WISE AFTER THE EVENT

Some reasons why we need more and better engineering geology and geotechnics

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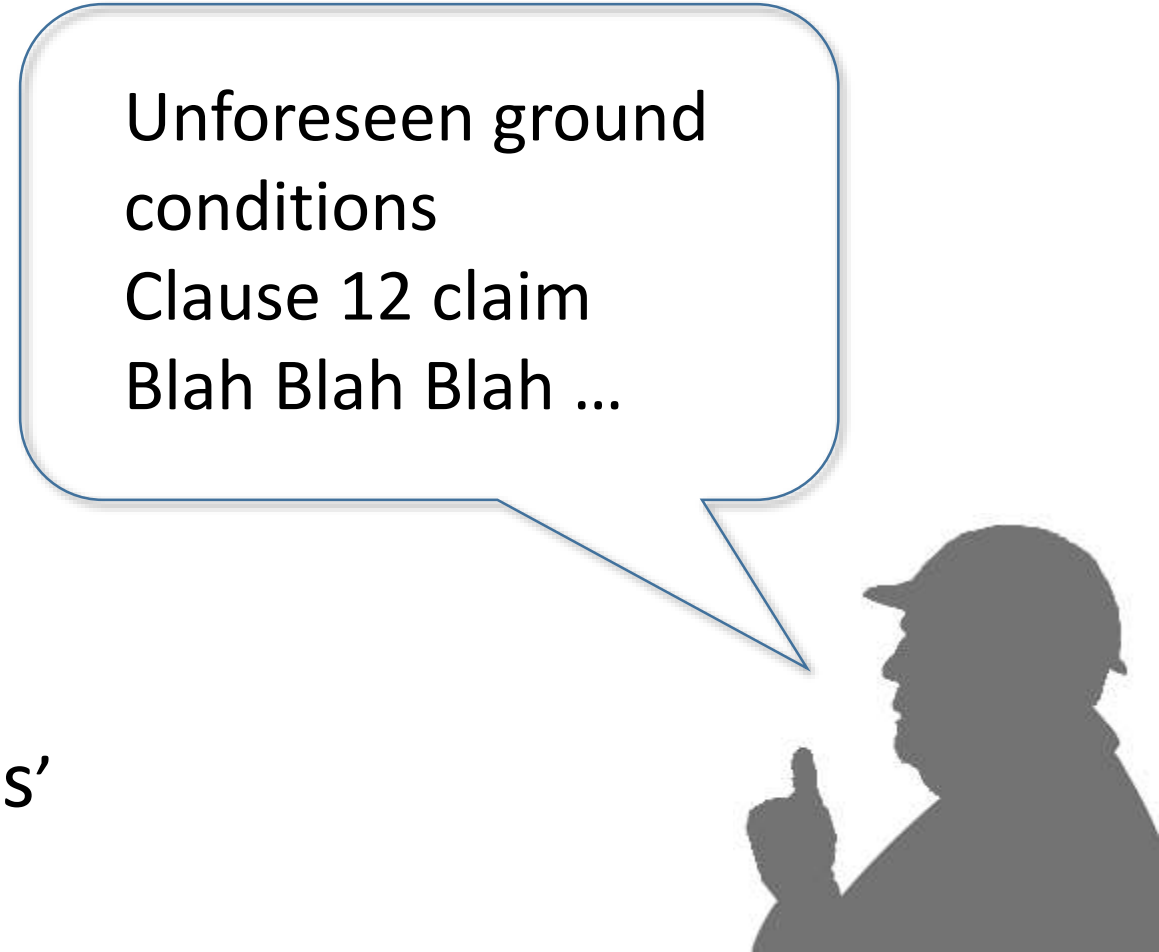
***Ex* Kingston University, 1973-2012**

Failures and delays in ground works …

- Add to cost
- Diminish reputation
- Give rise to litigation
- May involve safety issues
- Can involve third parties



- Provide work for overpaid ‘experts’

Education and Training

- Then:

longer terms, more hours,

more laboratory work,

more field courses, smaller groups

stricter assessments (and more of them)

Now: ….

At least there is now emphasis on safety, PPE etc

Equipment and methods

Then:

Shell and auger

Big firms

Now:

Shell and auger

Fencing

PPE

Site toilets

Subcontractors

Testing, testing, testing, 1, 2, 3, testing …

Then:

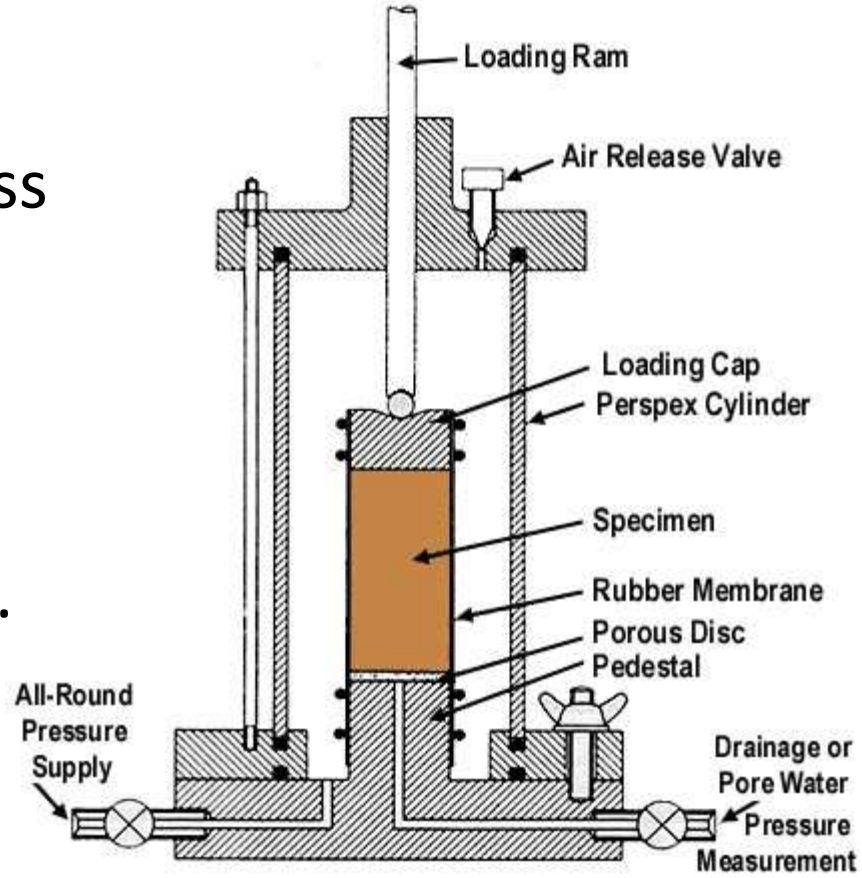
Wimpeylabs in Hayes could do 100 effective stress triaxial tests simultaneously

Now:

