Chris Townsend

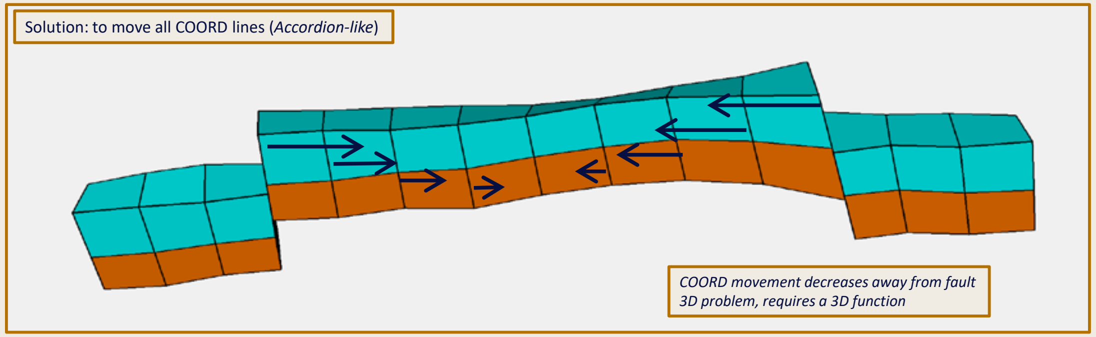
University of Stavanger

Flexigrid –
UiS research project proposal

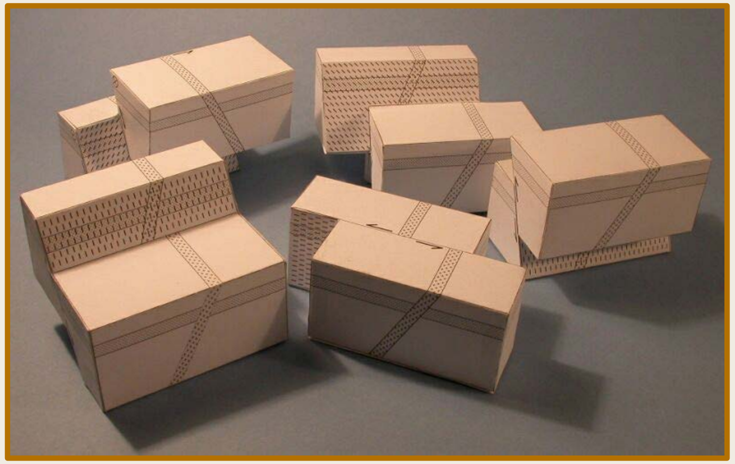
Flexigrid Project

- Proposed University of Stavanger research project
- New way of handling structural uncertainty in 3D grids
- Attempt to overcome a number of issues related model ensembles
- Asking for funding from the oil industry
- Employ 2 new researchers at UiS; PhD and/or Post–Docs

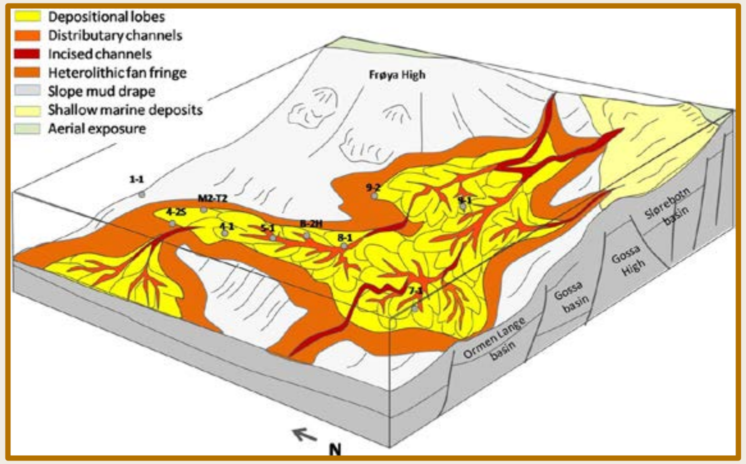
- UiS Staff: Chris Townsend, Nestor Cardozo, Pål Andersen & Espen Knudesen*
    * Cegal



Facies vs Structural Models



Vs



<u>Scenario/Ensemble methods need both facies/properties and structural</u>

Outline

- Explain the structural modelling process
- Discuss the application of structural uncertainty and current problems
- Explain the aims of Flexigrid project to overcome these issues
- Outline of the Flexigrid project

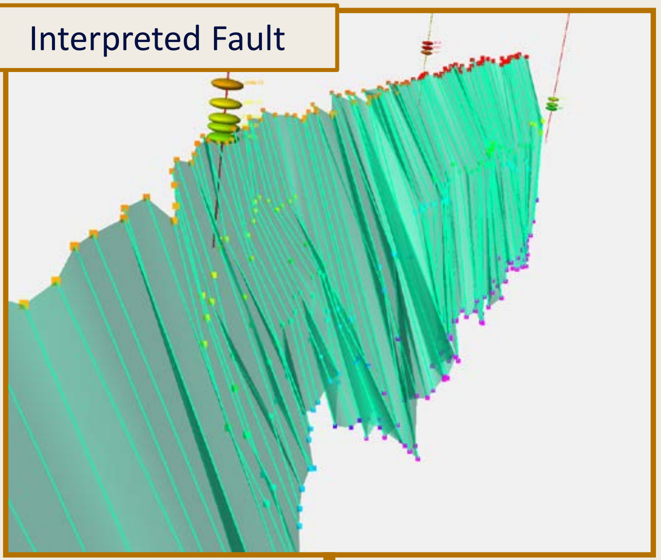
Faults

- horizons terminate <u>‘exactly’</u> at the fault
- faults are located <u>‘exactly’</u> at horizon terminations
- faults and horizons are intrinsically linked!!

