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Fundamental Concepts to Consider When Characterizing Melanges and Other Bimrocks

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AEG Short Course: Tunneling Through Fault Rocks and Tectonic Melanges: A Short Course for Engineering Geologists and Geotechnical Engineers

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Melange and Similar Bimrocks

- **Bimrocks:** block-in-matrix rocks
  - a mixture of rocks composed of geotechnically significant blocks within a bonded matrix of finer texture
- **Melanges:** UNCHILE geological mixtures of competent blocks composed of sedimentary/ metamorphic blocks in weaker matrix of sheared shale /serpentinite
- **Similar Bimrocks**: Fault Rocks, Breccias, Lahars, Tillites, etc.

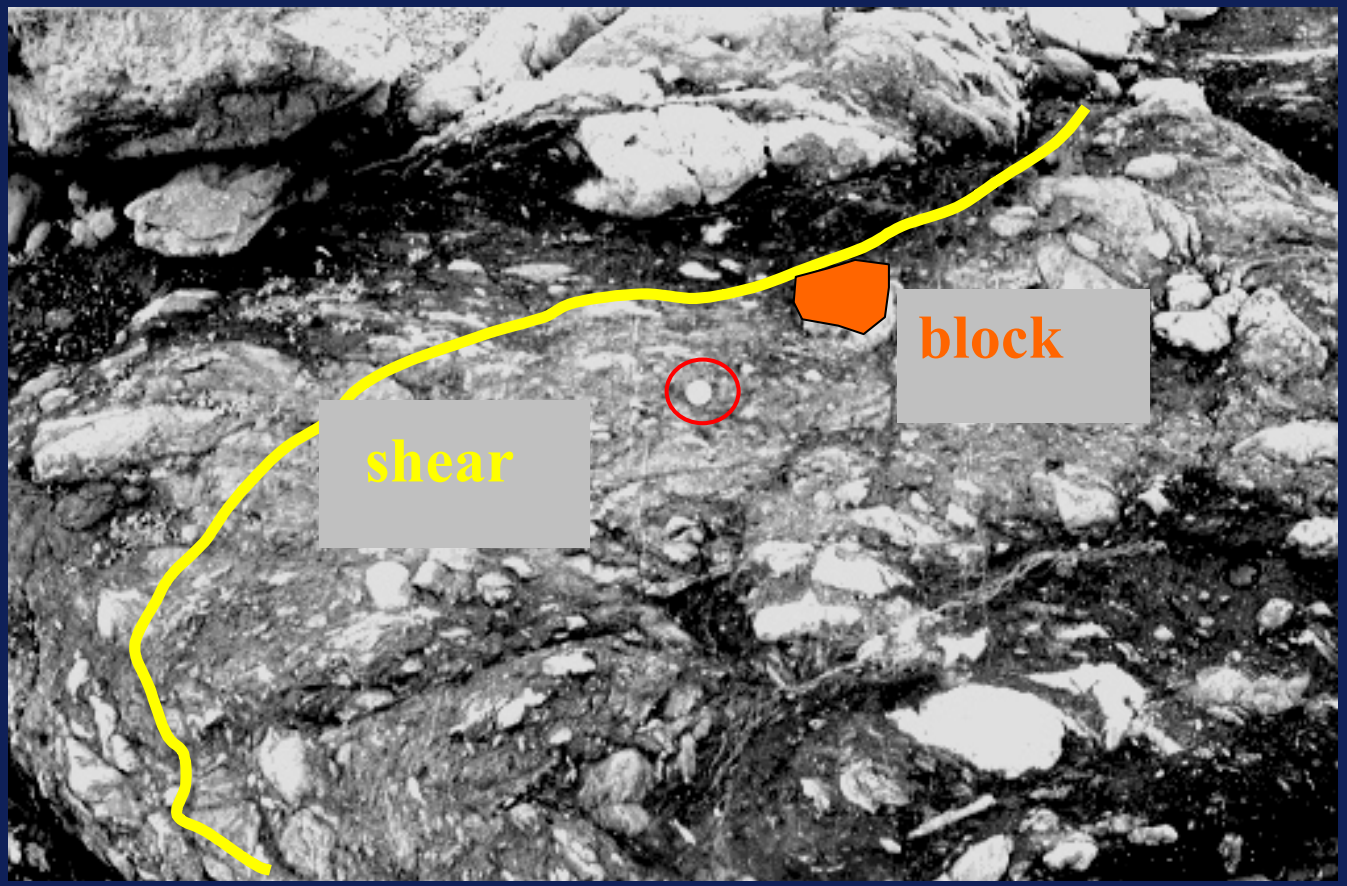
Melange: geological mixture with polylithologic blocks ranging in size from sand to mountains: Blocks in the Gwna melange, Anglesey, North Wales

