US Army Corps of Engineers
Louisville District

Geotechnical and Dam Safety Section

McAlpine Lock Replacement Project

Foundation Characteristics and Excavation

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Presented to 2005 Tri-State Infrastructure Systems Conference & Exposition
August 3, 2005

Presentation Items:

- Project History and Regional Geology
- Construction Activity and Interactions with Site Geology
- Corrective Measures Required due to Construction Activity Problems
- Disputed Issues and Lessons Learned

General Geologic Conditions at McAlpine

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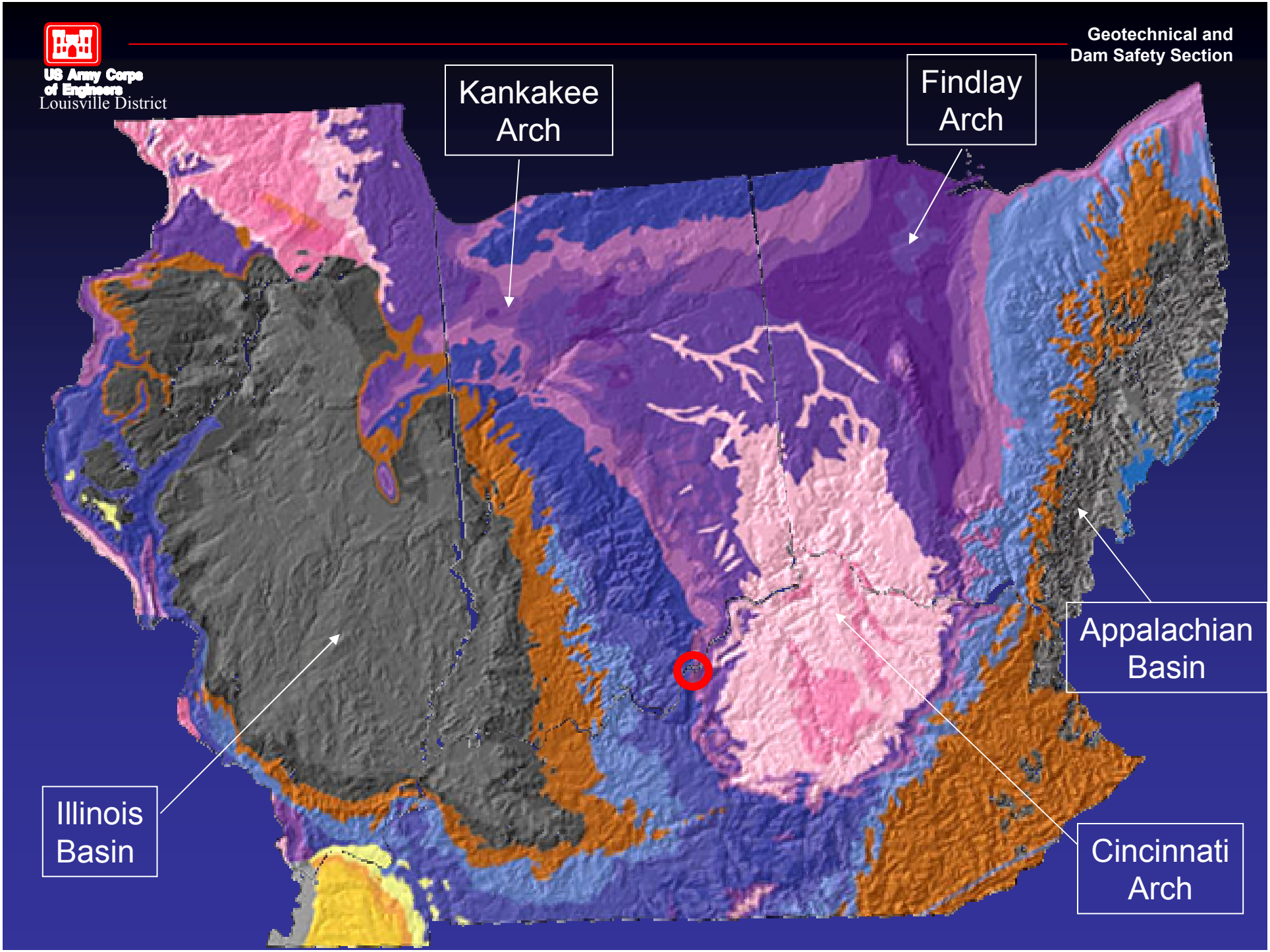
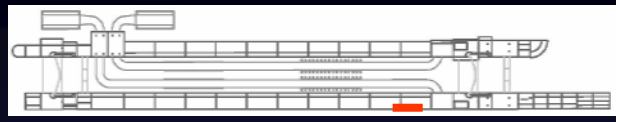


General Geology



New Albany Shale

Beechwood Limestone

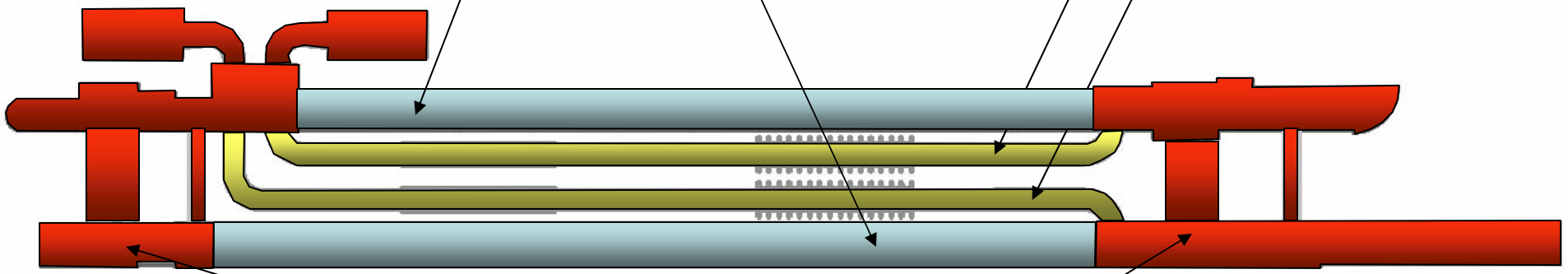
Silver Creek Limestone

Jeffersonville Limestone

General McAlpine Layout

Roller Compacted Concrete (RCC) Monoliths

Lock Floor Culverts



Conventional Concrete Monoliths

Mechanical Rock Excavation


Location of new lock extension


2000. 3. 2


2000. 3. 2

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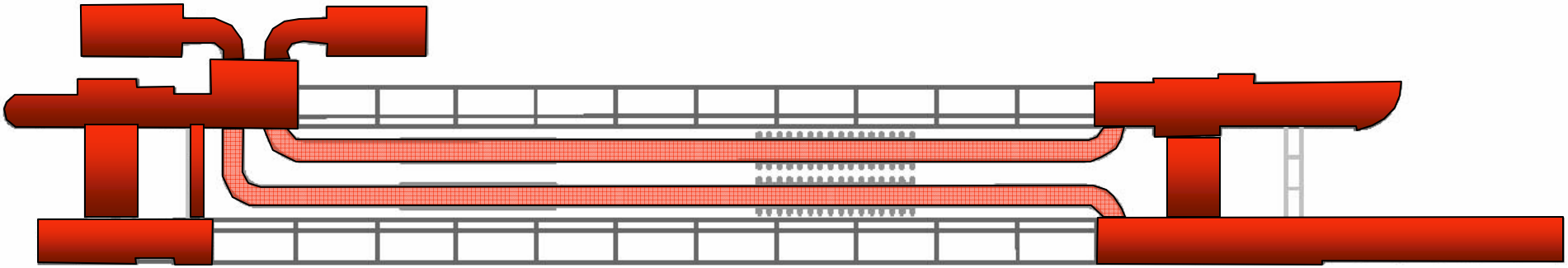
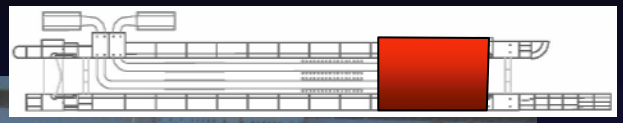
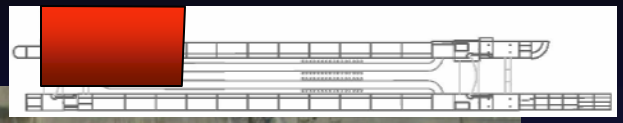
Explosive Rock Excavation

Excavations which penetrate into rock anywhere from 5-feet to 35 feet, requiring controlled blasting techniques.