300 pages of contaminated land chemical tests …

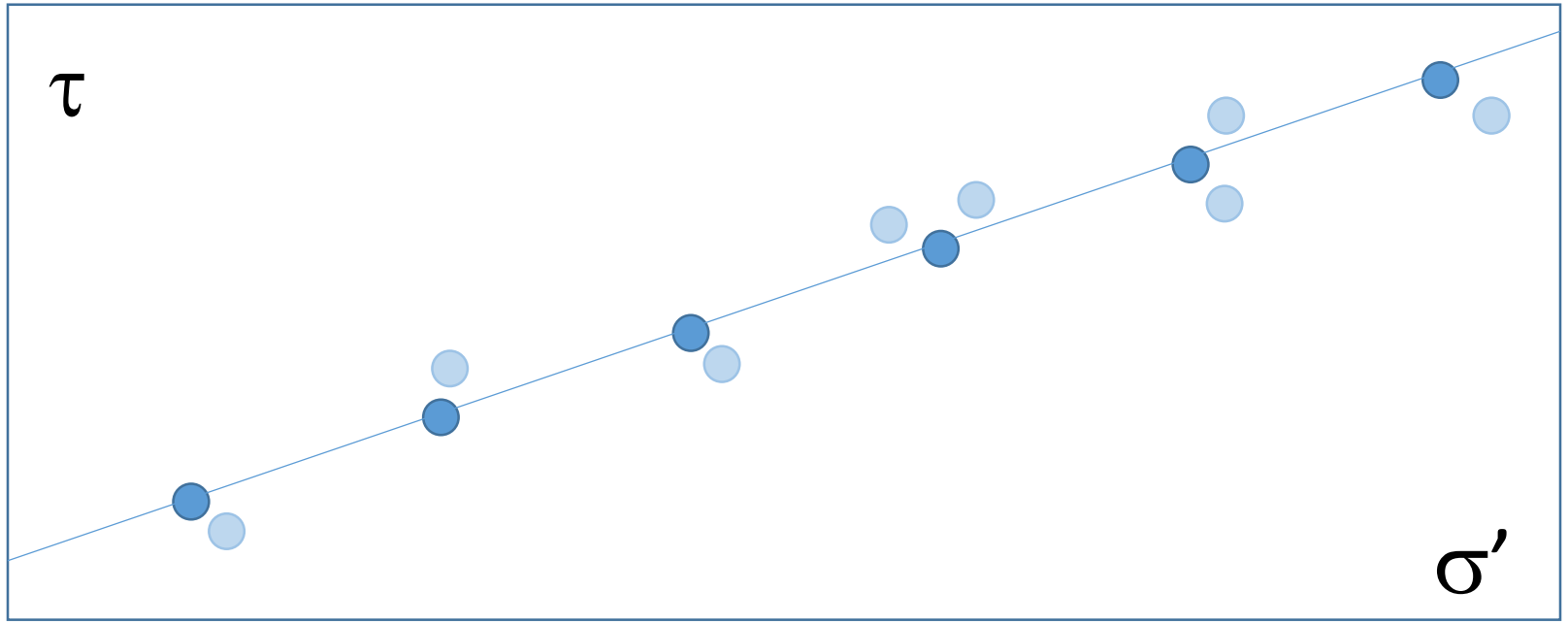
Everything seems to be correlated to SPTs

Bad testing practice is rife – if any is done at all



Soil properties variability and measurement error

- If the variability is measurement error, we can take the mean



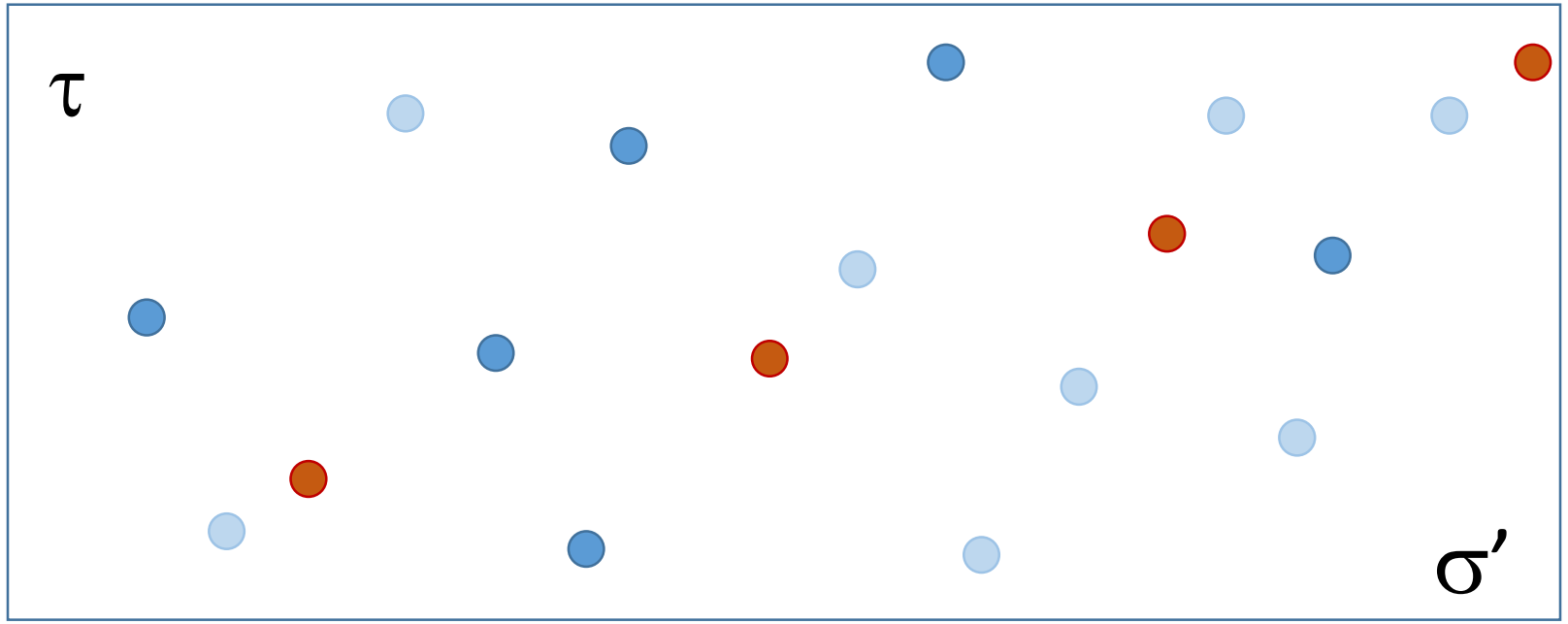
More data gives more confidence

Pick any 3 points, and fit a line …

Then what do you get for c', ϕ' ?