Gwna Melange, North Wales

Franciscan Complex,

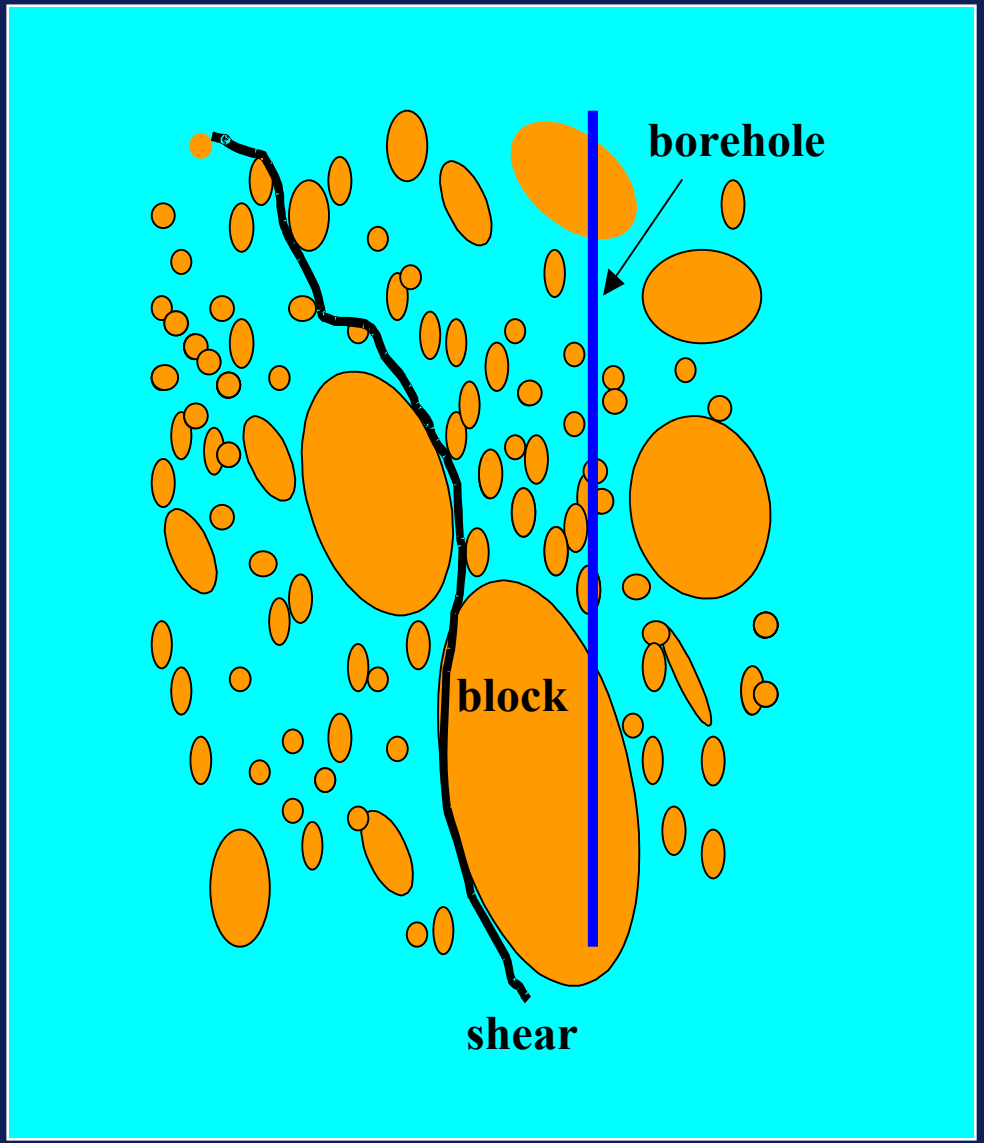
El Cerrito, California

Franciscan Complex melange (Point Delgada, California)

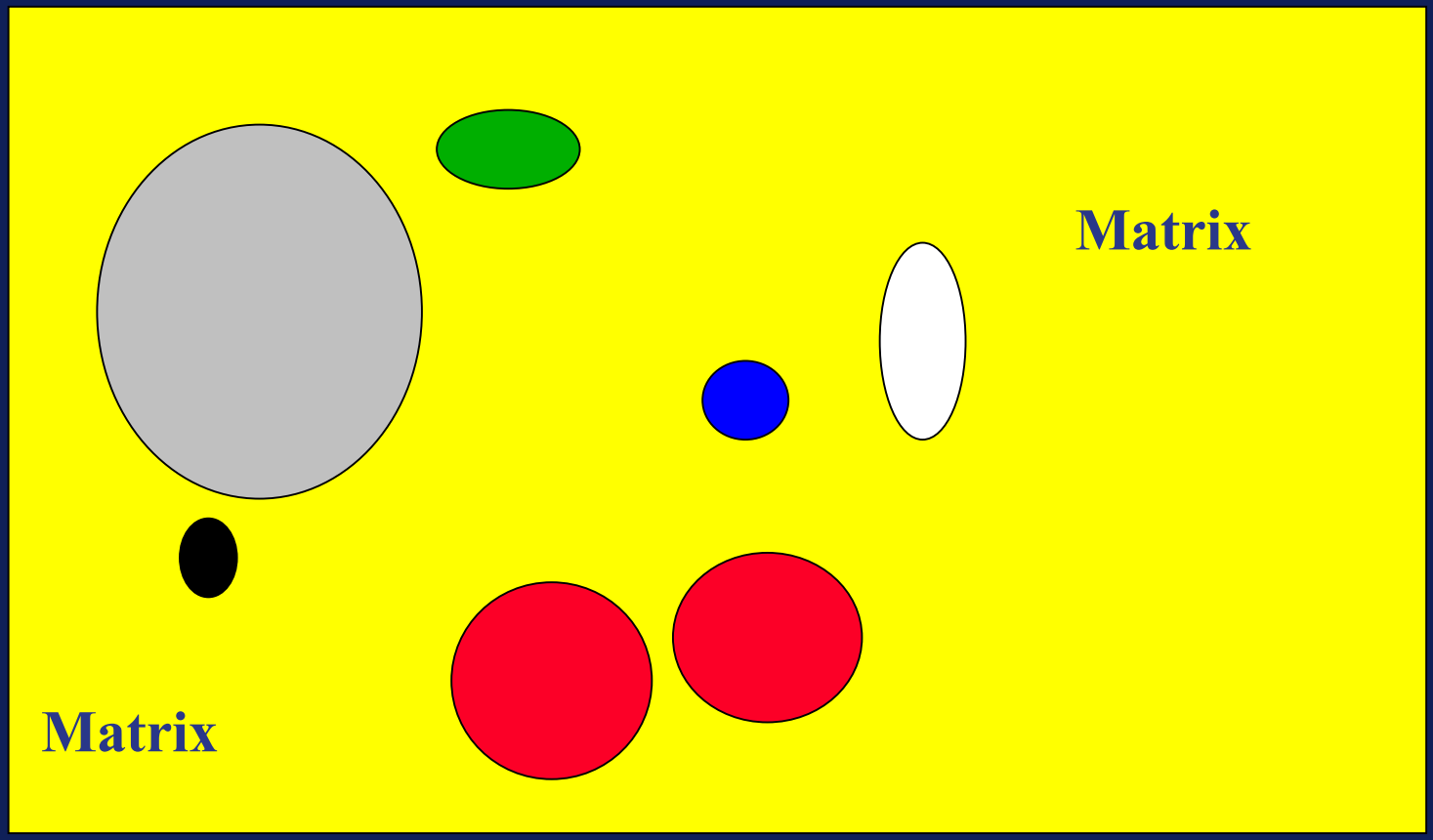


A real problem !!

We can only characterize three-dimensional chaos with one-dimensional boreholes and two-dimensional plans and cross-sections……

