Modelling for Understanding

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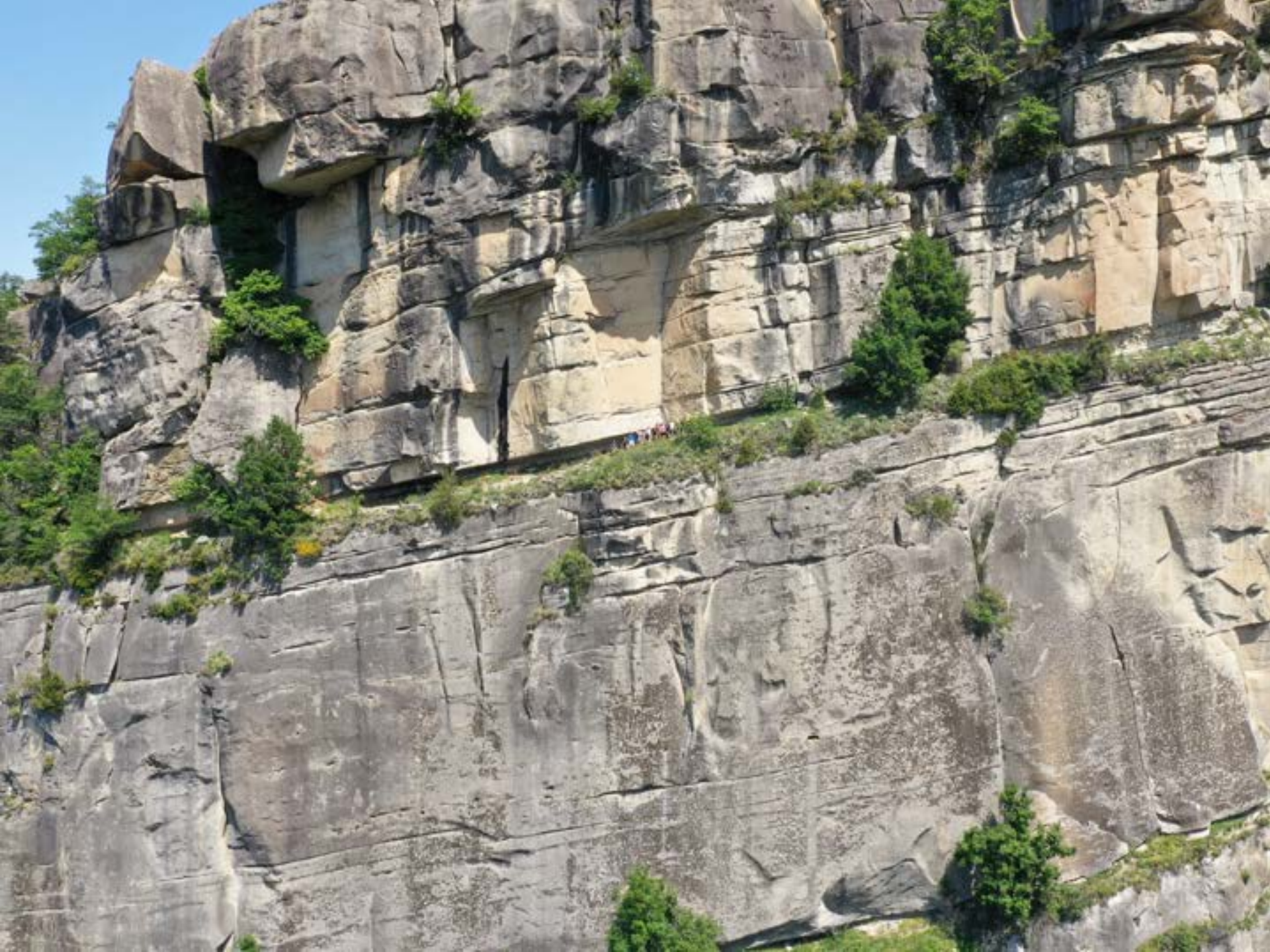
… with contributions from Ed Stephens, Tom Buckle & Rona Hutton



