Does Scenario Modeling Really Lead to an Explosion in the Amount of Work We Have to Do?*

By

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Abstract

Traditional best practice leads us to make detailed syntheses of data to build a geological model. The model produced, we believe, is the best solution given the constraints of data and time. These models are often vigorously defended representing months of work that embody the distillation of our knowledge and experience.

Even with the best data and our best endeavors we find that on drilling, or the acquisition of additional data, the model is inadequate or even wrong. The model needs to be either modified or the modeling process must begin again. Many industry projects go through a cyclical workflow of data acquisition, model building and drilling, with projects evolving through several very different model paradigms in their lifetime. The authors have carried out some controlled studies to assess the level of uncertainty inherent in interpretation. This work has indicated that even when the best interpretational practices are deployed the creation of a single deterministic model will still lead to a significant level of uncertainty.

Recognition that geological datasets are massively unconstrained means that we need to adopt new workflows to define the range of "possible" models. Once the full range of models is acknowledged, they can be ranked for their impact on outcome and hence decision. Using current interpretation and software methodologies, multiple complete models would need to be built prior to making

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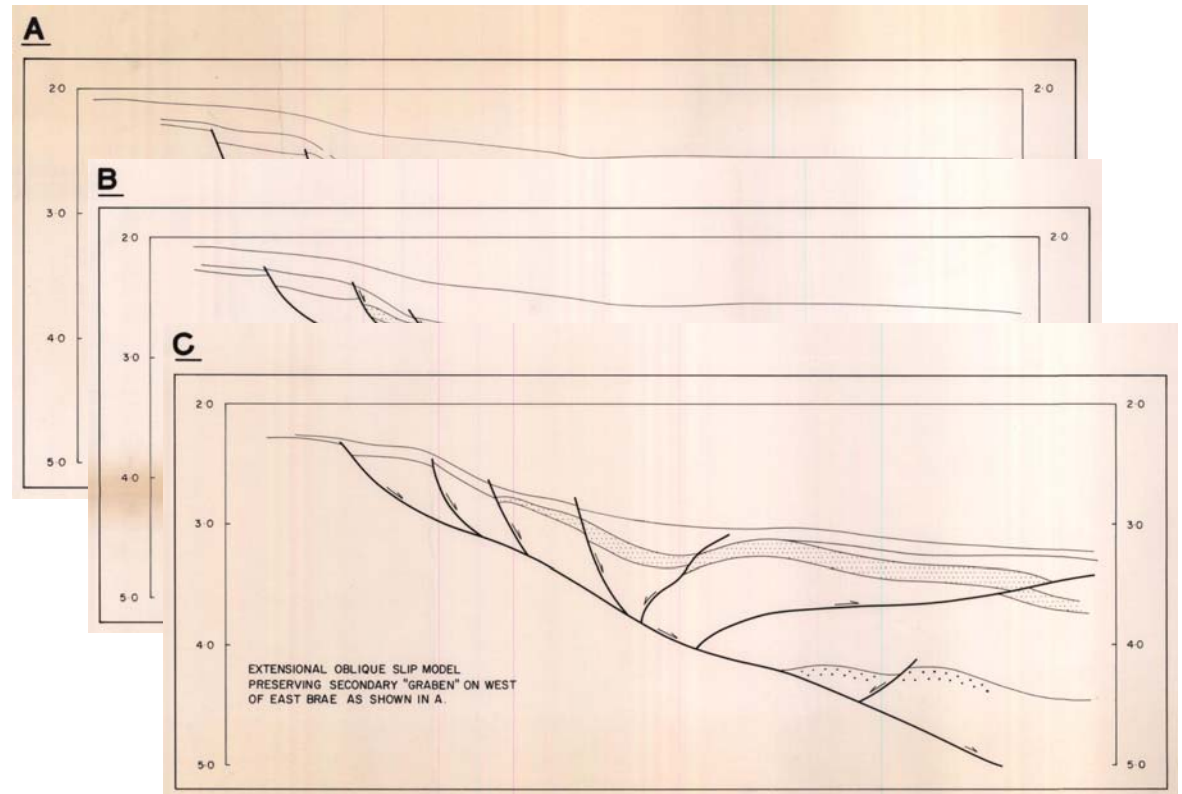- Culture to create the right interpretation and model
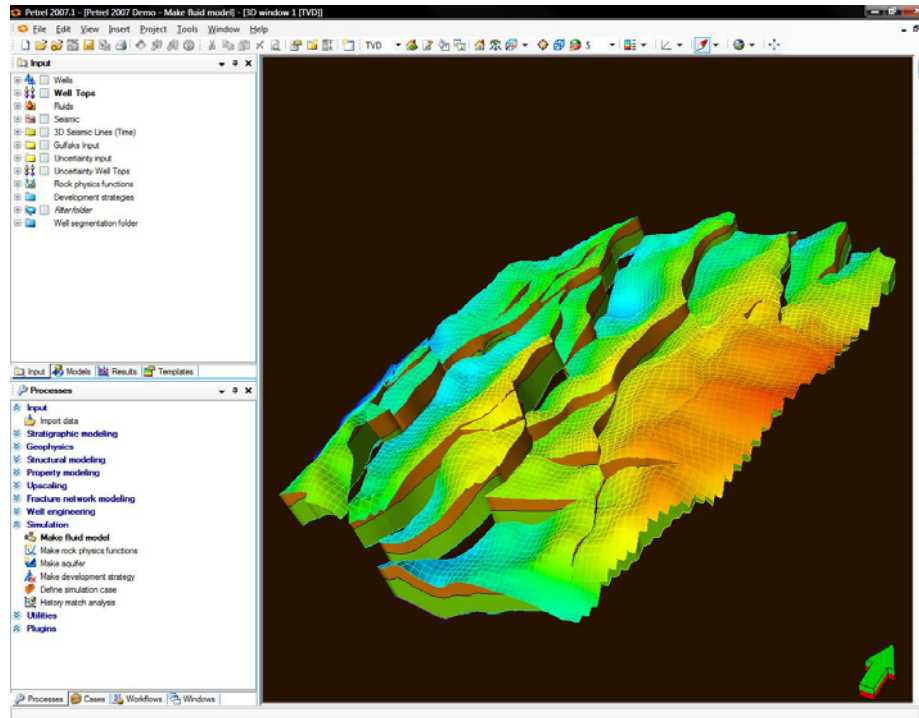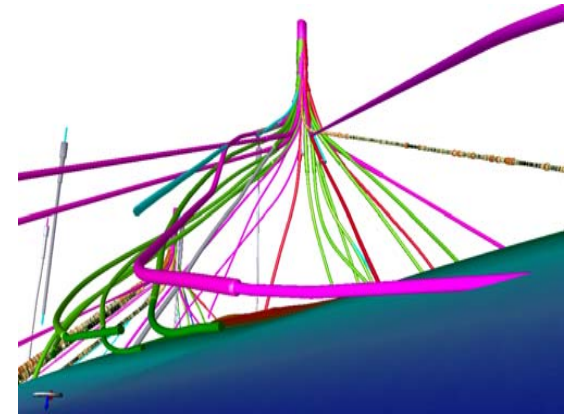