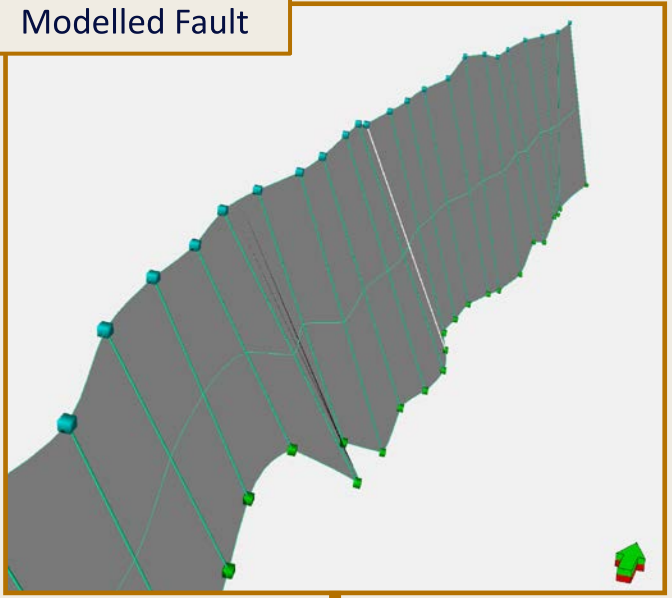
Structural Modelling Process – Faults

3 Fault Stages in Modelling

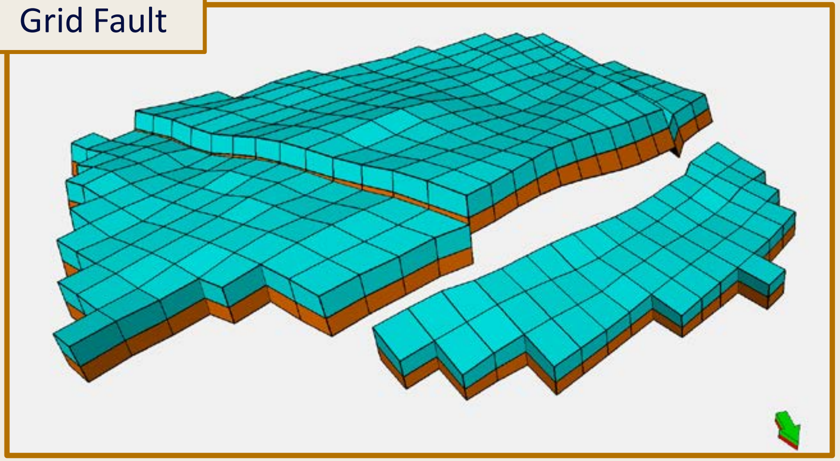
Interpreted Fault



Modelled Fault

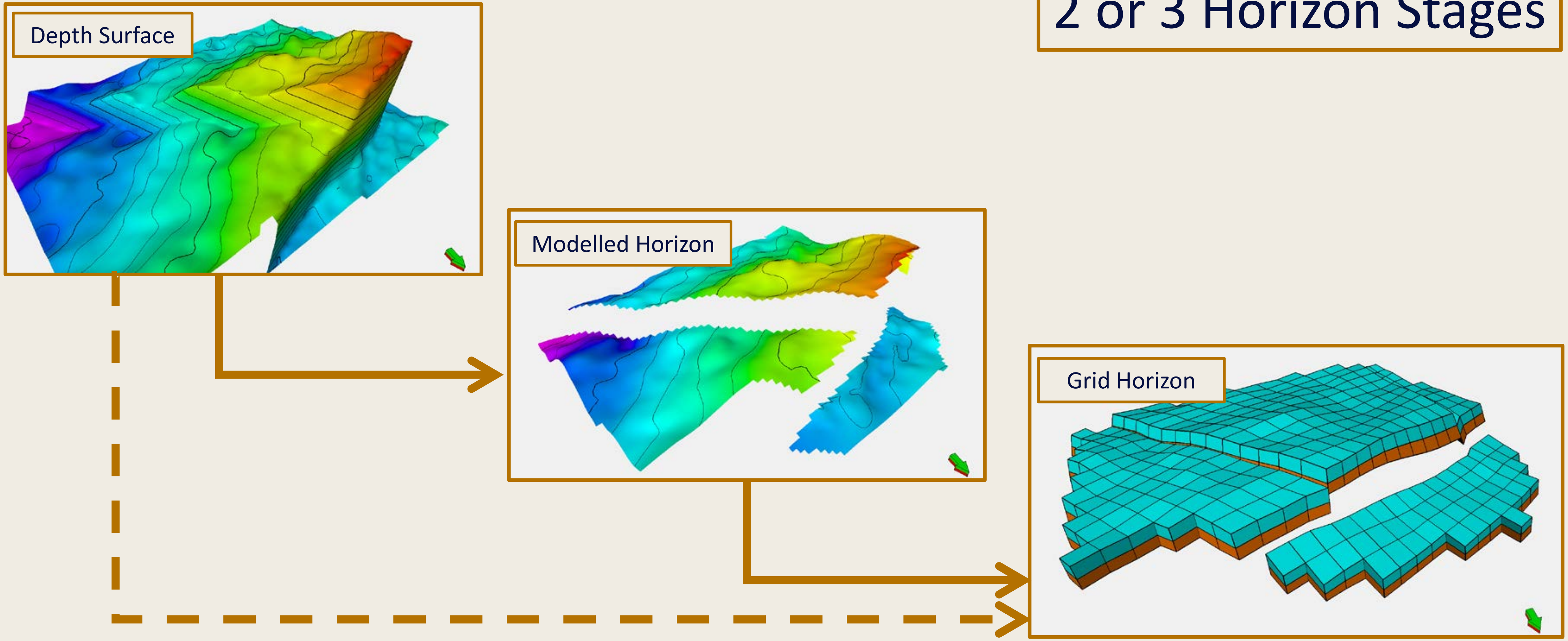


Grid Fault

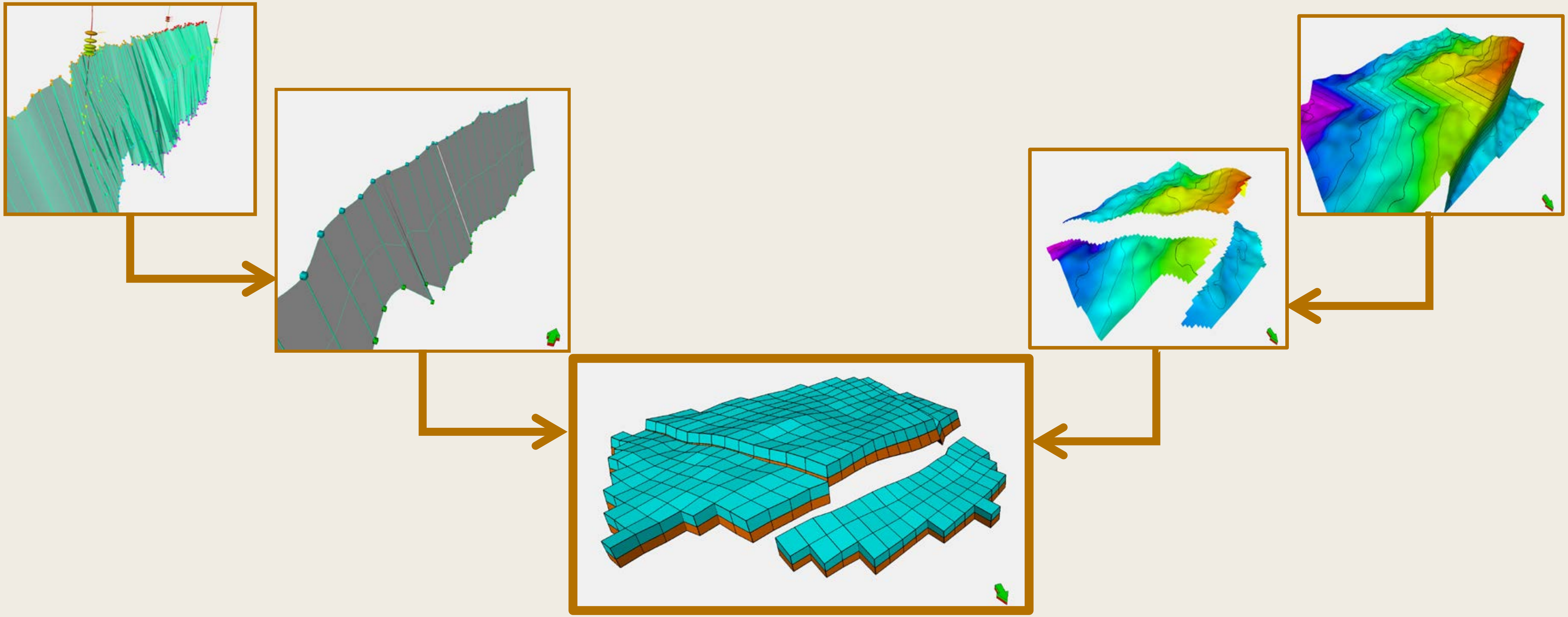


Structural Modelling Process – Horizons

2 or 3 Horizon Stages

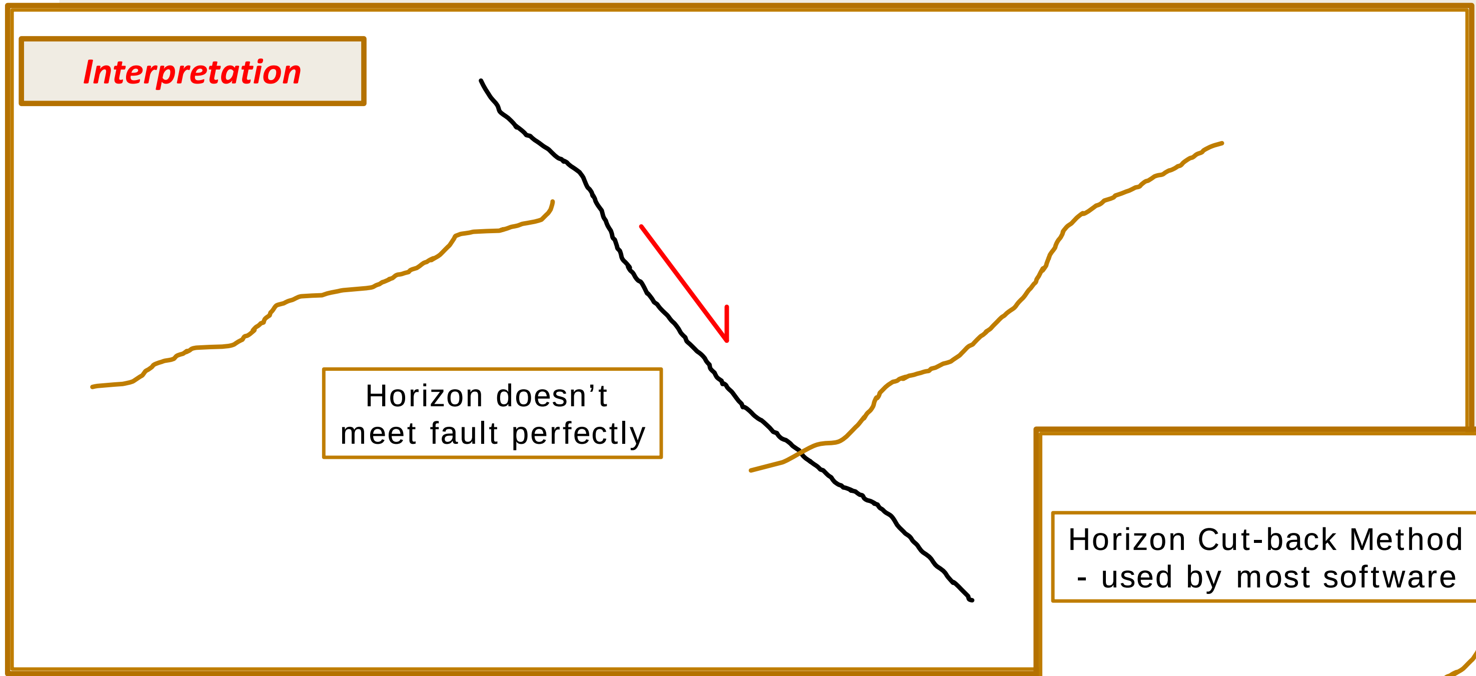


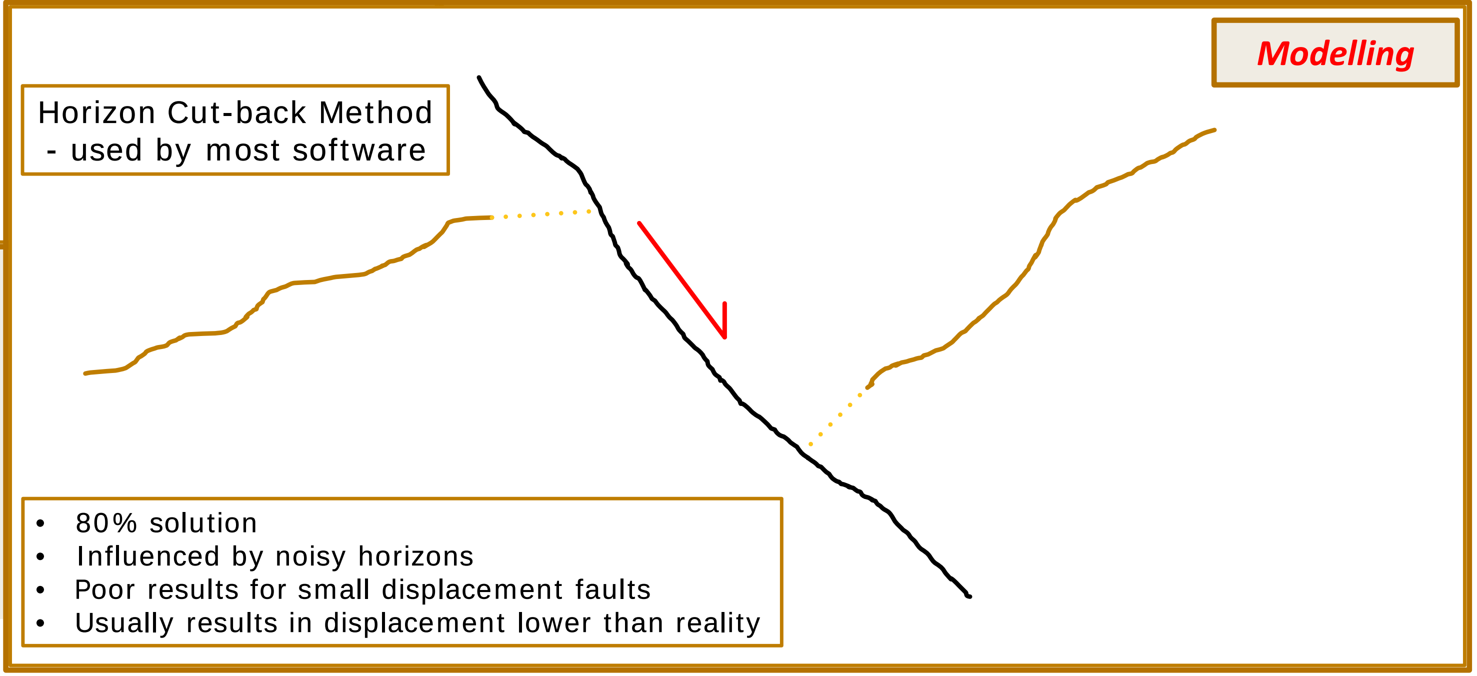
Structural Modelling Process – 3D Grid



Faults & Horizons are modelled independently
