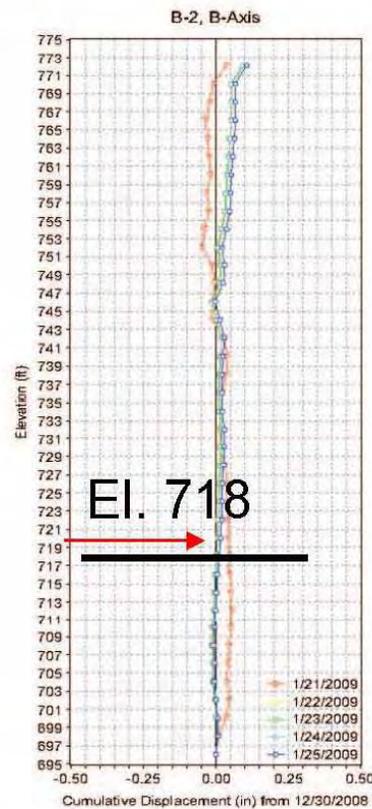
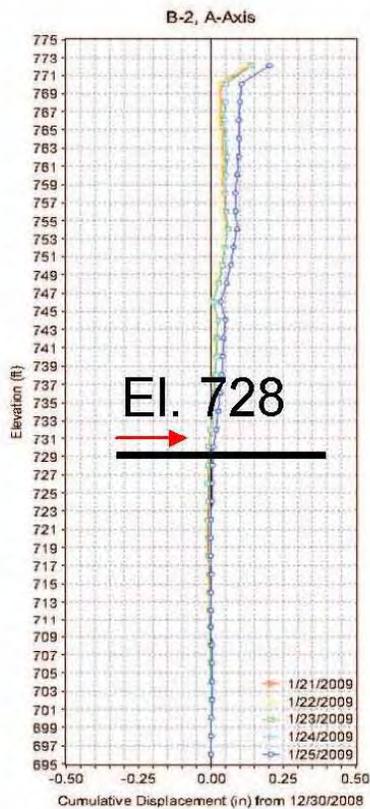
Dikes C and D Slope Inclinometer Locations and Movements