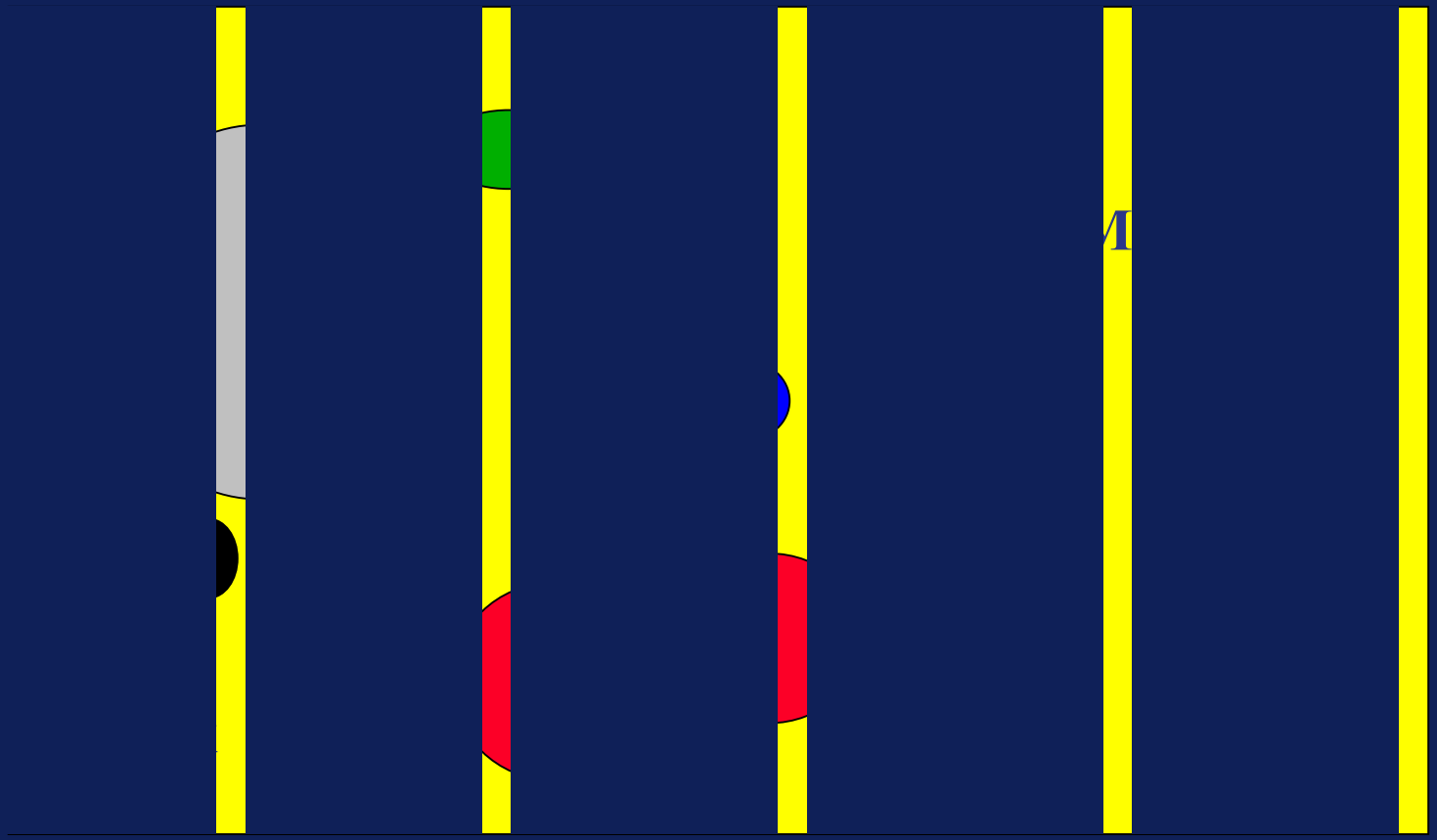


Exploring Bimrocks is NOT a piece of cake….



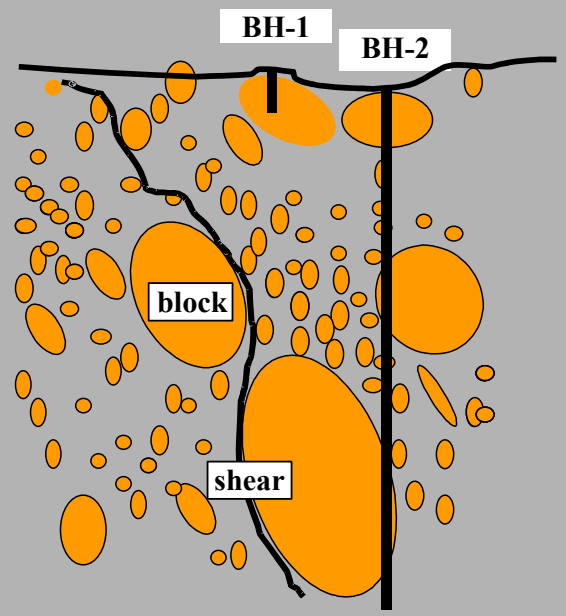
Willis, 2000; after Medley, 2000

Bimrocks as Mapped, or as drilled and cored



Willis, 2000

Exploring melanges: they are obvious!!!



log of BH-2

sandstone
shale
sandstone
shale
sandstone
sandstone and shale
greenstone
shale
chert
shale
serpentinite

Looks like, but IS NOT, "inter-bedded shales and sandstones"*

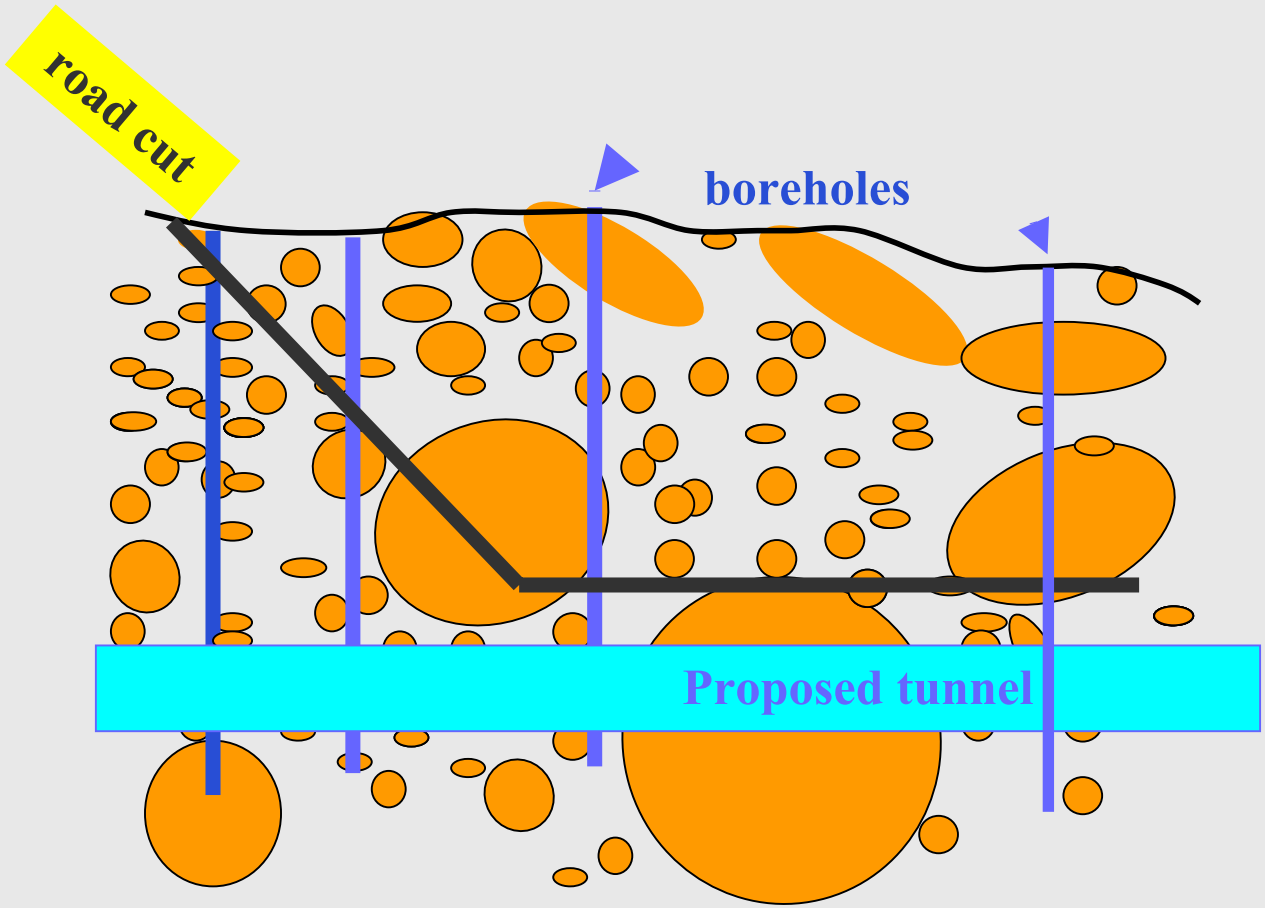
Big Clues

*Also beware terms like: "soil with boulders". "miscellaneous soils"