– no intrinsic link until the 3D grid is constructed

Fault Modelling – Horizon ‘cut–back’

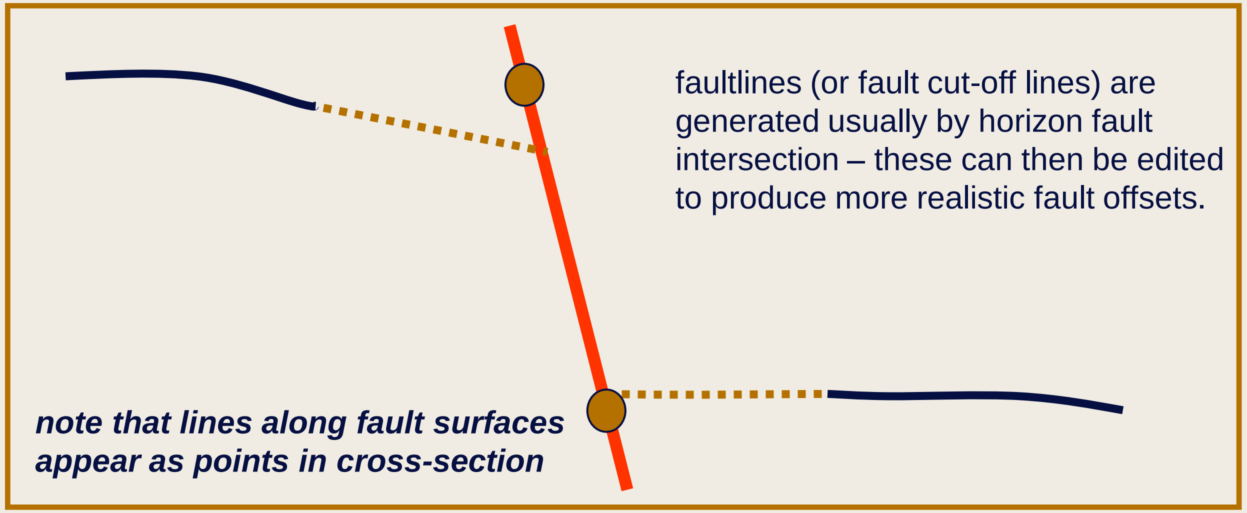


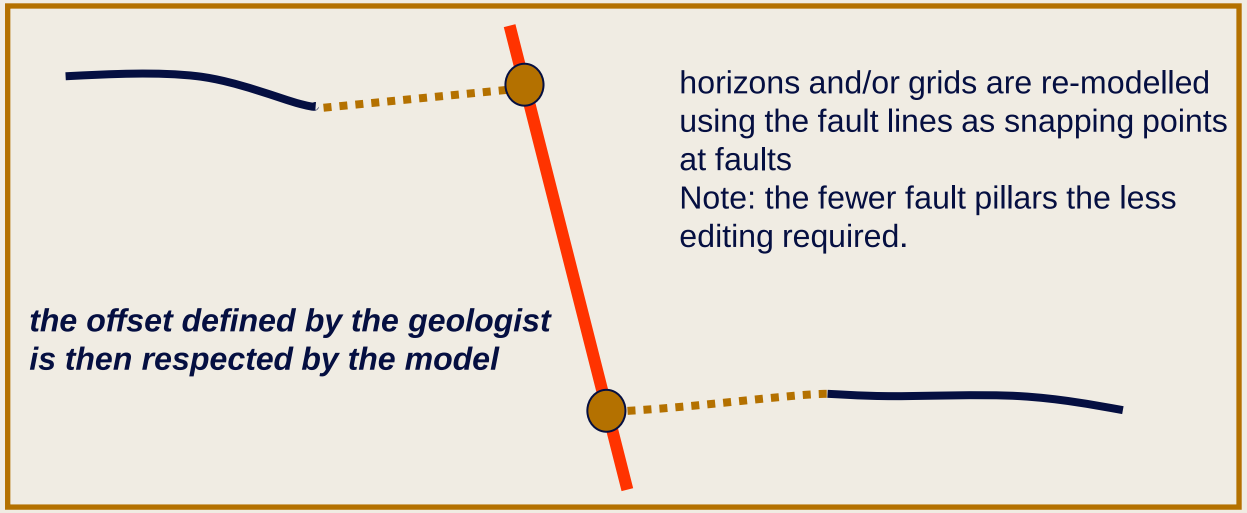


Method introduced to compensate for horizons not terminating ‘exactly’ at the fault

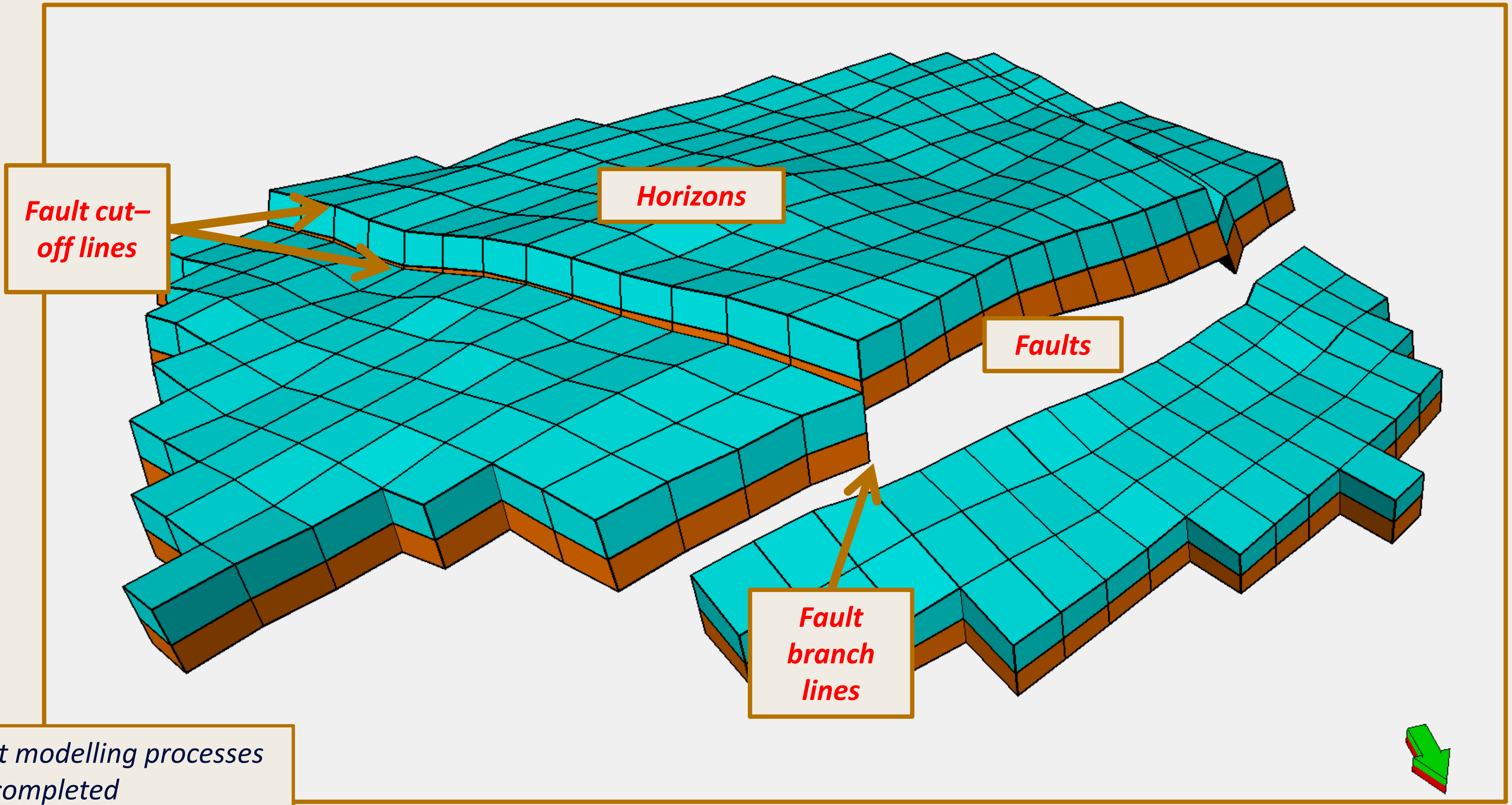
Fault-Horizon Modelling – Fault Lines

- Fault lines are used to control fault offset
- problem is generating & editing
- difficult to repeat for multiple structural realisation