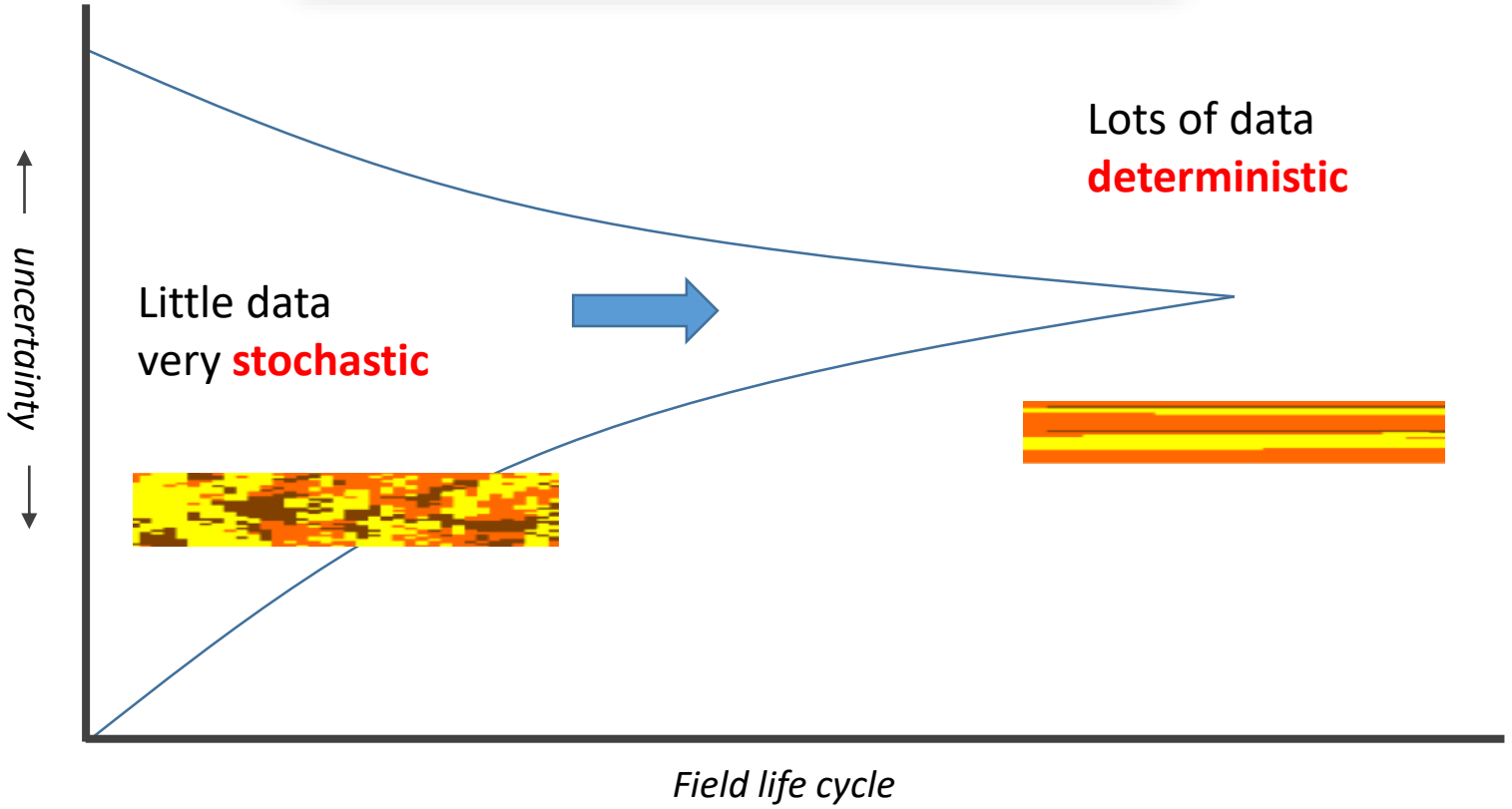
One view

stochastic

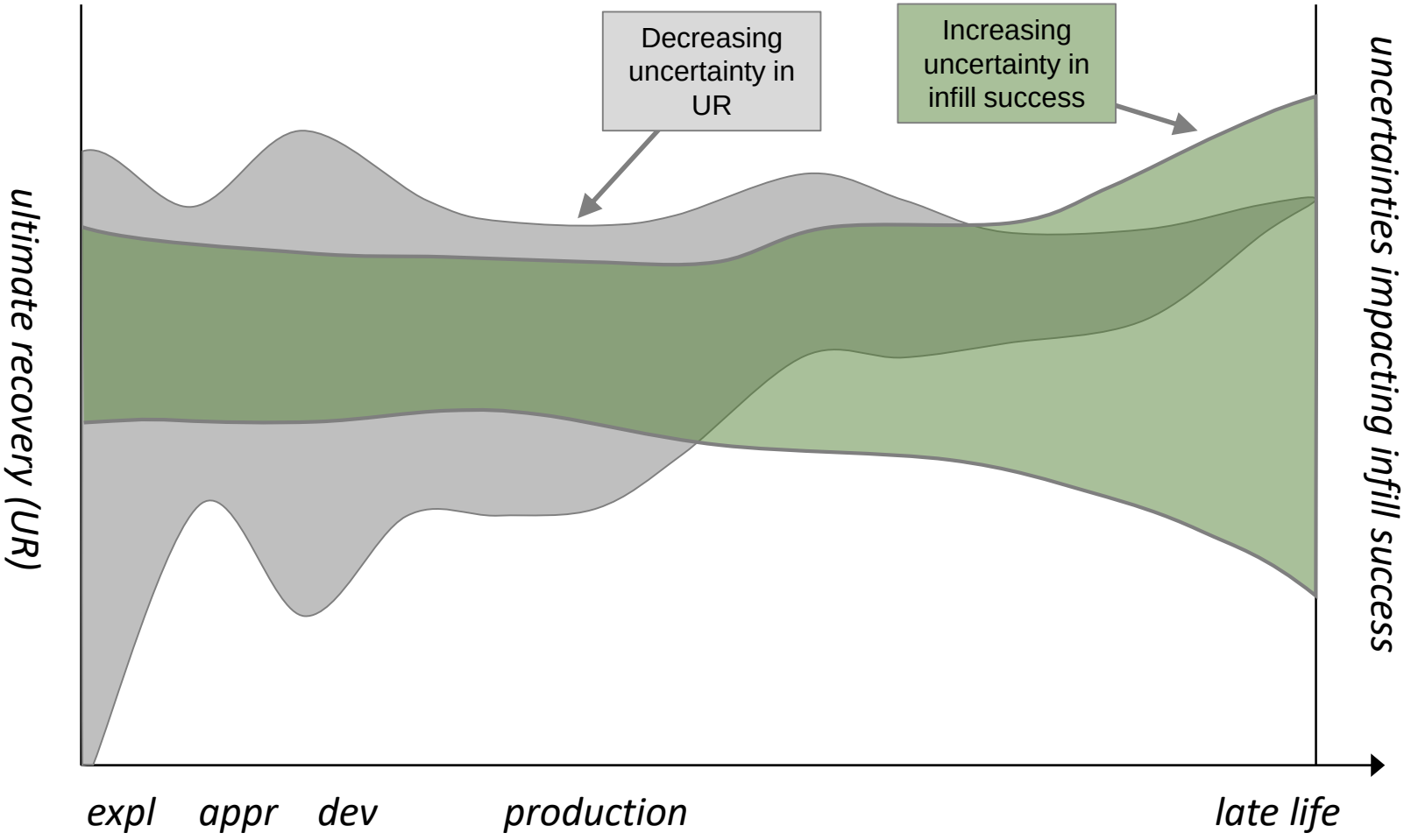
/stə'kastɪk/

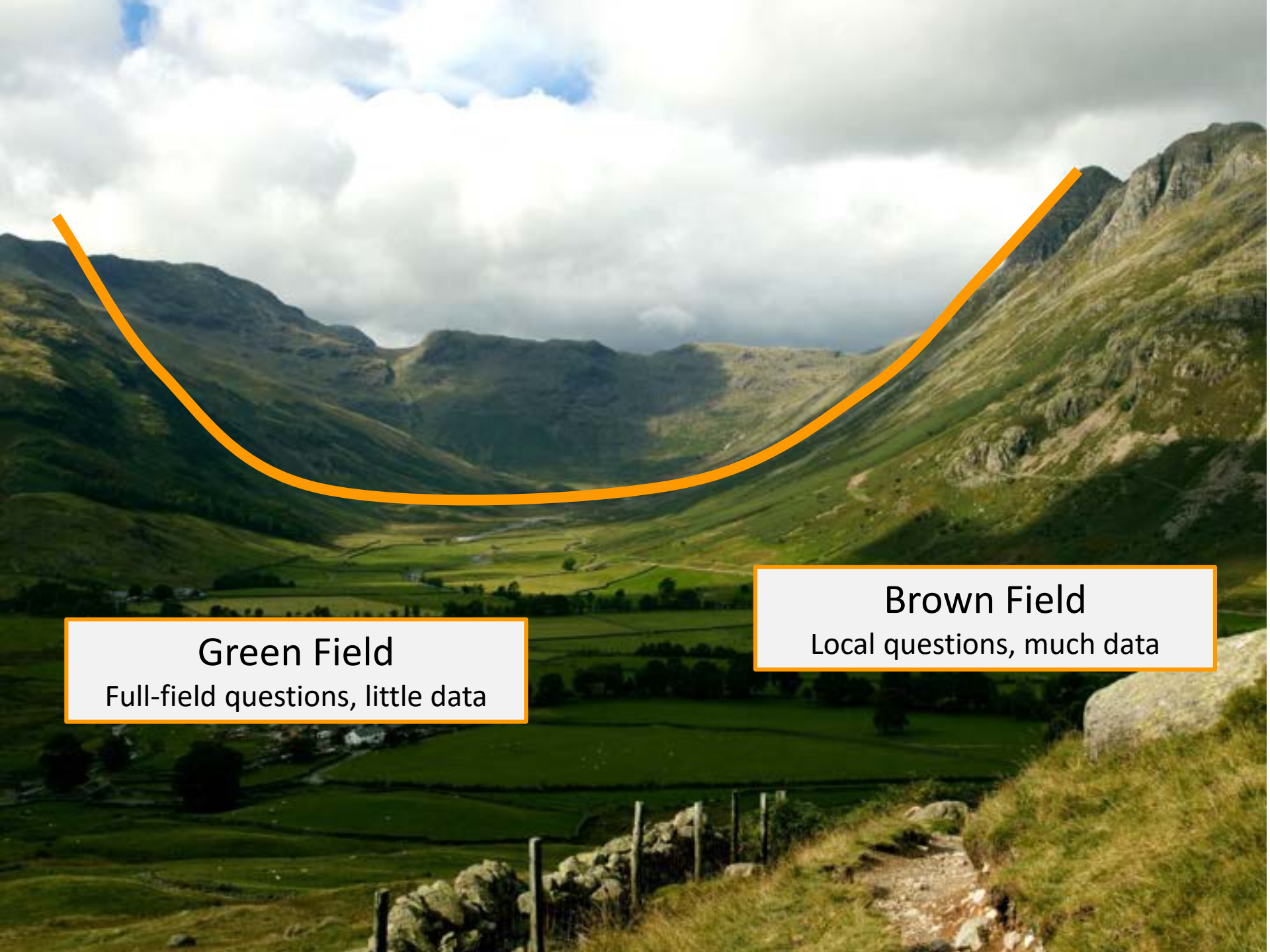
adjective TECHNICAL

having a random probability distribution or pattern that may be analysed statistically but may not be predicted precisely.



Life cycle uncertainty




Green Field
Full-field questions, little data
Brown Field
Local questions, much data

Heterogeneity – Col de la Cayolle

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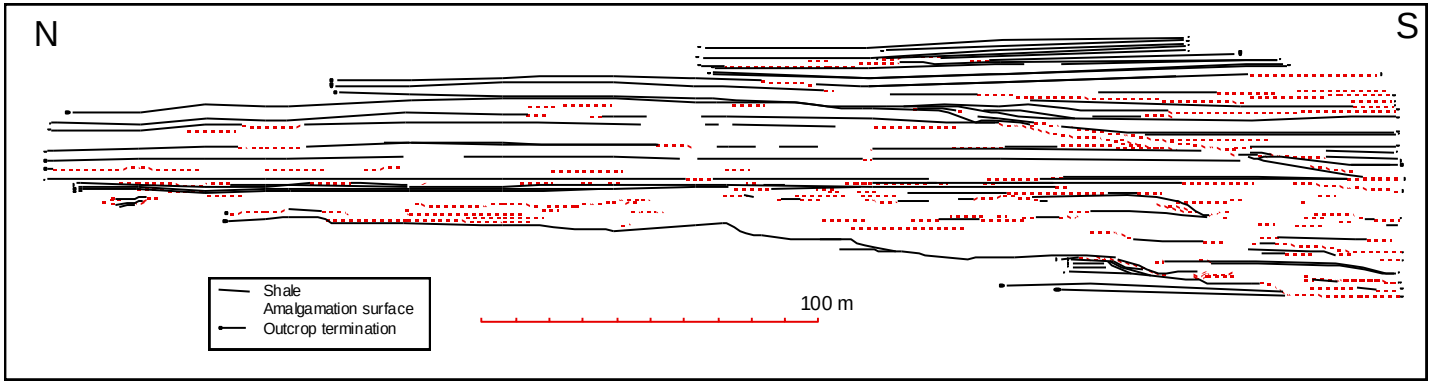
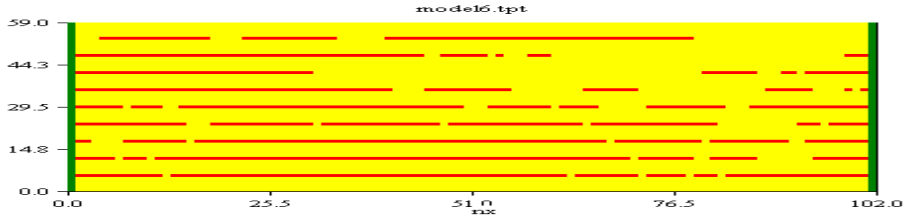
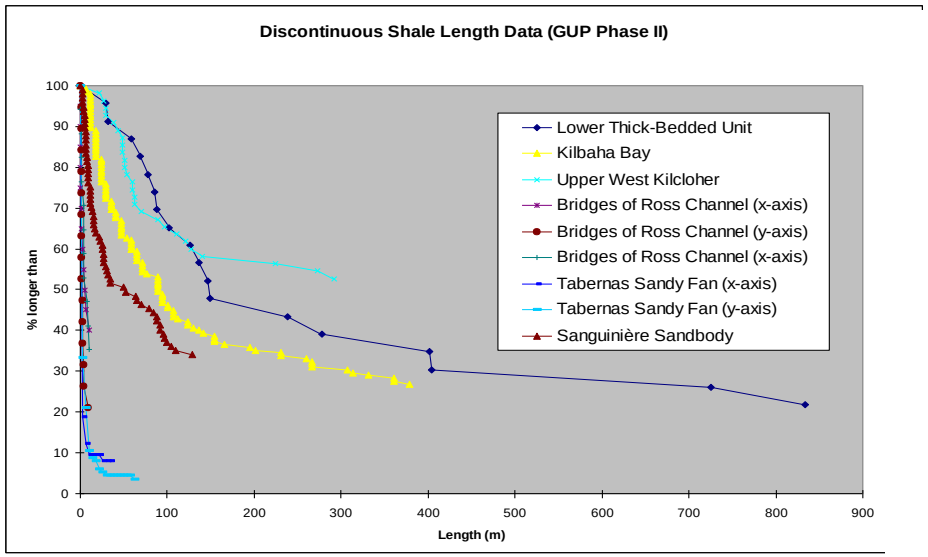
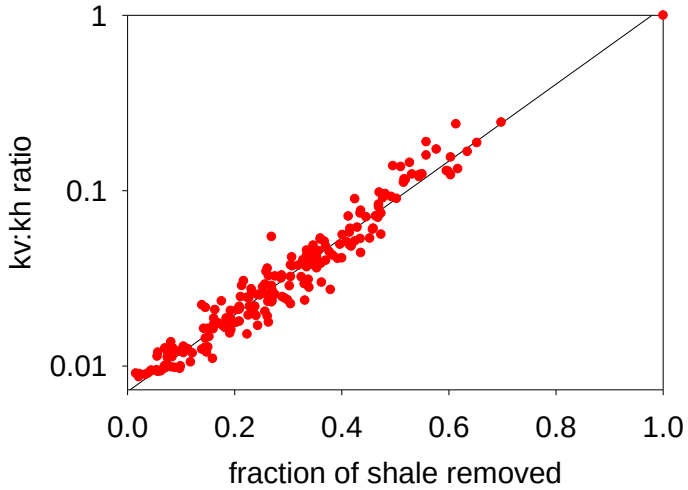