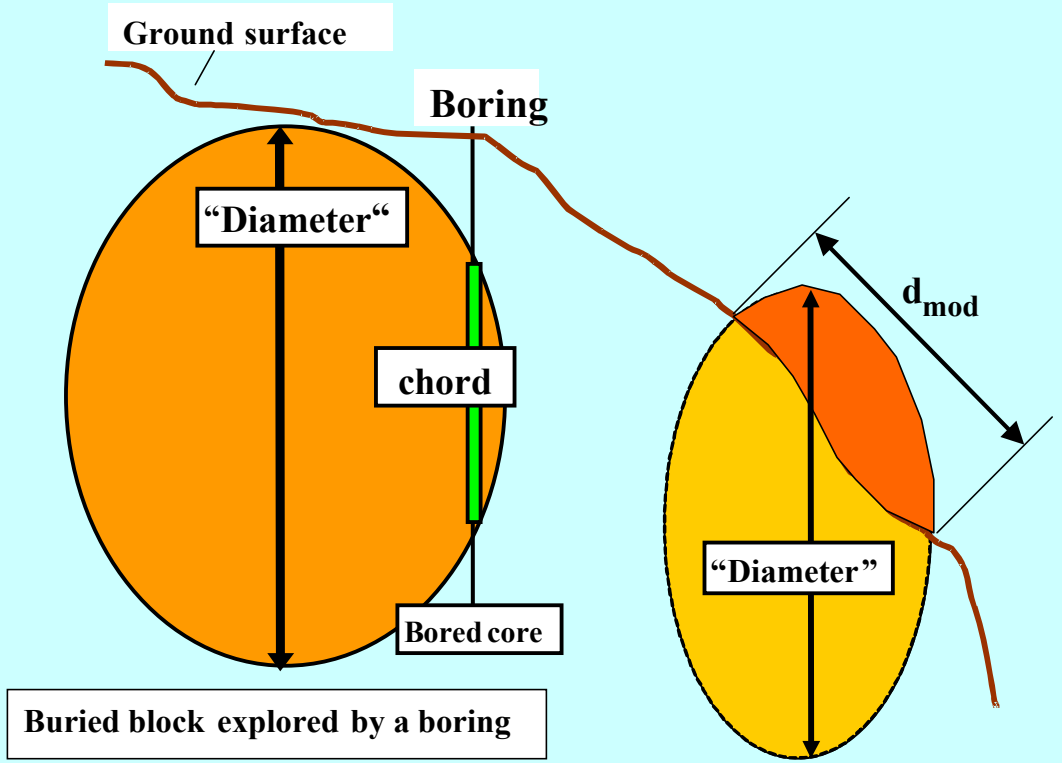
The complexity of a turbidite sequence - REAL interbedded sandstones and shales

(Devil's Slide, Pacifica, California)

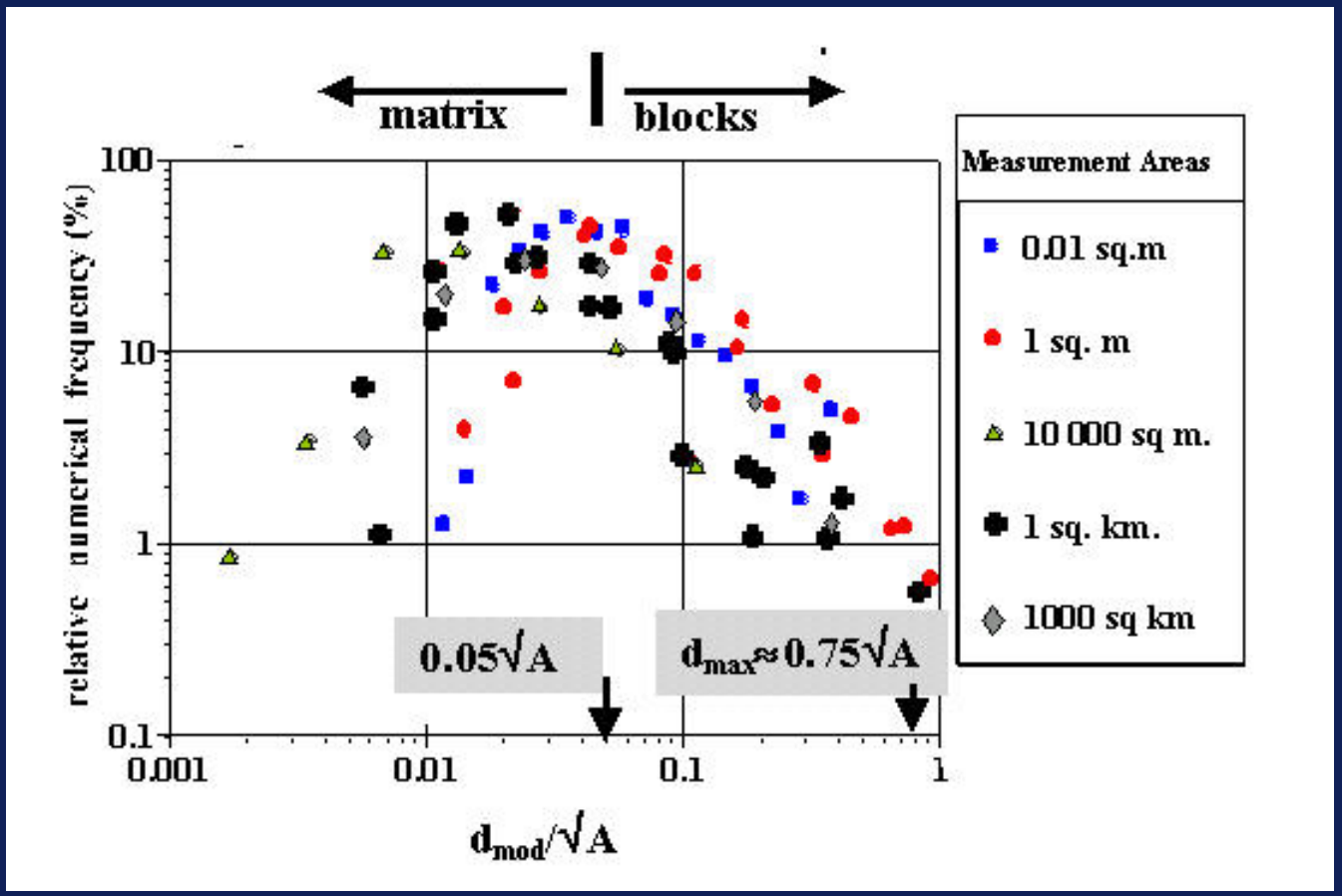
When investigating think BLOCKS!!