Detected Ground Movements from Dike D Inclinometers by Stantec

B-2

B-3



Dikes C and D
TVA Kingston Fossil Plant
Kingston, Tennessee

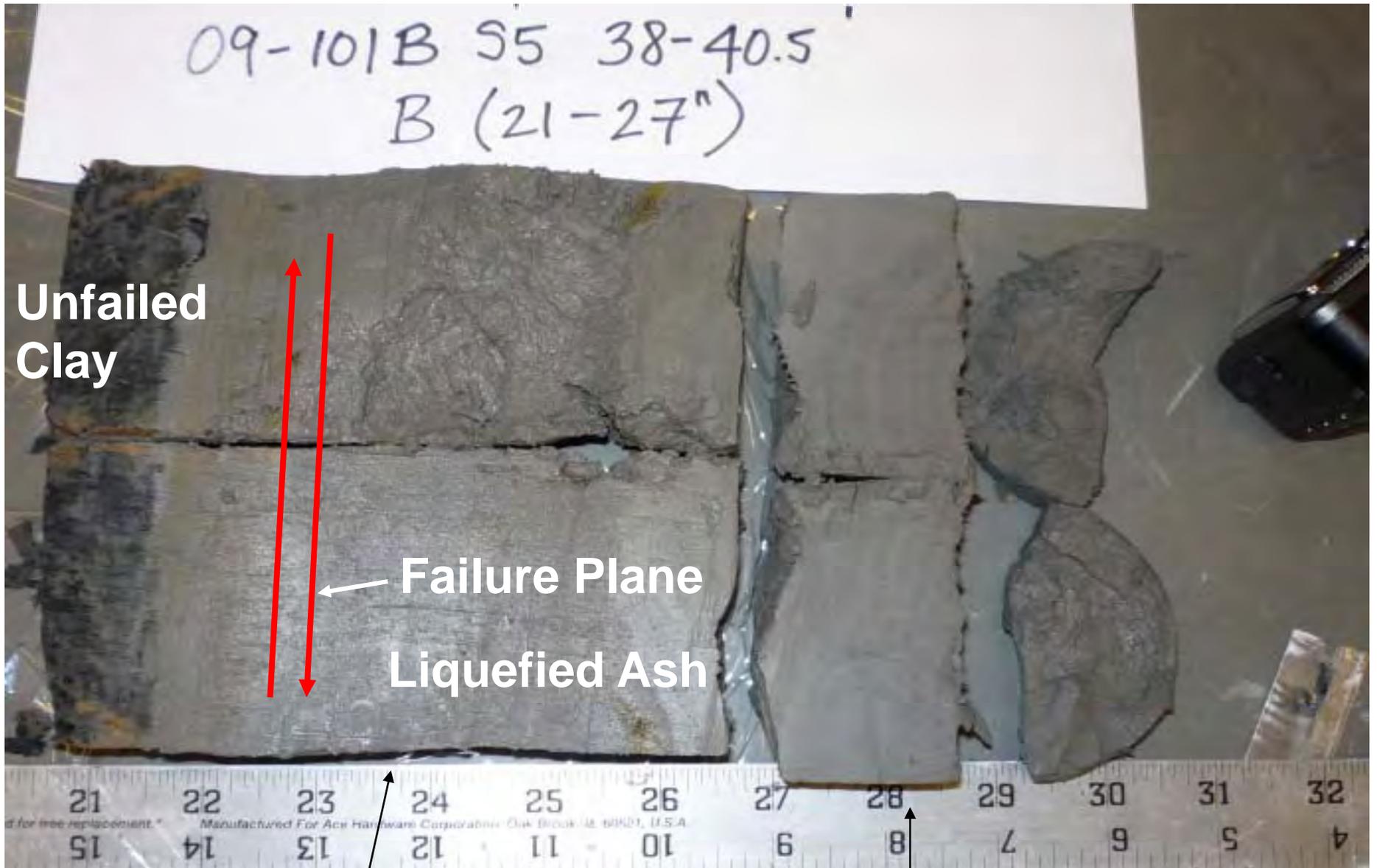


Dikes C and D
TVA Kingston Fossil Plant
Kingston, Tennessee