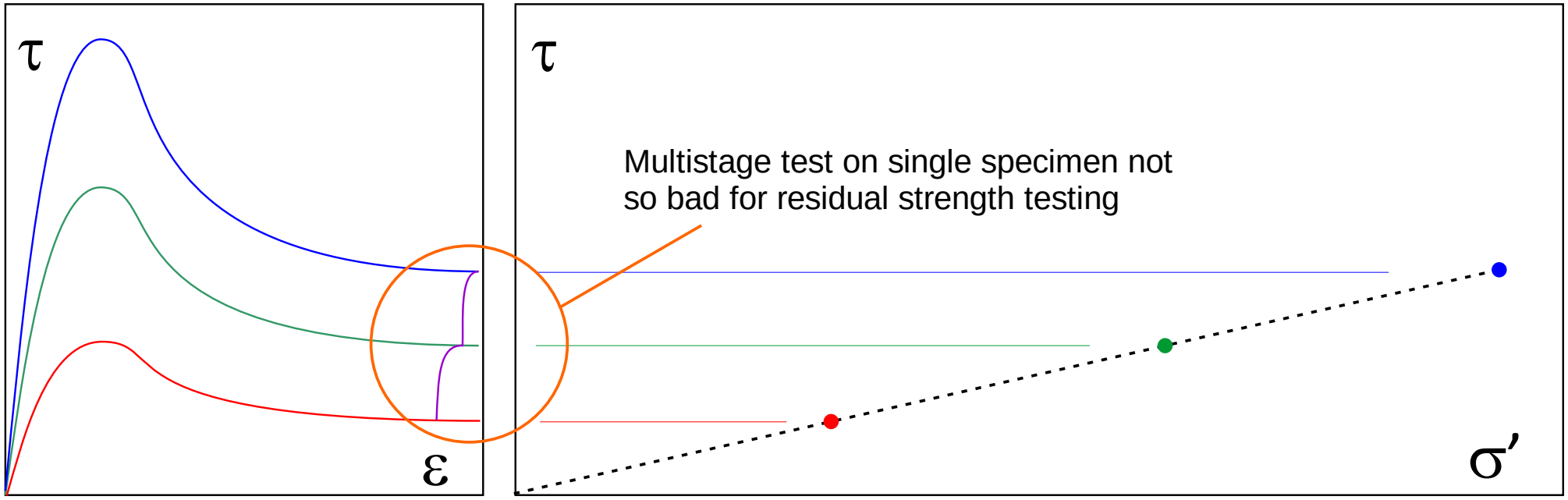
Soil properties variability and measurement error

- If the variability real variability, what does the mean mean?