The "size" of blocks



Scale-independent block size distributions of Franciscan melanges



Medley, 1994

Q: What is Block/What is Matrix?

For any rock volume use an appropriate scale to determine block/matrix threshold, such as

- $\sqrt{A}$
- Size of largest mapped block (d_{max})
- Some *characteristic engineering dimension* (L_c)

  (tunnel diameter; thickness of landslide; diameter of laboratory specimen, etc.)

Use these guidelines at *any scale of interest*

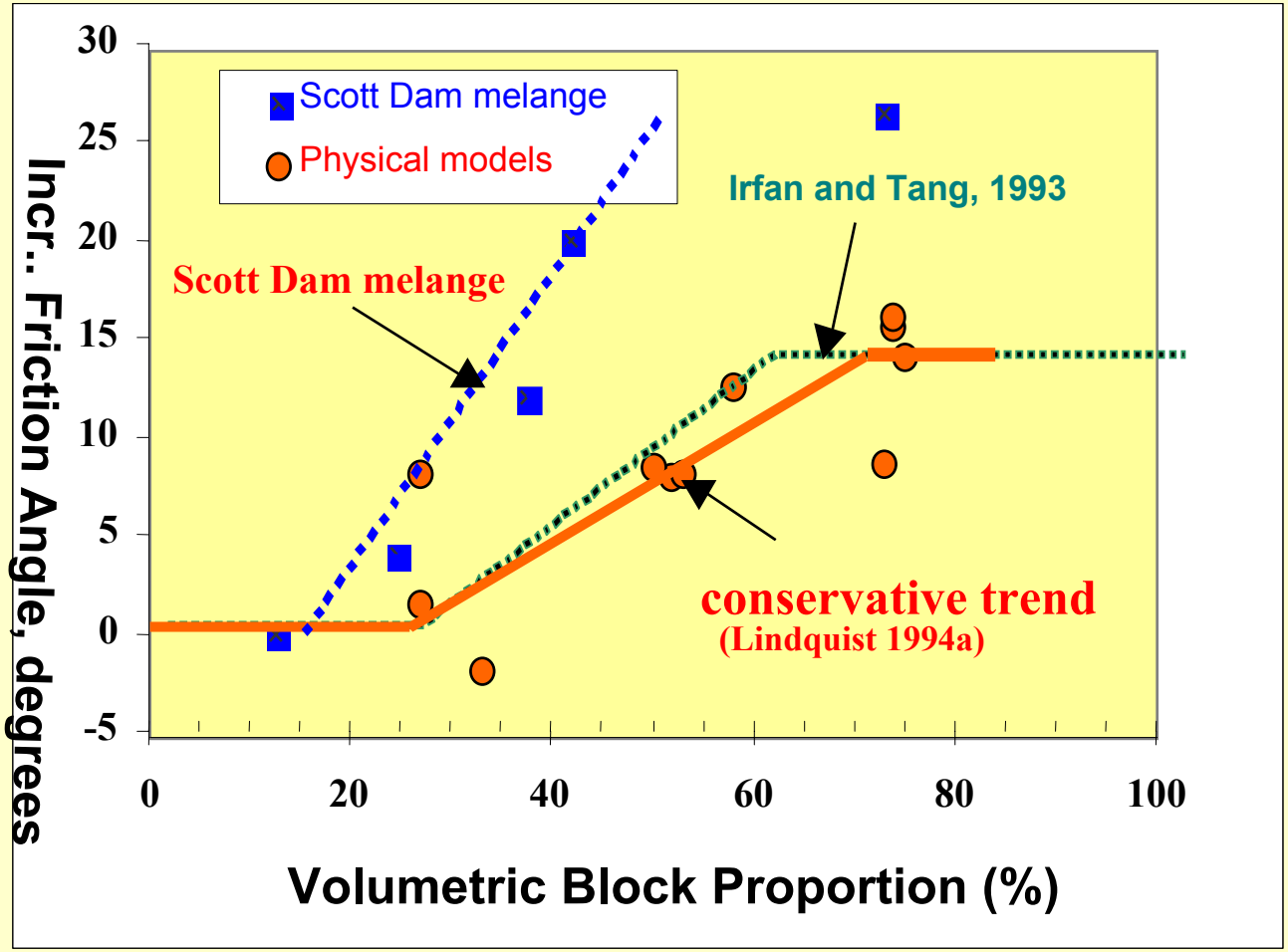
- **smallest blocks are:**

  $0.05L_c$ or $0.05\sqrt{A}$ or $0.05d_{max}$

- **largest block is:**

  $0.75\sqrt{A}$ or $0.75Lc$ or $0.05d_{max}$

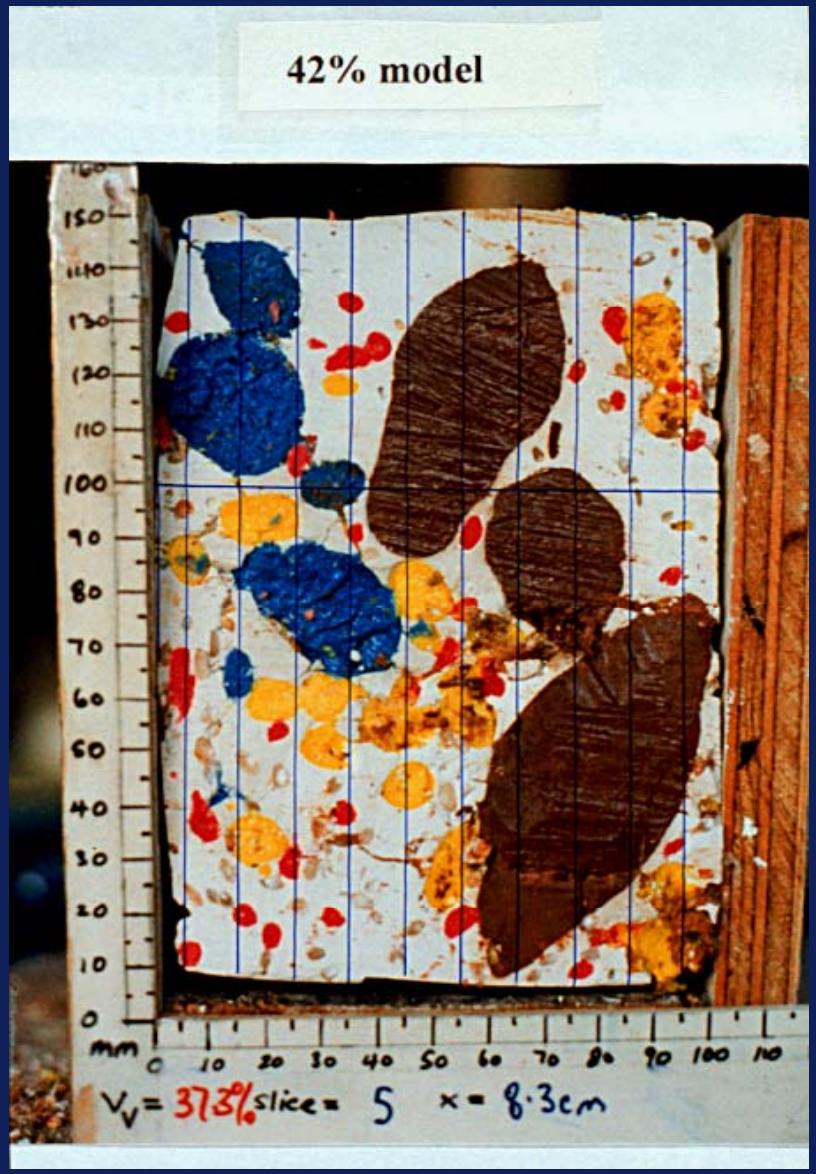
Strength of bimrock depends on volumetric block proportion