3D Seismic

Framework modelling

- Precision conceals real level of uncertainty

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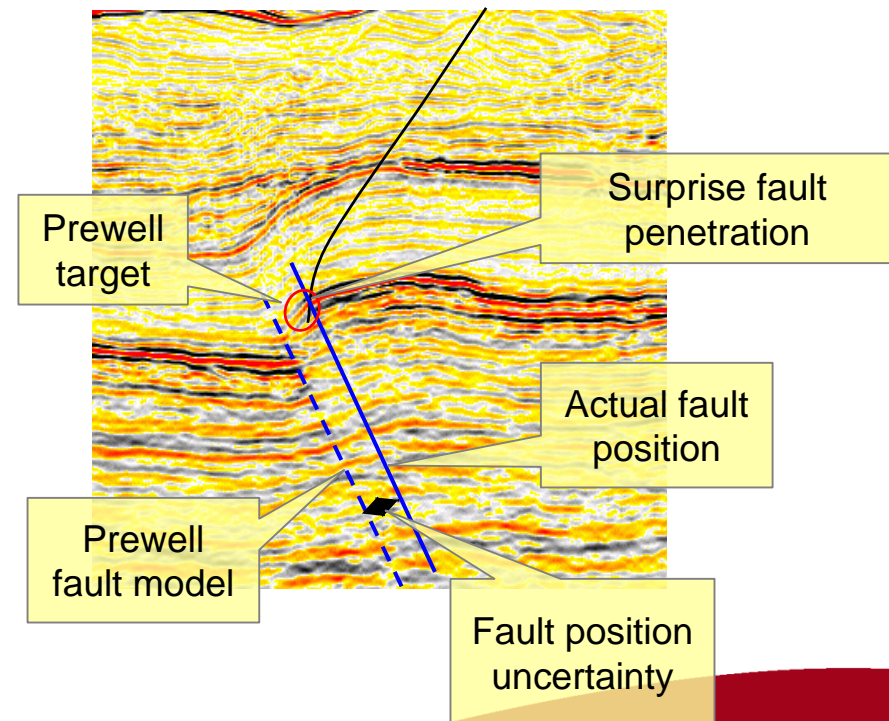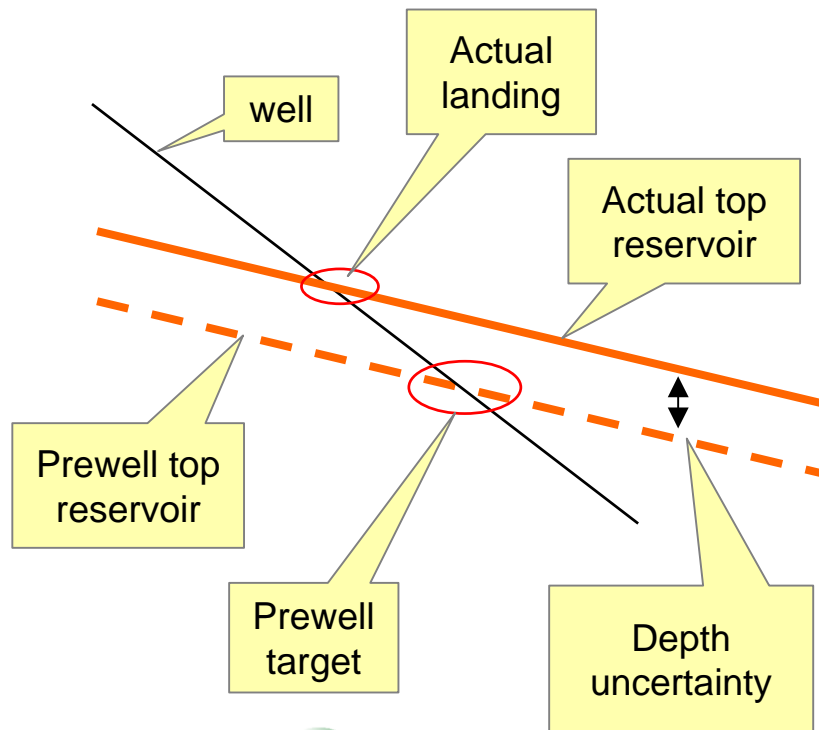- It is part of the interpretation process to generate multiple models

From the 1980's

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- Models are just that - *models*
  - At some level they are always wrong

  - Geological problems are massively under-constrained

  - No single deterministic answer

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Symptoms of Structural uncertainty

- Target error (too high / too low / wrong place / absent)
- Surprise (fault / boundary in unexpected place)

well

Actual landing

Actual top reservoir

Prewell top reservoir

Prewell target

Depth uncertainty

Prewell target

Surprise fault penetration

Actual fault position

Prewell fault model

Fault position uncertainty

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- Classic approach:
  - Create and defend "best model"
  - until "surprises" force a new interpretation

- Sequential realisations
- Costly
- Inefficient

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- ## Scenarios created in series
  - eg. Compartmentalised field with "challenging" history

From 1980 to 2002

Models for Primary Structure dominated by:

- Marginal fan build up
- Terraces with straight faults
- Listric fan
- Slump over basement step
- Salt withdrawal
- Oblique trans-tension
- Relay step-over with late inversion
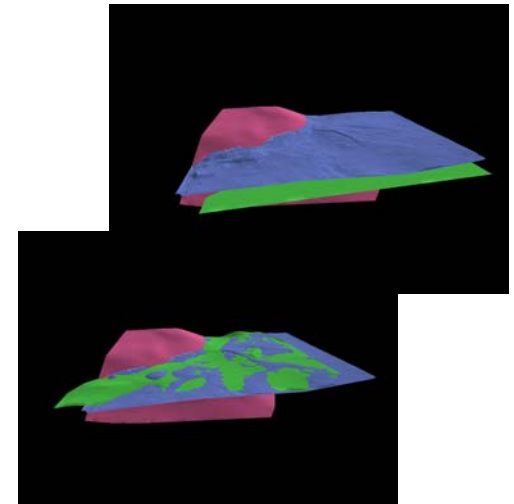
- ## Need scenarios created in parallel

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Multiple scenarios allow us to ask:

- What would change the <u>Decision</u>?

- What would change the <u>Outcome</u> of that Decision?

What are the tipping points?

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Identifying Tipping Points for Decision and Outcome
-understanding impact of technical uncertainties

Models

Parameters

Eg:
Elastic properties
Geomechanical
Geometric

Single model
Multiple models
Common process
Multiple processes

Sensitivity

Processes

Eg:
Restore, seds, fracs, hydro systems

Restore revise interpretation cycle

Analysis
Comparison

Cross plots
Pseudo wells

Differences
Residuals

Co-
Visualisation

Attribute
mapping

Decision and outcome plus 3rd party analysis

Re-usable workflows, Batching and Data handling

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New workflows and tools

Process

Parameters

Valid Parameters

Query and analysis

Possible outcomes

Decision

Outcomes

Base Model

Alternatives

Valid Models

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- Need an evolution in
  - Workflow practices
  - Interpretation culture
  - Software tools

- Tool requirements

  - insert into current practices

  - workflow supported

  - allow rapid scenario exploration

  - retain knowledge and scenarios

  - allow co-visualisation

  - numerical analysis and comparison

  - output to downstream users

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- # What does it look like?

Push to Move

Workflow sheets
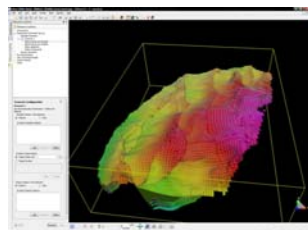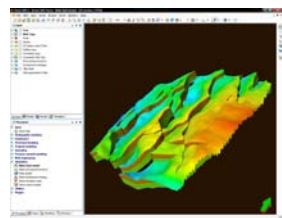
To drilling model

Primary
Interpretation
or framework
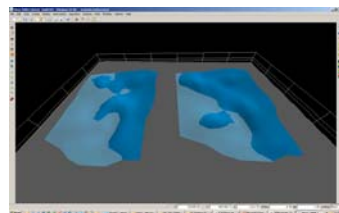
Rapid scenario models
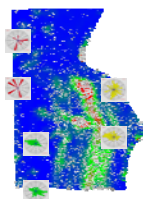
To fluid model

Base case
development

Analysis

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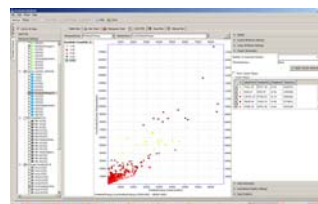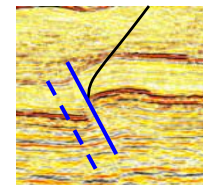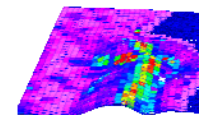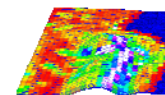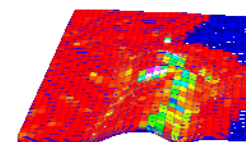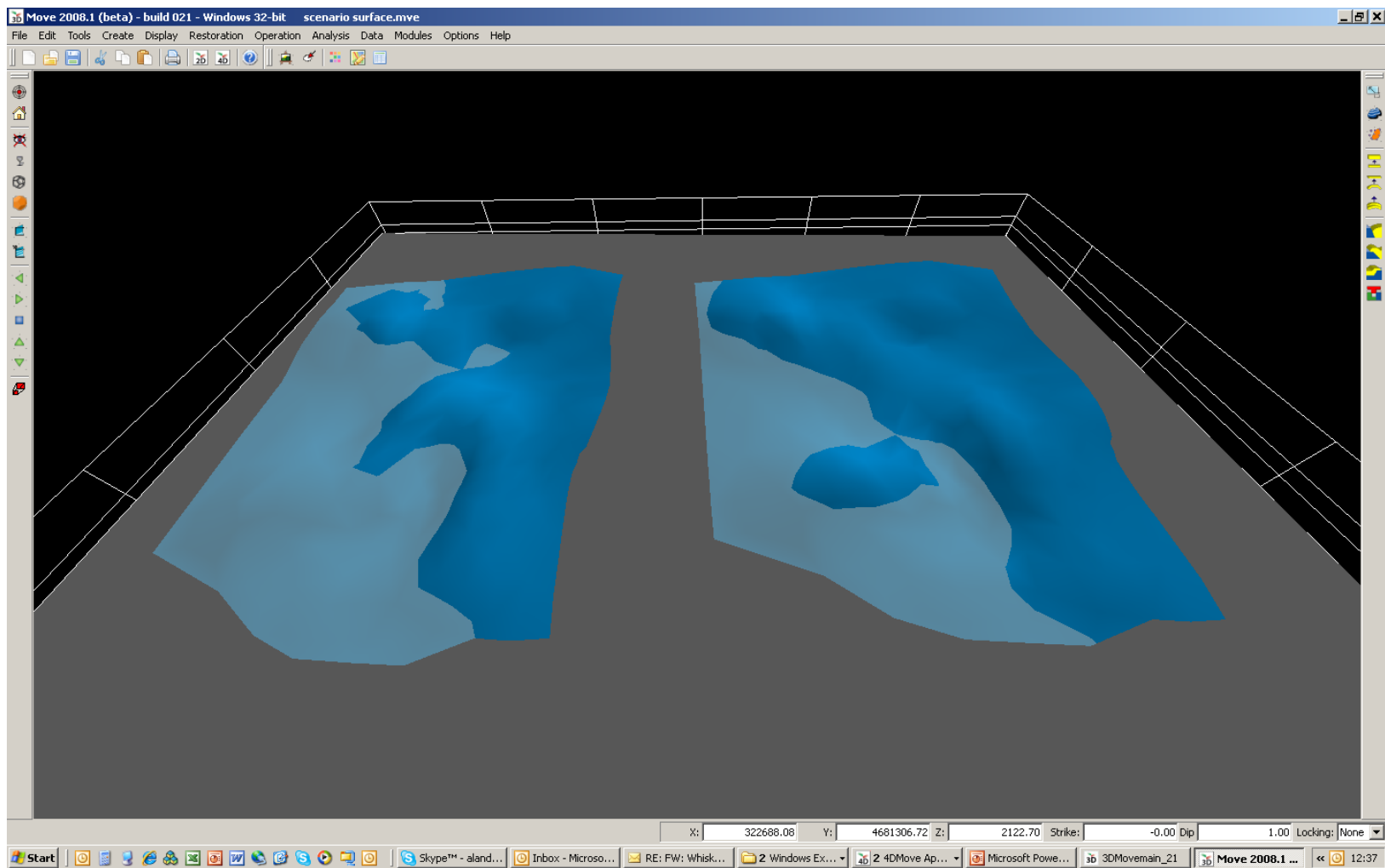
Co-visualisation of two alternative restored palaeo-surfaces