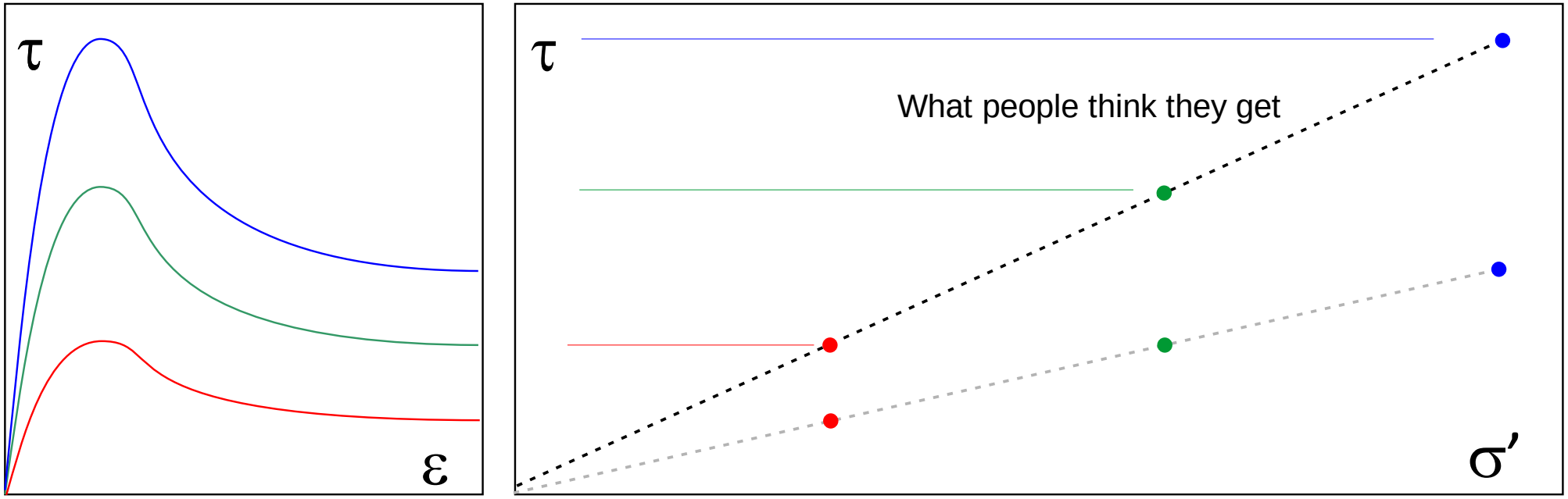
More data gives more understanding

Beware the ~~Jabberwock~~ multistage test, my son*



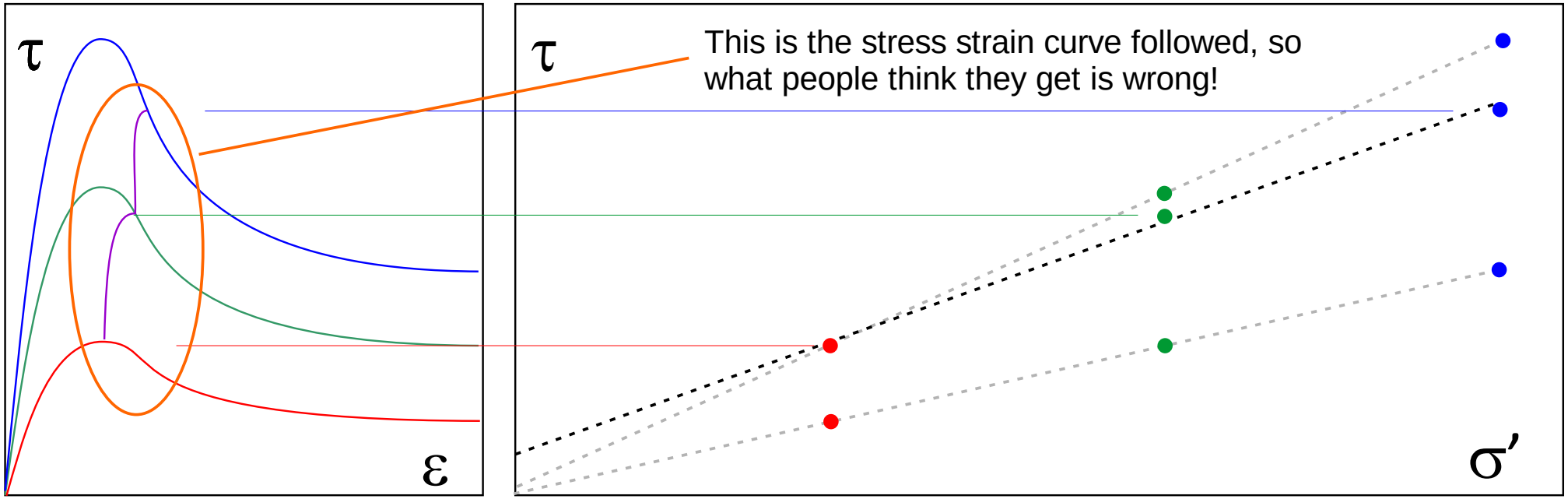
* Lewis Carroll

Beware the multistage test



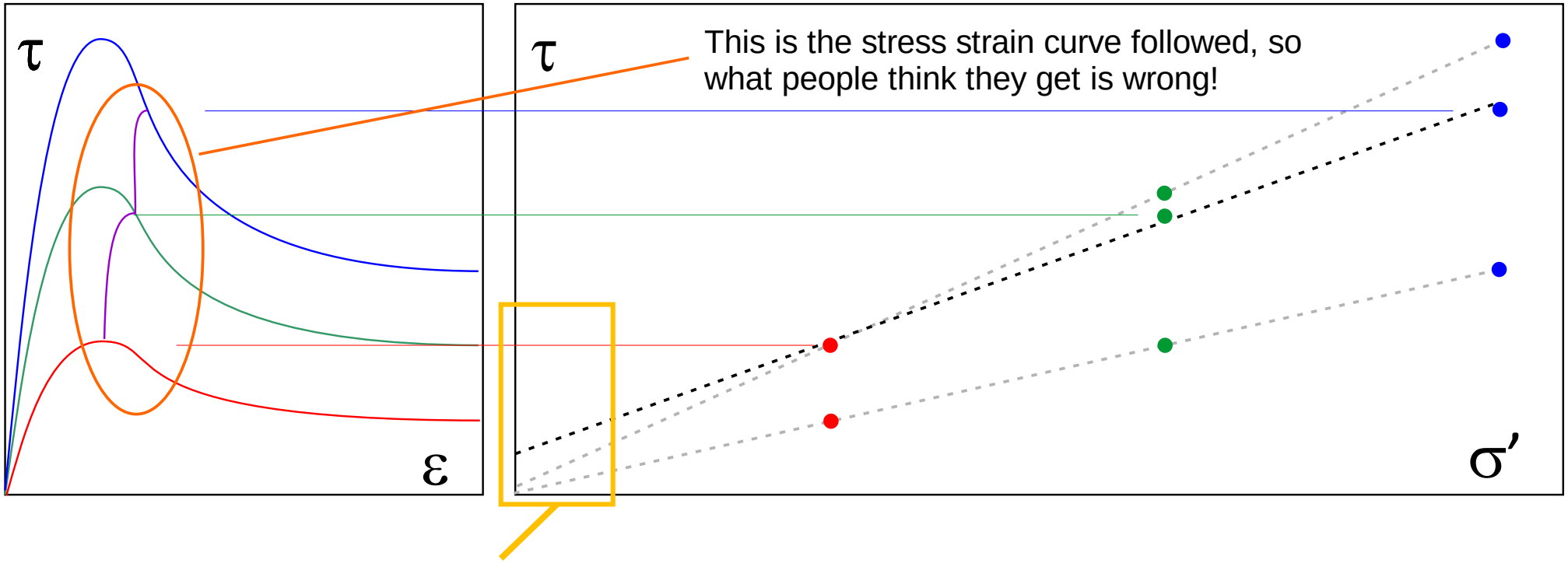
And it probably is, if 3 separate specimens tested
(although real data is never this good)

Beware the multistage test

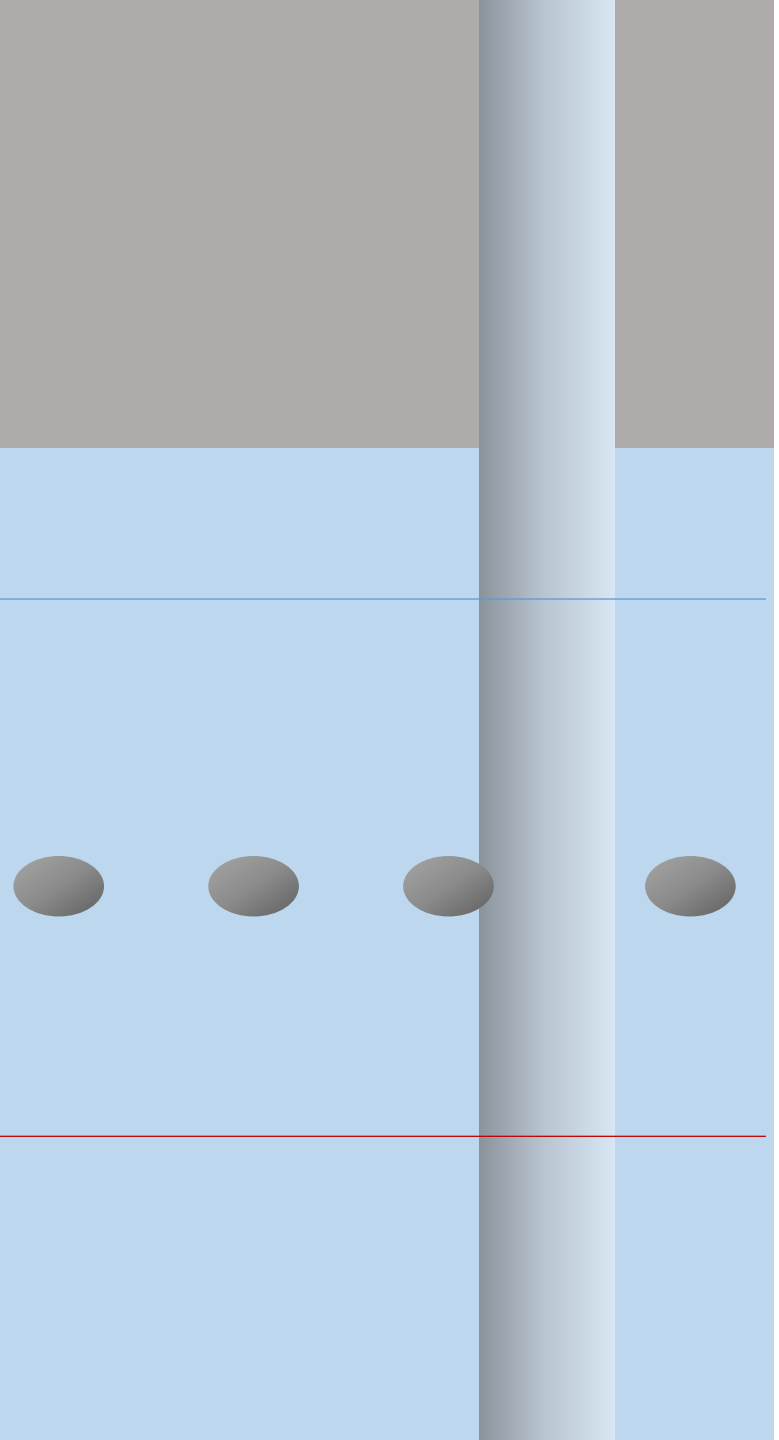


So what, doesn't this underestimate ϕ', and so it is safe?

Beware the multistage test



No, because at field stress levels, the increase in c’ overestimates strength



Does it matter?