Estimation of volumetric block proportions

- Determine linear proportion from drill core
- Apply stereological principle:

  linear proportion = volumetric proportion
- TRUE ONLY when you perform lots drilling/$$$) so beware uncertainty (error)

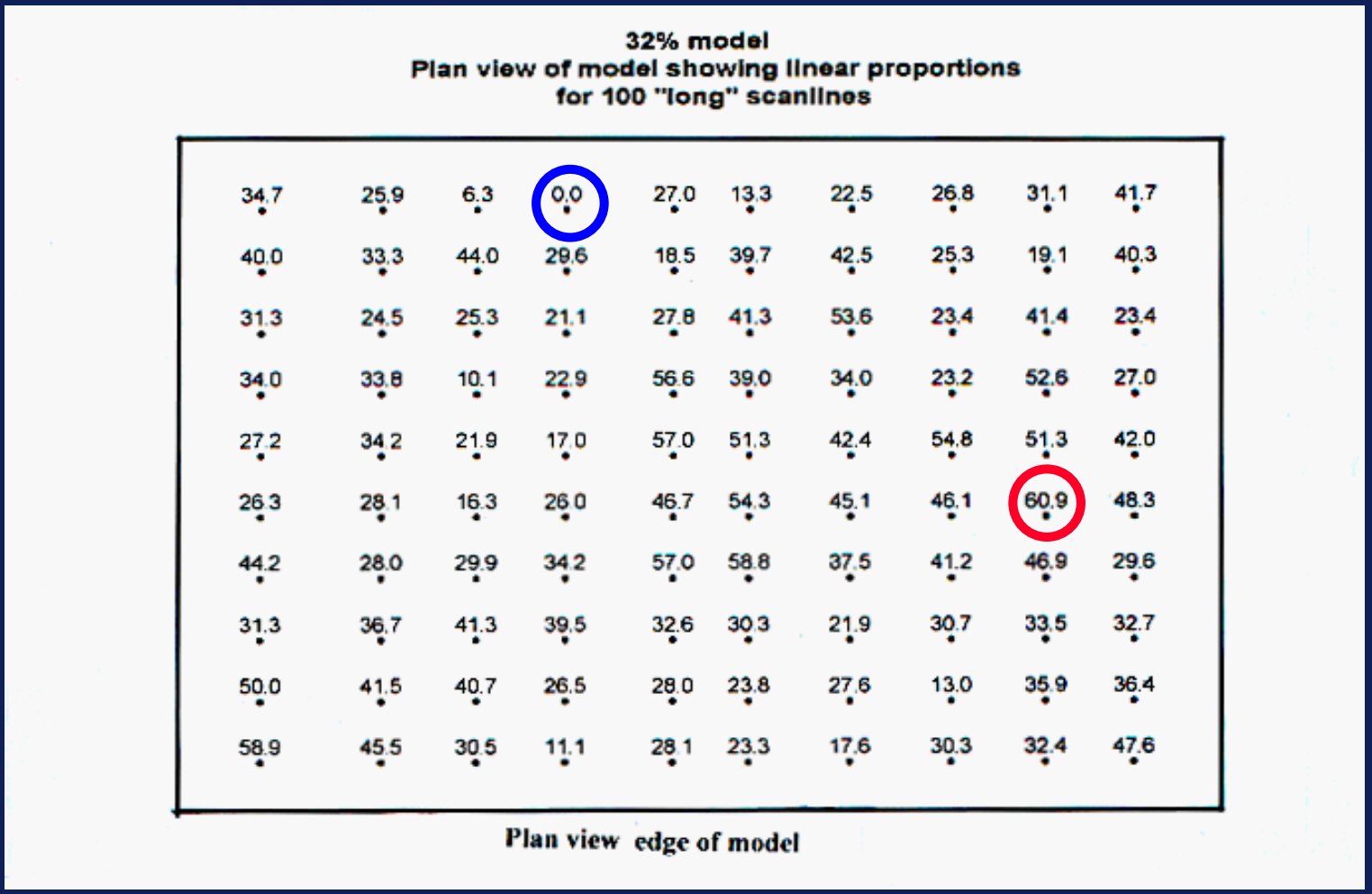


Estimating volumetric block proportion: how true is our estimate using a few boreholes?

Slice of a physical model bimrock with a known volumetric block proportion and block size distribution, explored by model boreholes.

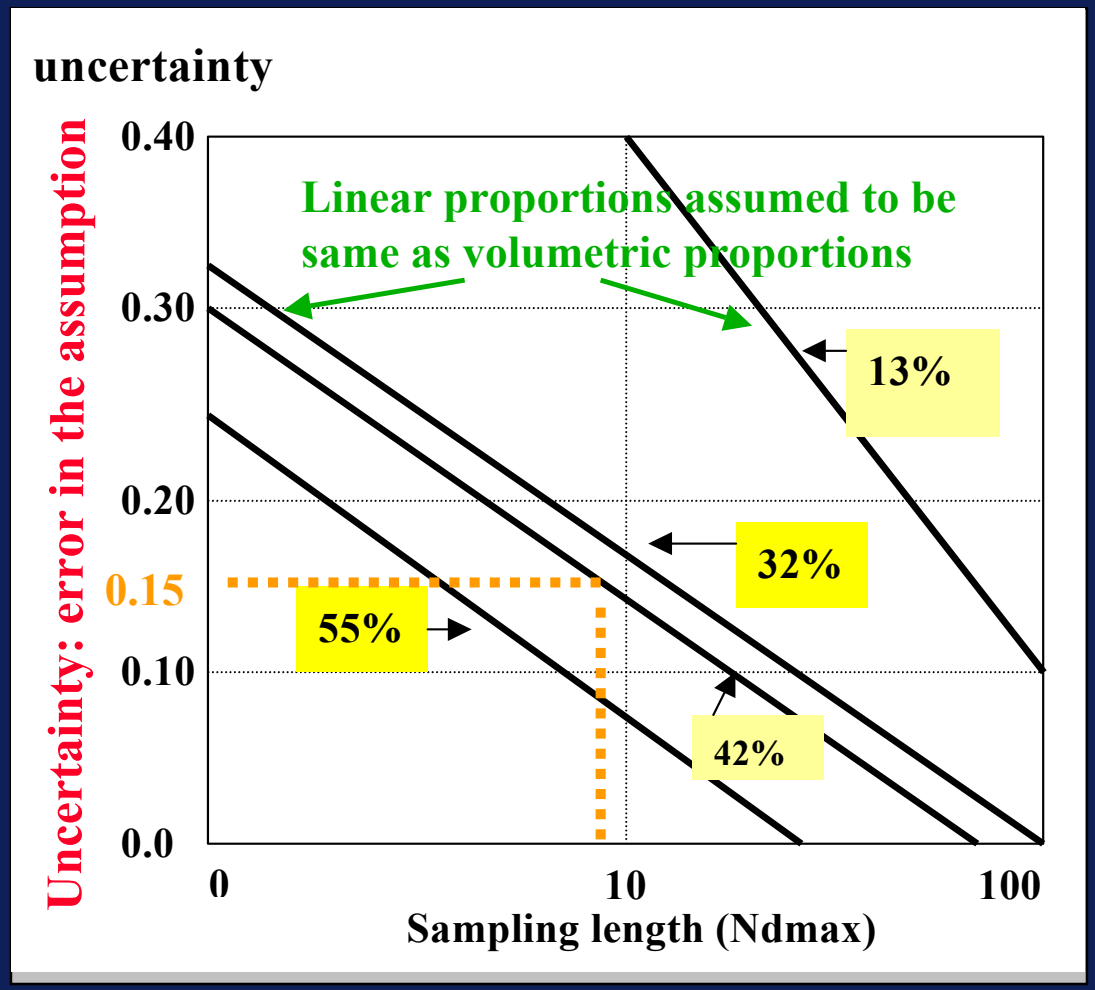
……. or, how wrong can we be?