DEERE



Smooth-Wall Blasting Technique

Sinking and production shots made previous to perimeter shots

Trim Blast

Buffer Holes

Trim Holes

As a consequence of choosing a method with no perimeter control, a diligent quality control (QC) program needs to be implemented.

Without a diligent quality control (QC) program, you end up with…

Examples of back-break due to lack of perimeter control.


TEREX
TEREX
DEERE

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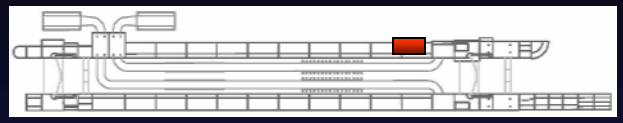
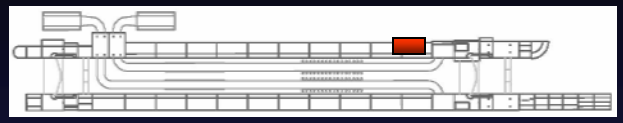
Effects of back-break on foundation integrity

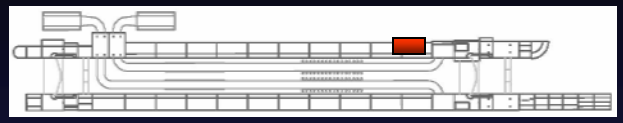
SM-17



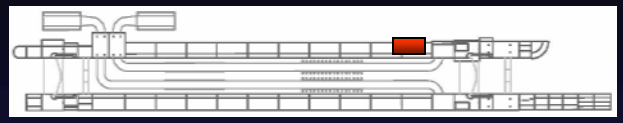

DEERE
CAT
HOLT
450C LC

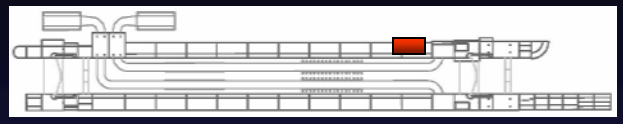