Weathering or lithological junction	Seen in driller's description
Thin weak zone	Commonly ignored
Nodular band	May not even be seen
Thin strong zone	Usually recorded – as a pretext for extra payment

Type of structure

Building foundations

Basement or retaining wall

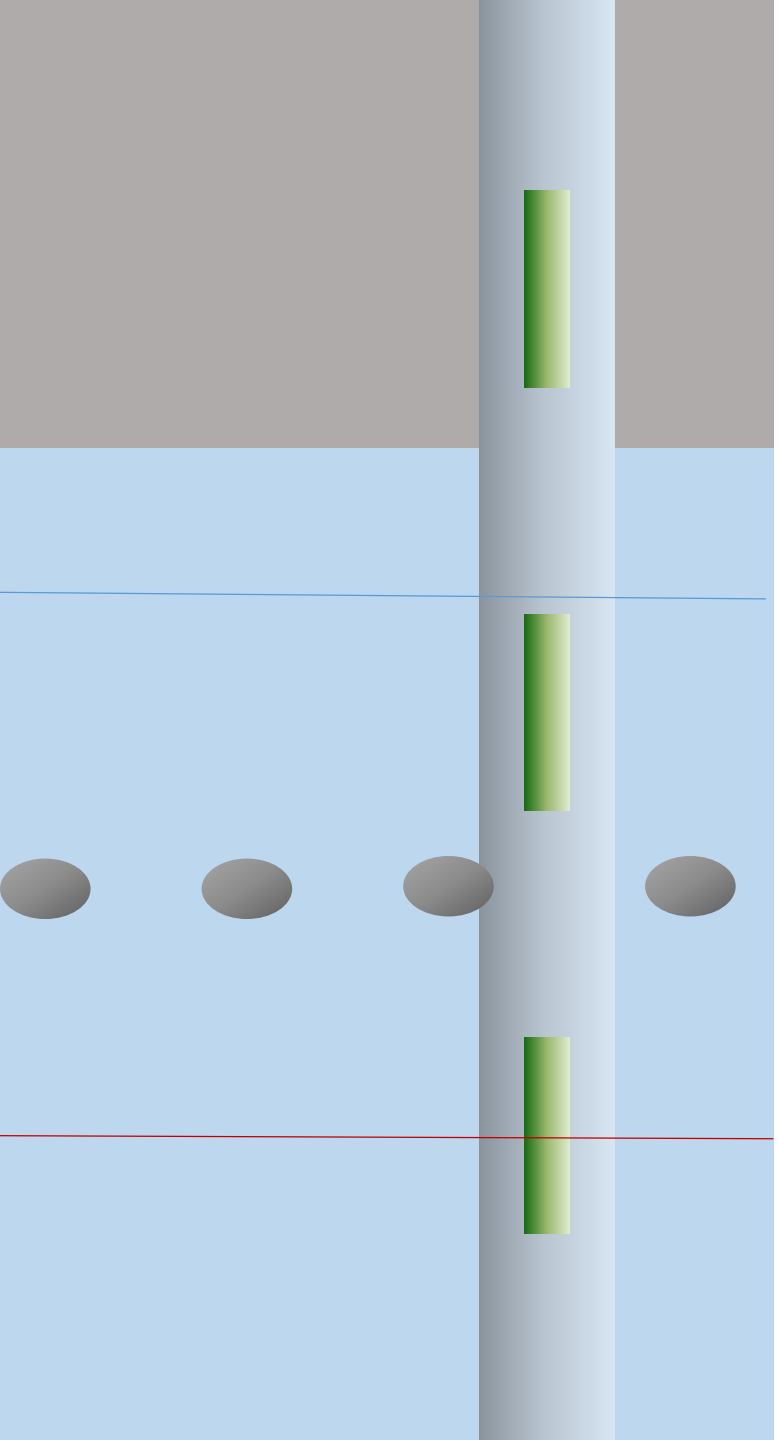
Slope

May seriously affect:

Slope stability

May seriously impede:

Building foundations
Piles
Sheet piles



Will I find it?

Weathering or lithological junction	Yes: Driller's description
Thin zone	No: if between samples
Nodular band	Yes: but only if in borehole
Thin zone in sample	No: if sample is used for lab test, not described or even discarded

Laboratory tests not normally done:

Microscope examination

Clay mineralogy

Palaeontology

Not always done:

Index tests and clay fraction

Activity

Interpreting the geology

Sometimes the geology is stratified so that it is possible to interpolate between boreholes with straight lines (although not in the landslides)

Barton Beds

Chale Bay, Isle of Wight

Deceptive rockhead

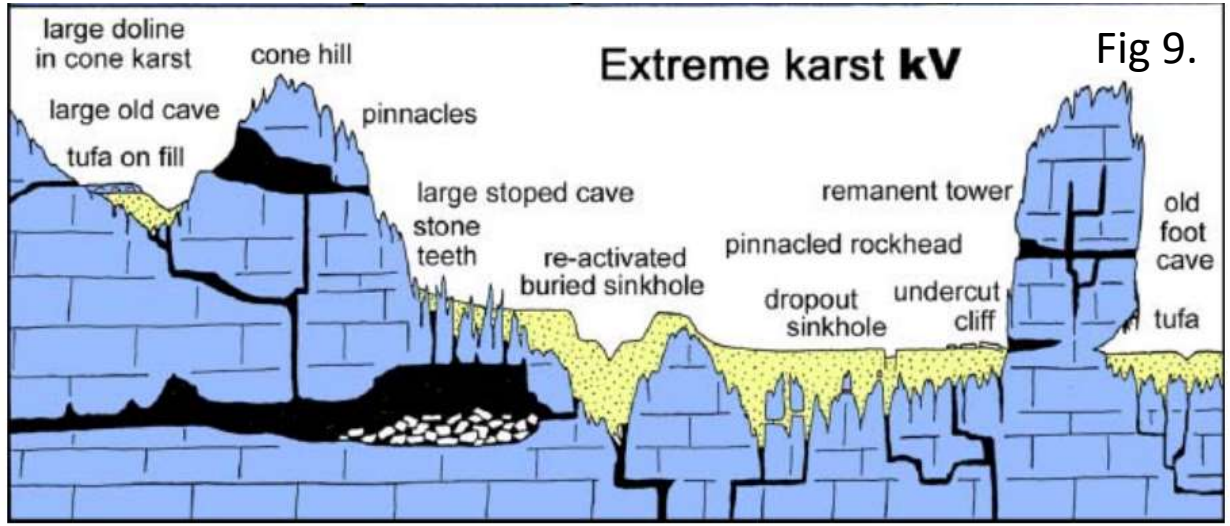
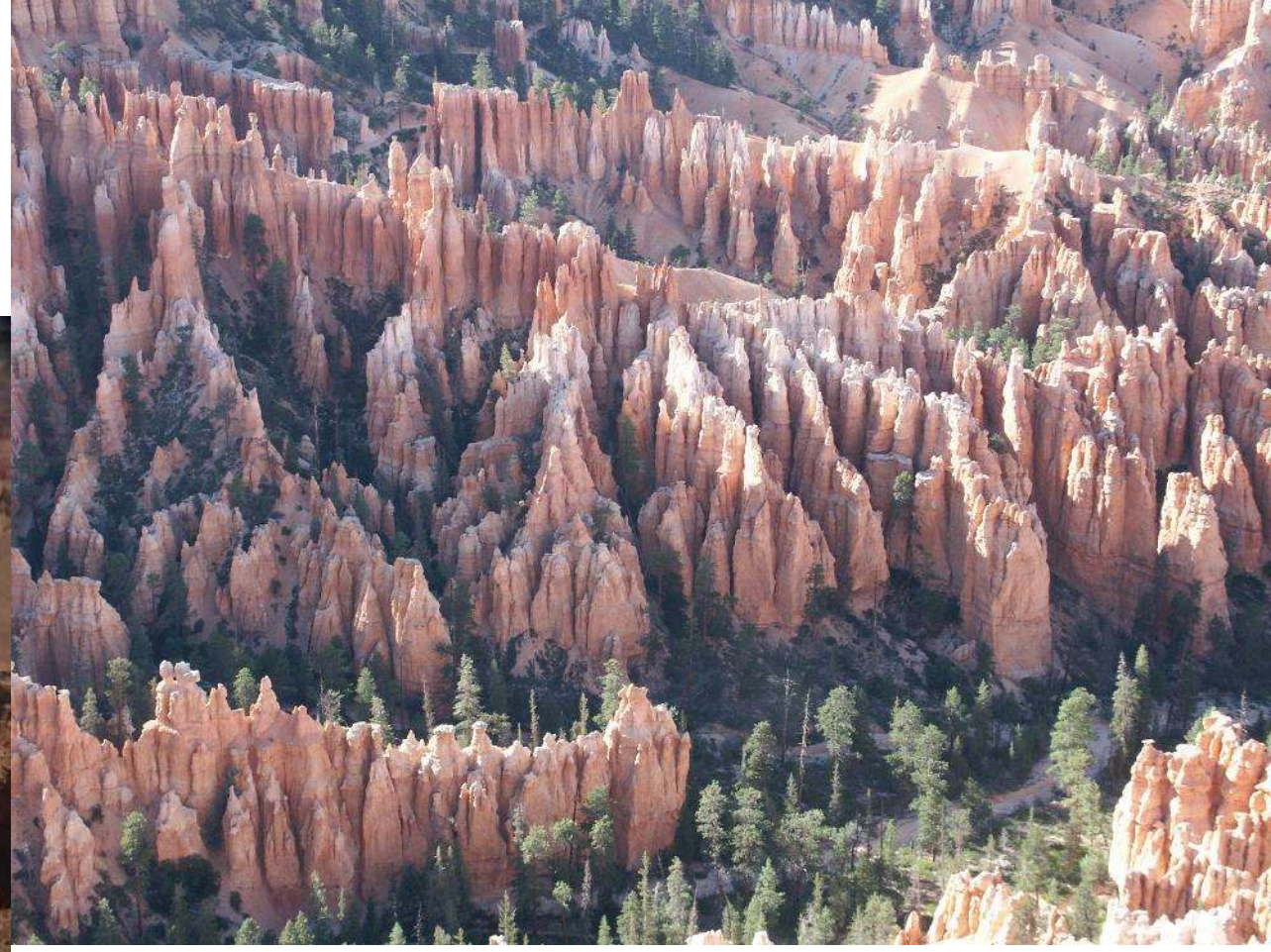