Actual volumetric proportion is 32%



Guidelines for estimating block volumetric proportion

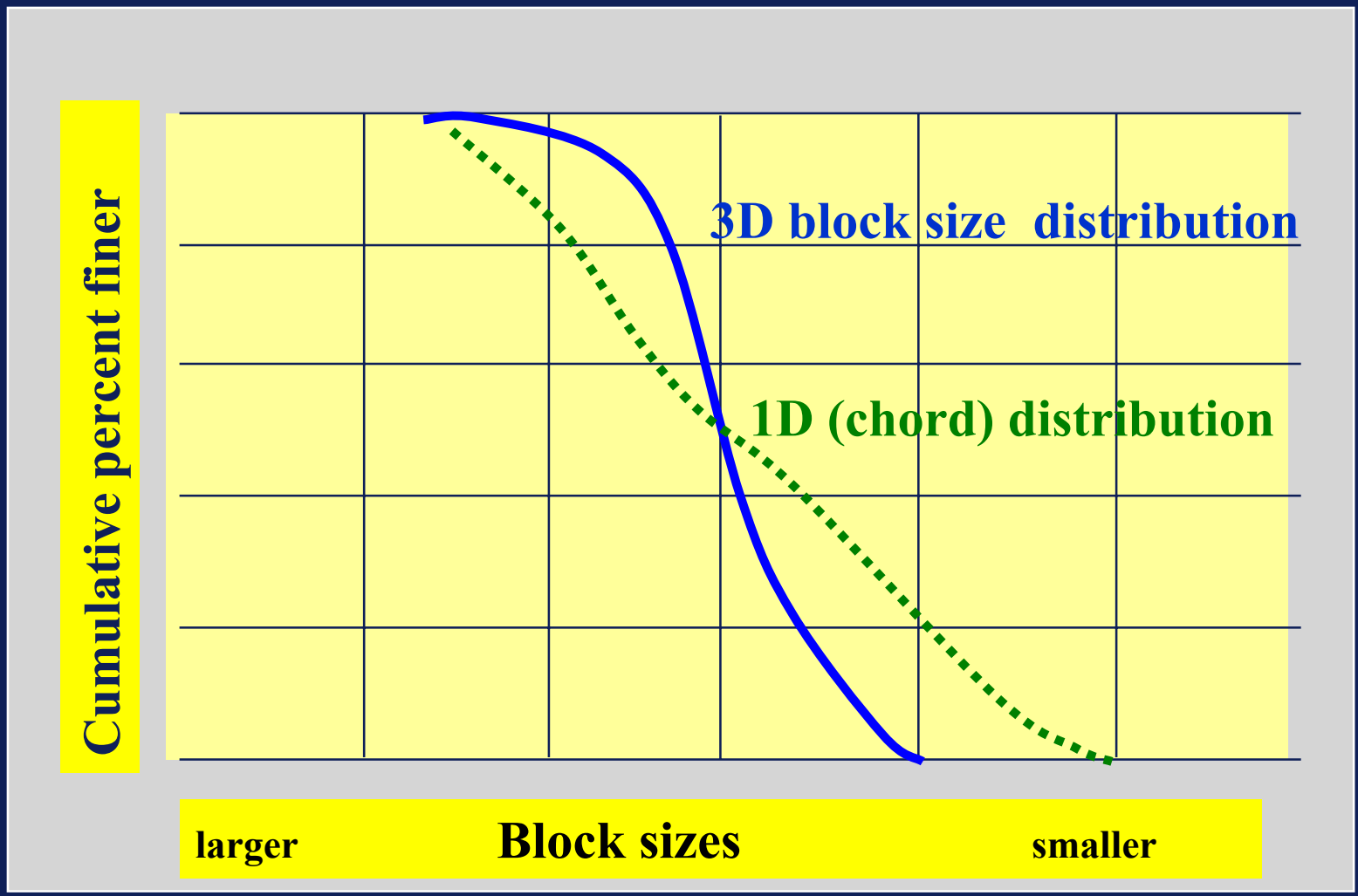
- Measure at least 10* d_{max} of drill core (e.g.: $7.5\sqrt{A}$)
- Take uncertainty into account, and:
  - adjust vol% estimate downwards for strength
  - adjust vol% estimate upwards for construction excavation purposes