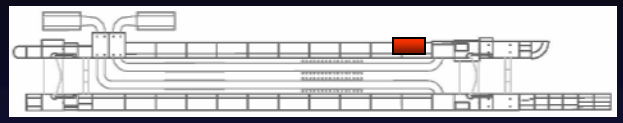

C
B
A

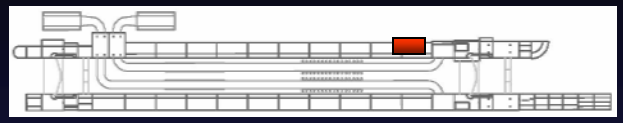


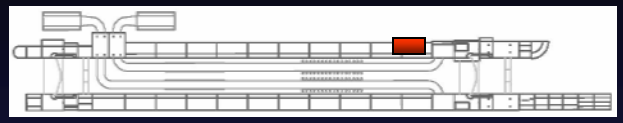

VOLVO





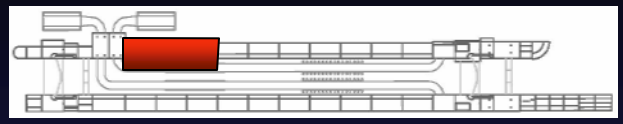


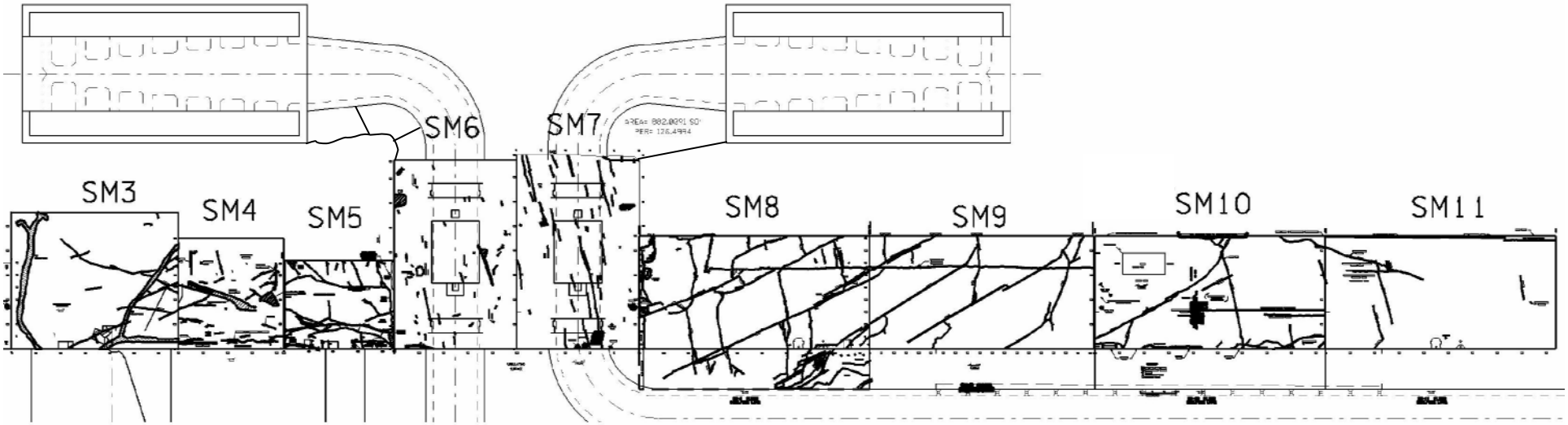


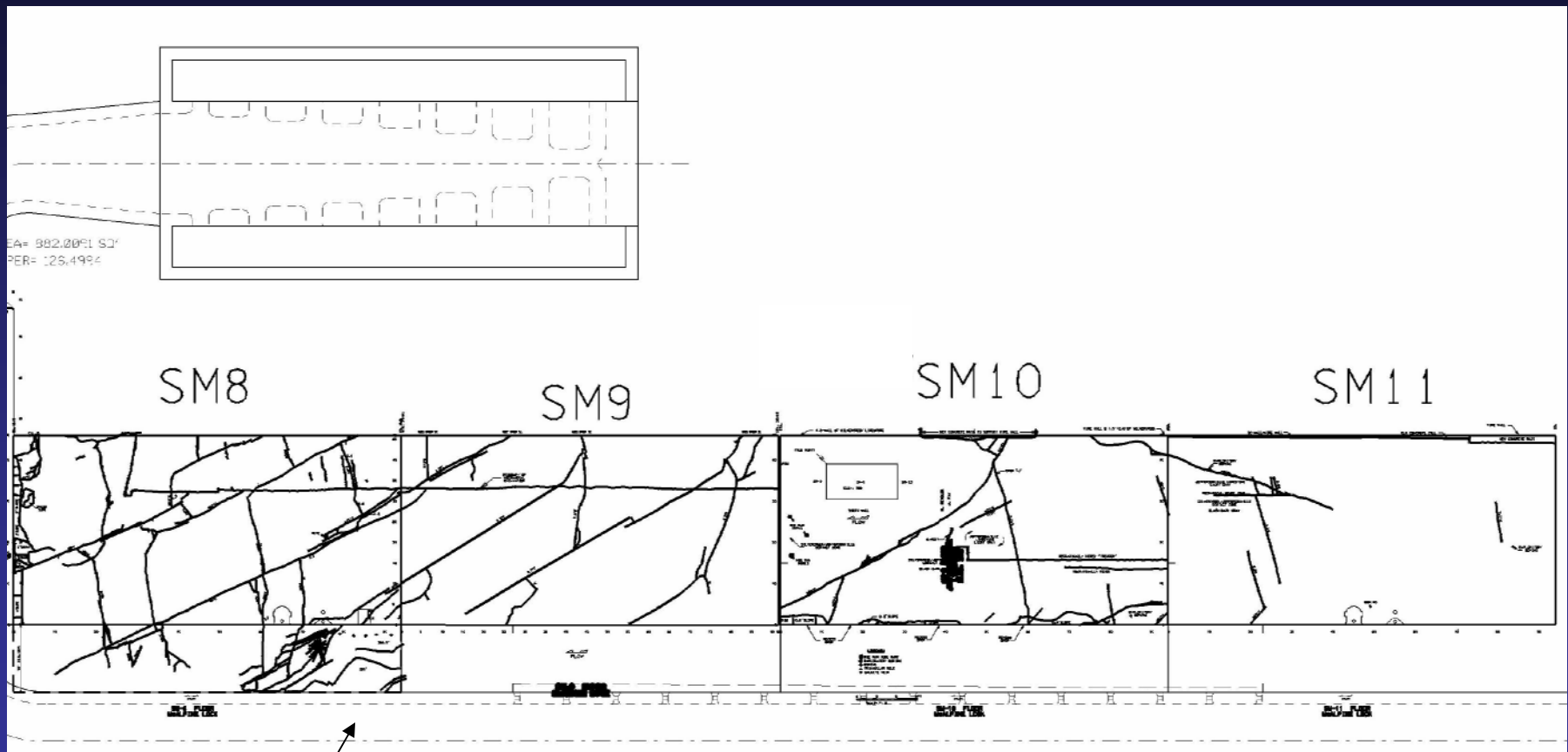


Effects of back-break on foundation integrity

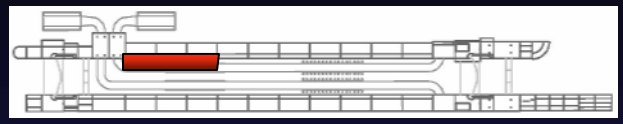
SM-8 through SM-11



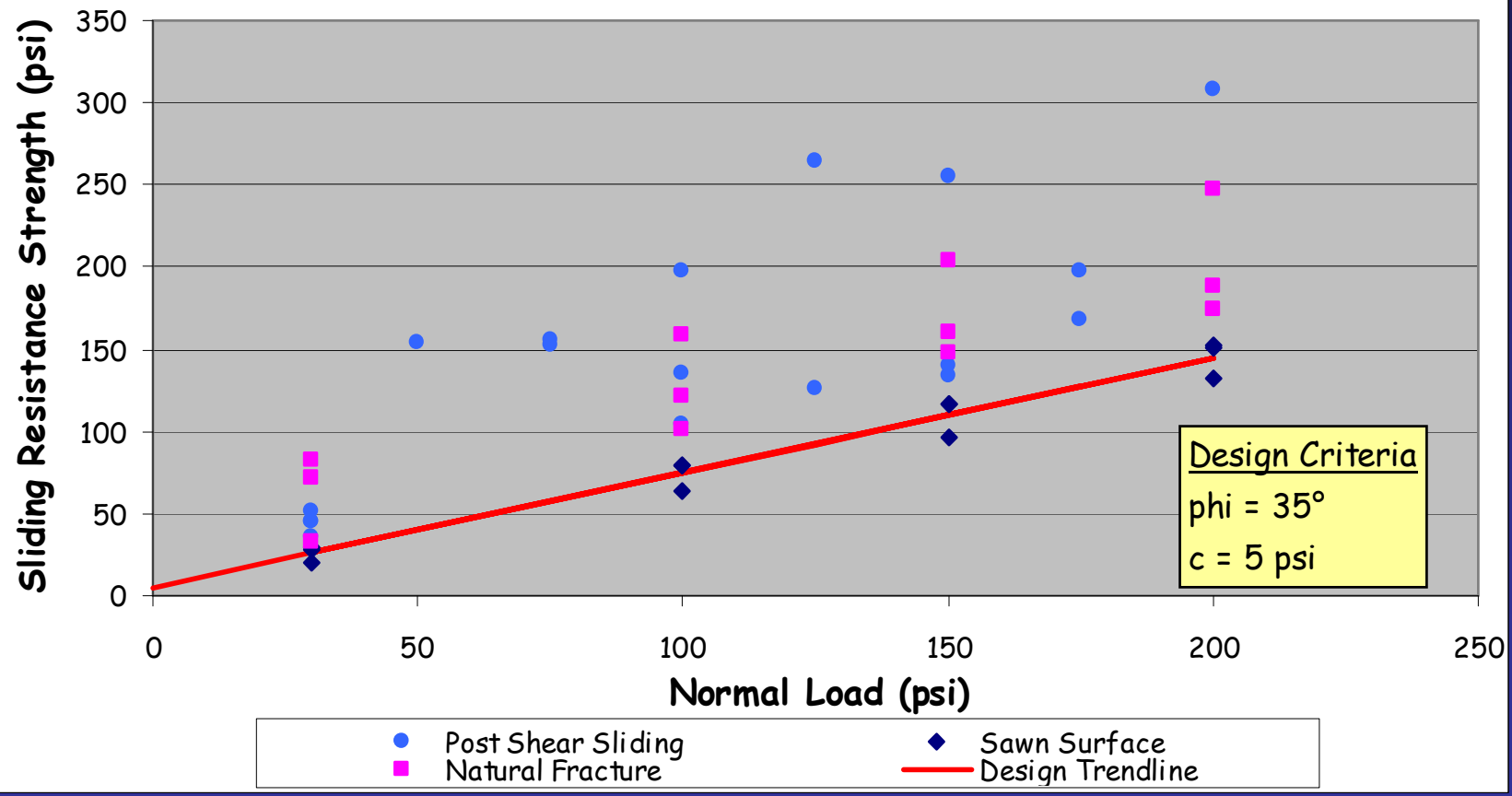

SM3
SM4
SM5
SM6
SM7
SM8
SM9
SM10
SM11

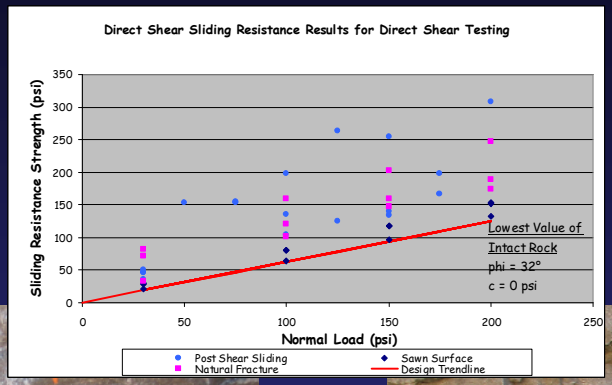

SM8
SM9
SM10
SM11
North Culvert in Lock Floor

Offset boreholes observed in north face of north culvert



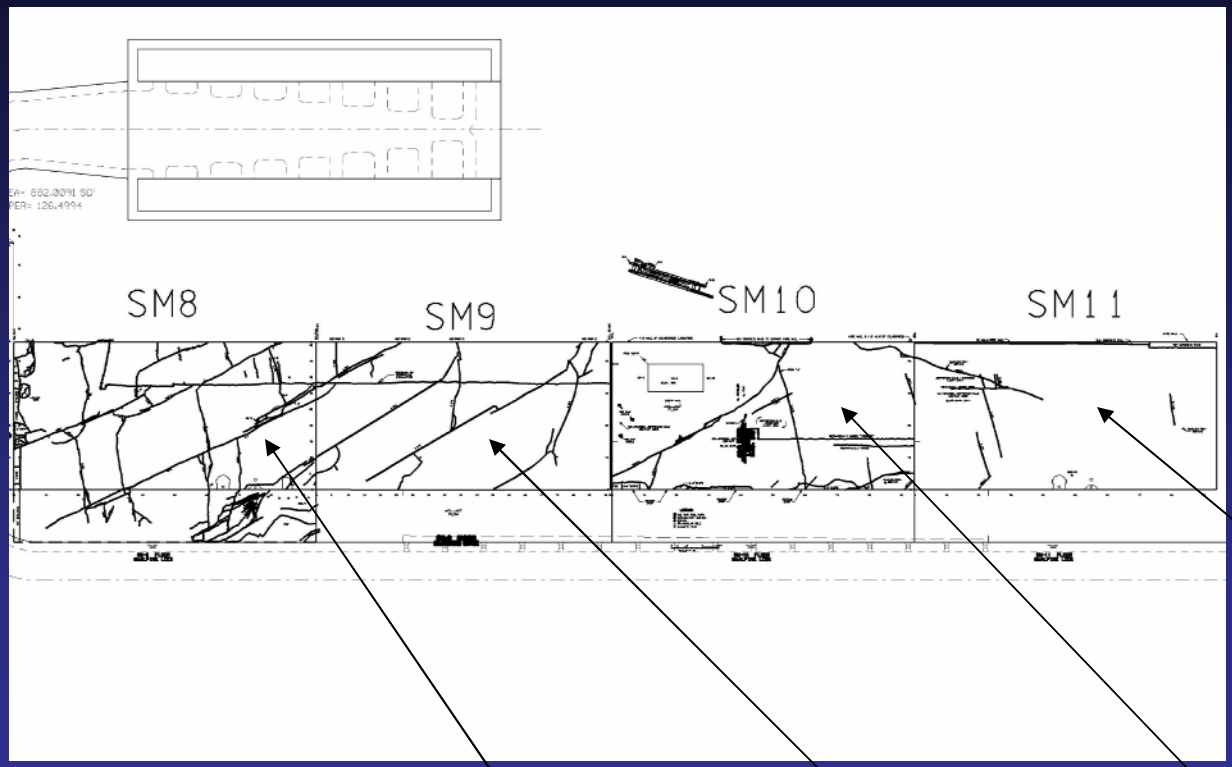
Sliding Resistance Results from Direct Shear Testing





What kind of strength do you give to a seam which has been damaged and shifted?