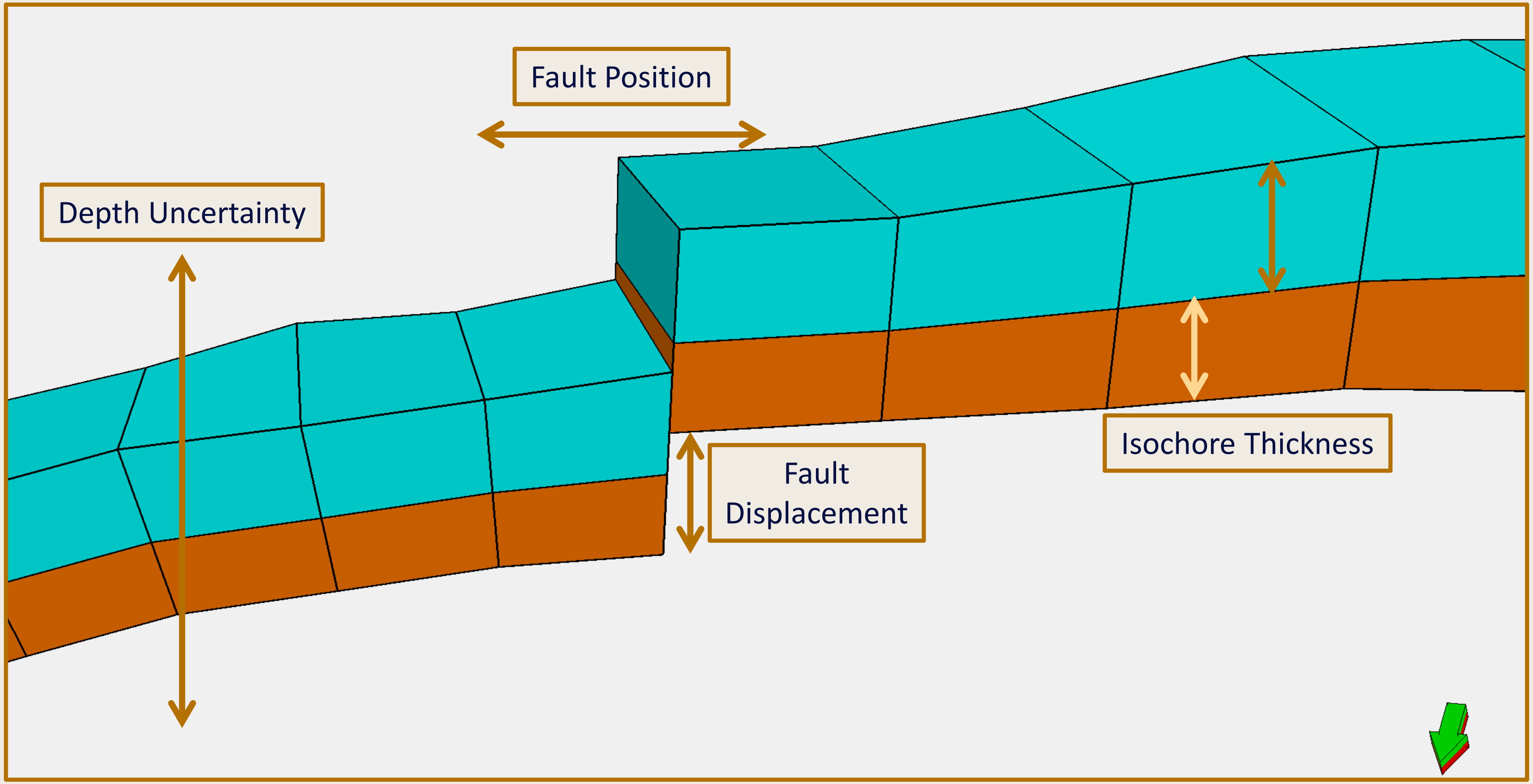


Faulted Grid



Once the horizon–fault modelling processes has been completed – the main structural components are defined and present in a 3D grid

Structural Uncertainty



Structural Uncertainty Modelling Issues

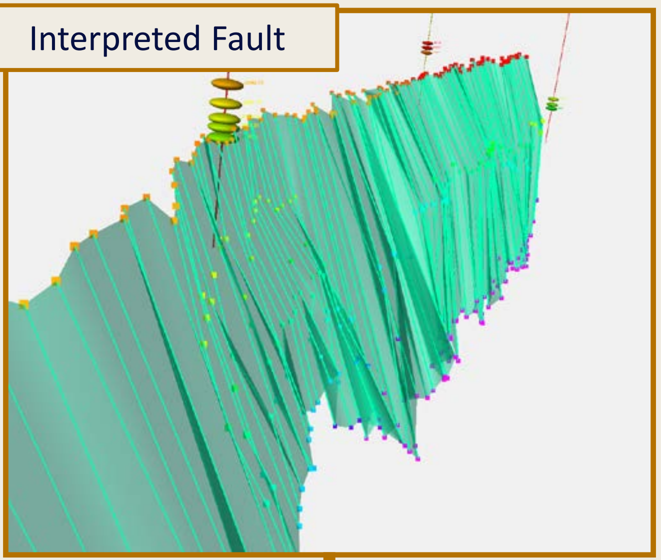
- 3 Main Issues with current workflows, create problems for handling structural uncertainties in an efficient and reliable process

  1. fault manipulation – fault building process has to be repeated
  2. fault or horizon manipulation – independent of each other
  3. horizon modelling around faults becomes unreliable

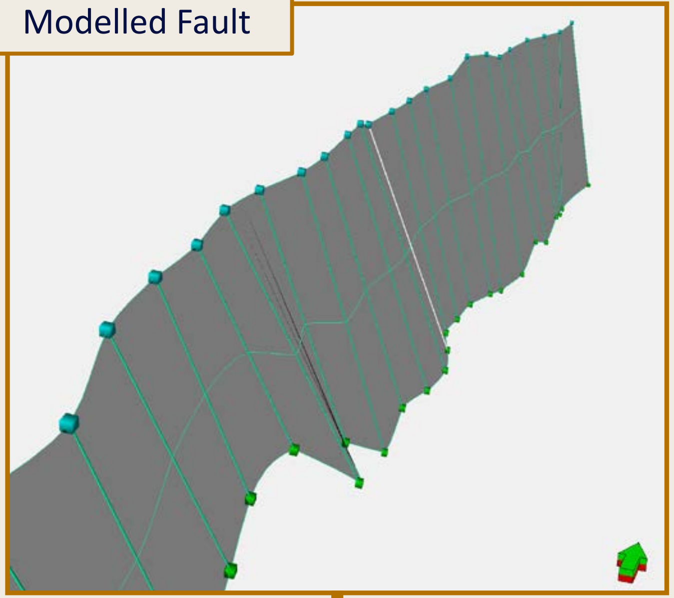
Issue 1 – manipulation > fault modelling