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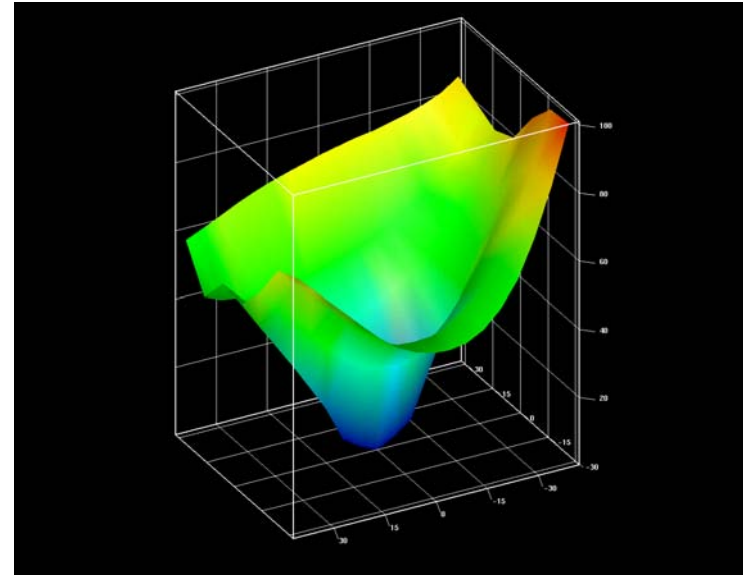The structural geology experts