Sliding Resistance Strength



Reduced from
phi = 35°
c = 5 psi

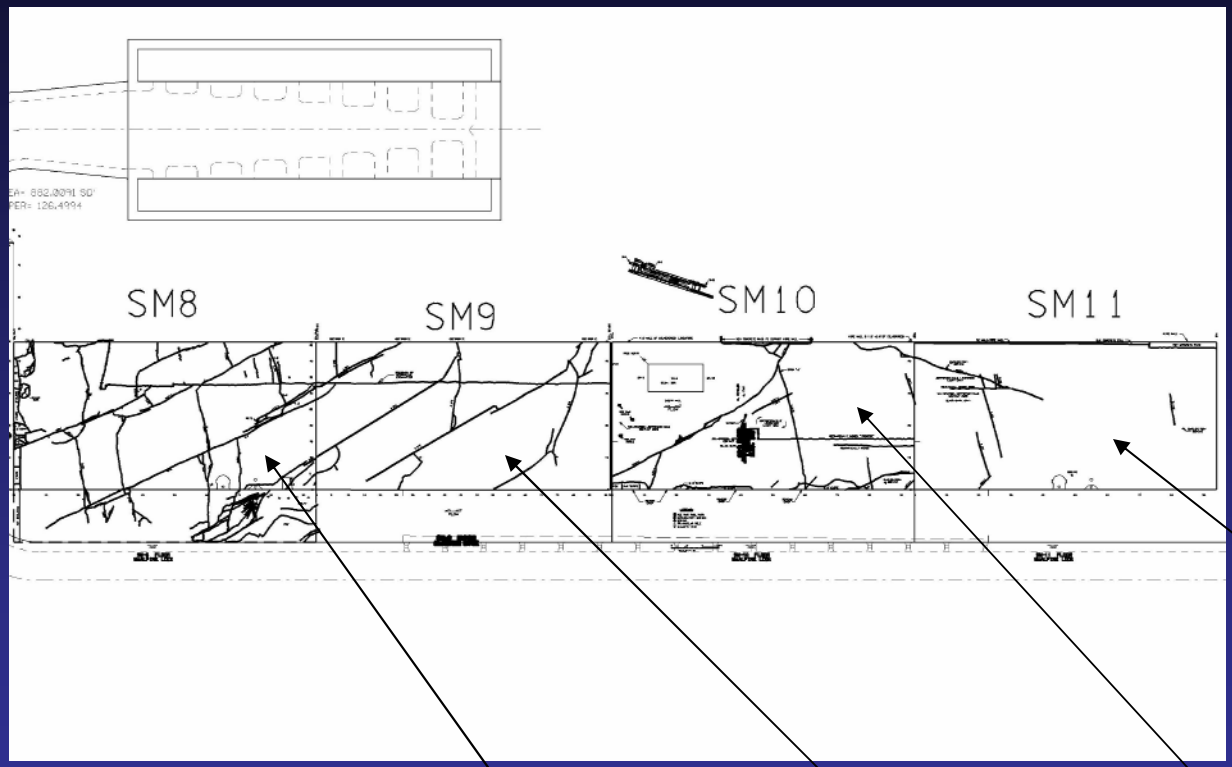
SM-8
phi = 22°
c = 0 psi

SM-9
phi = 25°
c = 0 psi

SM-10
phi = 27°
c = 0 psi

SM-11
phi = 29°
c = 0 psi