3 Fault Stages in Modelling

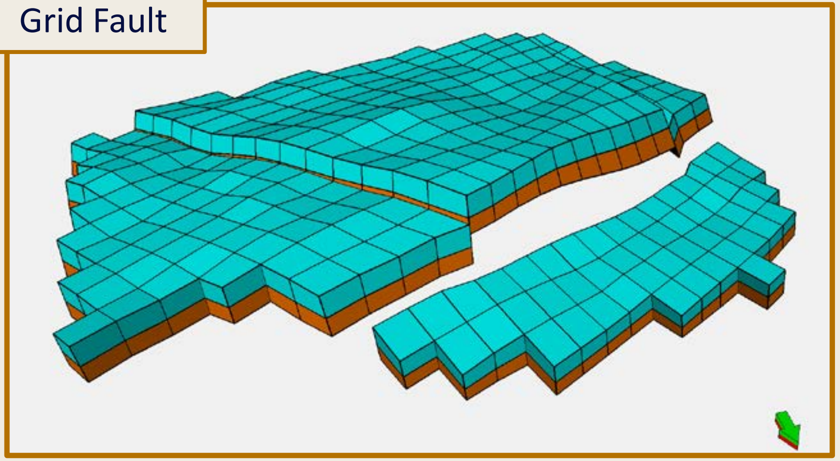
Interpreted Fault



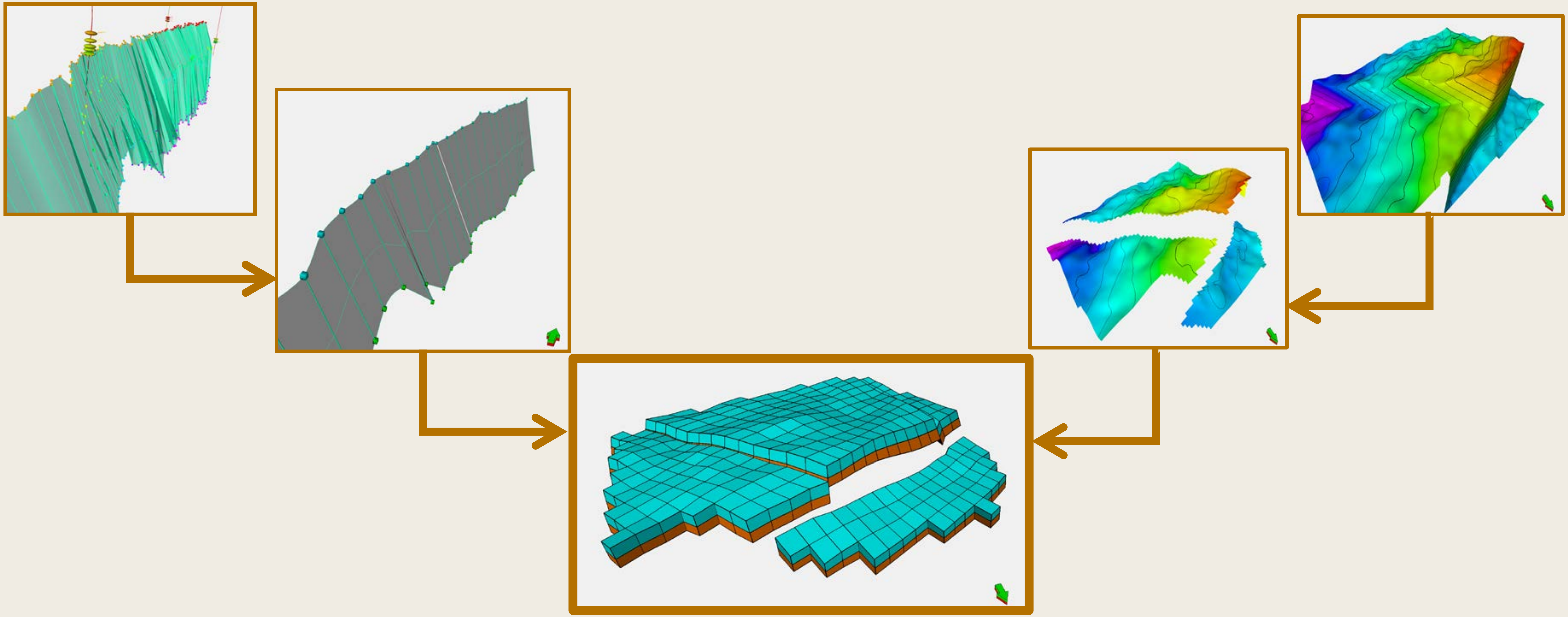
Modelled Fault



Grid Fault



Issue 2 – horizons/faults independent

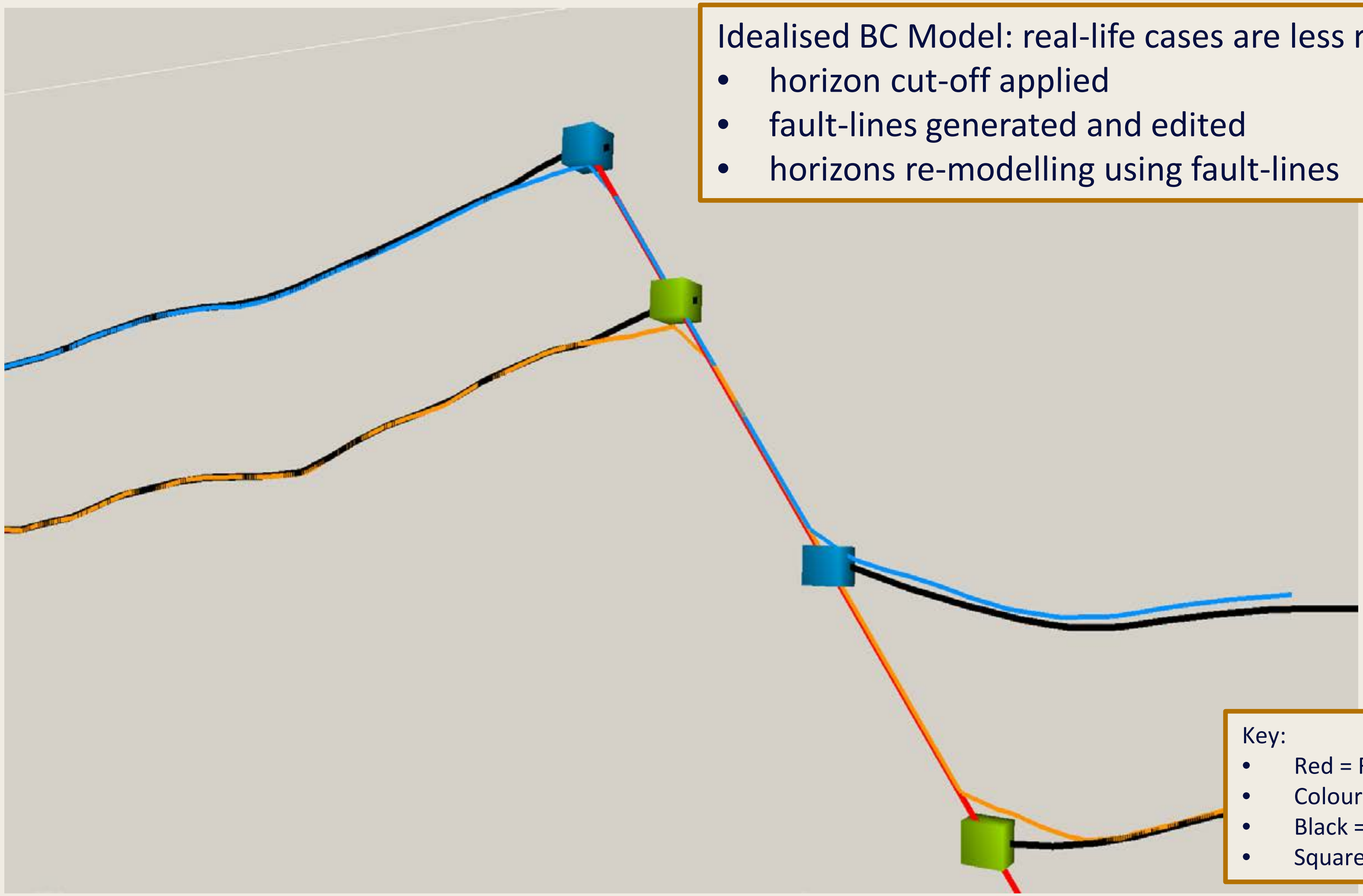


Faults & Horizons are modelled independently
– no intrinsic link until the 3D grid is constructed

Issue 3 – horizons around faults

Idealised BC Model: real-life cases are less reliable

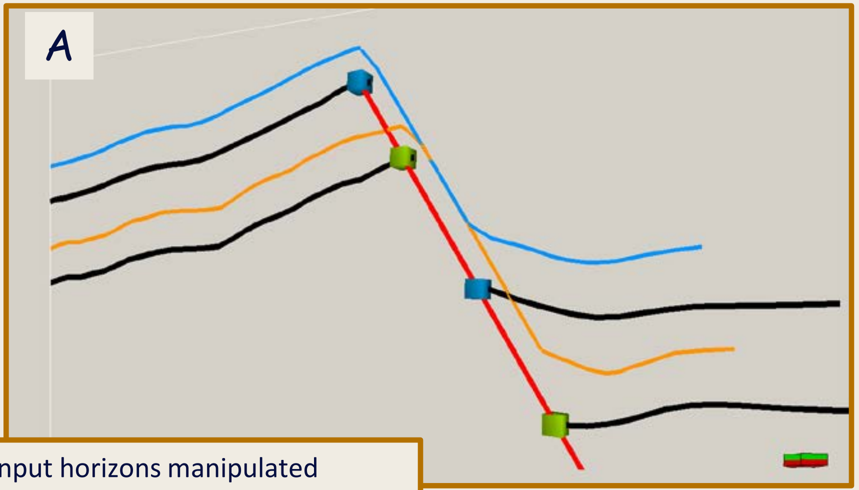
- horizon cut-off applied
- fault-lines generated and edited
- horizons re-modelling using fault-lines



Key:

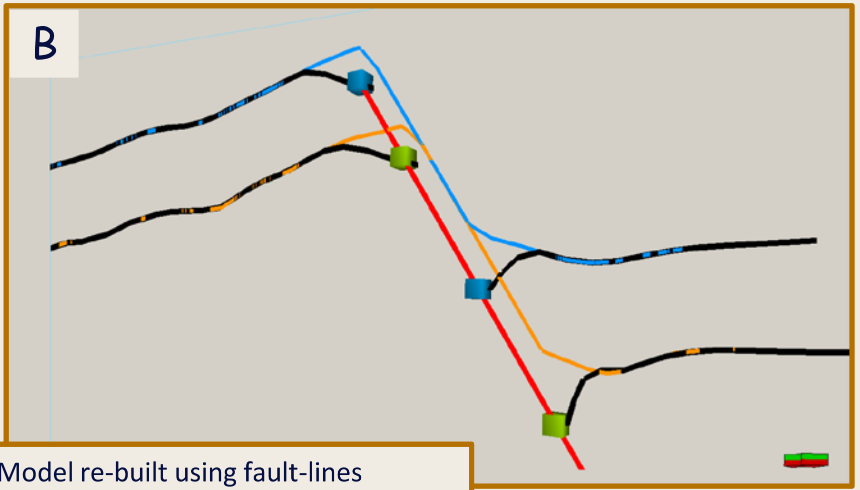
- Red = Fault
- Coloured = Input Surfaces
- Black = Modelled Horizons
- Squares = fault cut-off lines

Issue 3 – horizons around faults

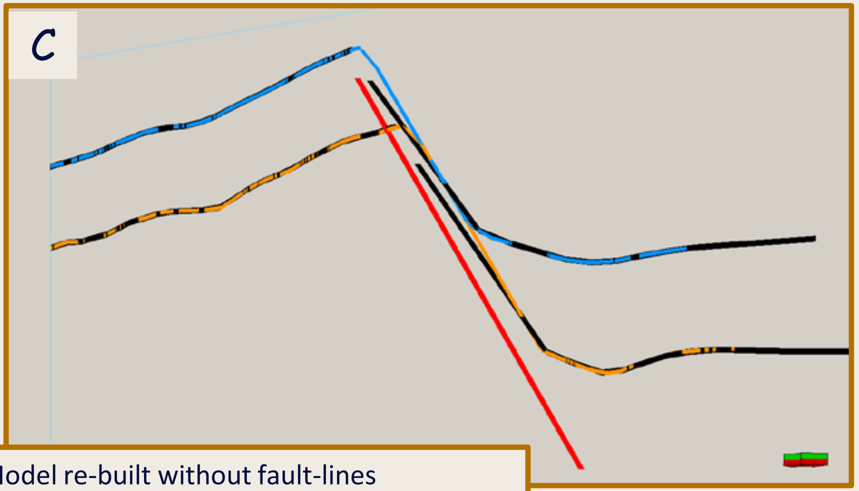


Input horizons manipulated
compare to BC model

Key:
- Red = Fault
- Coloured = Input Surfaces
- Black = Modelled Horizons
- Squares = fault cut-off lines