Heterogeneity – we've been here before

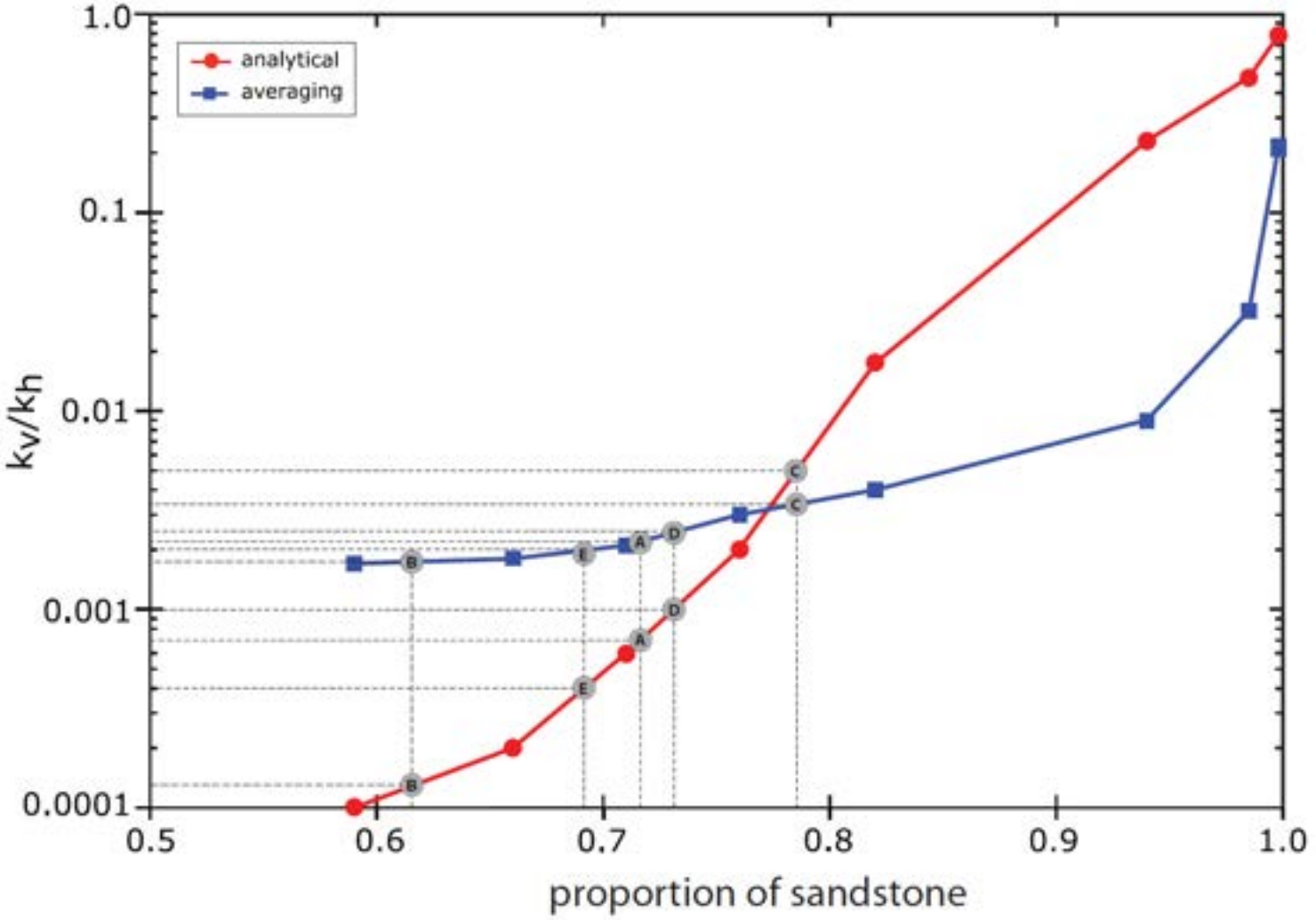






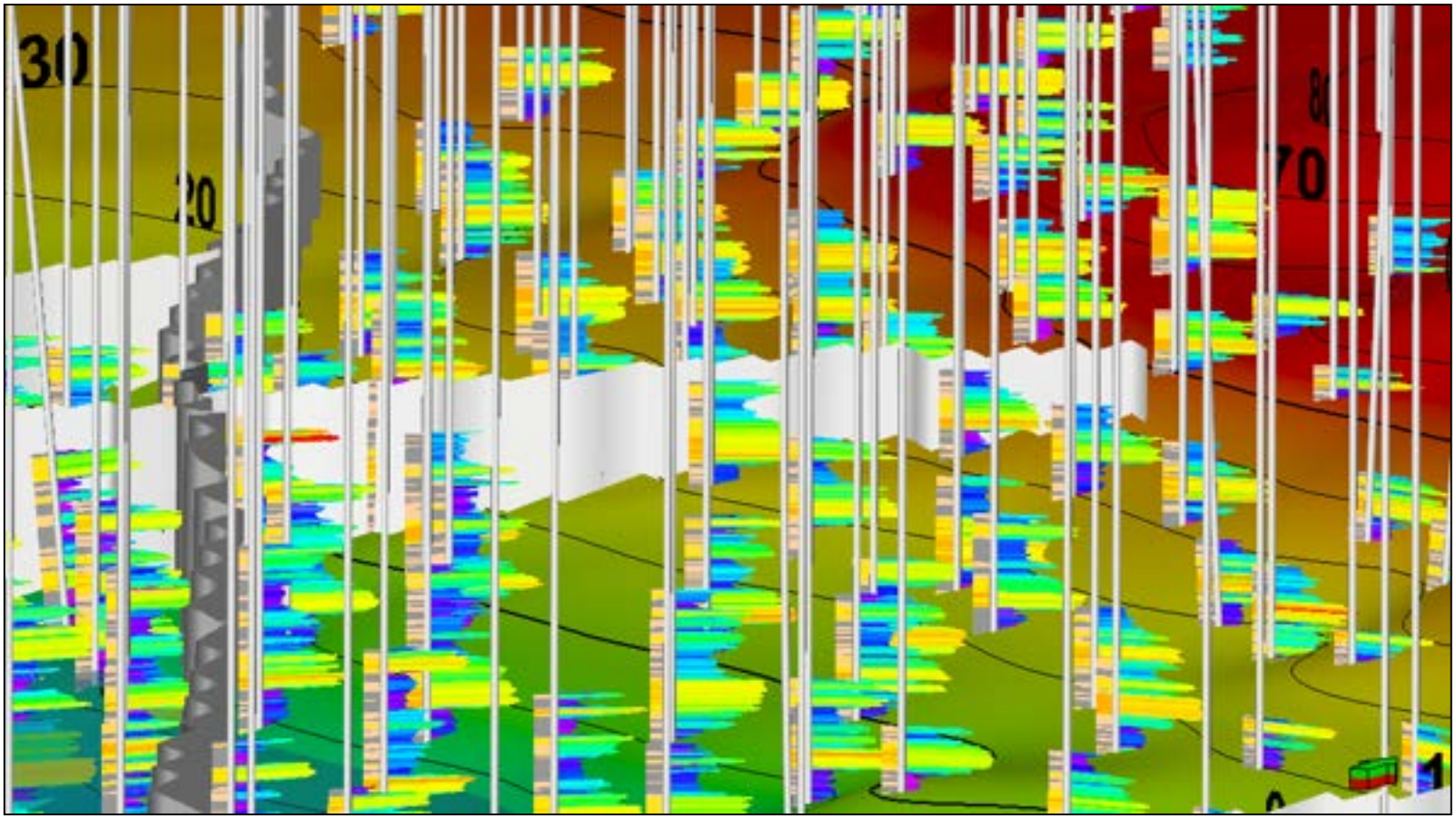
Stephen, Clarke & Gardiner 2001

Heterogeneity – and the work goes on



Onyenanu, Hampson, Fitch, Jackson, 2019

We tend to build big full-field models



Why?