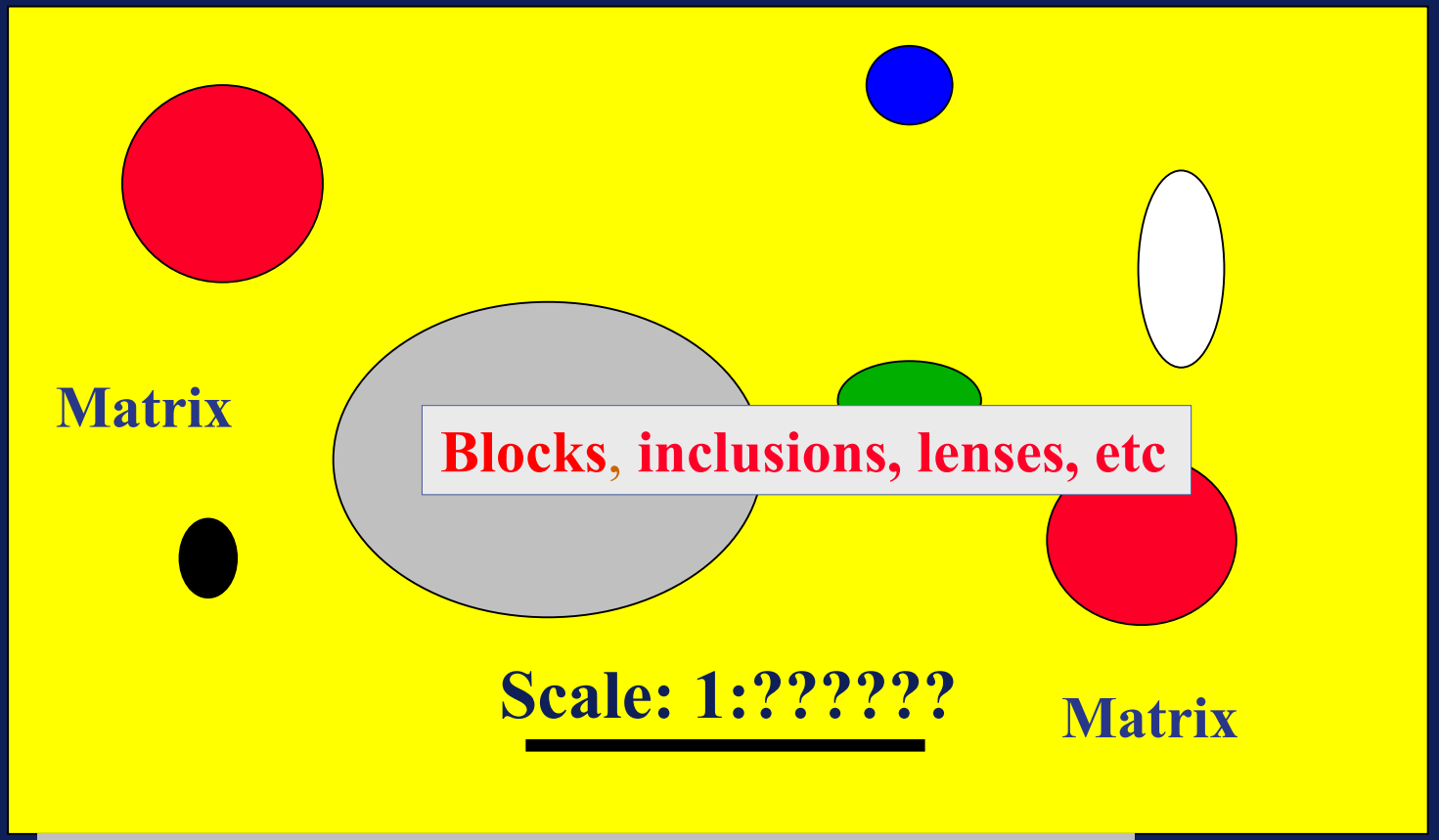
Estimating volumetric properties on the basis of linear boring measurements

0.15x40% = 6%: use 34% block proportion

3D and 1D Block Size Distributions

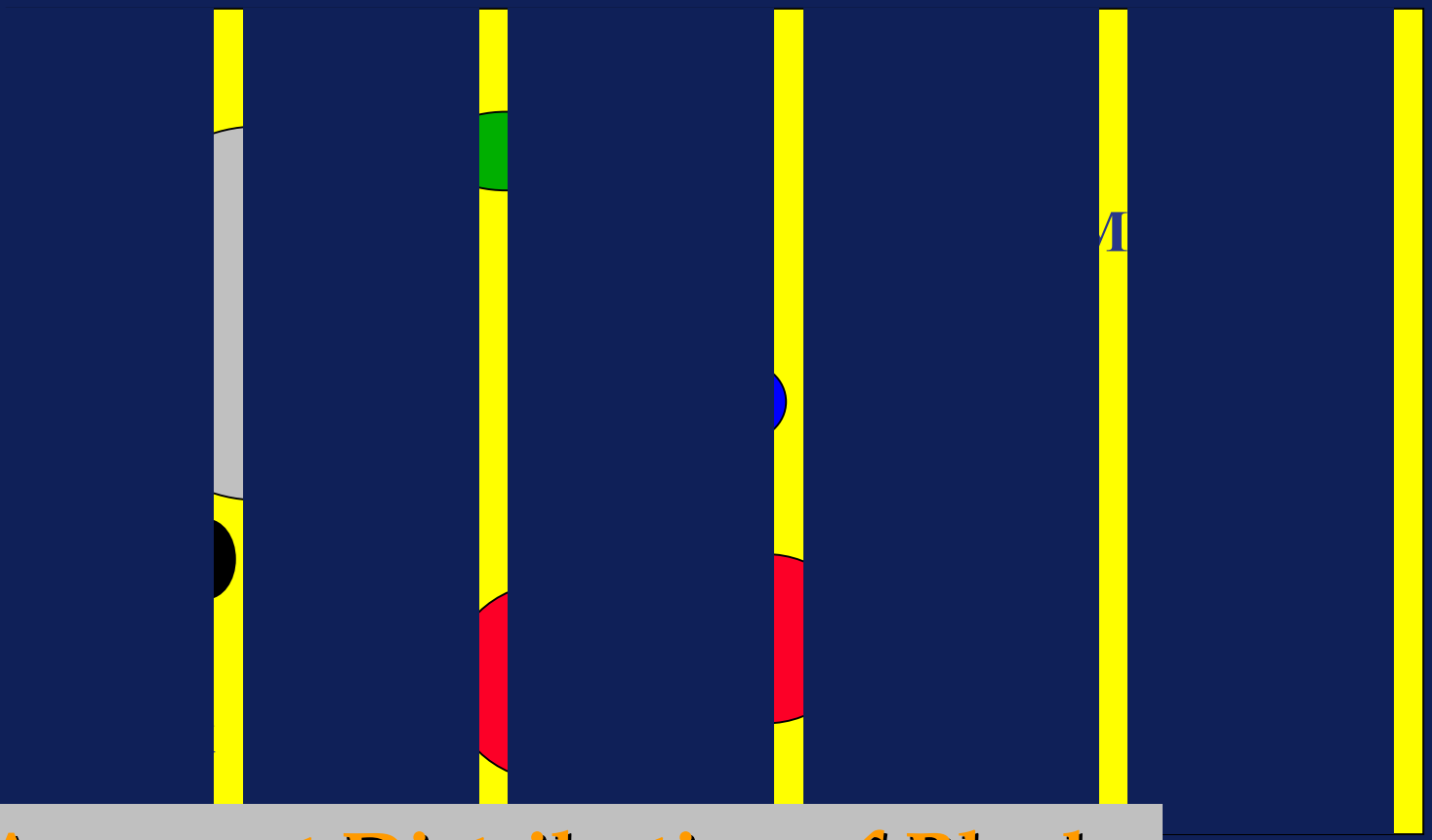


BIG CONCLUSION 1:
Remember this picture!!!



Actual Distribution of Blocks

BIG CONCLUSION 2:
Remember this picture as well!!!



Apparent Distribution of Blocks

Willis, 2000