Model re-built using fault-lines
retains BC displacement



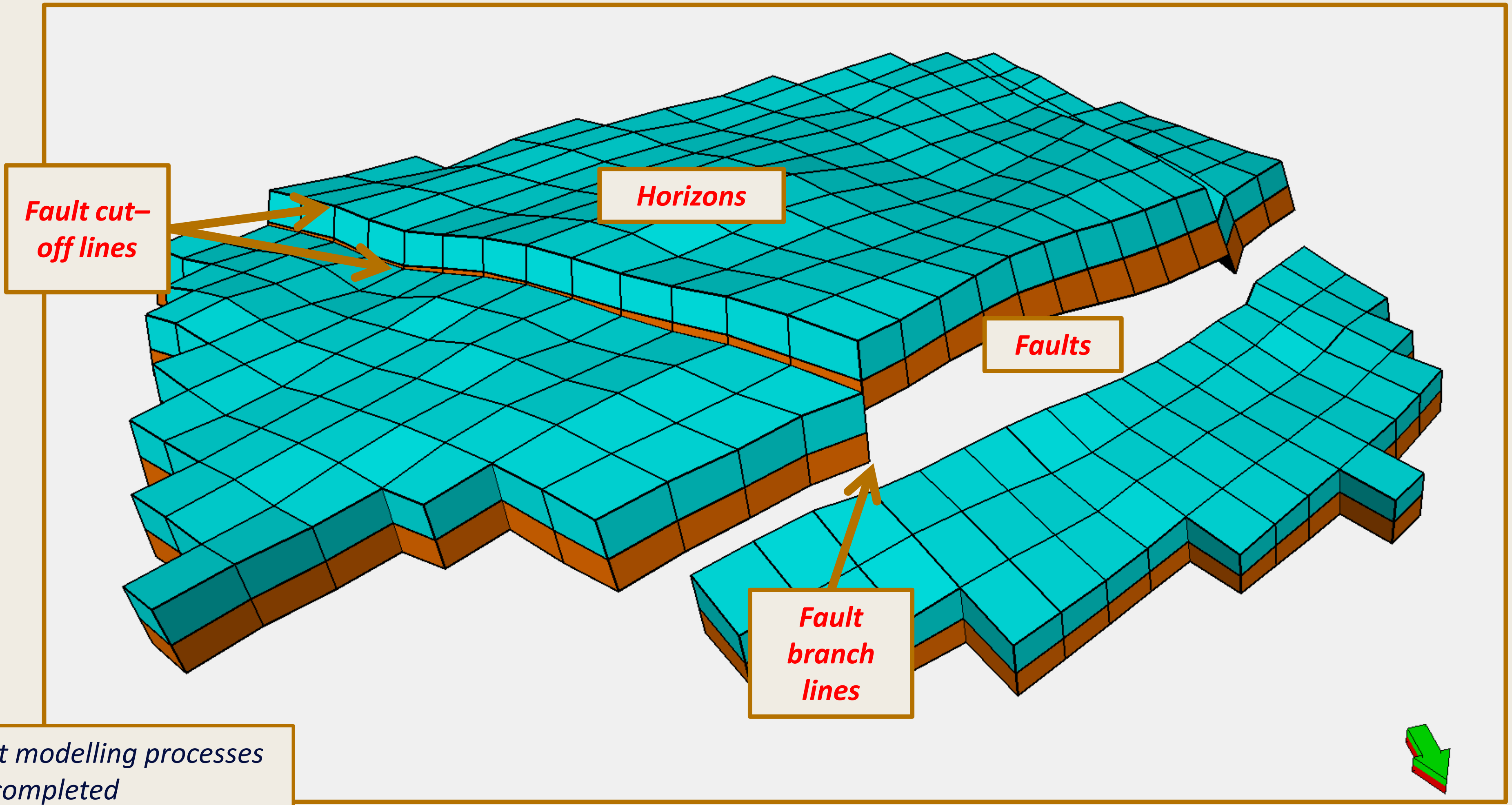
Model re-built without fault-lines
(poor displacement representation)

Flexigrid – Solutions

- How do we intend to solve these problems?
- Generate realistic multiple–structural–realisations
    - without user intervention

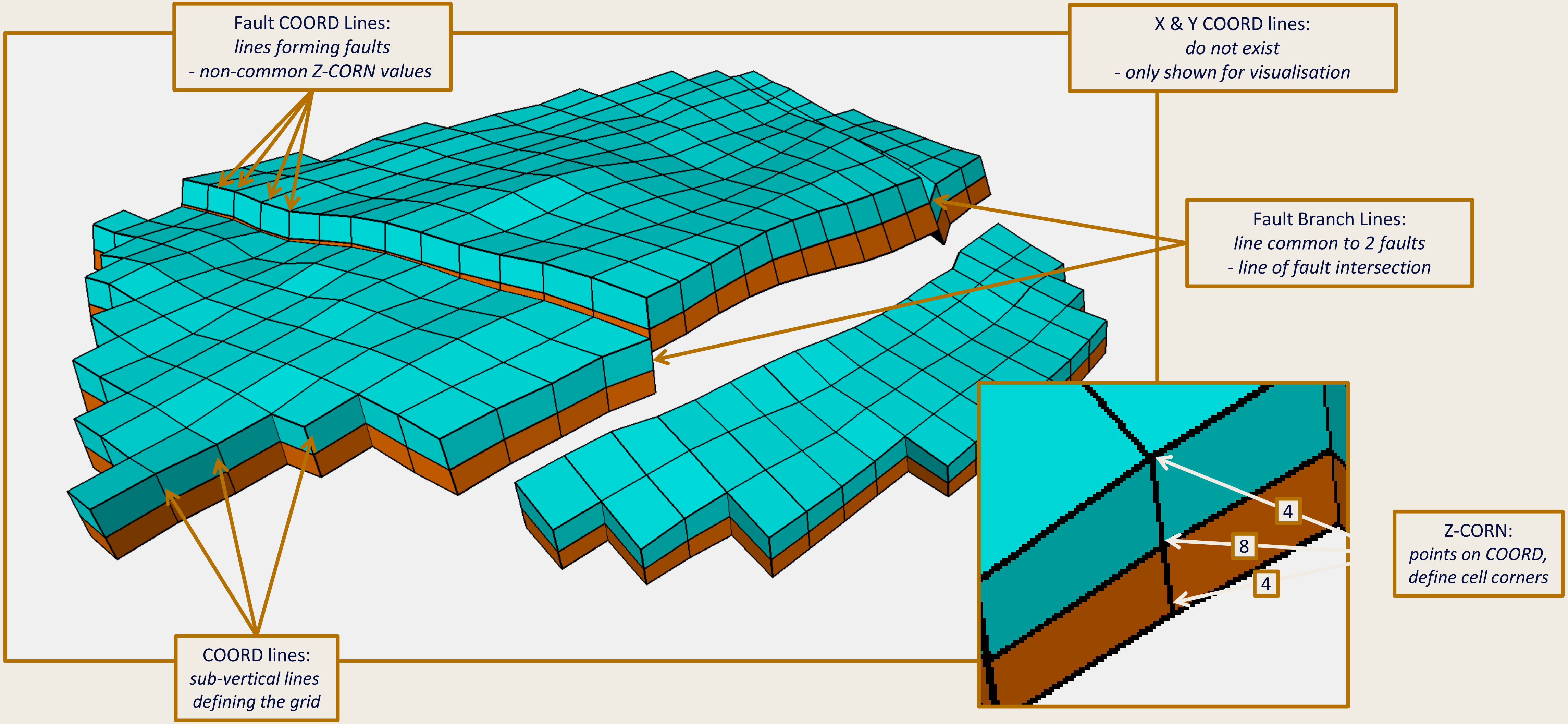
- Difference: all uncertainty modelling takes place on an already constructed 3D-grid with its defined faults, seismic horizons and geological horizons

Faulted Grid



Once the horizon–fault modelling processes has been completed – the main structural components are defined and present in a 3D grid