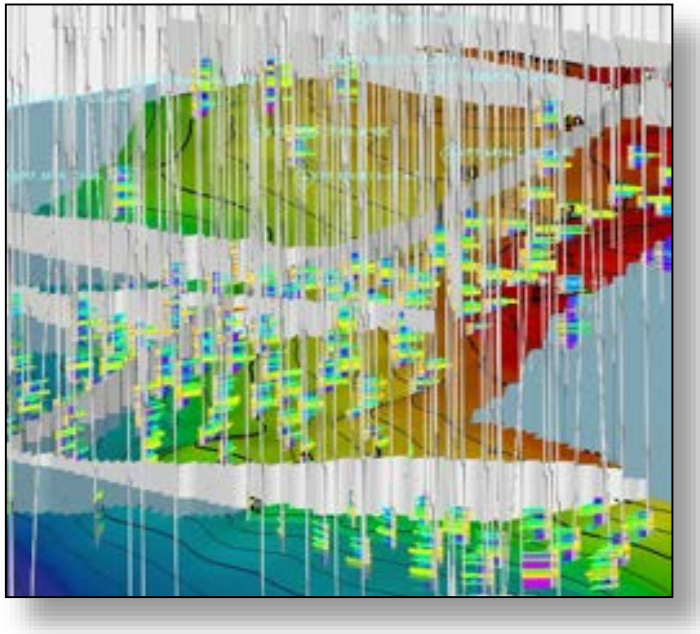
We have a complex problem

We had one thing we didn't understand

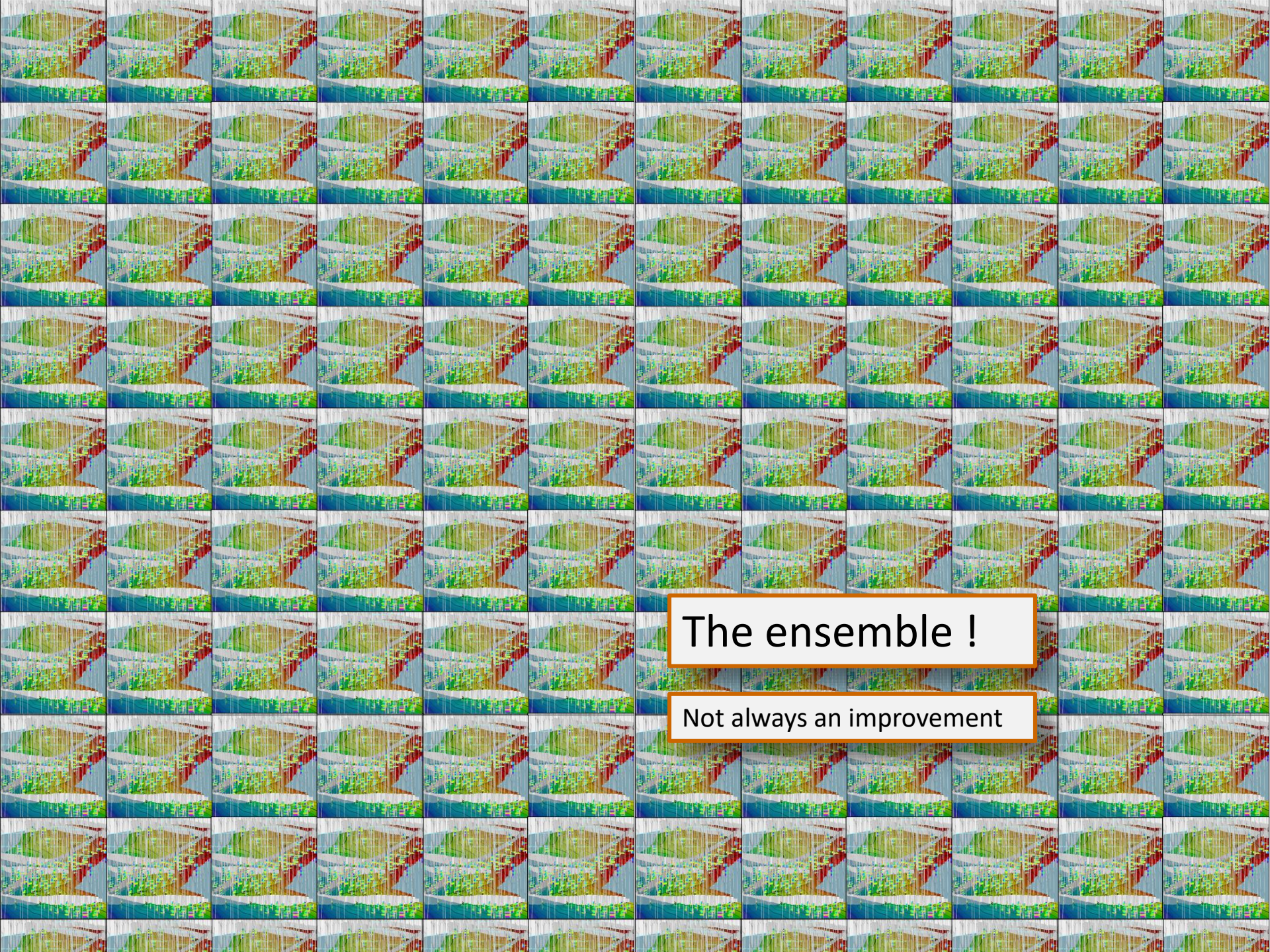
so ...

Now we have two

We build a complex model



... with a thank you to Phil England


The ensemble !
Not always an improvement

Model choices

A base-case history-matched static-dynamic 3D model pair ★

Analytical models only (type wells, decline curves)

Low-mid-high versions of the above ★

Multiple models – statistical (more stochastic) – *the ensemble* ★

Multiple models – conceptual (more deterministic) - *scenarios*

2D maps and Monte-Carlo models

Full field models ★

Sector models

Well models

Mechanistic 'box models'

REV models (multi-scale)

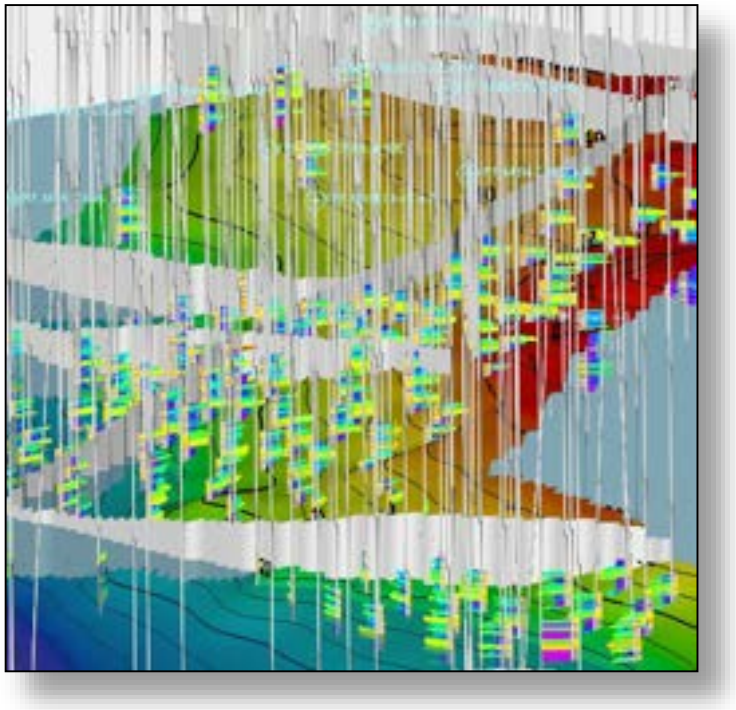
Spreadsheet

2D cross-sectional models

No model

How did this happen?

Because in the face of choice, we tend to default to the standard workflow



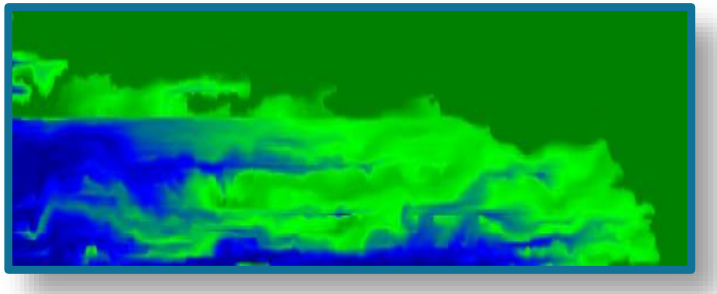
This talk …. question the workflow

A refinement

'Truth Models'

A different approach

'Modelling for Understanding'