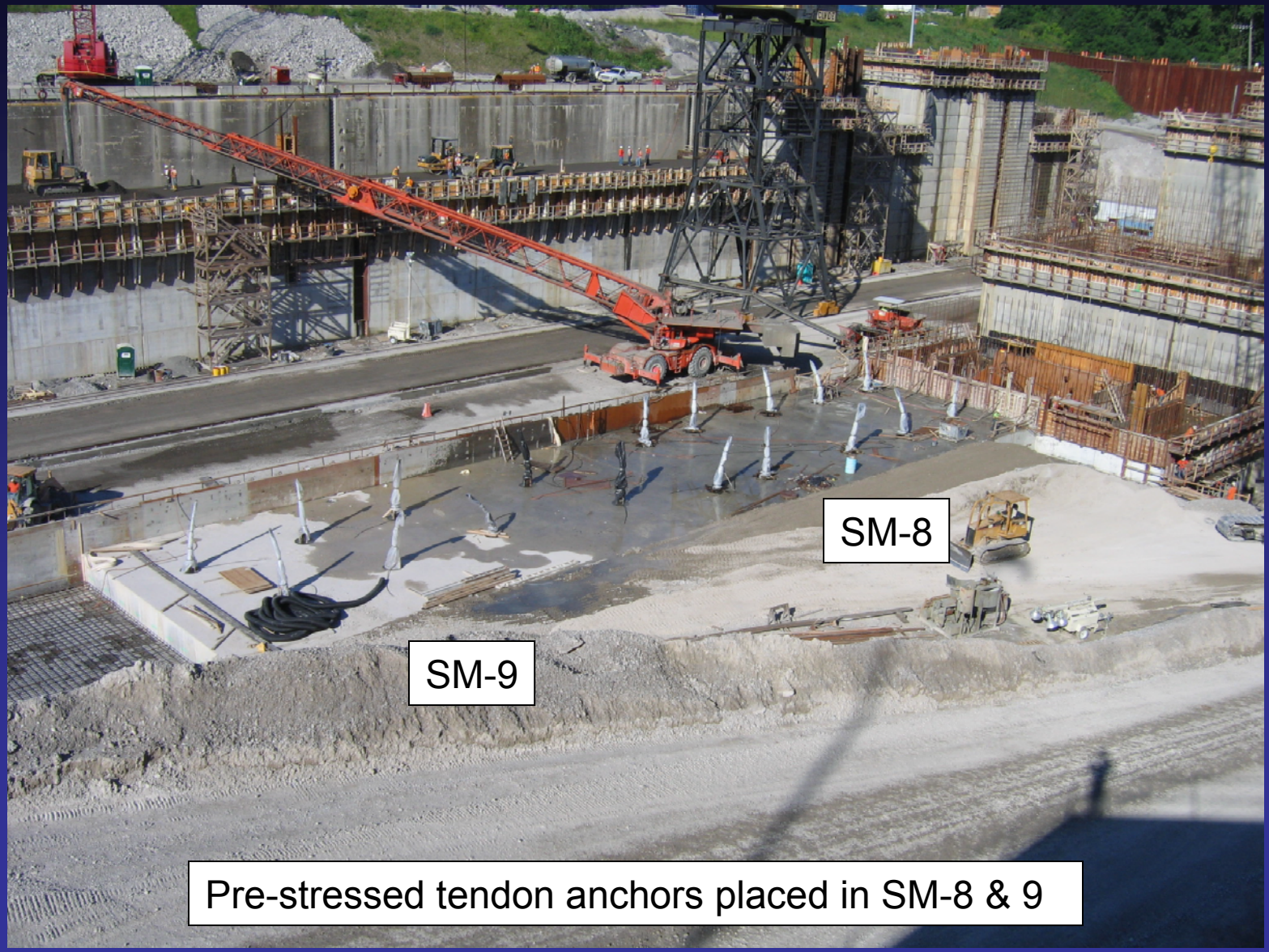
Allowable Bearing Capacity



Reduced from 62 ksf

SM-8	SM-9	SM-10	SM-11
29 ksf	46 ksf	46 ksf	62 ksf


SM-11
SM-10
SM-9

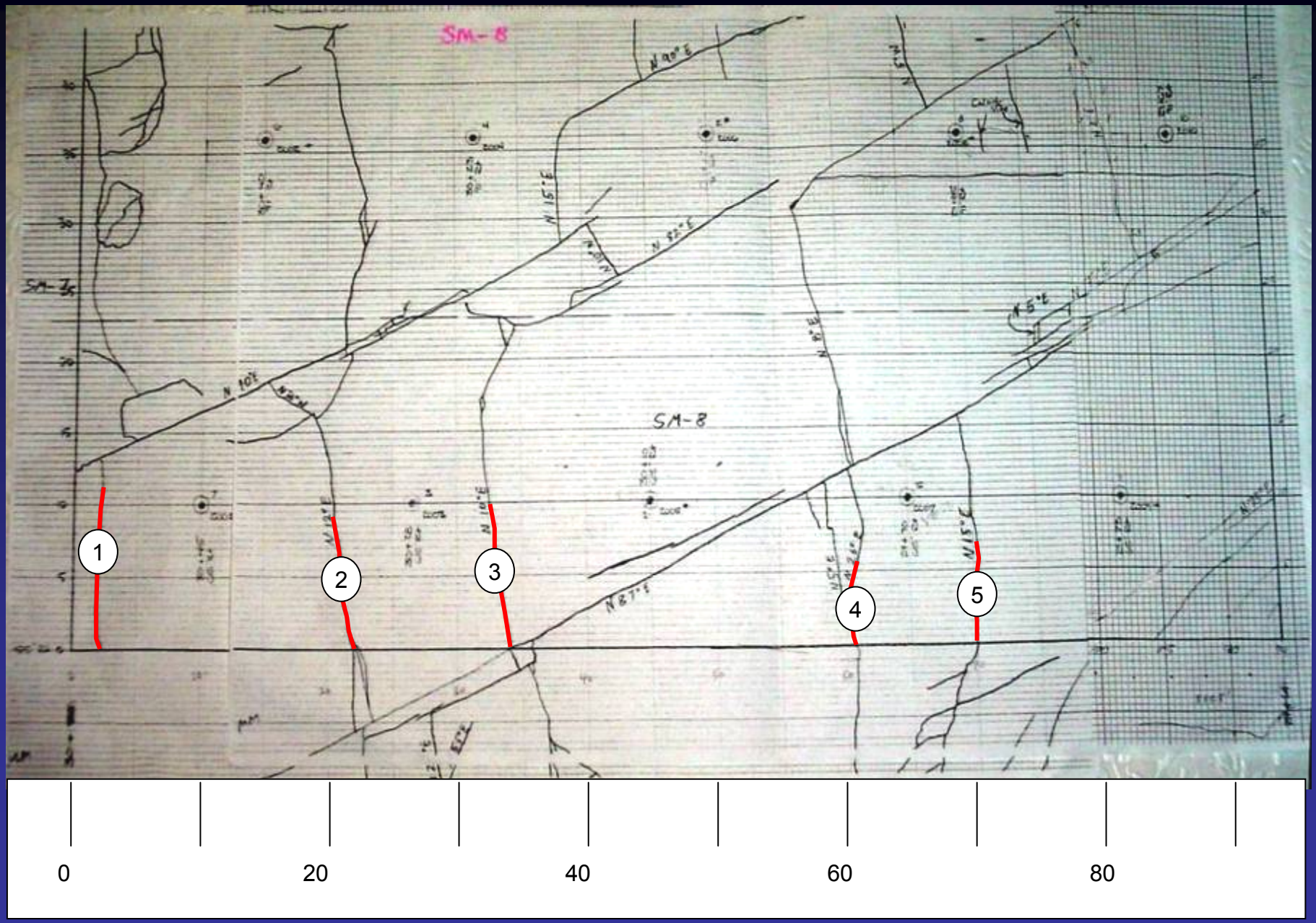


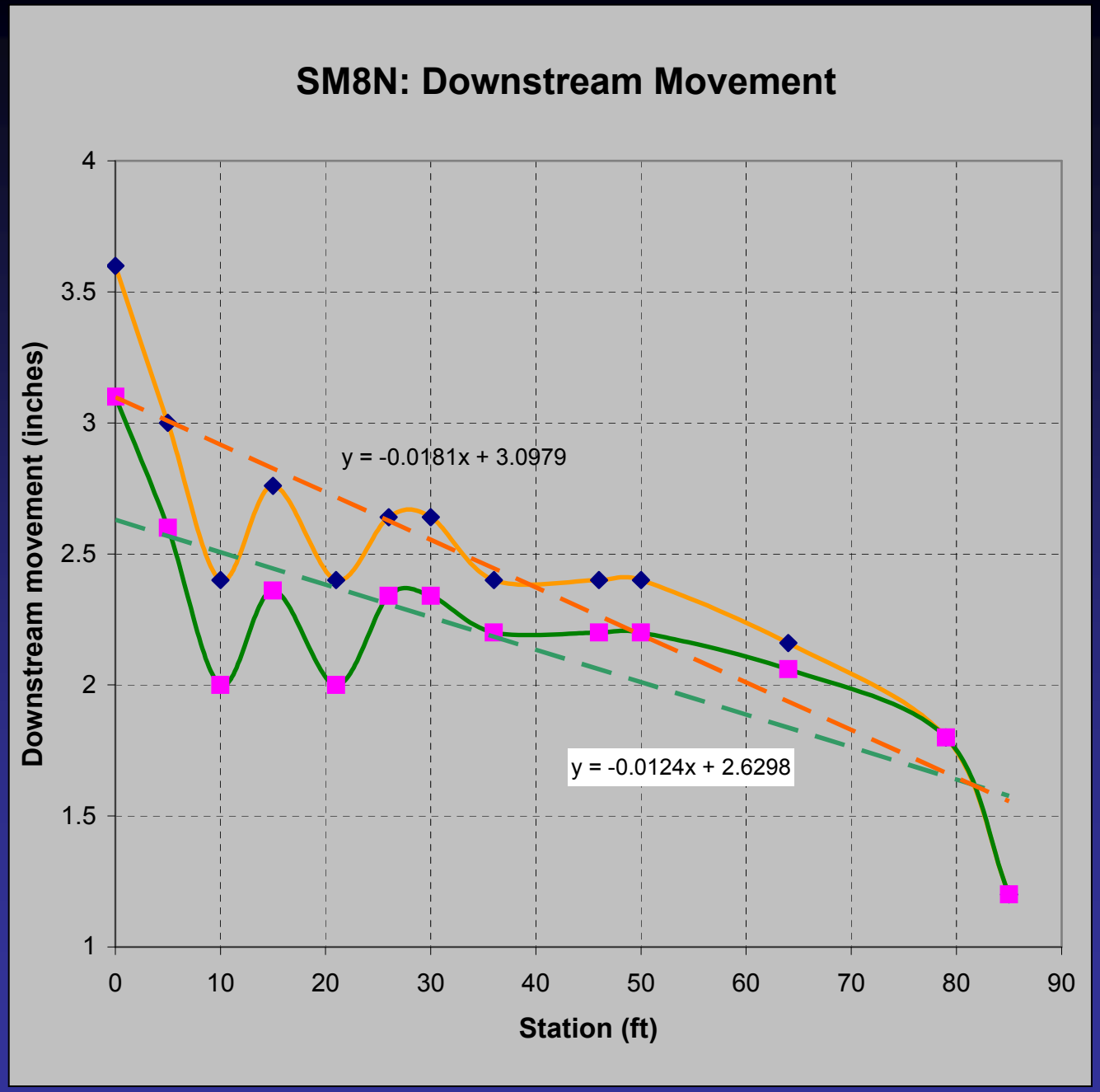