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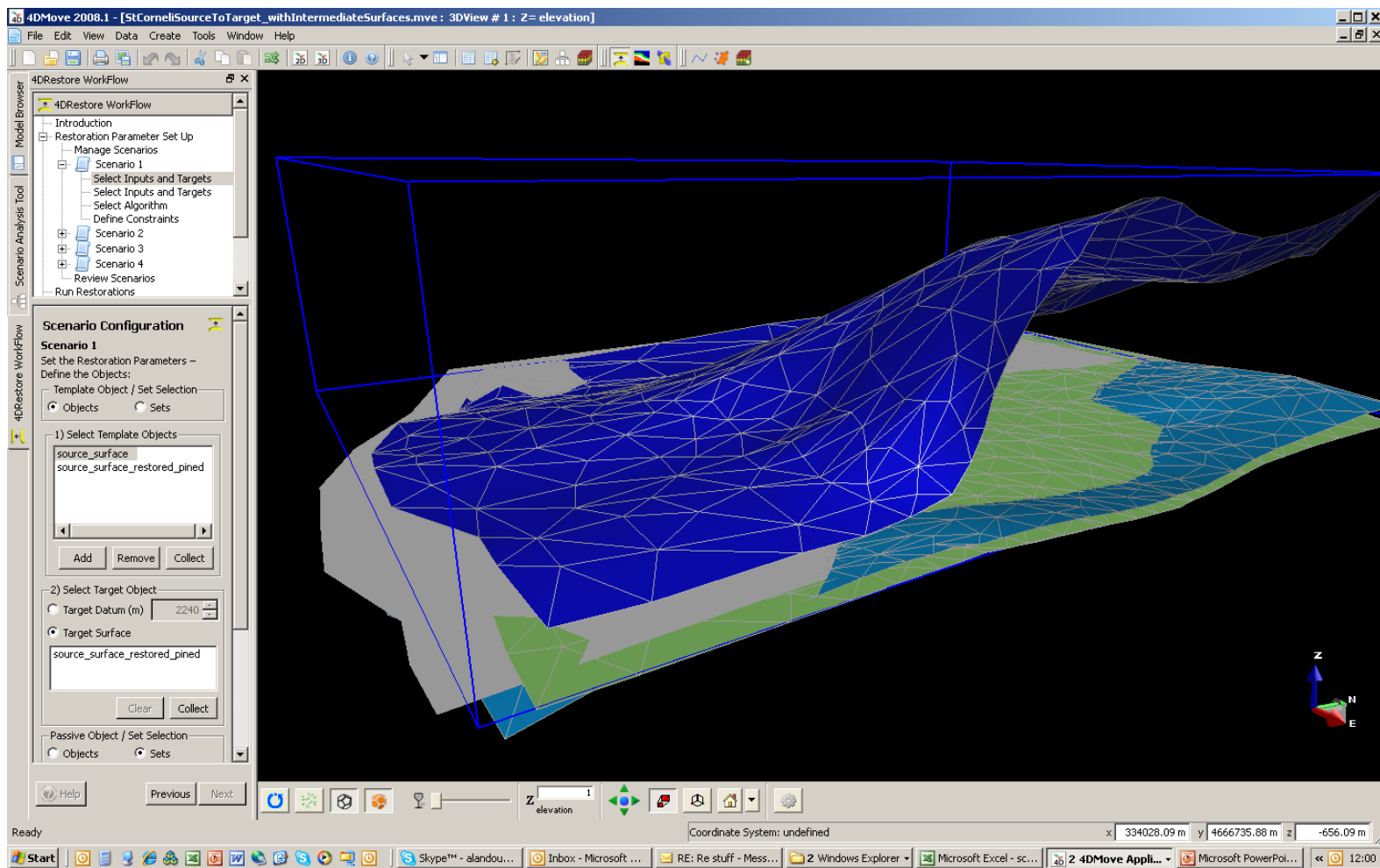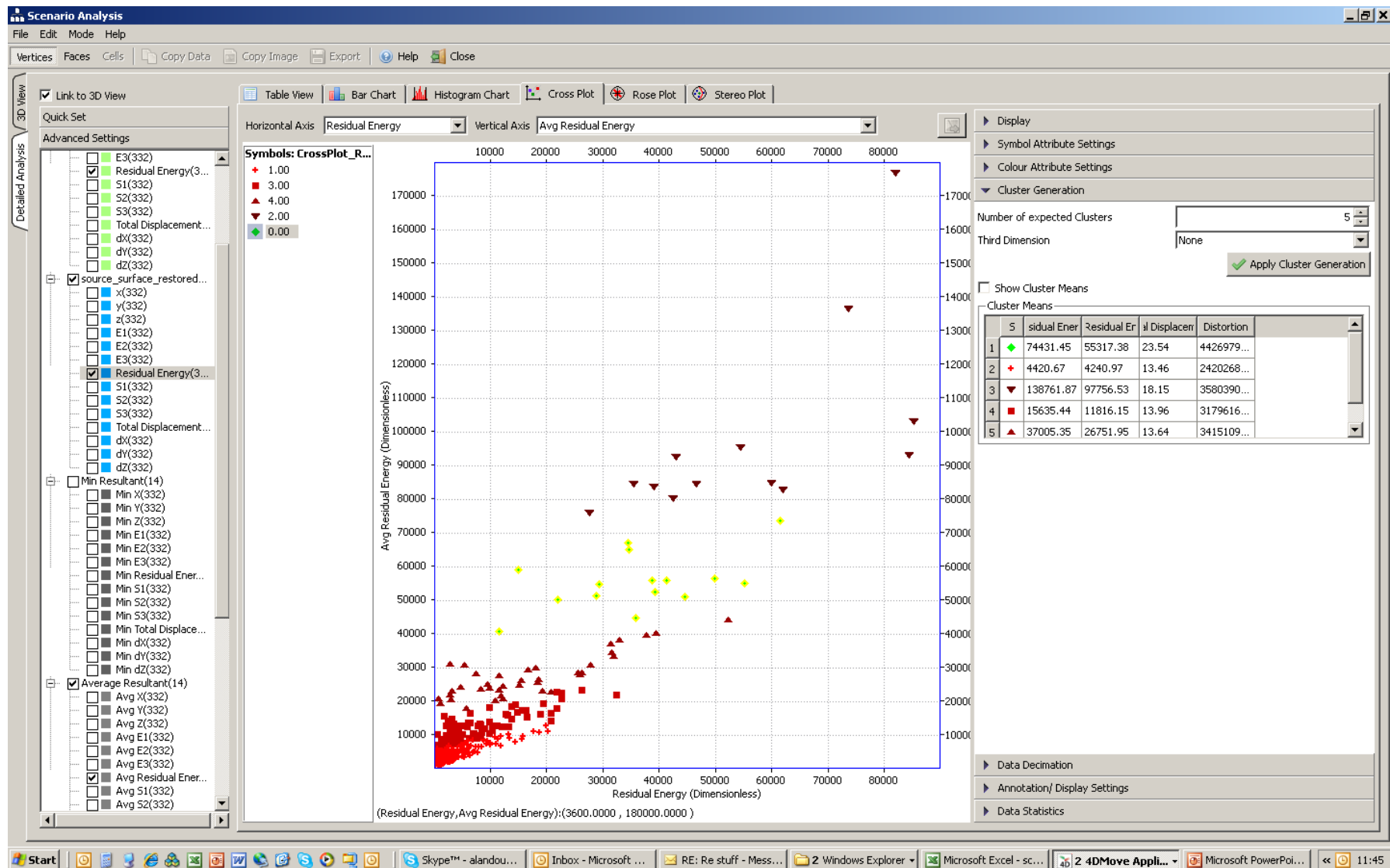
Residual energy ("restoration uncertainty") of alternate models

