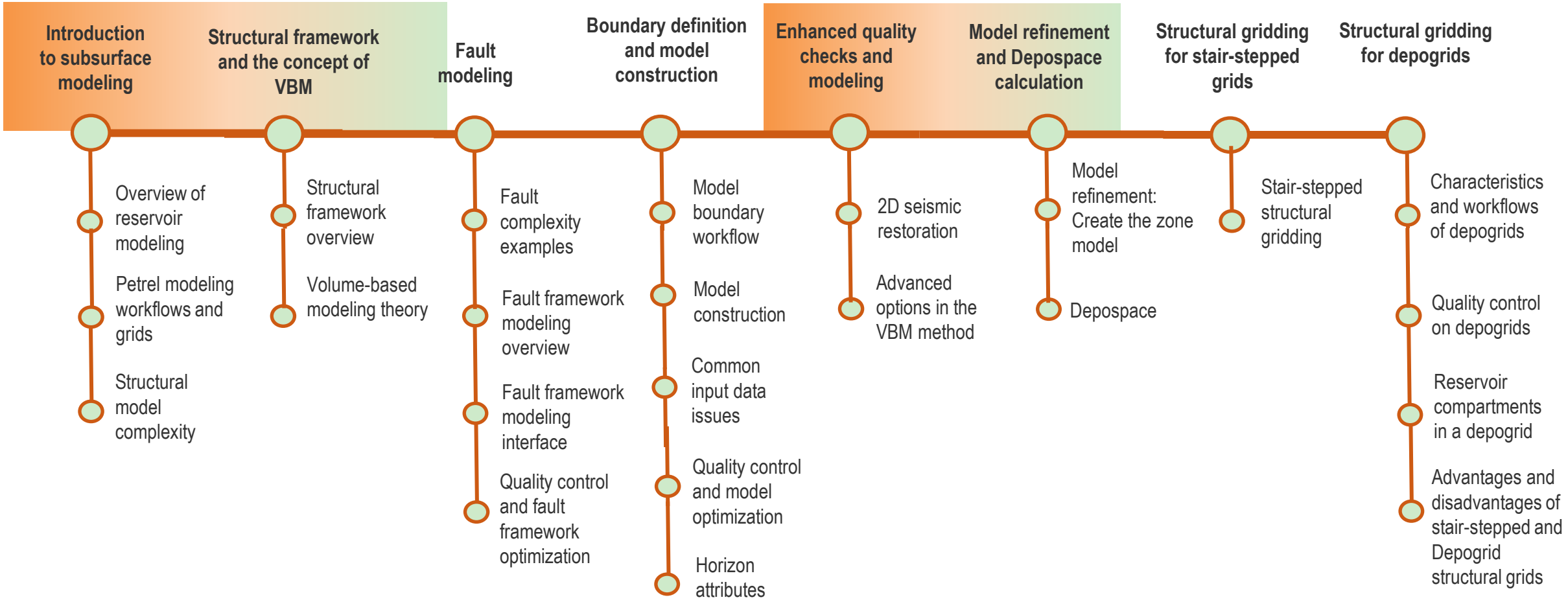
Structural Framework Workflows for Petrel 2018