Photos of Slide Plane in Slimes at 09-104B



Failed Clay/Ash Interface at 09-101B



**4-INCH SHEAR PLANE OF
TOTAL LIQUEFACTION**

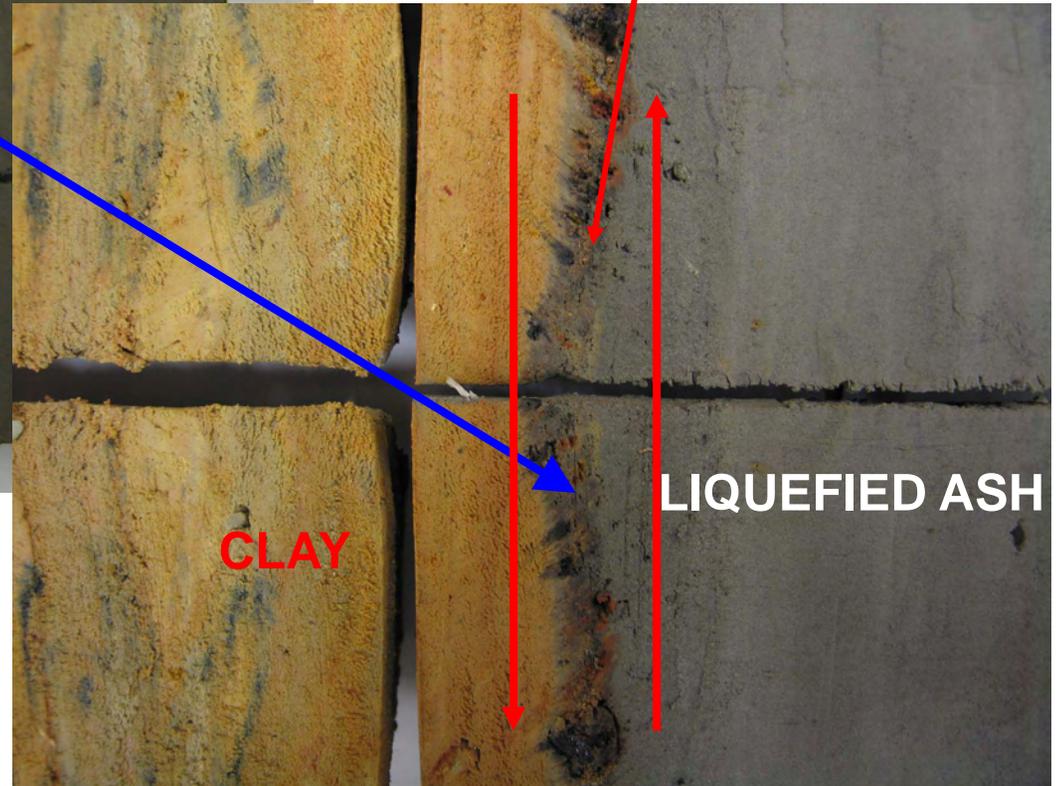
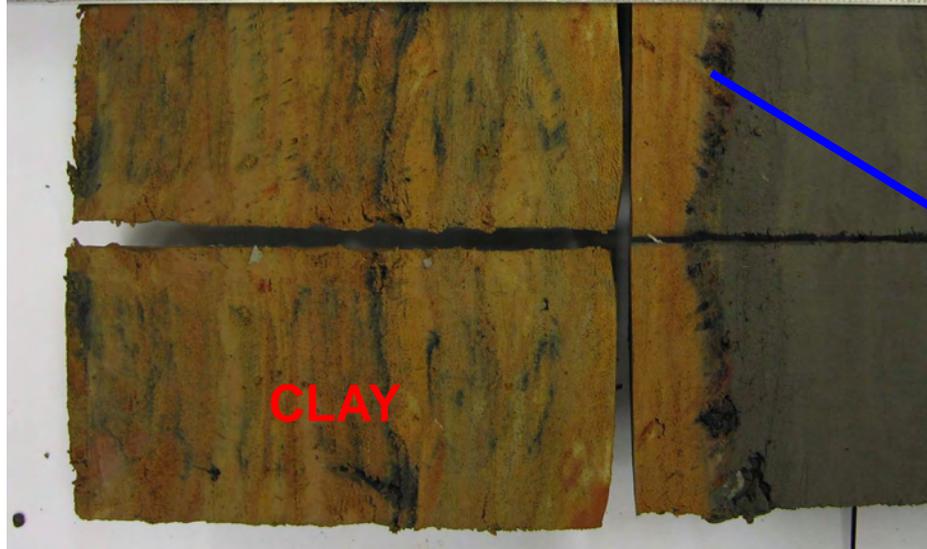
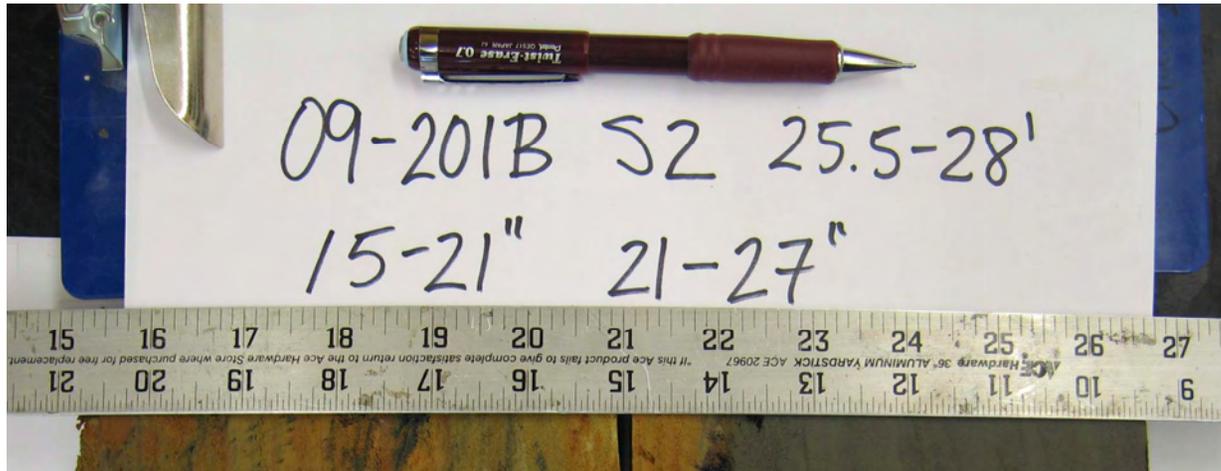
PARTIAL LIQUEFACTION