The scale gap

Core Plug

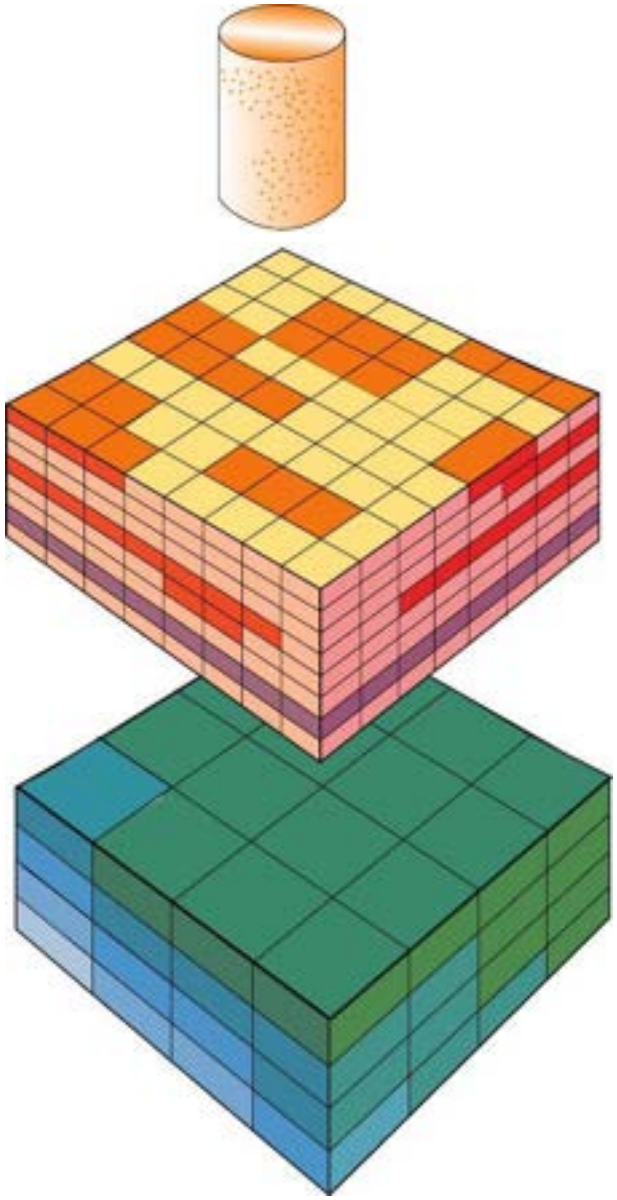
0.03m x 0.012m radius

Static Model

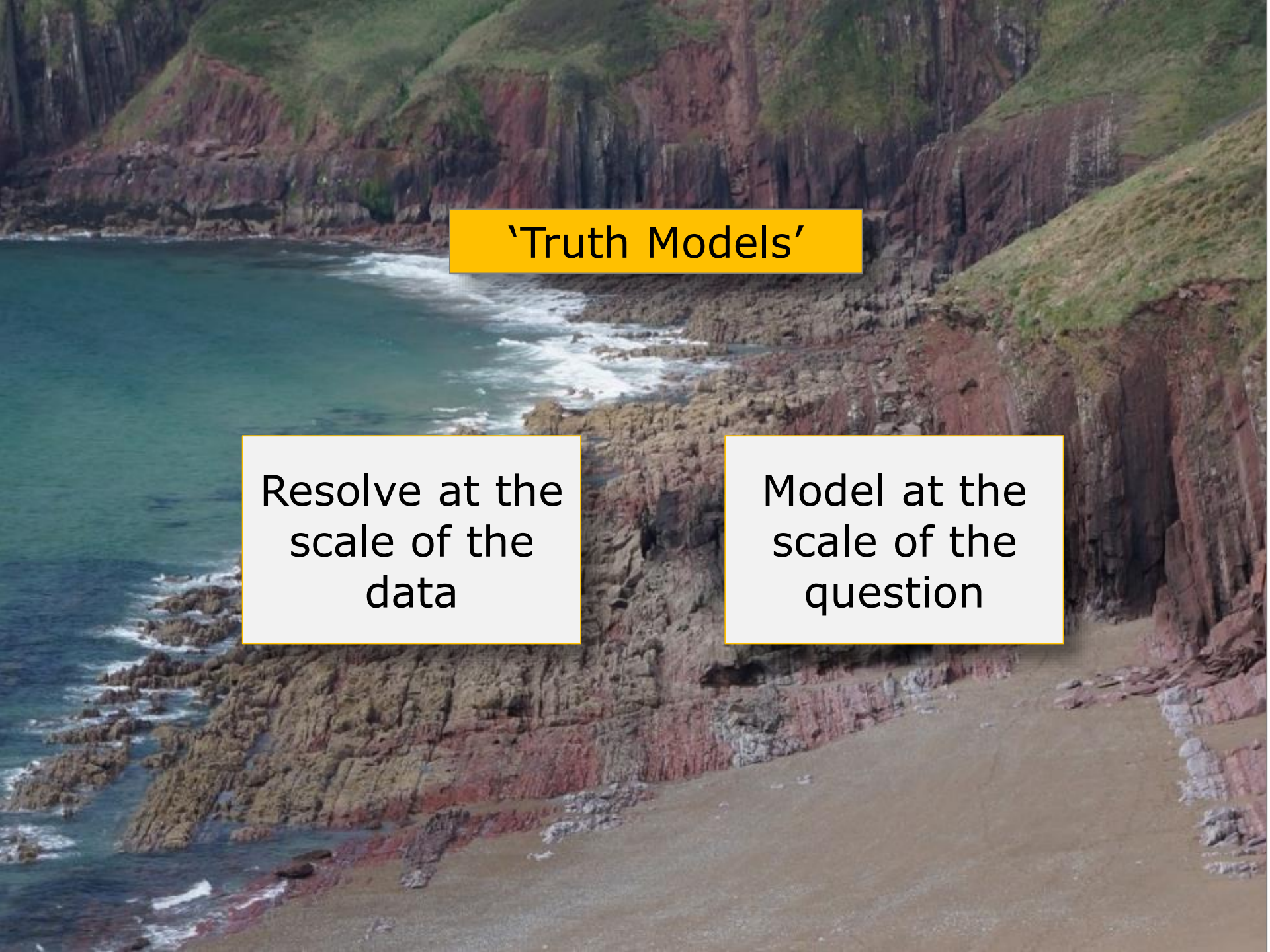
25m x 25m x 0.5m
Cell size

Dynamic Model

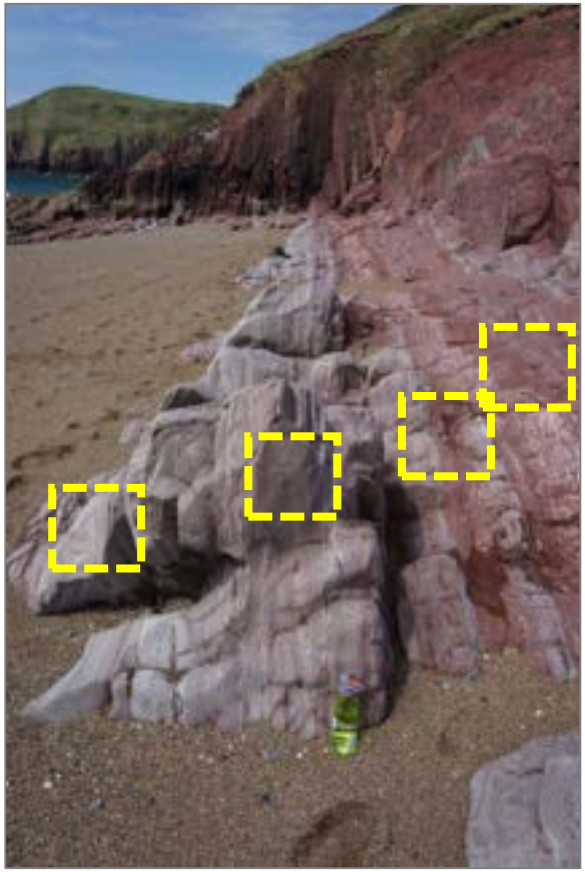
50m x 50m x 2m
Cell size

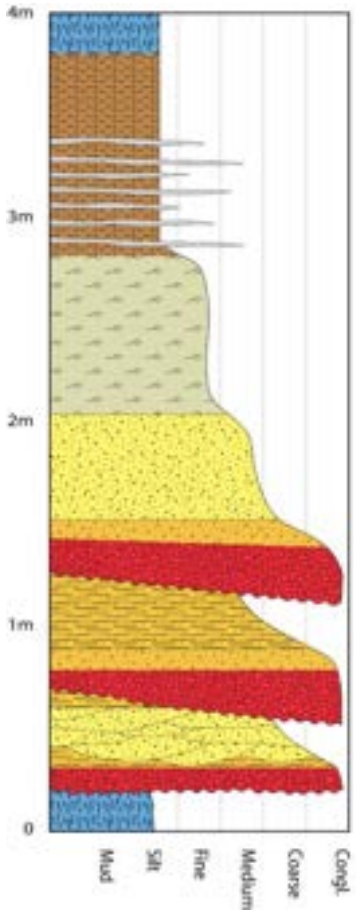


My, what a big simulator you've got…


‘Truth Models’
Resolve at the scale of the data
Model at the scale of the question

Understand one heterogeneous bed



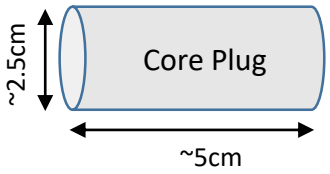


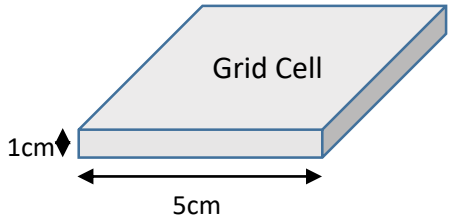
‘Truth modelling’

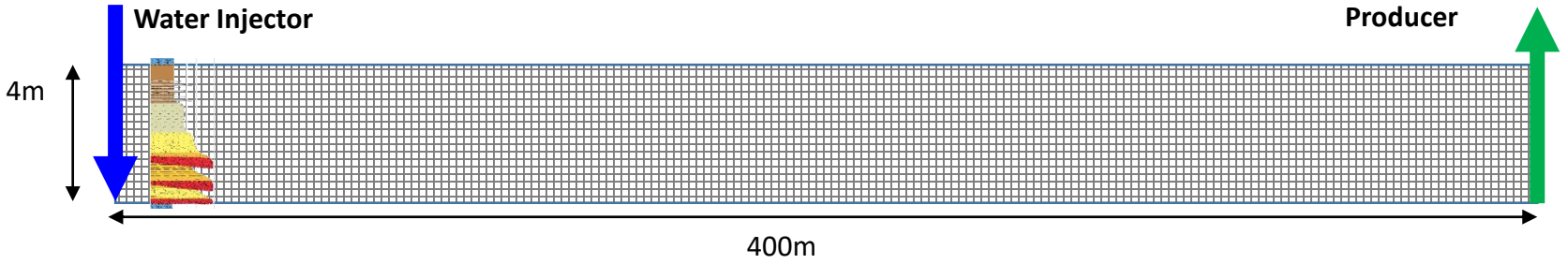
2D cross-sectional model

Typical offshore well spacing

Cell resolution close to the scale of the input data (SCAL)





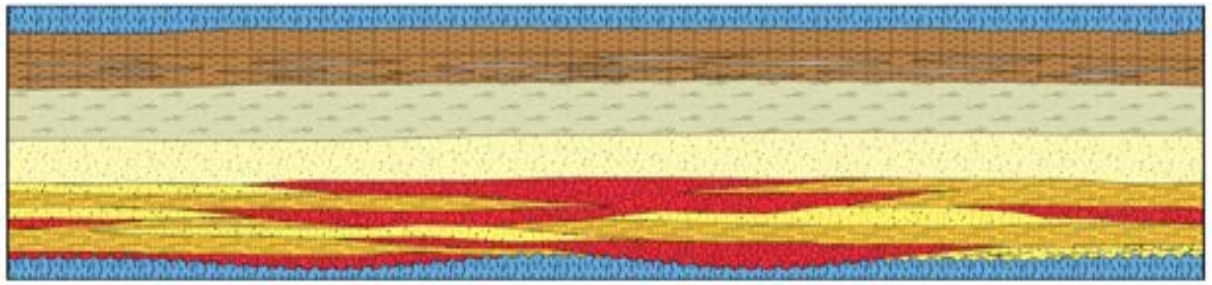


3.2 million cells

(the full field equivalent would be a few trillion cells)

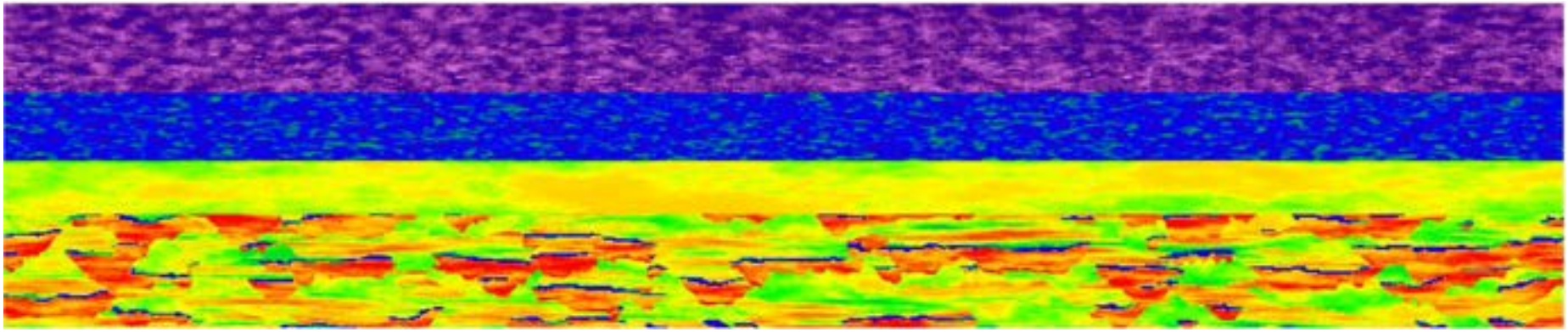
Heterogeneity – *if you can sketch it …*