Module 3: Fault modeling

NExT
A Schlumberger Company

Structural framework with Petrel 2018 – Modeling line

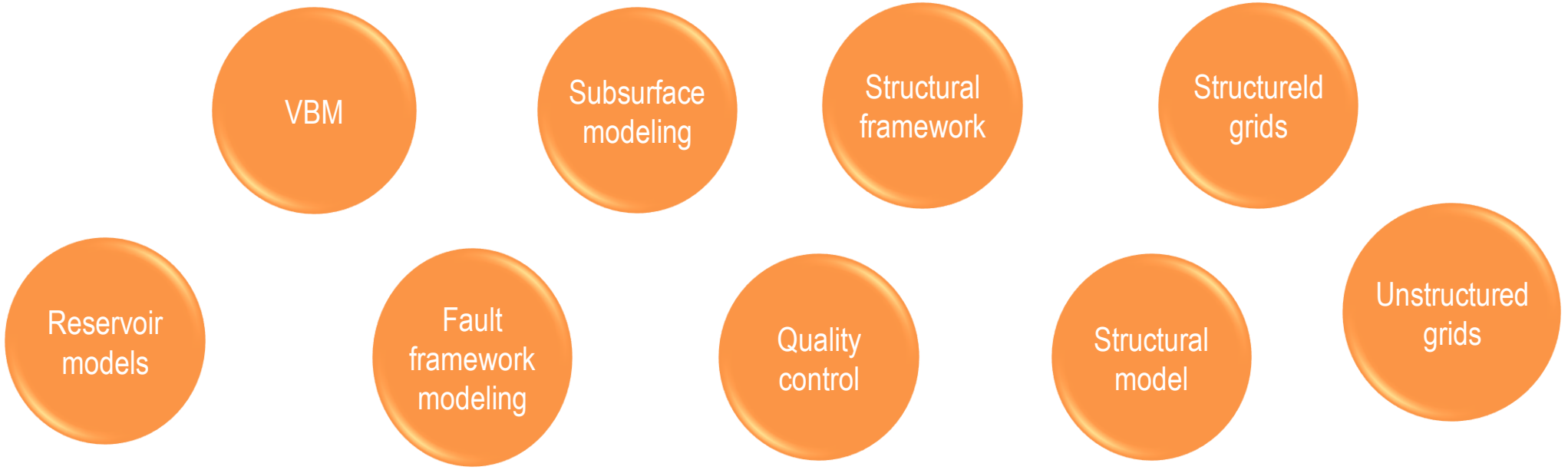


NExT
A Schlumberger Company

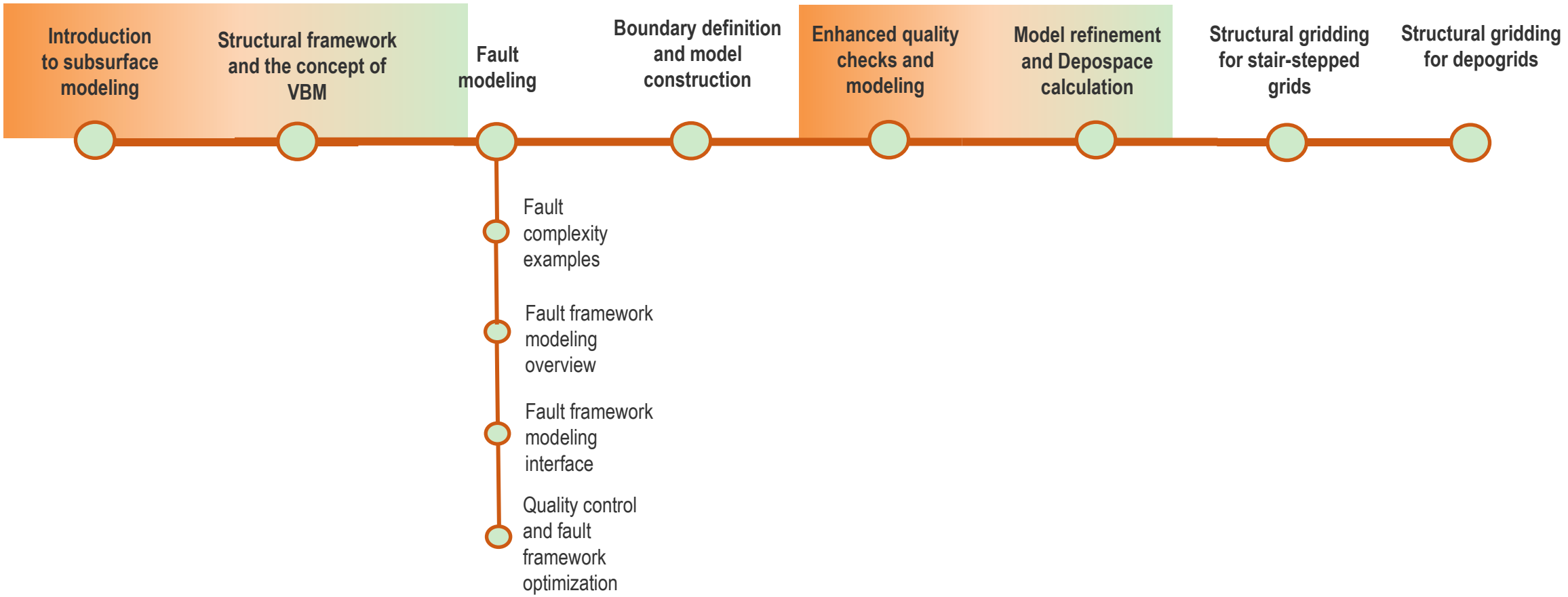
Agenda
Structural framework – Day 1

9.00-12.00	12.00-12.30	12.30-14.00	14.00-16.45	16.45-17.00
Introduction to subsurface modeling	Lunch	Structural framework and the concept of VBM	Fault modeling	Review

KEYWORDS



Module 3: Fault modeling



NExT
A Schlumberger Company

Learning objectives

When you complete this module, you will know

- different types of fault models you can find in nature
- fundamental elements of the **Fault frameworks modeling** dialog box
- how to build a fault framework
- multiple ways to assess the quality of the fault model
- several ways to edit the result

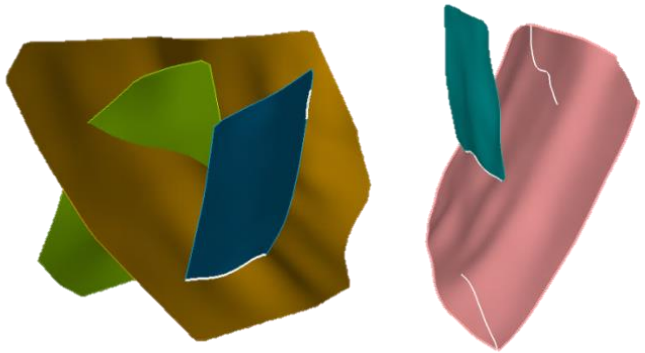
Fault modeling

- Fault complexity examples
  - Faulting and damage zones
  - Normal or extensional faulting
  - Conjugate or crossing faults
  - Antithetic and synthetic faulting
  - Foreland folds and thrust belts
  - Transpression and transtension (strike slip faulting)
  - Flower structures
- Fault framework modeling overview
- Fault framework modeling interface
- Quality control and fault framework optimization