Clay/Laminated Slimes/Failed Ash at 09-500B, OST5



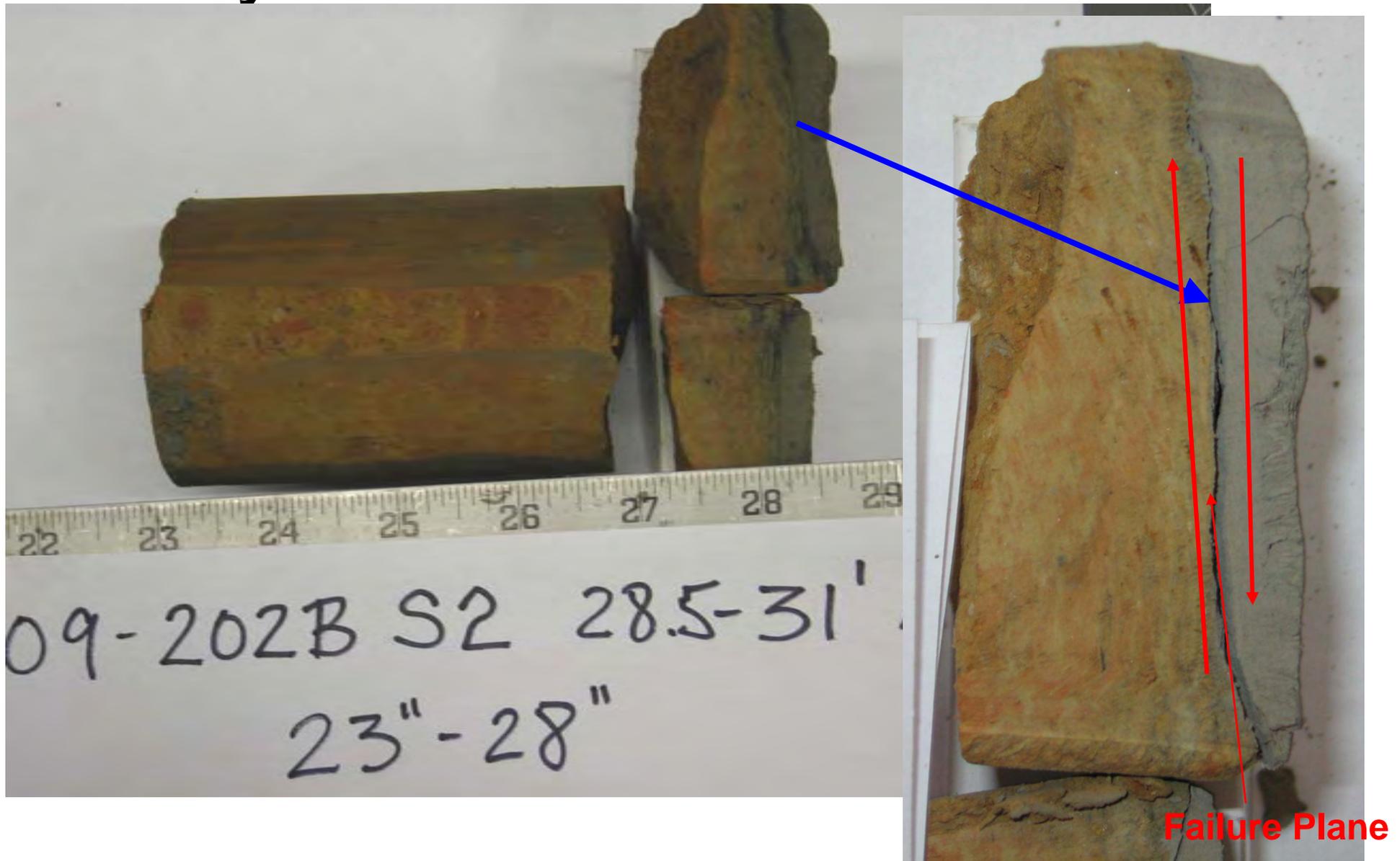
09-500B S5 29.0 to 31.5 ft

Clay/Failed Ash Interface at 09-201B



09-201B OST 2
25.5 to 28.0 ft

Clay/Ash Interface at 09-202B



09-202B S2 28.5 to 31.0 ft