Training image



50m

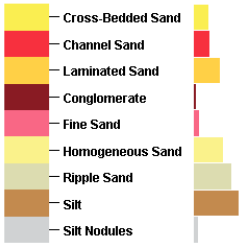
MPS realisation (internal channel character added)

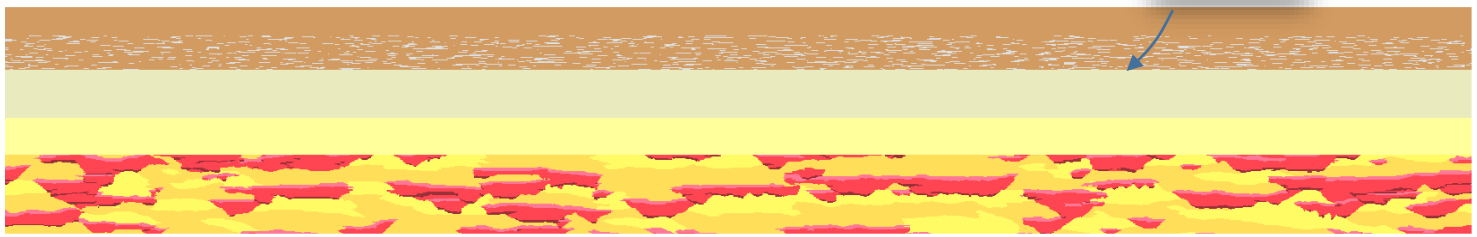


400m

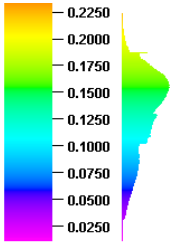
If you can sketch it ….

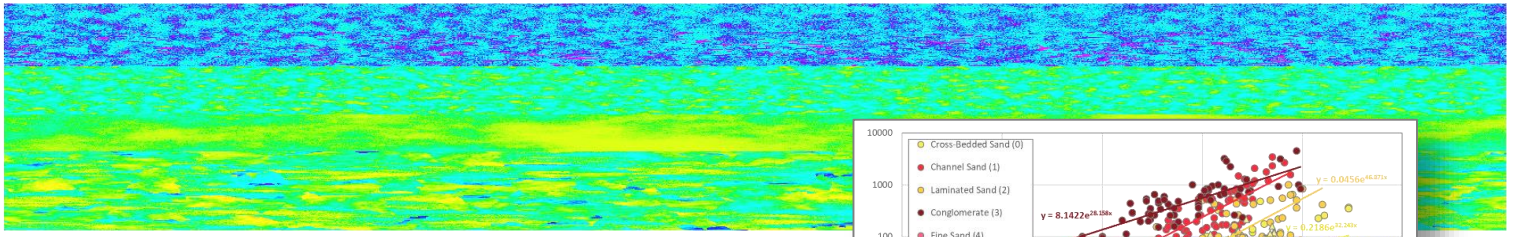
Model elements from multi-point statistics (MPS)

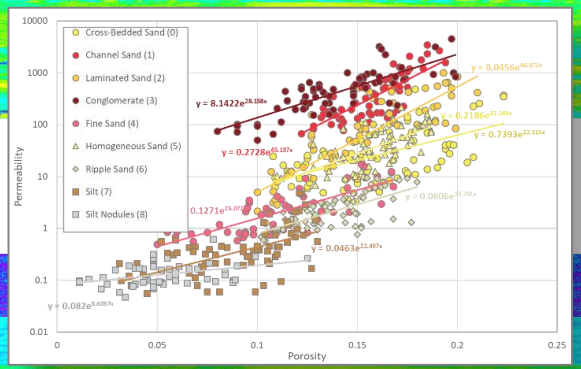




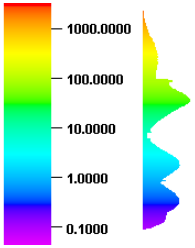
Porosity (frac)

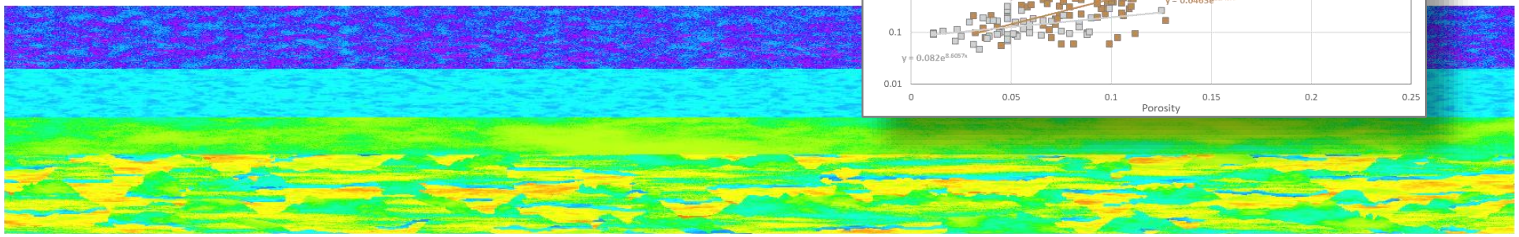




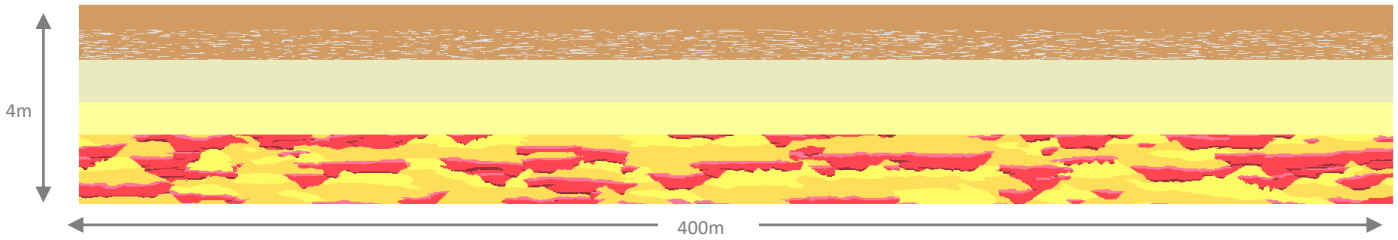


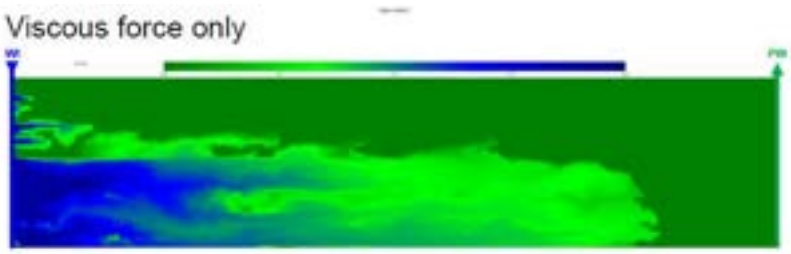
Permeability (mD)