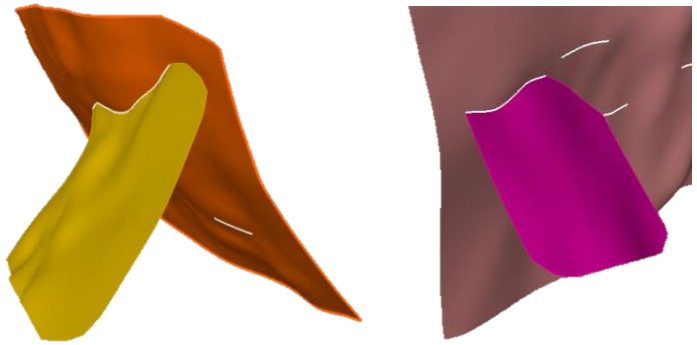
Fault complexity examples (1)

VBM algorithm handles different types of complex fault relationships.

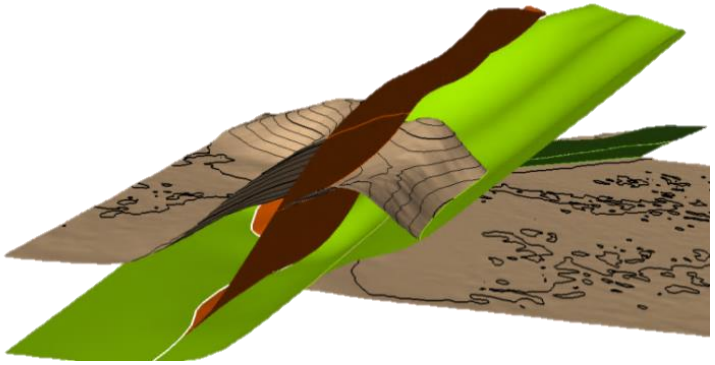
Crossing (X) – synthetic/antithetic (Y)



Lambda (λ)



Reverse or low-angle thrusts

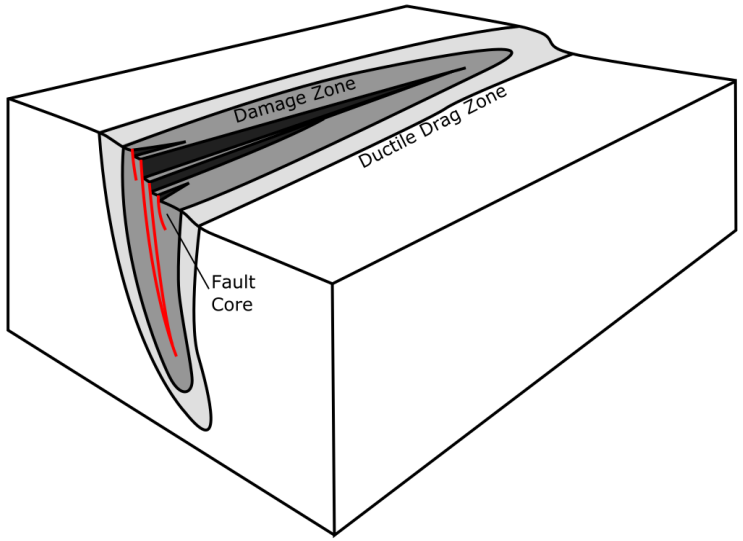


NExT
A Schlumberger Company

Fault complexity examples (2)