Fig 9.

Engineering classification of karst ground conditions.
A.C. Waltham and P. G. Fookes (2005)
Speleogenesis and Evolution of Karst Aquifers
The Virtual Scientific Journal ISSN 1814-294X
www.speleogenesis.info

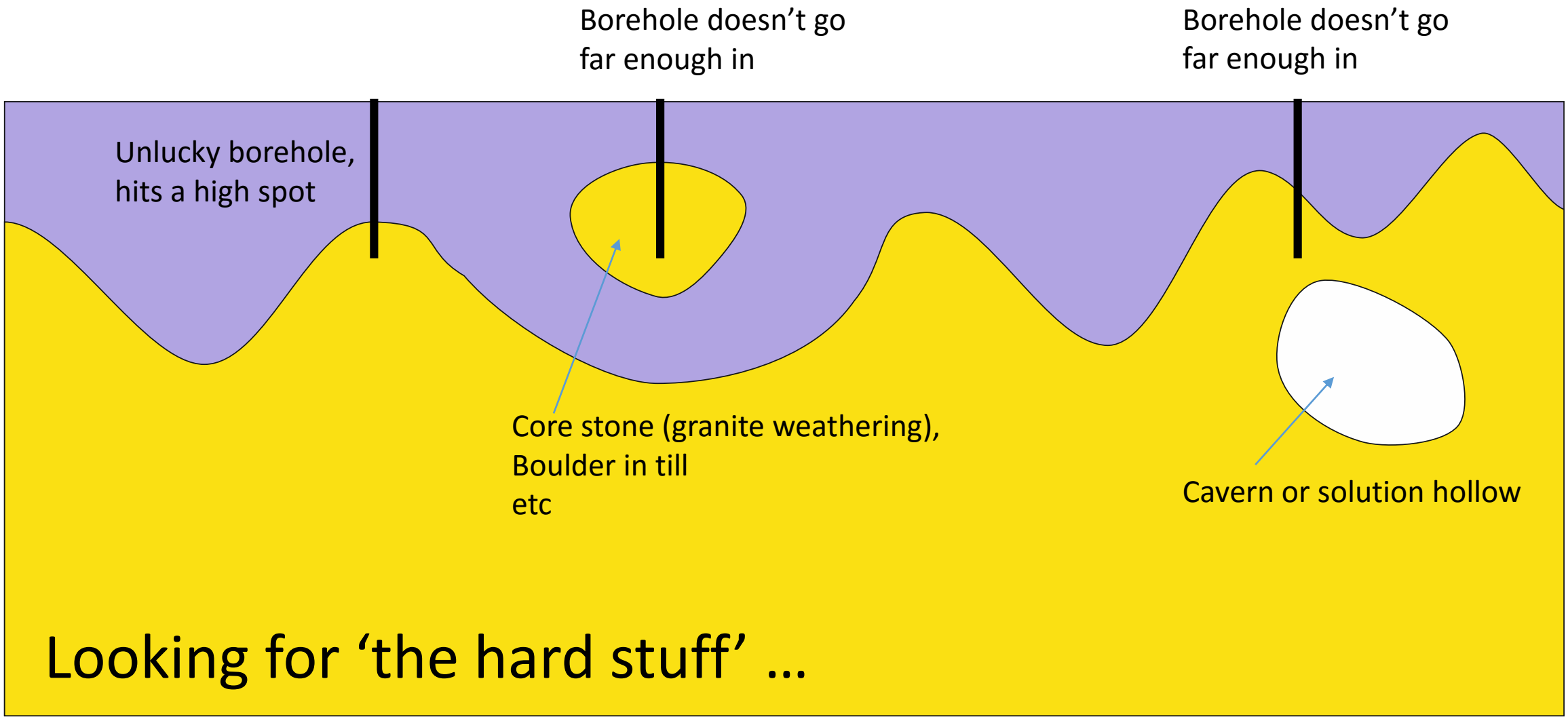
In the case of pinnacle rockhead, there is great variability in the elevation of the soil-rock contact. This may or may not be evident at the surface.
Problems arise if:
(a) You underestimate the height of pinnacles when excavating.
(b) You underestimate the depth of infill when looking for a bearing stratum.