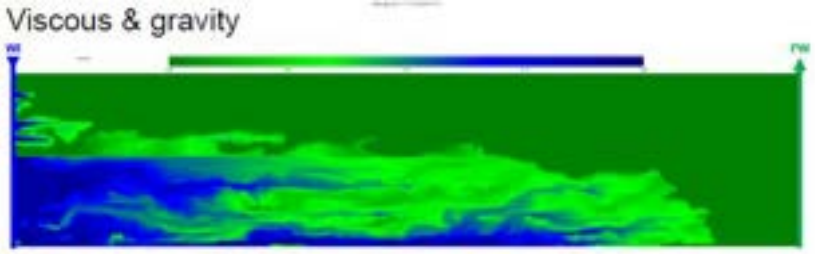


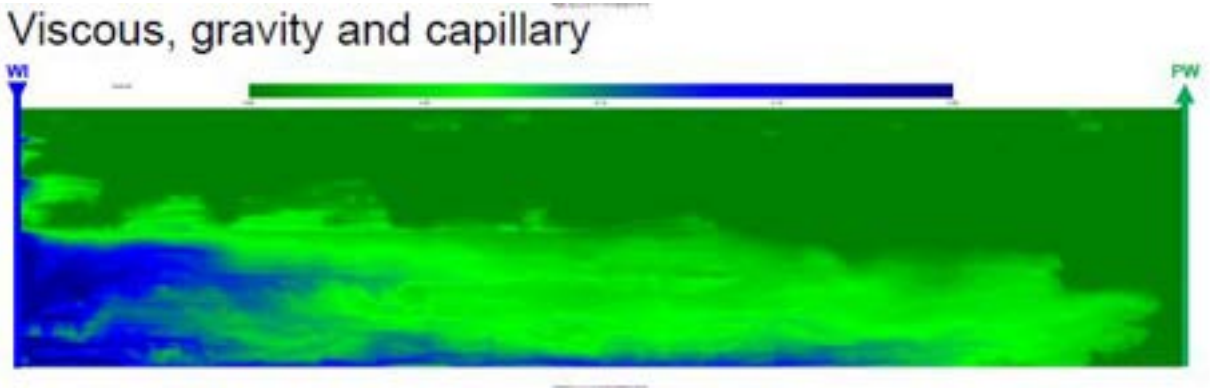


Truth models – building understanding





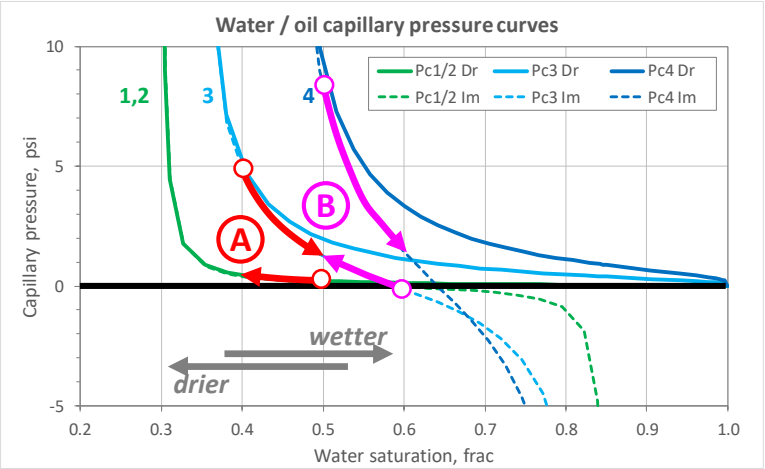


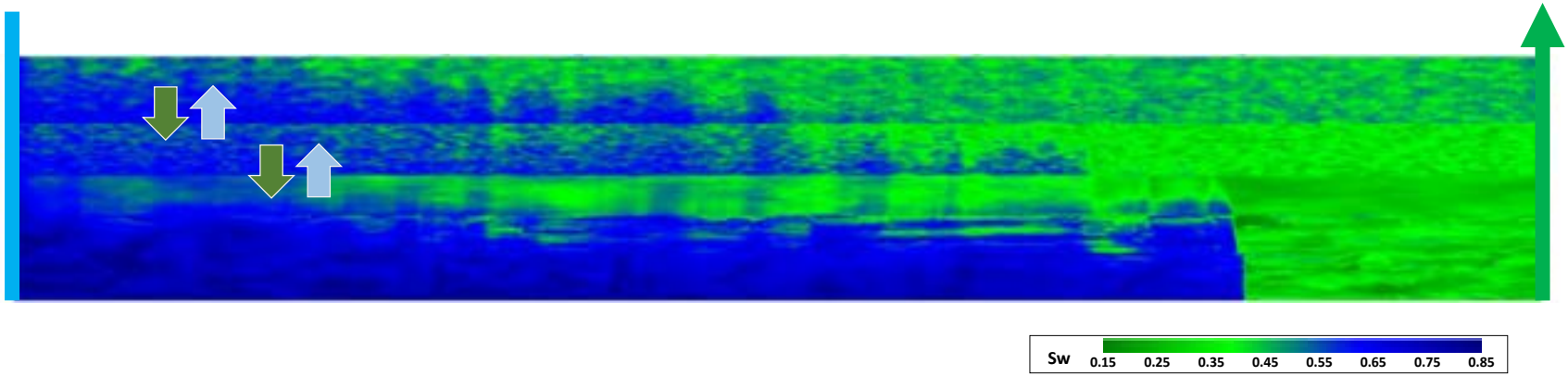


Understanding 1– impact of capillary forces

Water drawn up displaces oil down

Additional recovery from nominally ‘non-net’ material

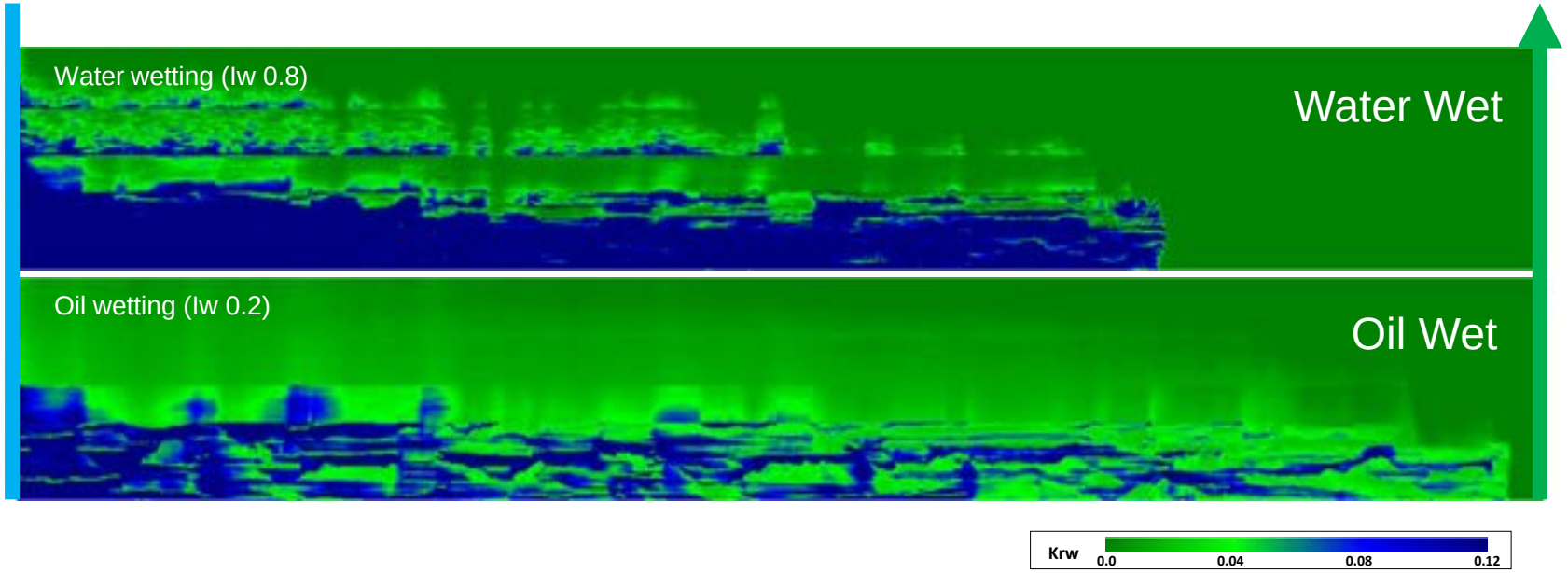




Understanding 2 – value of knowing wettability

WW: WBT later by ~ 10%,
RF higher by ~ 3%
Stronger spontaneous imbibition into upper units

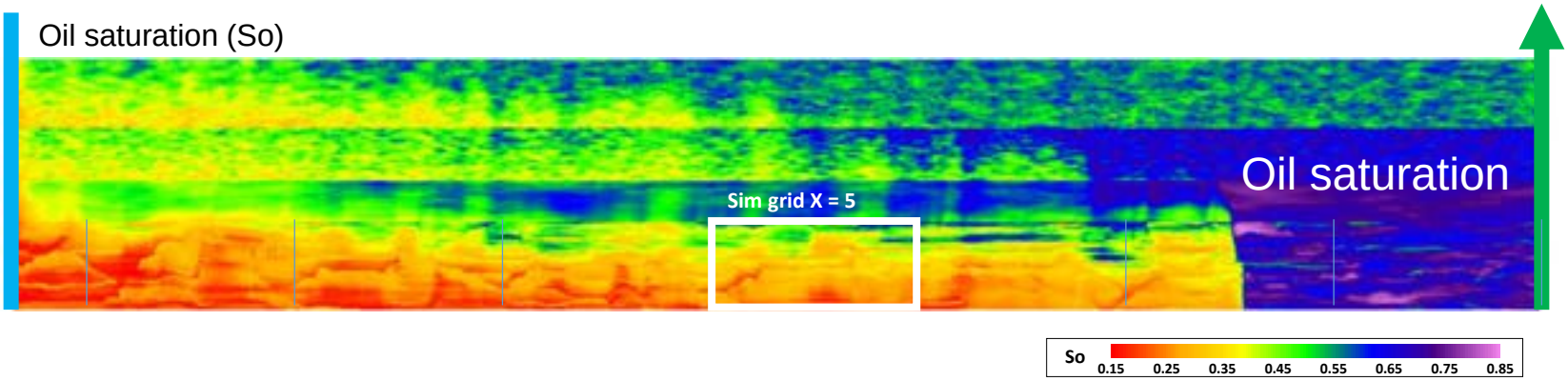
OW: WBT earlier by ~ 20%,
RF lower by ~ 10%
Bypass of lower perm material within lower unit



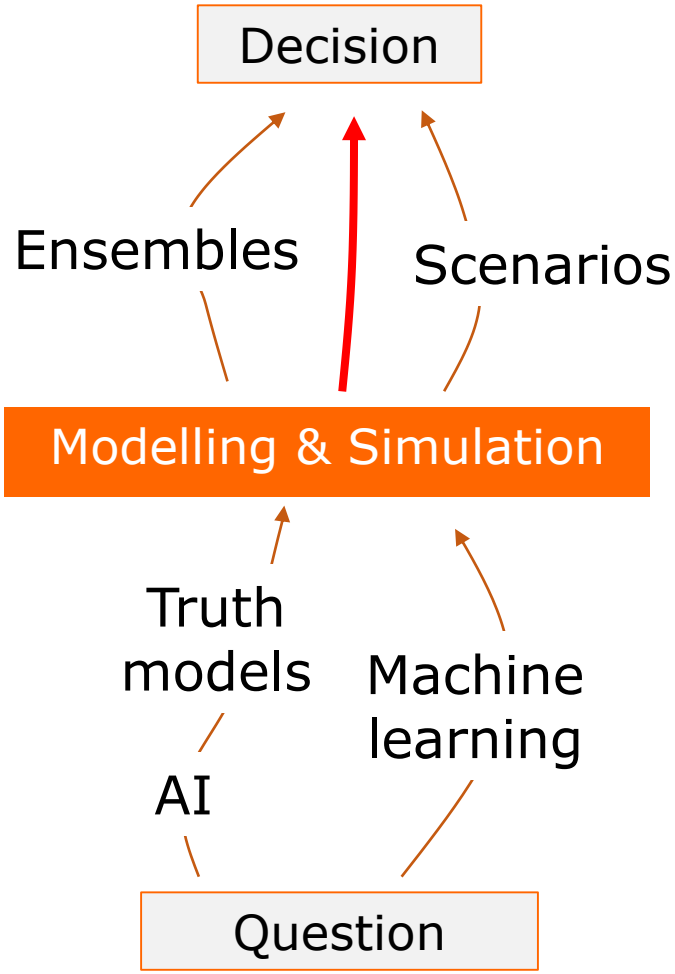
Understanding 3 – locating remaining oil