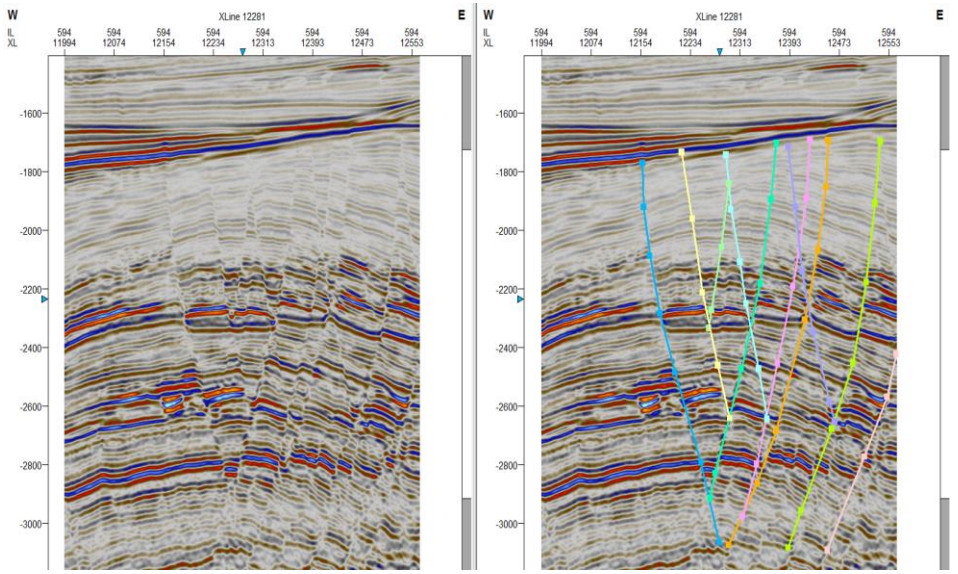
Faulting and damage zone

Evolution of fault creation and damage zone affects fault sealing



Interpreted and modeled faults

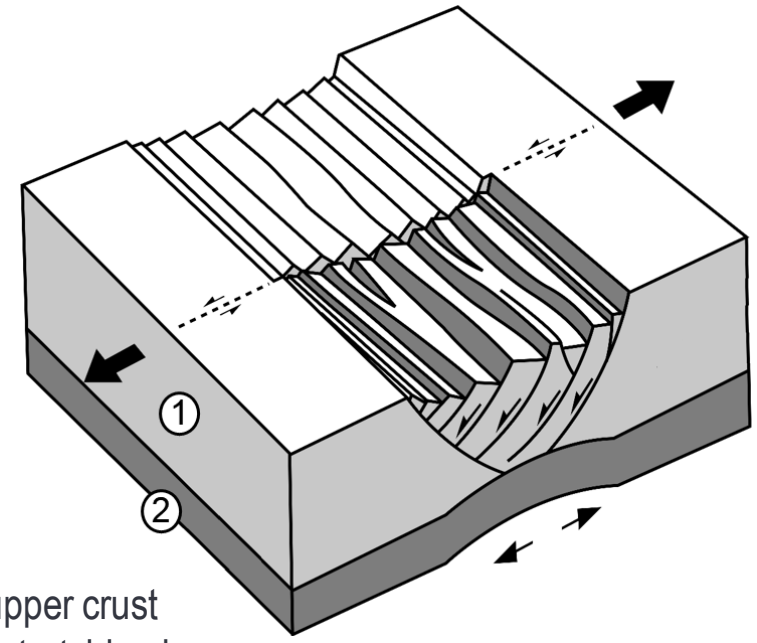
- Represent faults as a single plane
- Imply damage zone through property model



NExT
A Schlumberger Company

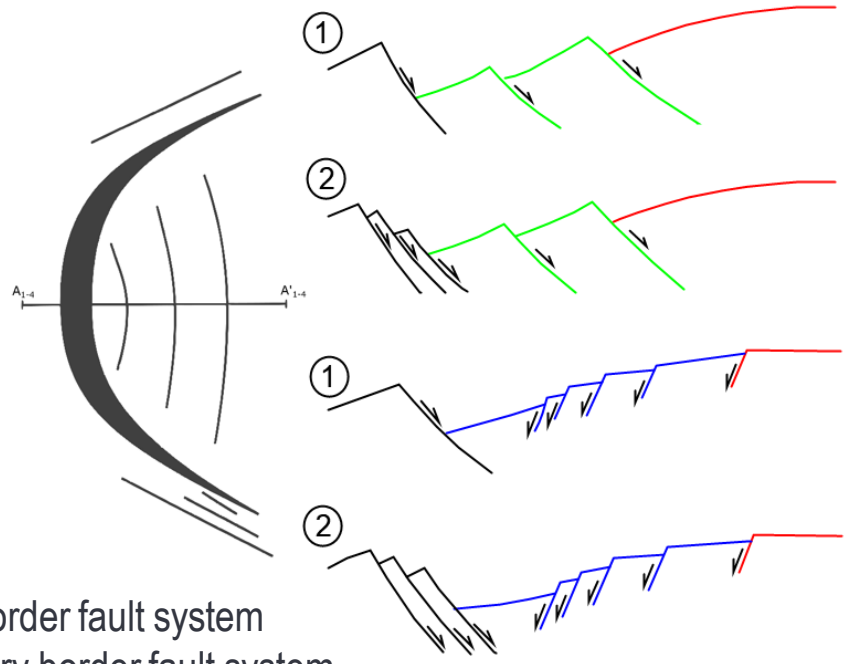
Fault complexity examples (3)