Imagine either of these landscapes covered in weak sediment, and the difficulty of finding ‘rockhead’ …
(Right) Bryce Canyon
(Below) Grand Canyon



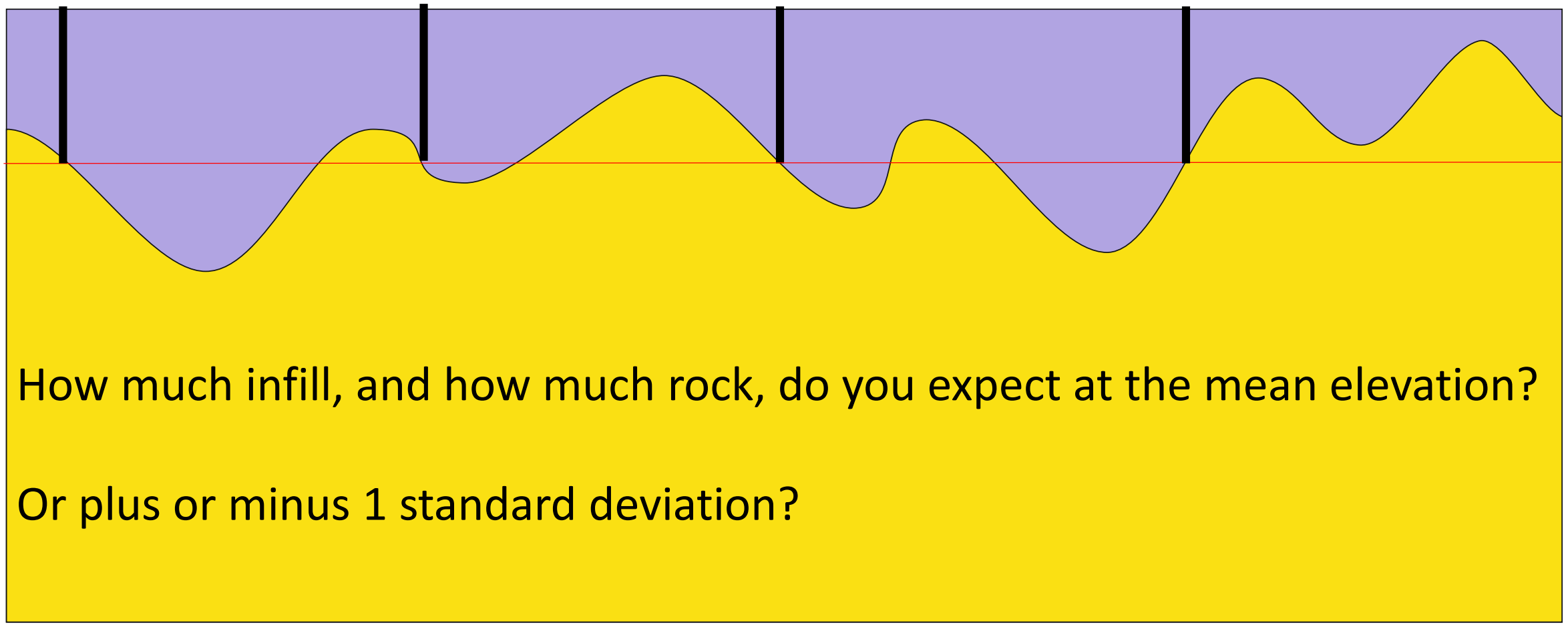
In both of these cases the bedding in the bedrock is horizontal – no help – and the shape is superimposed on that by erosion

Deceptive ‘rockhead’



Irregular ‘rockhead’

Improbable, but “Sod’s Law”



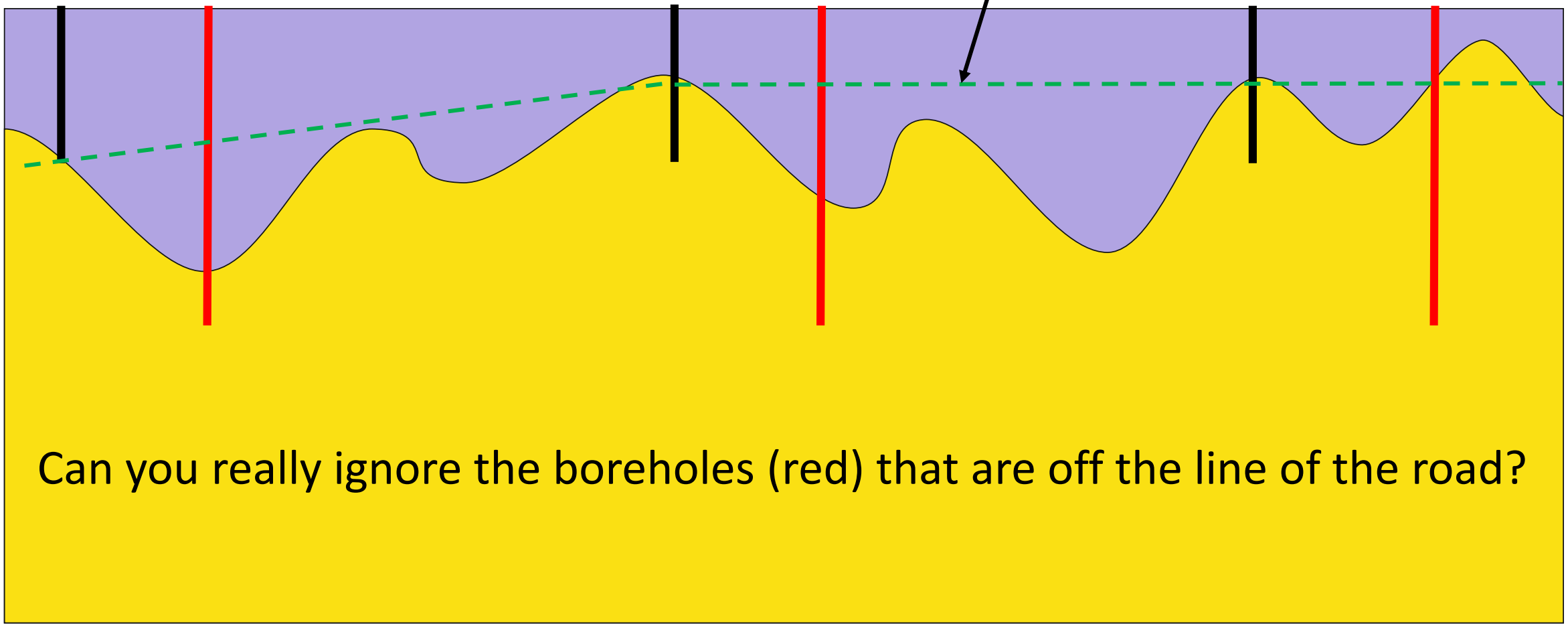
How much infill, and how much rock, do you expect at the mean elevation?

Or plus or minus 1 standard deviation?

The probability of <u>not</u> detecting irregularity goes down with more boreholes

Irregular ‘rockhead’

Prediction (dashed) based on boreholes (black) on the line of a road.



Can you really ignore the boreholes (red) that are off the line of the road?