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Solution space
diagrams

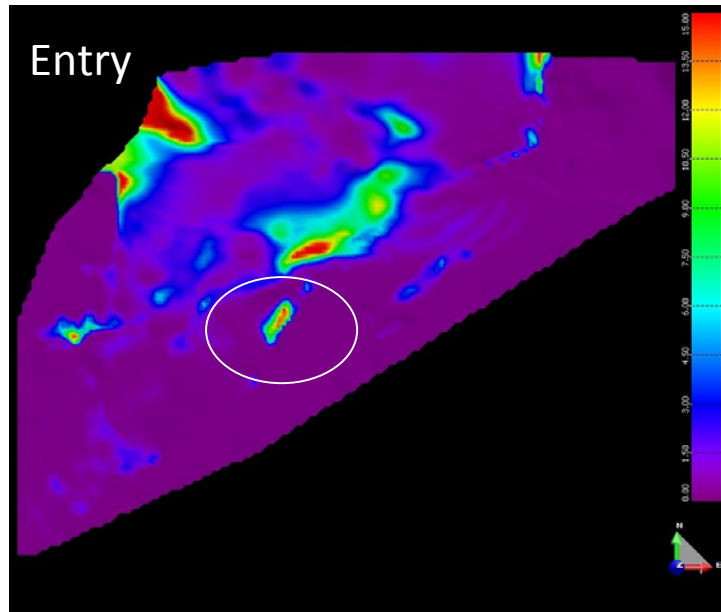Best / Worst case
realisation

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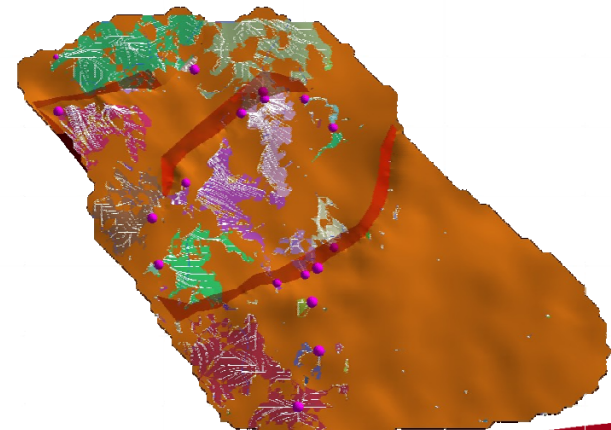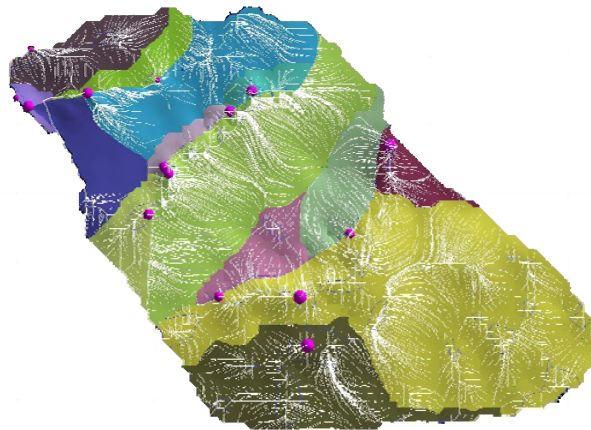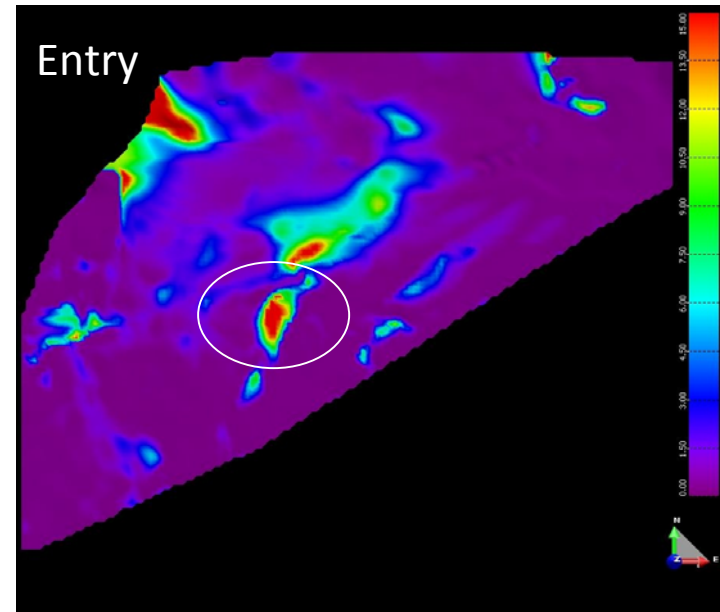
• Sensitivity to sediment deposition

- • Palaeo-surface
- • Entry point
- • Sediment load
- • Basal erosion
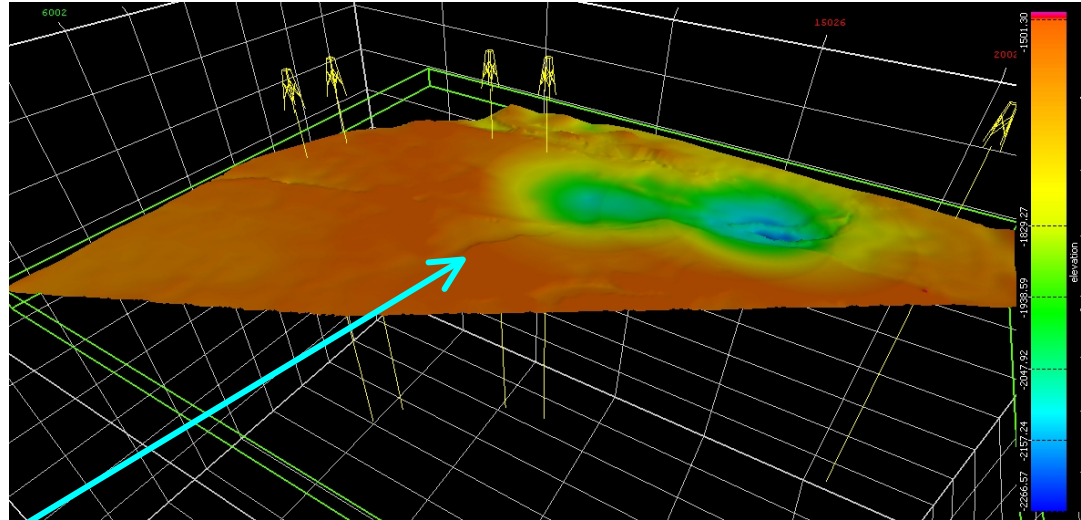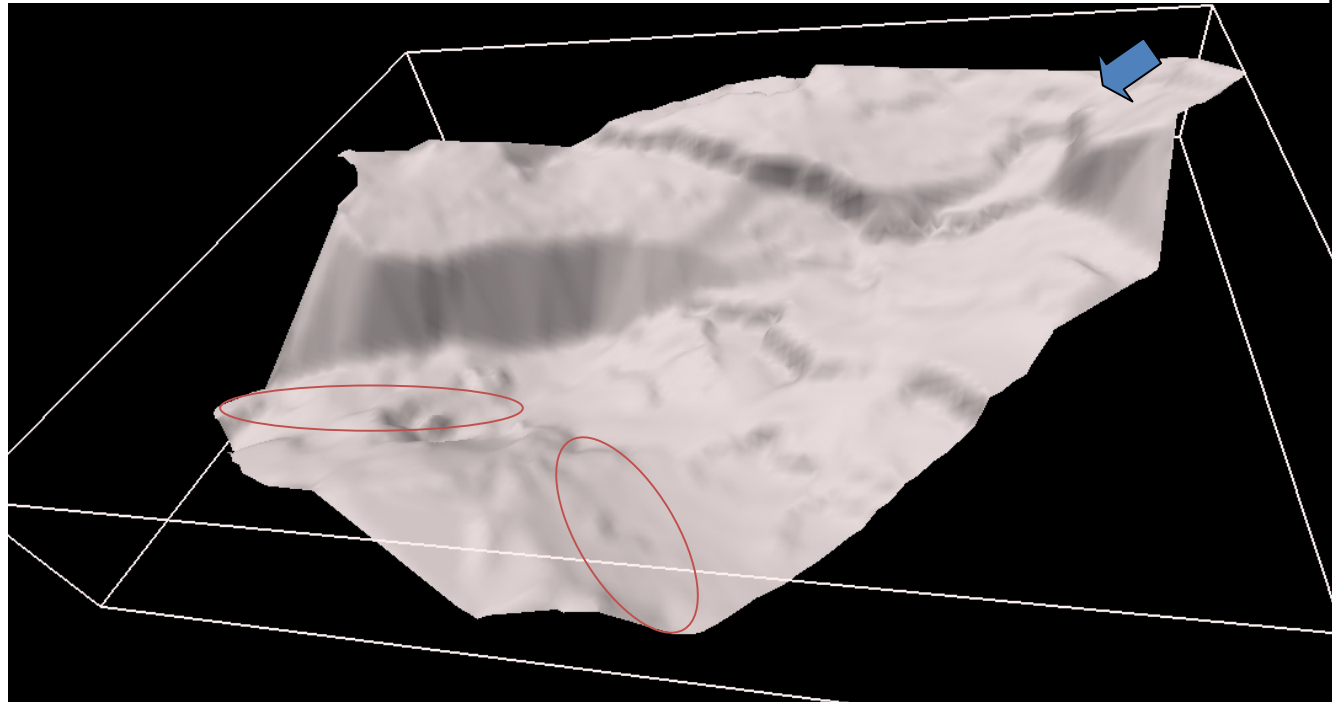