Normal or extensional faulting



1 Brittle upper crust
2 Ductile stretching layer

Antithetic and synthetic faulting



1 Simple border fault system
2 Distributary border fault system

Intrabasin Antithetic faults

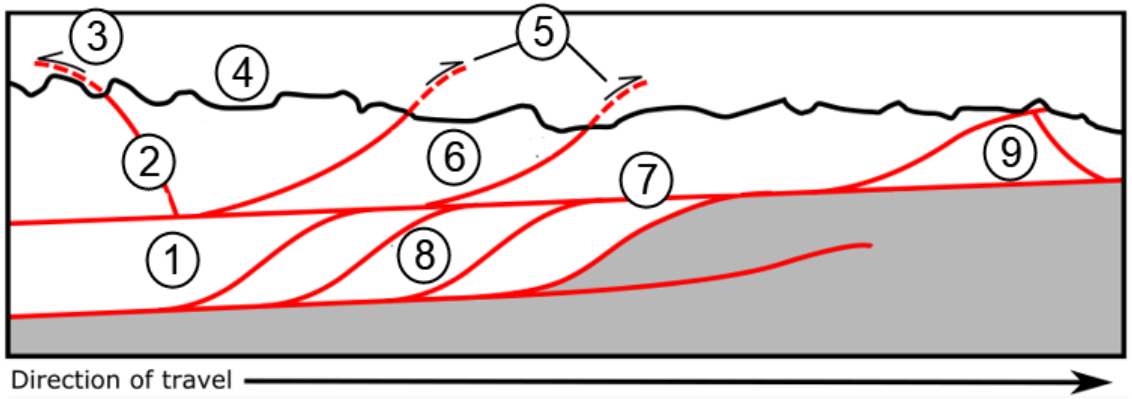
Intrabasin Synthetic faults

Flexure shoulder

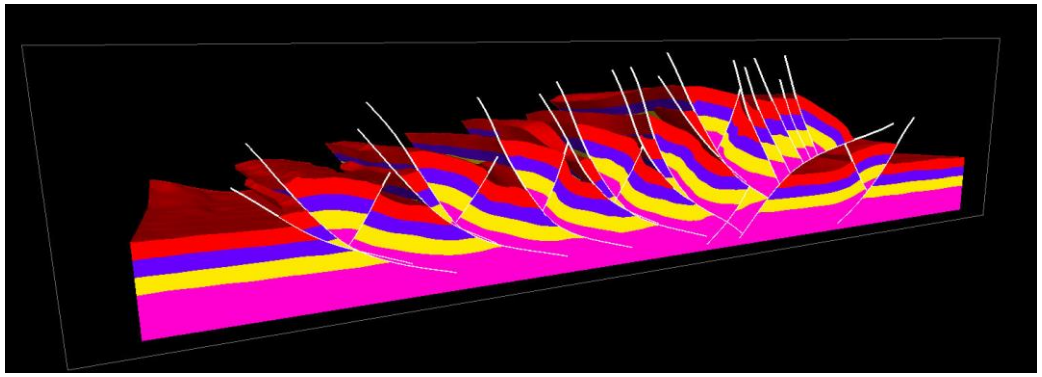
NExT
A Schlumberger Company

Fault complexity examples (4)

Foreland folds and thrust belts



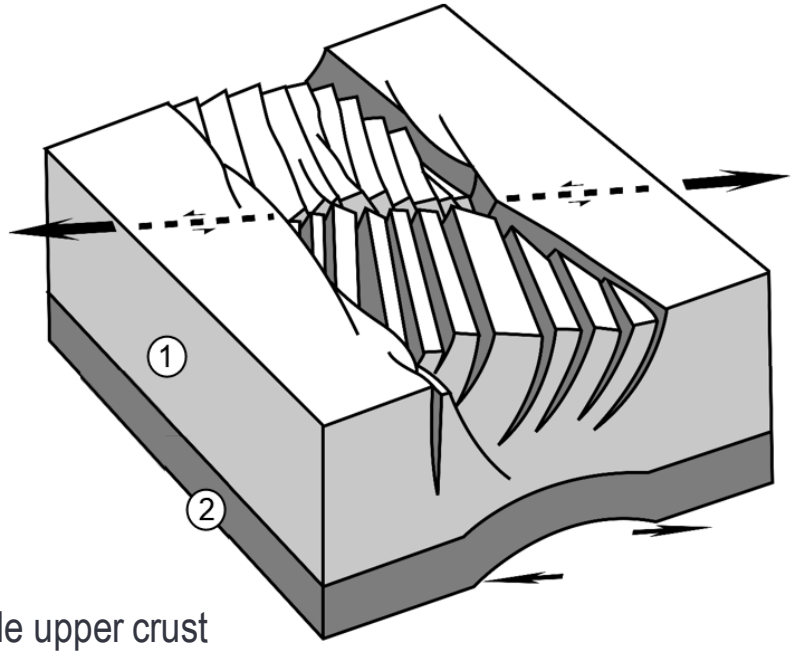
1. Duplex
2. Hanging wall
3. Backthrust
4. Pop-up
5. Emergent thrusts
6. Listric ramp
7. Roof thrust
8. Horse
9. Triangle zone