Pre-stressed tendon anchors placed in SM-8 & 9

Interpretation of what caused the damage

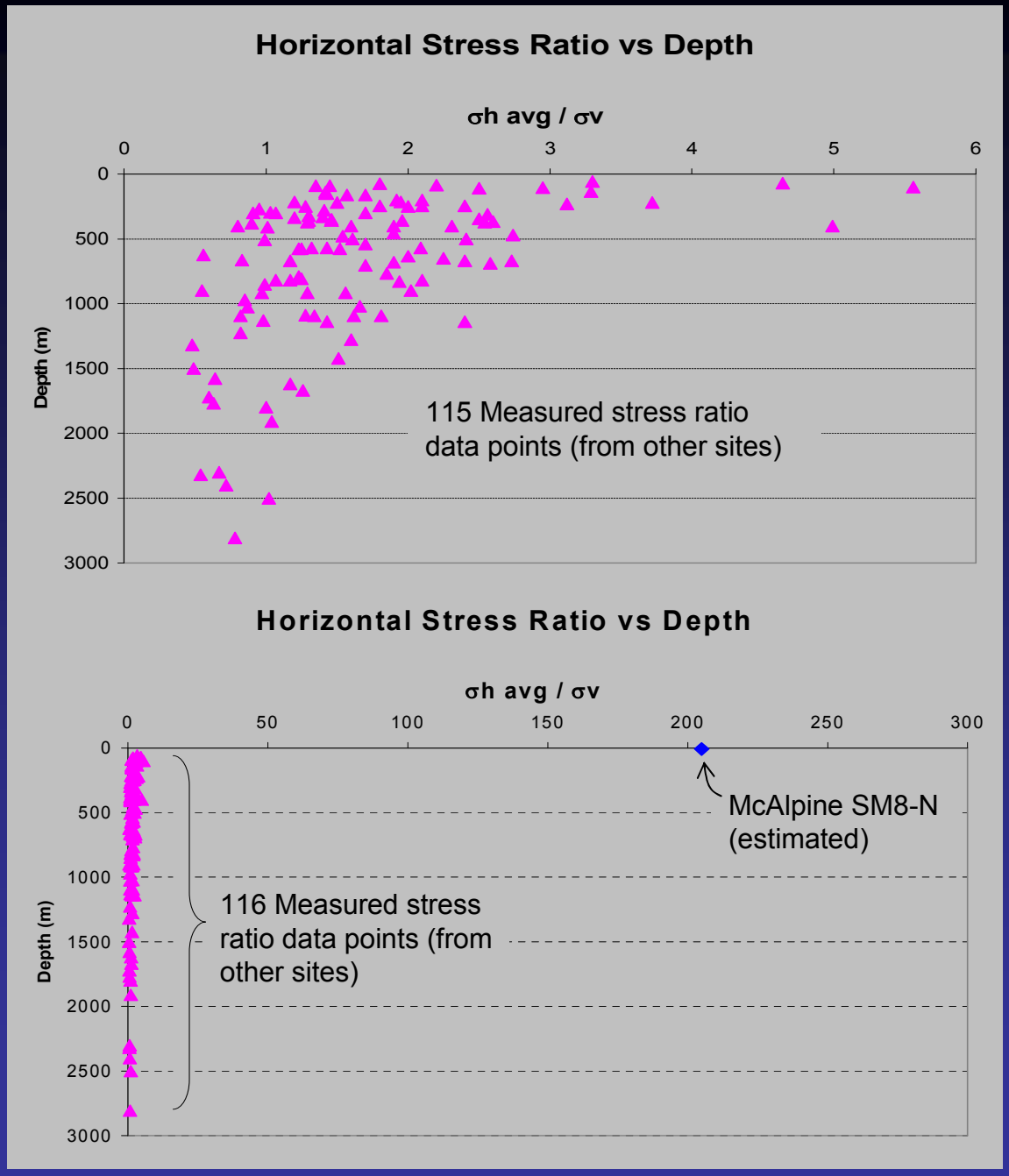
In-Situ Stress

"Prove that it is there" … vs … "Prove that it is *not* there"