Potential prospect

No basal erosion and re-deposition   Basal erosion and re-deposition

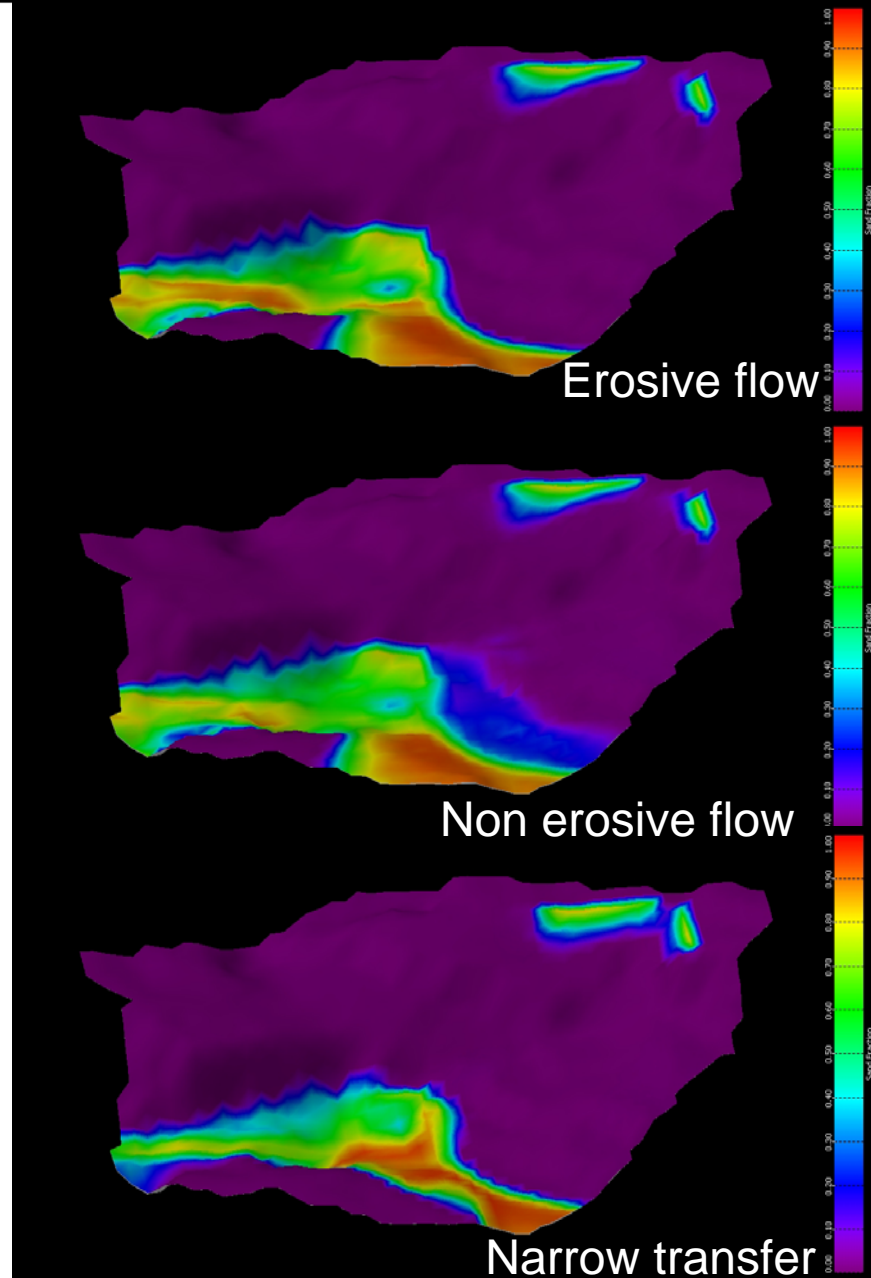Presence or absence of basal is the critical factor in this prospect model