Rules to avoid failures

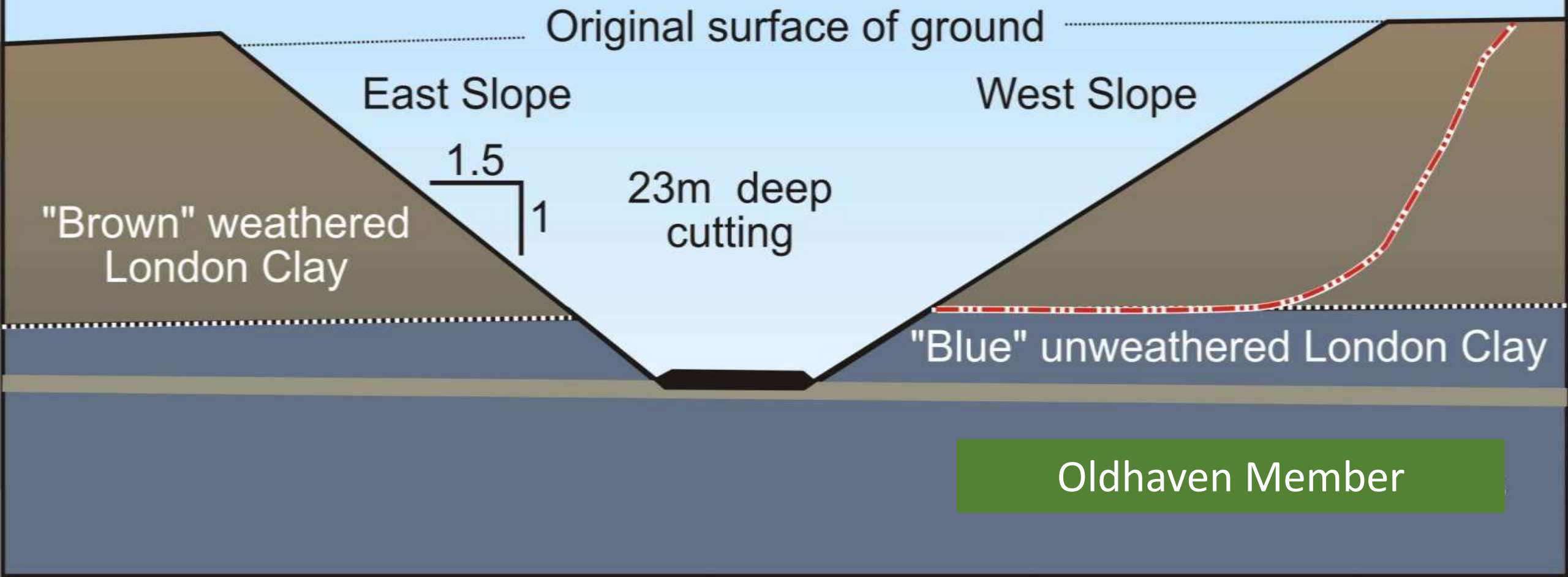
1. The project team must contain qualified and experienced people *who are not overworked*
2. This includes during the ground investigation
3. The geotechnical investigation needs to be thorough and adequate
4. The ground model needs to be correct *where it counts*
5. Analyses need to be sensible *and not overcomplicated*
6. There must be an ***independent*** technical review
7. Contractors must be prevented from doing stupid things *by adequate supervision*
8. Criminal behaviour should not be tolerated, *like falsifying data*

Rules to avoid failures (2)

9. Temporary works conditions are important, and need to be considered *at the design stage*
10. Small errors and failures should not be allowed to progress to catastrophe – in design or construction
11. Many failures result from overstress and brittle (strain-softening) behaviour
12. Water is always your enemy, *understand, control, reduce but beware of inducing settlement*
13. If all else fails, know where you can get a good lawyer, or a one-way ticket to Rio de Janeiro, or both!

Slide in cutting at New Cross, 2nd November 1841 (*C. H. Gregory, 1844*).

26th November 1841: A slide on the East slope as well.
The cutting was about 3 years old.



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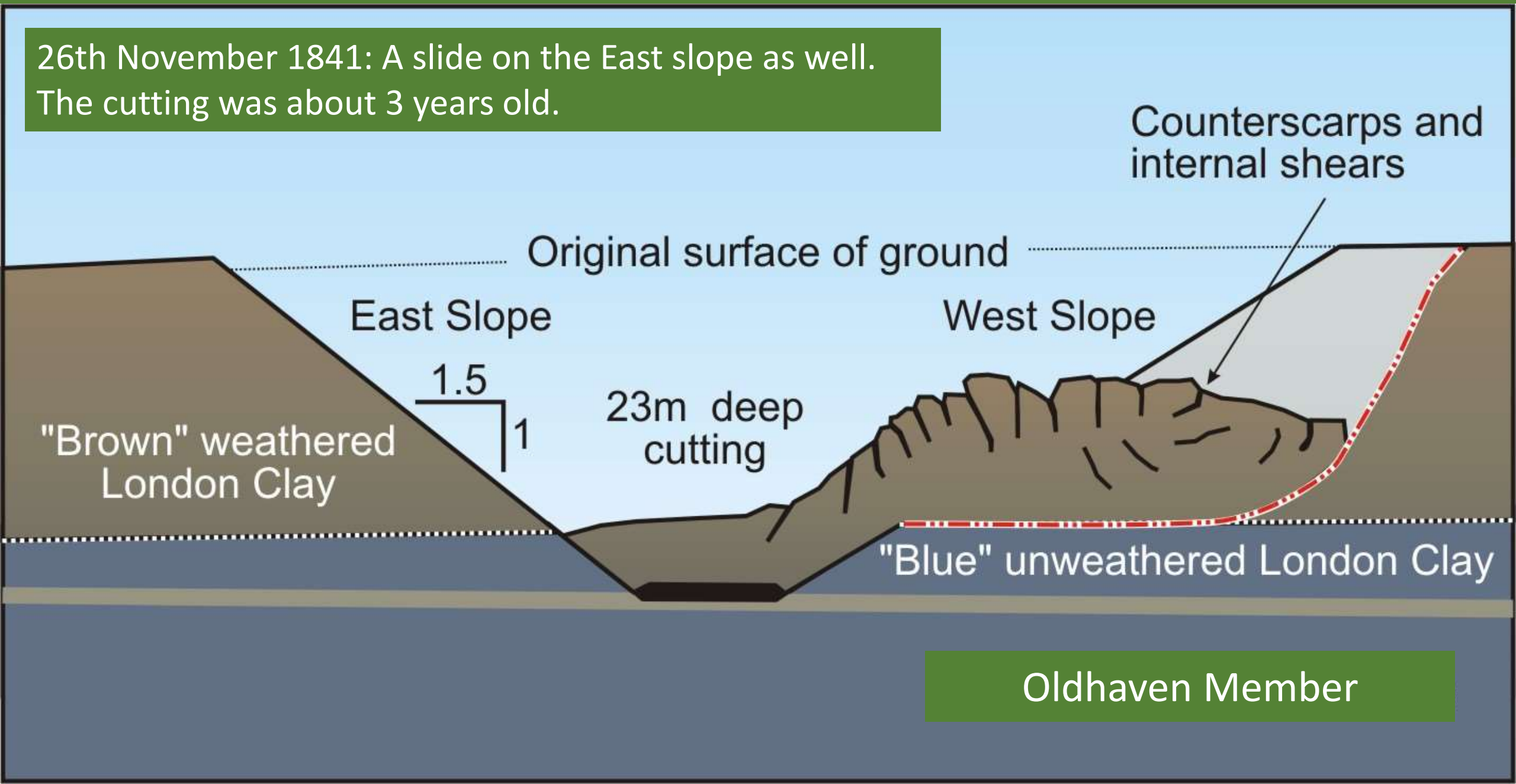

Gregory: *"I cannot think how I came to overlook it,"* said the inspector with an expression of annoyance.

Holmes: *"It was invisible, buried in the mud. I only saw it because I was looking for it.“*

Gregory: *"What! you expected to find it?"*

Holmes: *"I thought it not unlikely.“*

The Silver Blaze (a Sherlock Holmes story) :
By Arthur Conan Doyle, 1892

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Geotechnica 2016 & Glossop Lecture 2011
(with acknowledgements to Arthur Conan Doyle)