SM-8
SM-8
1
2
3
4
5
0
20
40
60
80



As presented by Dr. Matthew Mauldon



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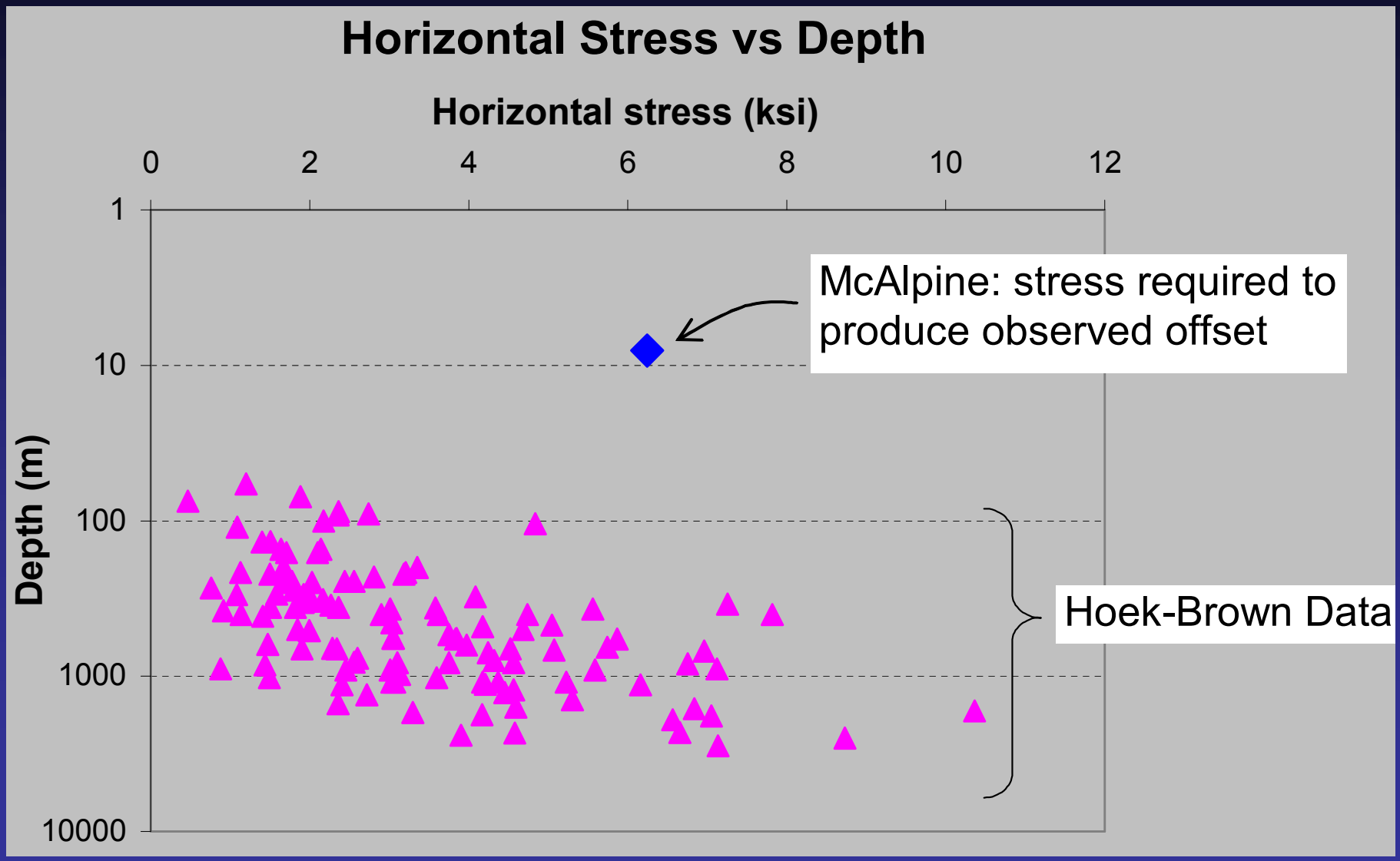
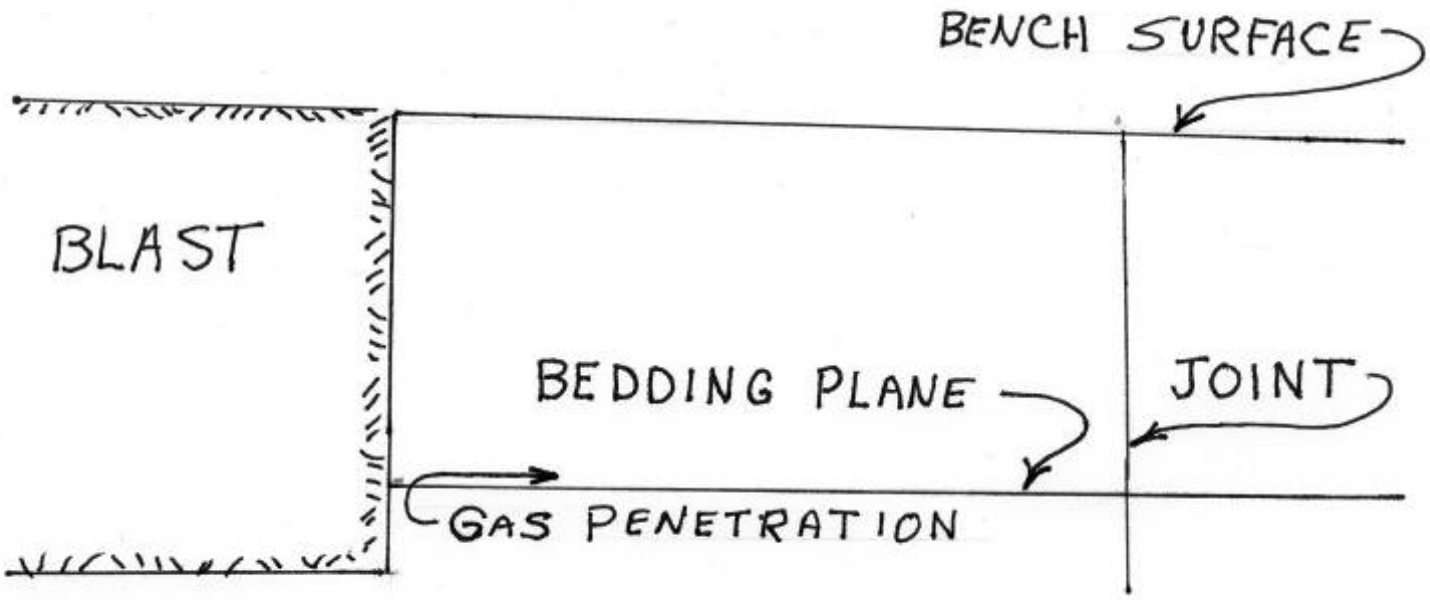
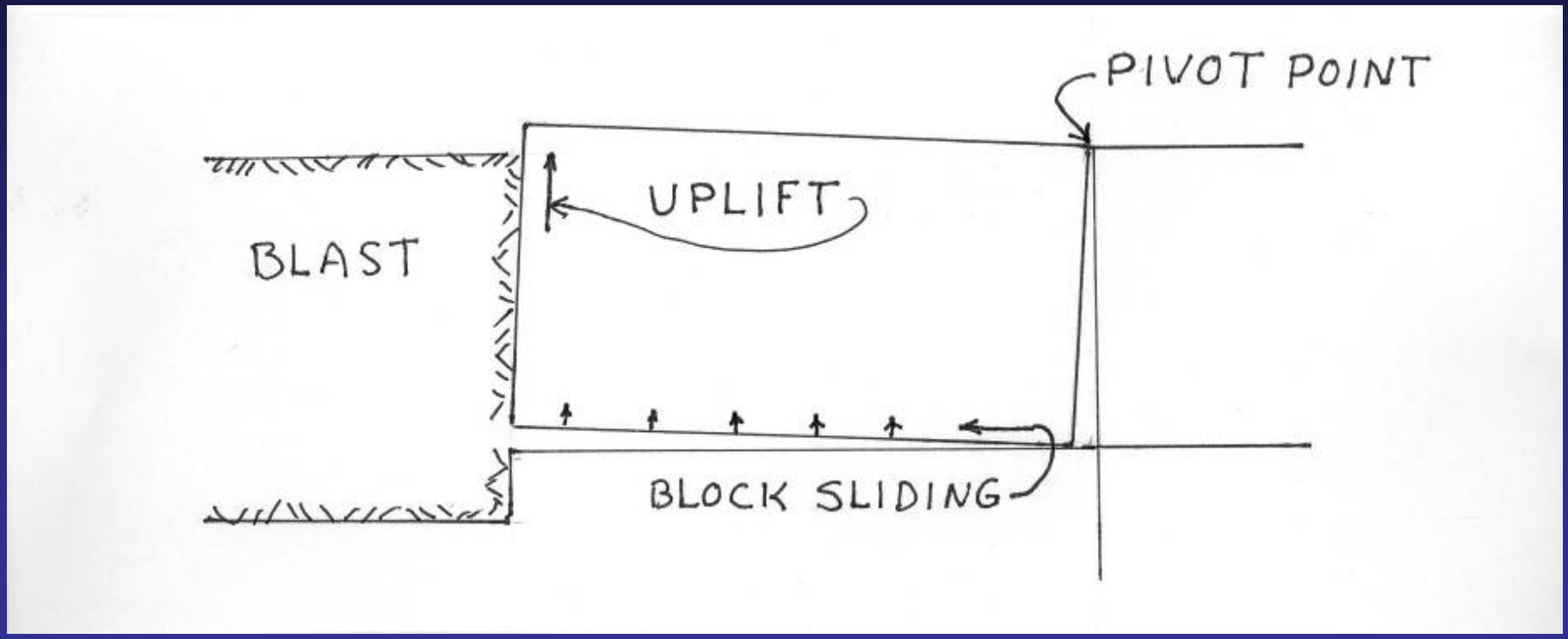