Petrel structural framework model of a thrust belt

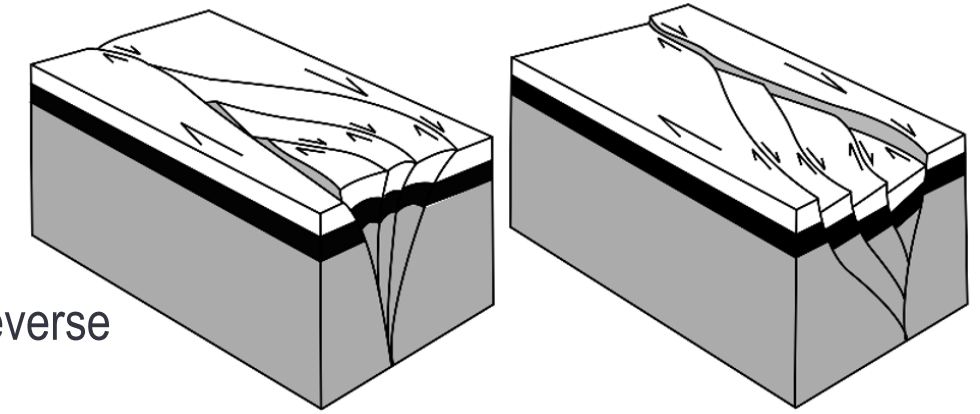
Fault complexity examples (5)

Strike slip faulting



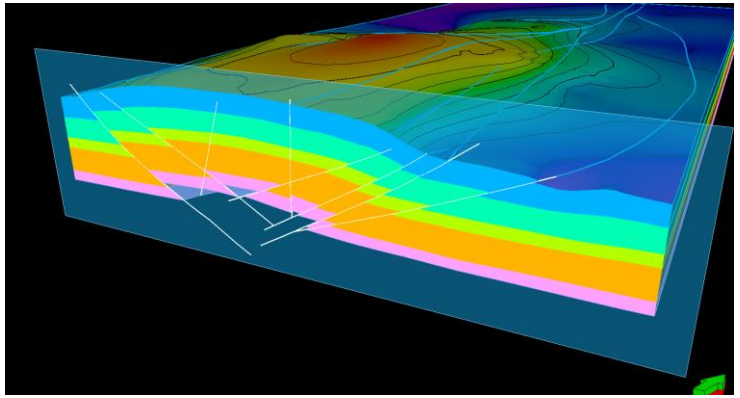
1 Brittle upper crust
2 Ductile stretching layer

Flower structures



Reverse

Normal



Petrel structural framework model of a reverse flower structure

NExT
A Schlumberger Company

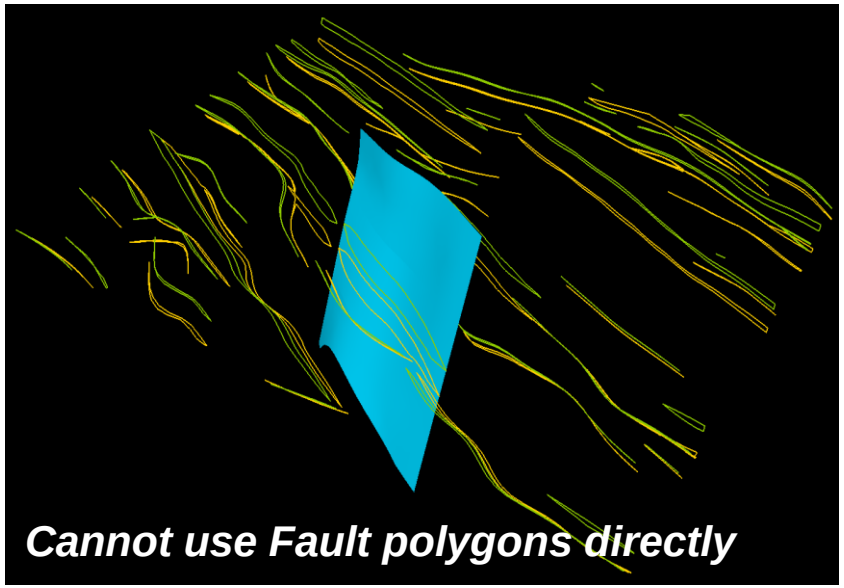
Fault modeling

- Fault complexity examples
- Fault framework modeling overview
  - Input data type
  - The workflow
  - Tip loop and fault extrapolation
- Fault framework modeling interface
- Quality control and fault framework optimization

Input data type

Each fault is interpreted as an individual planar feature.

- The input data must characterize each fault as an individual planar feature.
- Input data includes **Petrel** fault interpretations, imported interpretations, points or surfaces.