Grid Components

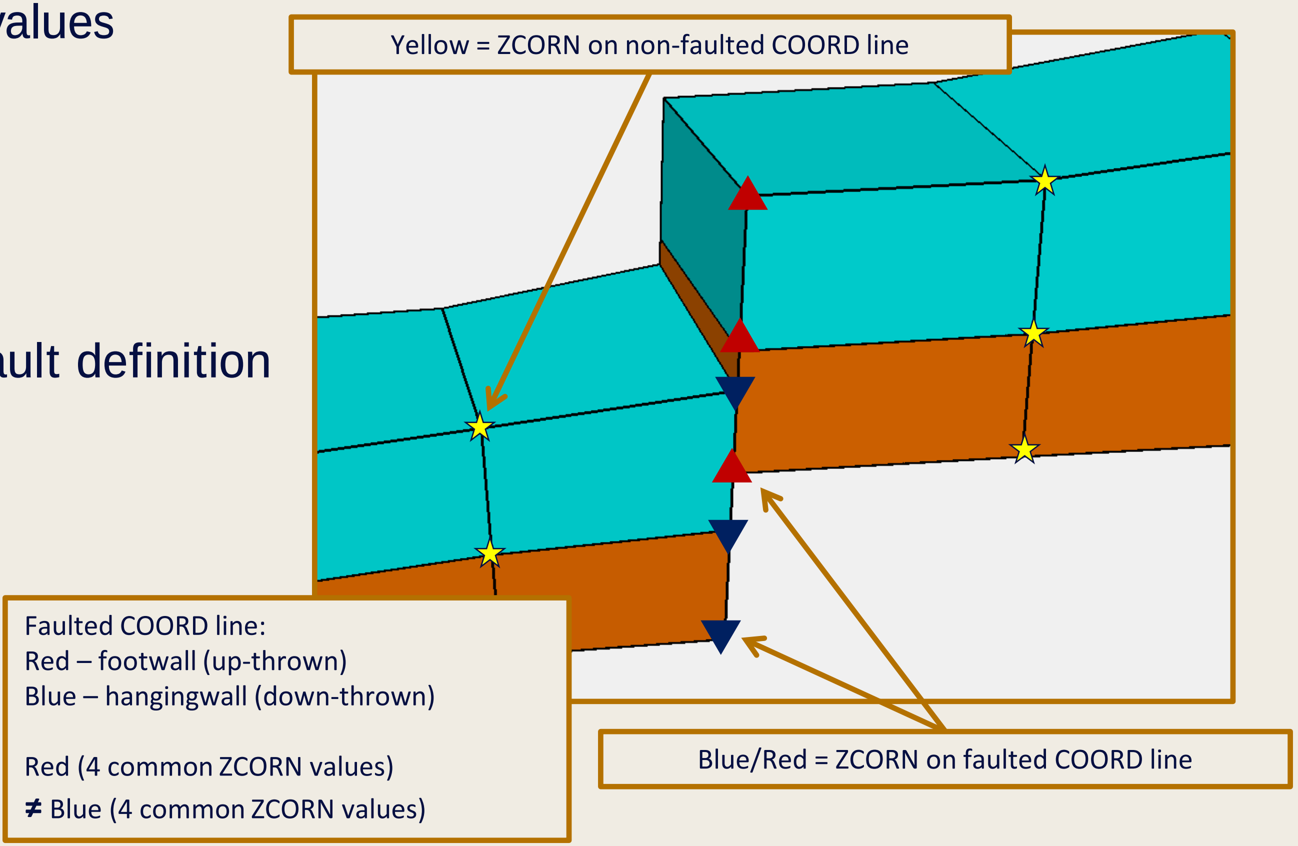


Grid Components: Fault Definition & Uncertainty

- Faults: defined by split in ZCORN values
- ZCORN points lie on COORD lines

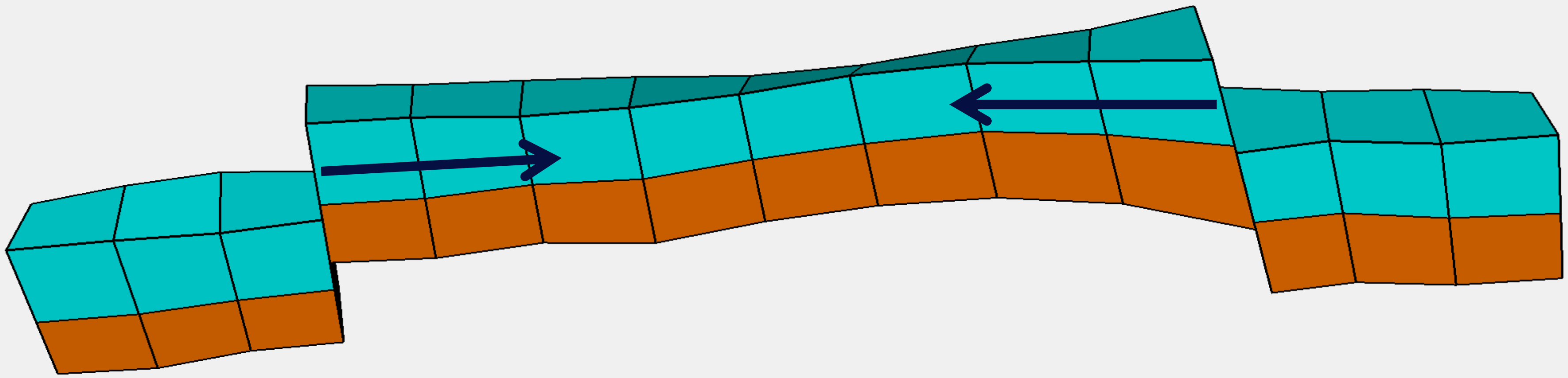
- Move COORD – Move the Fault
- Move ZCORN – Move the Horizon
- Move COORD/ZCORN – Horizon/Fault definition maintained

- Uncertainties
  - depth – corner points
  - isochore – corner points
  - displacement – CP per fault block
  - fault location – COORD line



Fault Location Uncertainty

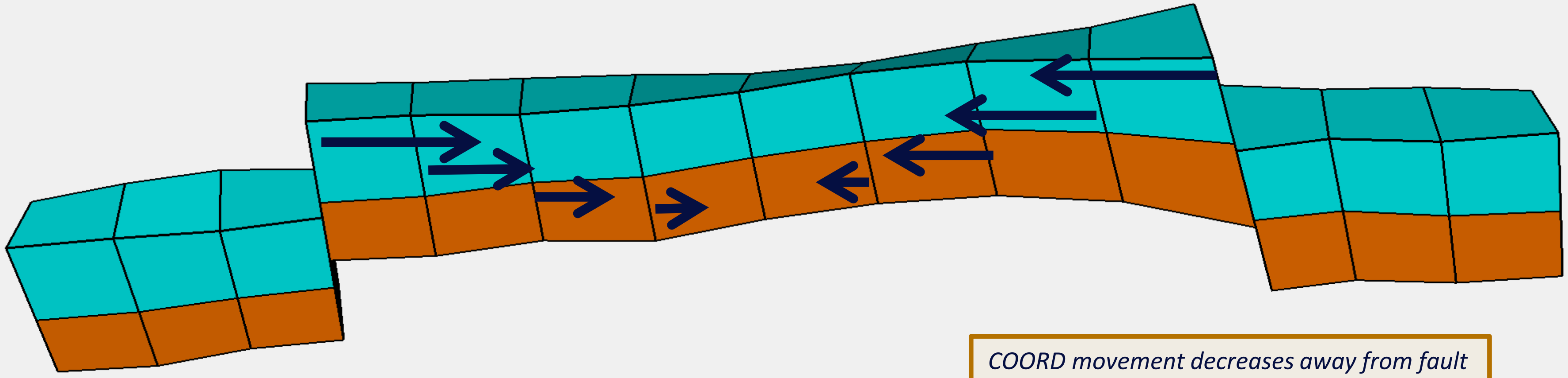
Moving faults in grid creates potential issue:
conflict between different faults and COORD lines



Potential for faulted COORD to move past adjacent COORD and even for faults to cross

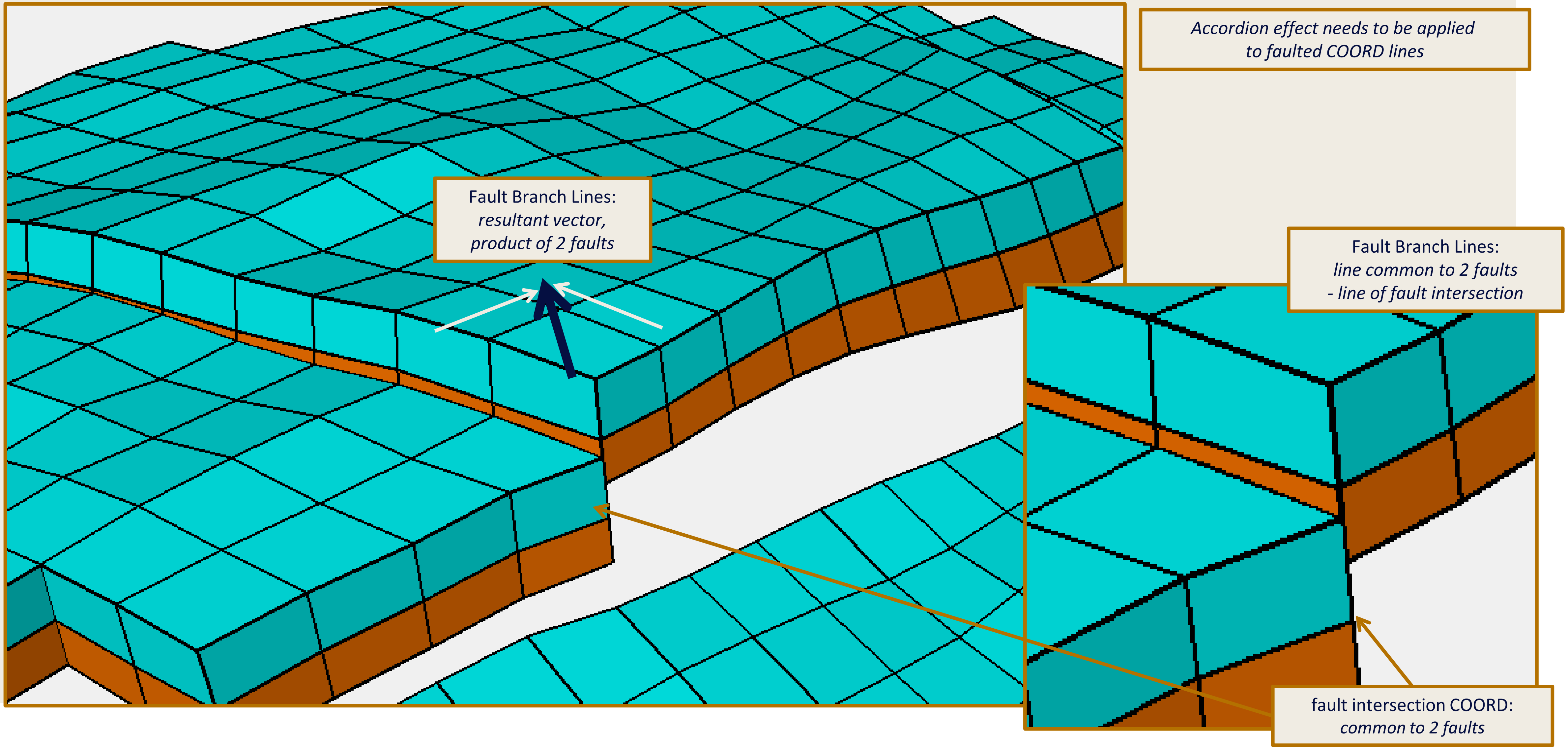
Fault Location Uncertainty

Solution: to move all COORD lines (*Accordion-like*)