As presented by Dr. Matthew Mauldon

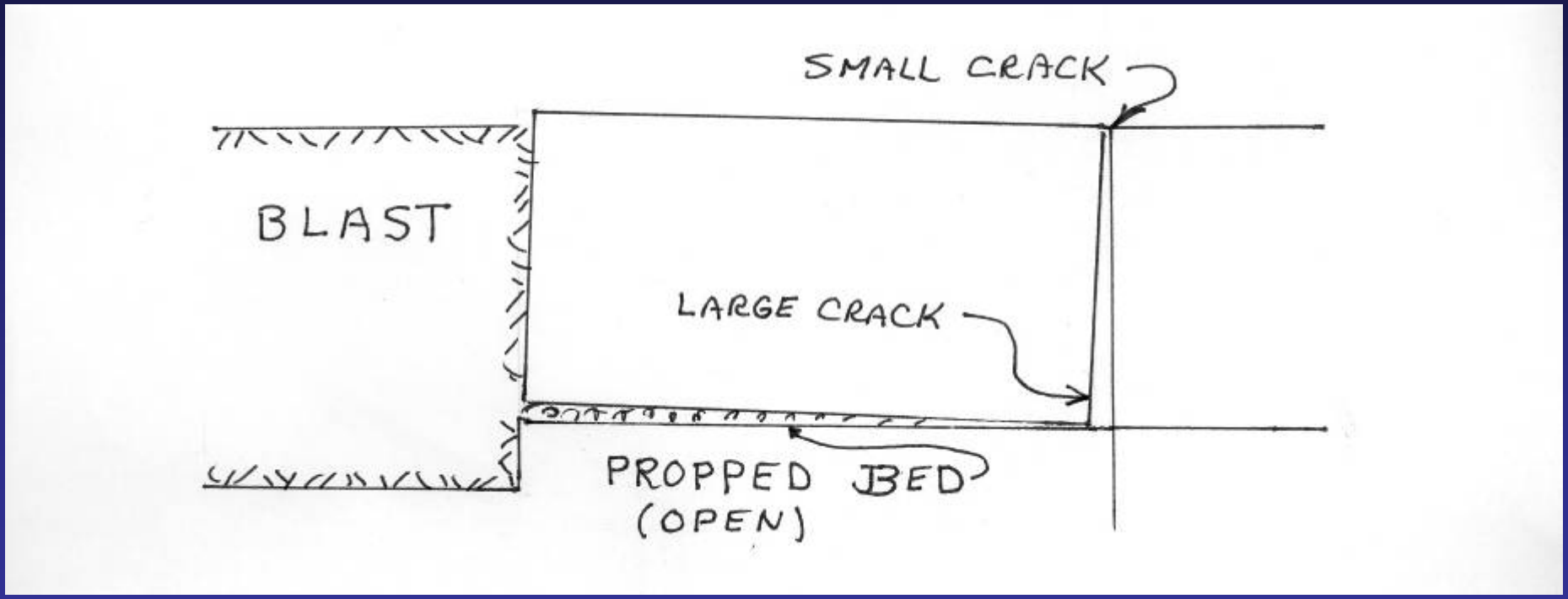
The right interpretation…



As depicted by Dr. Calvin Konya



As depicted by Dr. Calvin Konya



As depicted by Dr. Calvin Konya

Besides….

North Culvert Shots Adjacent to SM-8

North Culvert Shots Adjacent to SM-8

Gas coming out of fracture in adjacent SM-8 foundation

North Culvert Shots Adjacent to SM-8

North Culvert Shots Adjacent to SM-8

North Culvert Shots Adjacent to SM-8

North Culvert Shots Adjacent to SM-8

North Culvert Shots Adjacent to SM-8

North Culvert Shots Adjacent to SM-8

North Culvert Shots Adjacent to SM-8

Lessons Learned

When blasting, always use a proven method which promotes perimeter control, helping to protect the final rock surfaces.

Document every possible observation in detail, no matter how insignificant it appears to be at the time !

In order to make said observations, specify what is expected of the Contractor to maintain as clean a work site as possible.

QC procedures must be implemented and adhered to. Post-blast conditions must be observed so future blast designs are modified to prevent perpetuating problems.

Questions?