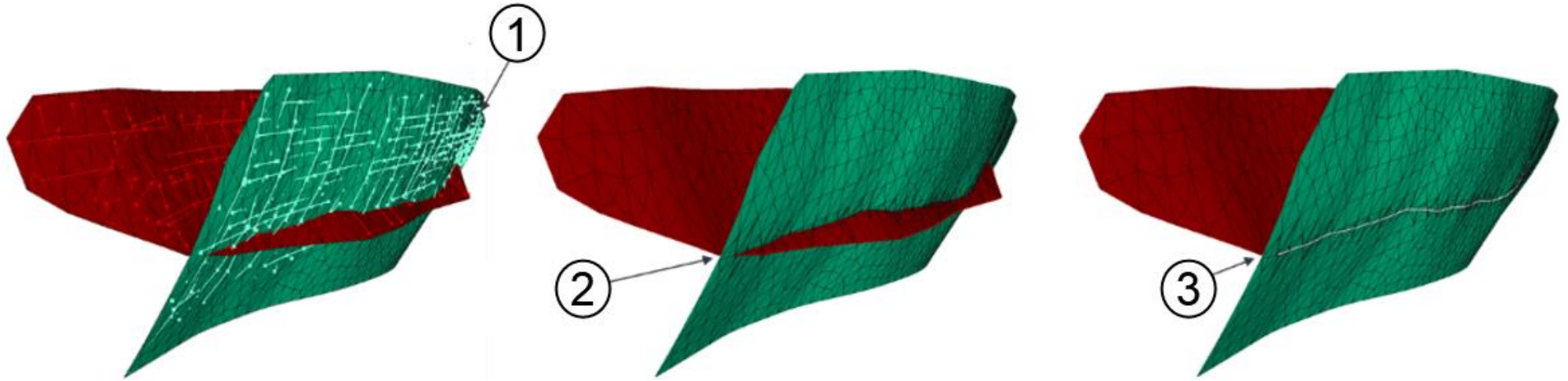
Import formats supported

- IESX / Charisma* Fault stick interpretation
- IRAP
- Polyline
- Points
- Surfaces
- Tsurf
- Fault tops

NExT
A Schlumberger Company

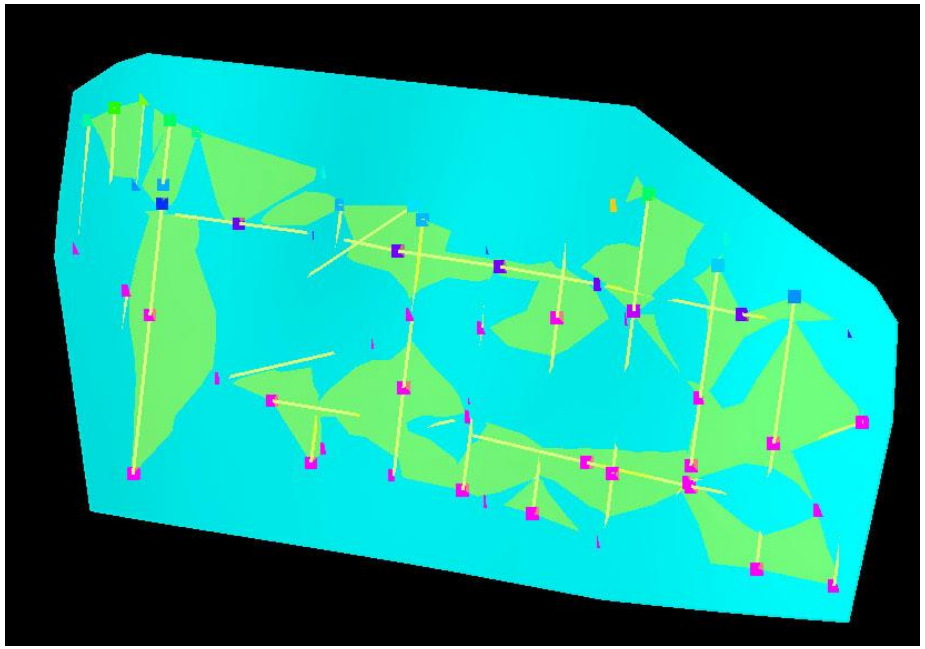
Fault framework modeling workflow

1. Build the triangular mesh: Model the faults based on the input data provided.
2. Weld the faults: Calculate the mesh intersection.
3. Truncate faults: Apply the truncation based on the fault relationship.