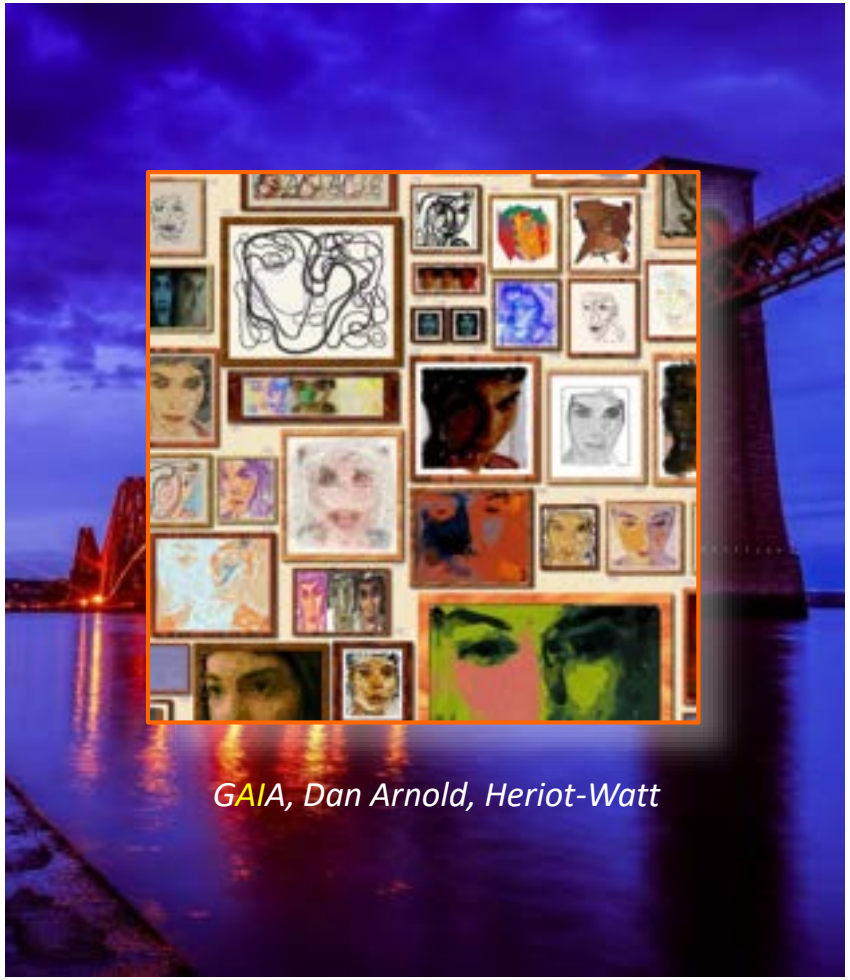
Saturation behind the flood front
Explore sim grid cell X=5 flowing ~90% water-cut

Model	Swi	W/cut	Krw	Kro	Soil
Ultra fine grid	30.7%	87%	**0.1305**	**0.0188**	**34%**
Sim grid X=5	30.6%	93%	**0.0992**	**0.0076**	**34%**

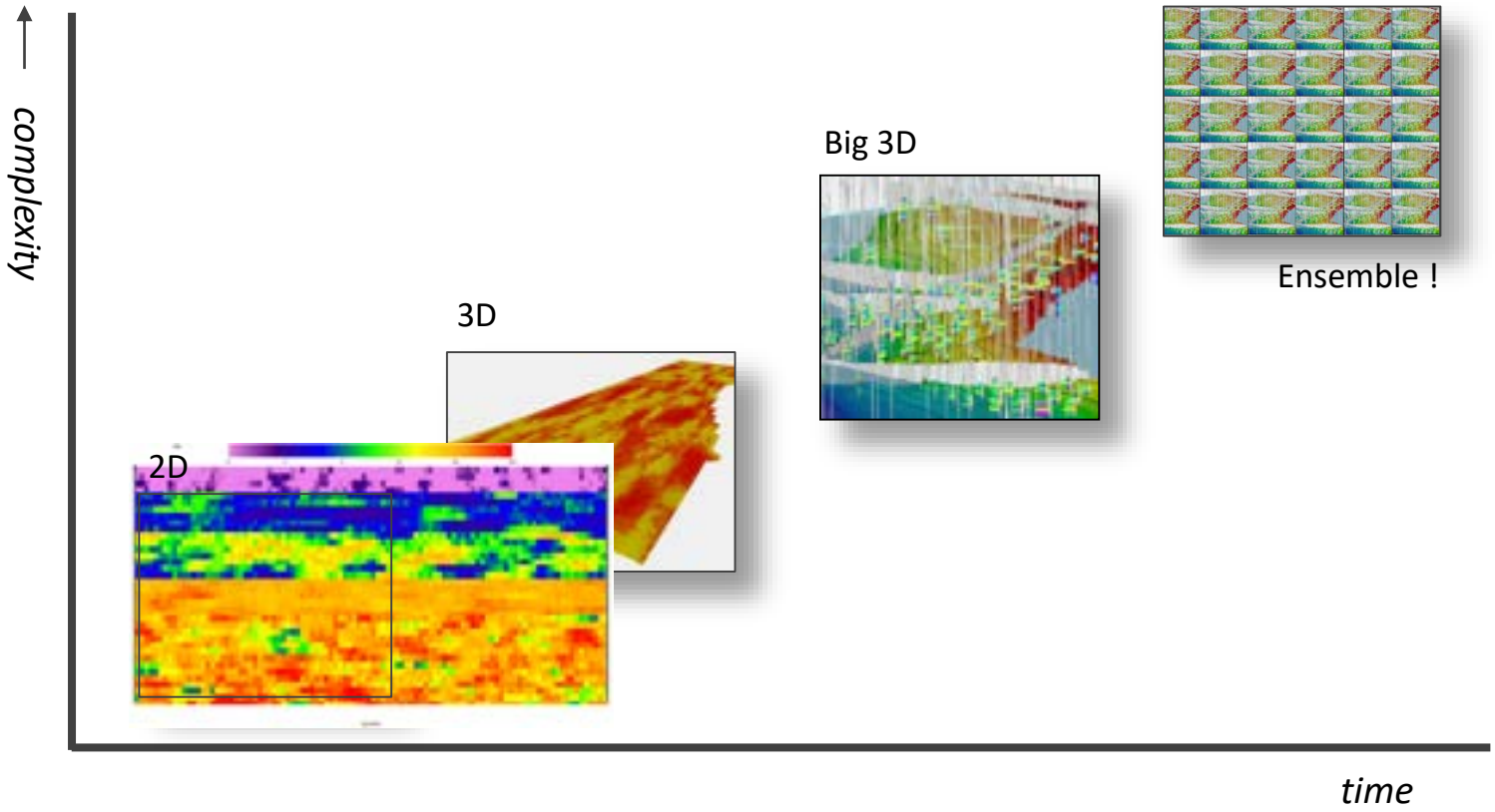


Questions and decisions …

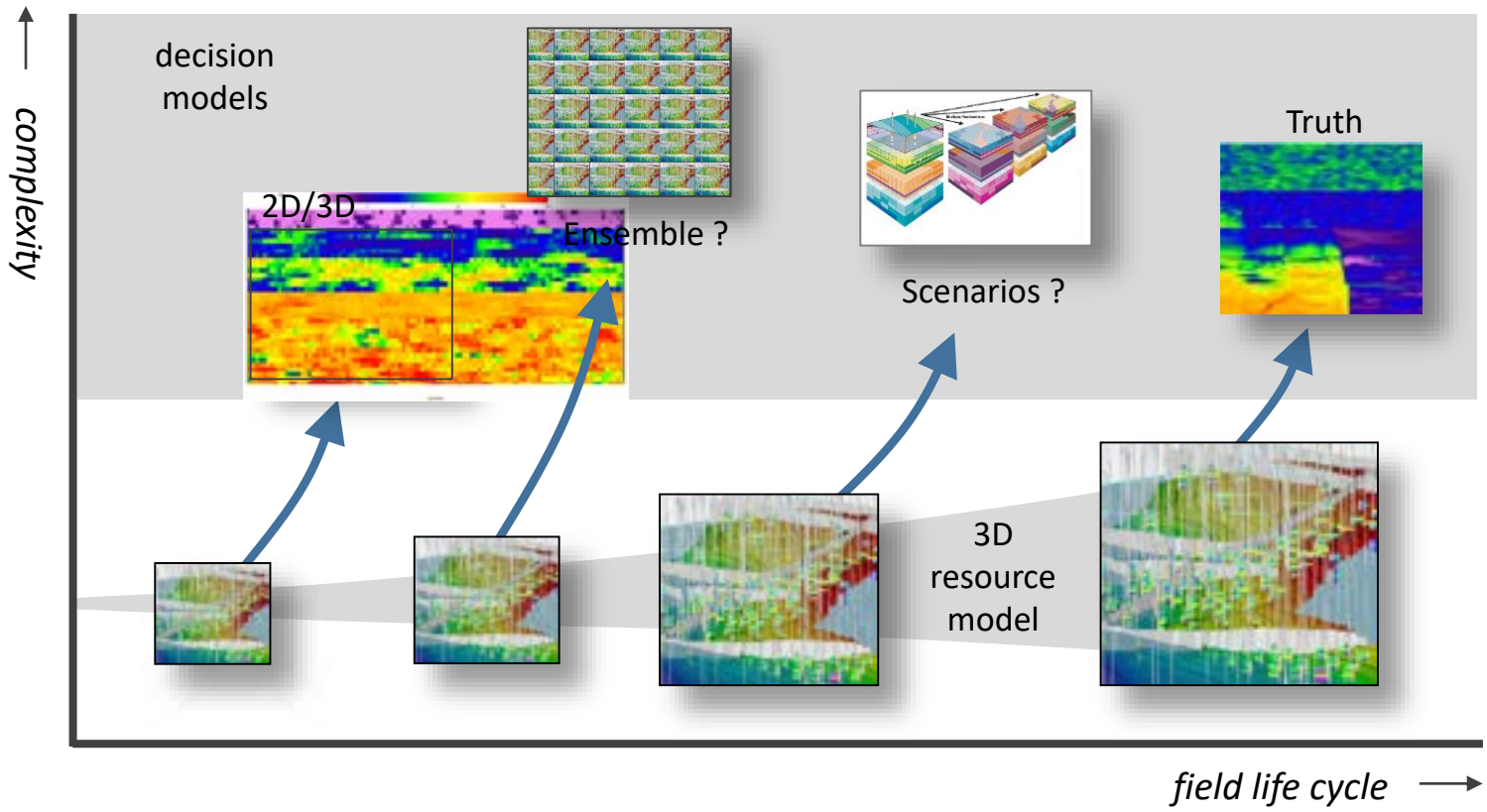




Modelling through time – not nimble



Modelling through time - less complex, more efficient




Decision
Ensembles
Scenarios
Understanding
Truth models
AI
ML
Question
Maybe modelling to understand the question is more important than trying to model up a complex solution …