COORD movement decreases away from fault
3D problem, requires a 3D function

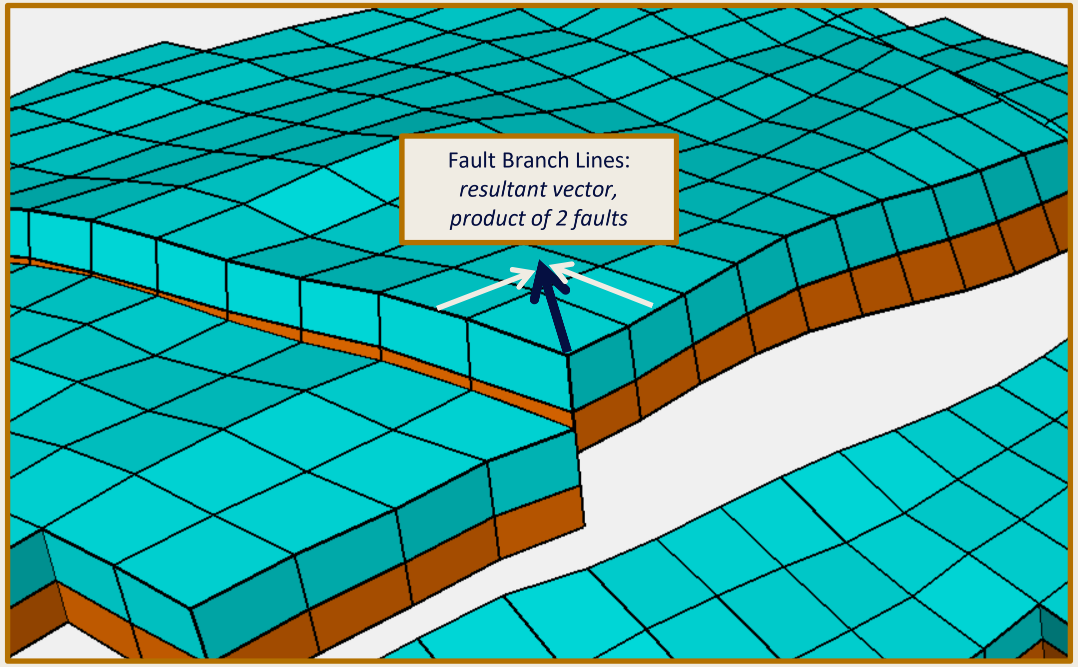
Fault Definition & Uncertainty



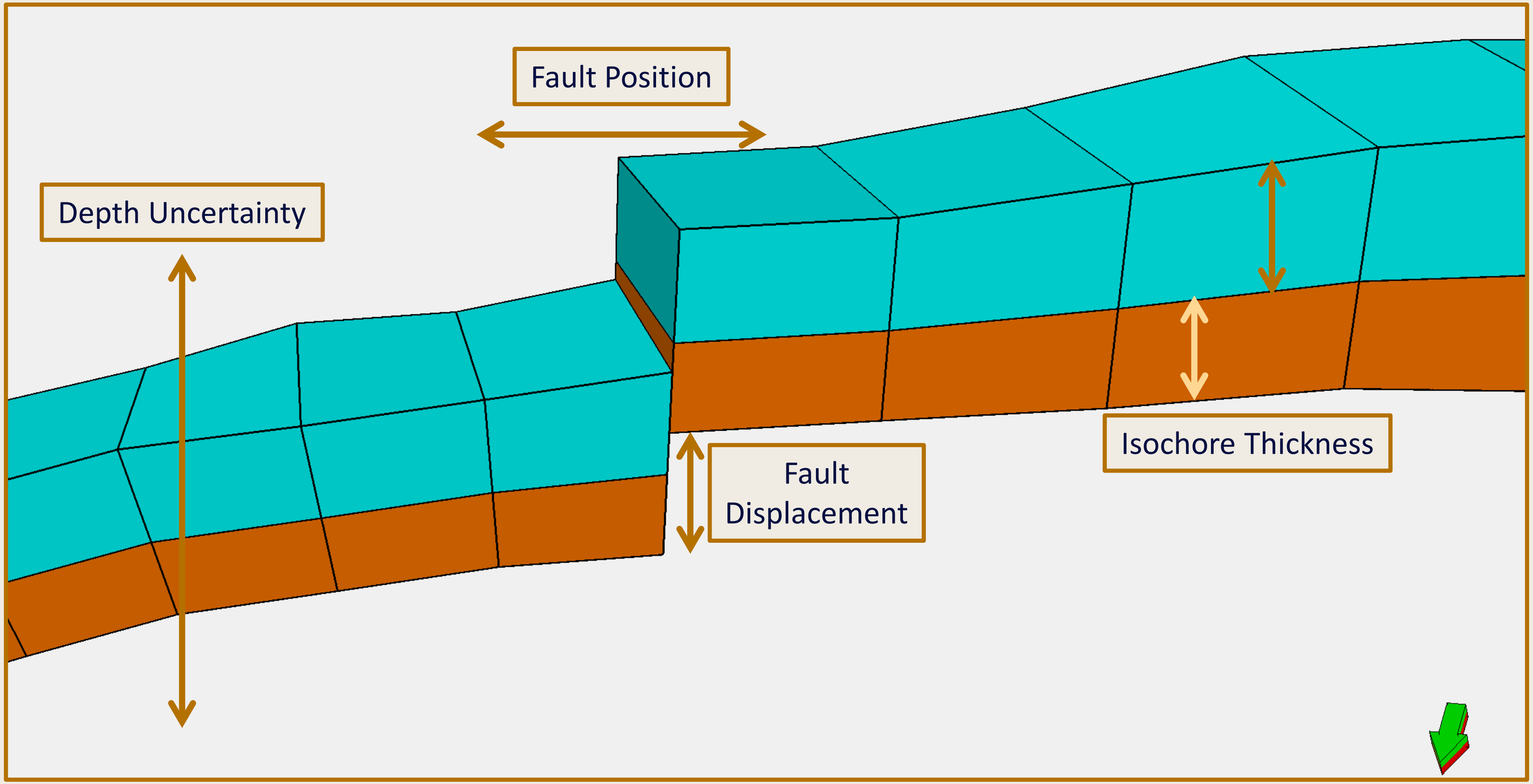
Fault Definition & Uncertainty

Grid Fault Uncertainty Method:

1. determine translation distance for each fault
2. determine vectors for branch-lines
3. determine vectors for fault COORD lines
4. determine vectors for non-faulted COORD lines
5. apply translation to whole grid simultaneously
6. apply elevation changes to ZCORN (horizon shift)

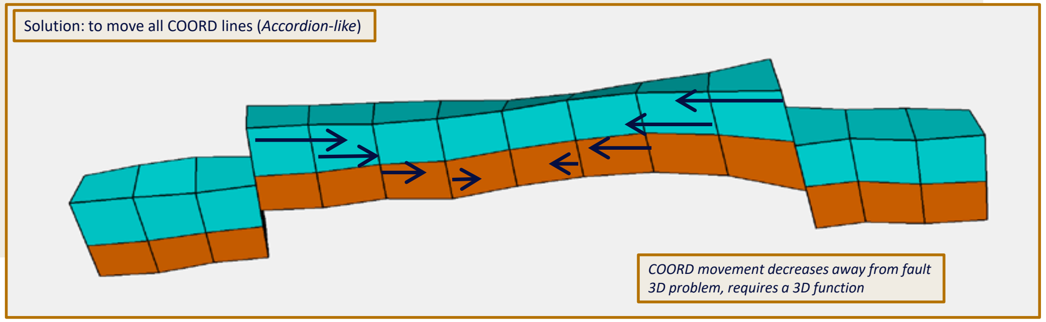


Summary

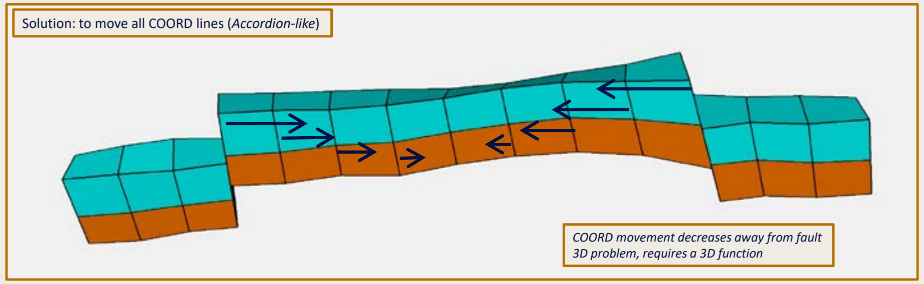

Fault Position
Depth Uncertainty
Fault
Displacement
Isochore Thickness

Flexigrid Project

- Proposed University of Stavanger research project
  - 4 year project
- Investigate different methods of handling structural uncertainty in 3D grids
  - Petrel–centric, but methods should be applicable to other software
- Attempt to overcome a number of issues related model ensembles
- Deliverables include
  - plugins and/or test software to run the techniques developed
  - description of the methods tested and implemented
  - meetings, input, publications etc



Flexigrid Project



- Asking for funding from the oil industry
  - aim for 4 sponsoring companies (minimum 2)
- Cost per company is Kr740k per year over 4 years
  - significant flexibility in payment schedule
- Employ 2 new researchers at UiS; PhD and/or Post–Docs
  - ideally 1 PhD and 1 Post–Doc
  - 1 geologist and 1 programmer
- Project proposal available through FORCE or UiS
  - further discussions
  - individual company presentations

- Further details: Chris Townsend (chris.townsend@uis.no, +47 90114323) or Nestor Cardozo (nestor.cardozo@uis.no, +47 40629562)