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- North Sea

  down flank
  turbidite
  play

Entry and source from crestal collapse feature

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Critical factor is the palaeo-geometry for sediment entry

Erosive flow

Non erosive flow

Narrow transfer

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Scenarios

- Range of geological possibility

- Assess and quantify uncertainty

- Critical tipping points for the decision

- Identify range of potential outcomes

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Output of scenario analysis:

- Decision process

- Reservoir model

- Basin model

- Drilling model

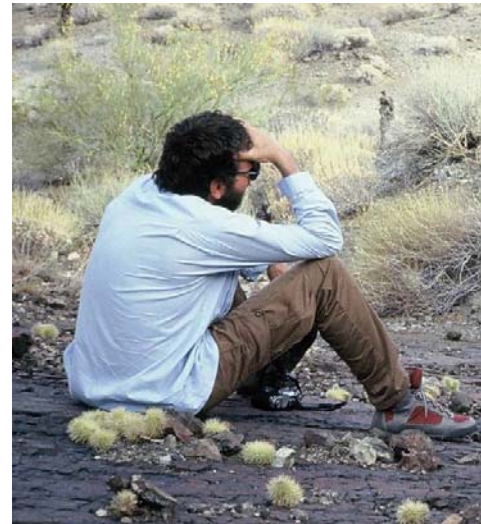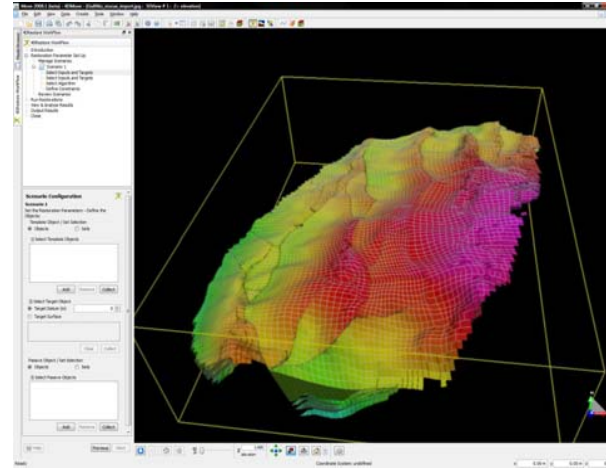- Iteration in interpretation cycle
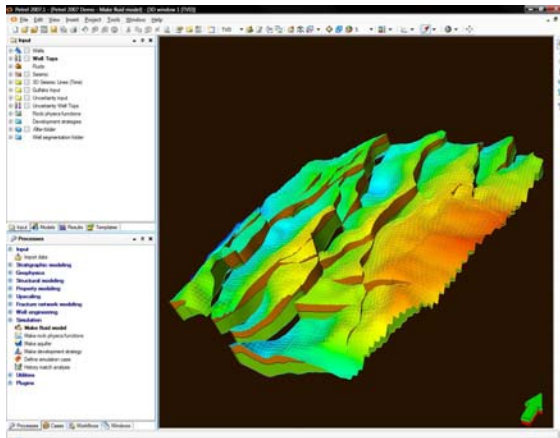
Eliminate the invalid

Some models may look good and honour the data but be geologically or concept invalid
Eliminating the invalid should leave a range of valid scenarios to capture the full range of probability
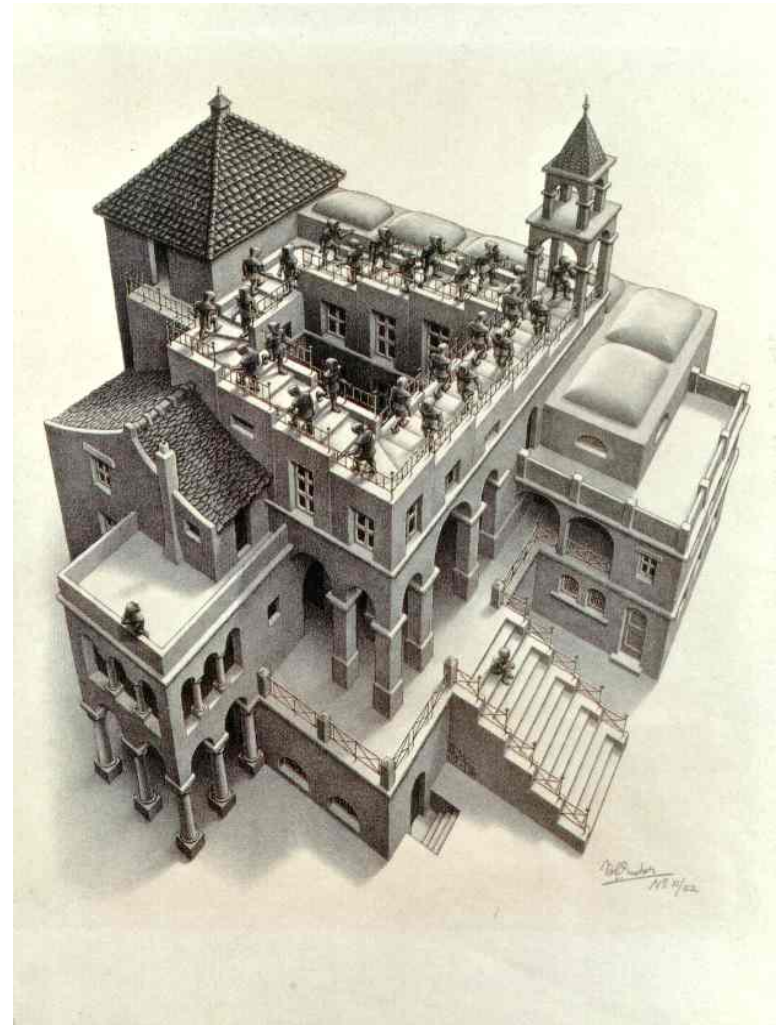
Capture the range of scenarios

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The model is just a model

Nature is more perplexing

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