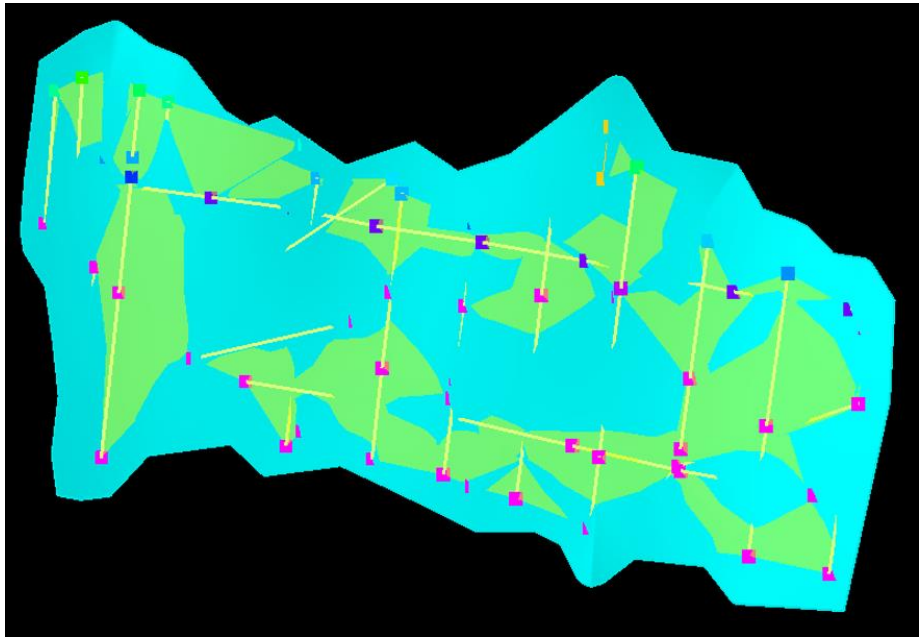
Tip loop and fault extrapolation

Convex tip loop style



The computation creates a boundary around fault input data that obeys geometric constraints to remain concave.

Concave tip loop style



The computation creates a boundary around fault input data that matches the geometric irregularity of that data.

NExT
A Schlumberger Company

Fault modeling

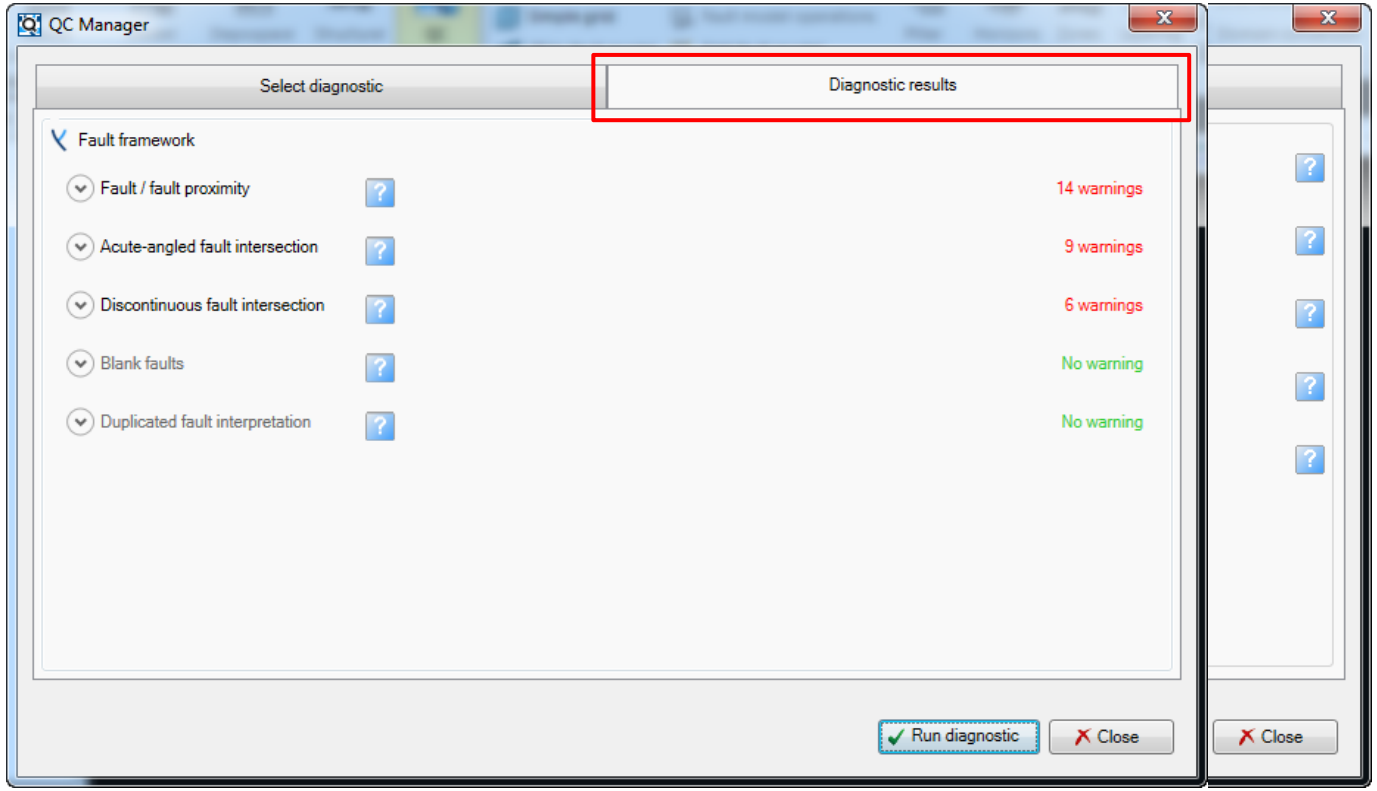
- Fault complexity examples
- Fault framework modeling overview
- Fault framework modeling interface
  - **Fault modeling** tab (Demo)
  - **Fault relationship** tab (Demo)
- Quality control and fault framework optimization

Fault modeling

- Fault complexity examples
- Fault framework modeling overview
- Fault framework modeling interface
- Quality control and fault framework optimization
  - Procedure - Run the visual fault model QC workflow (Demo)
  - QC Manager
  - Dip / dip direction

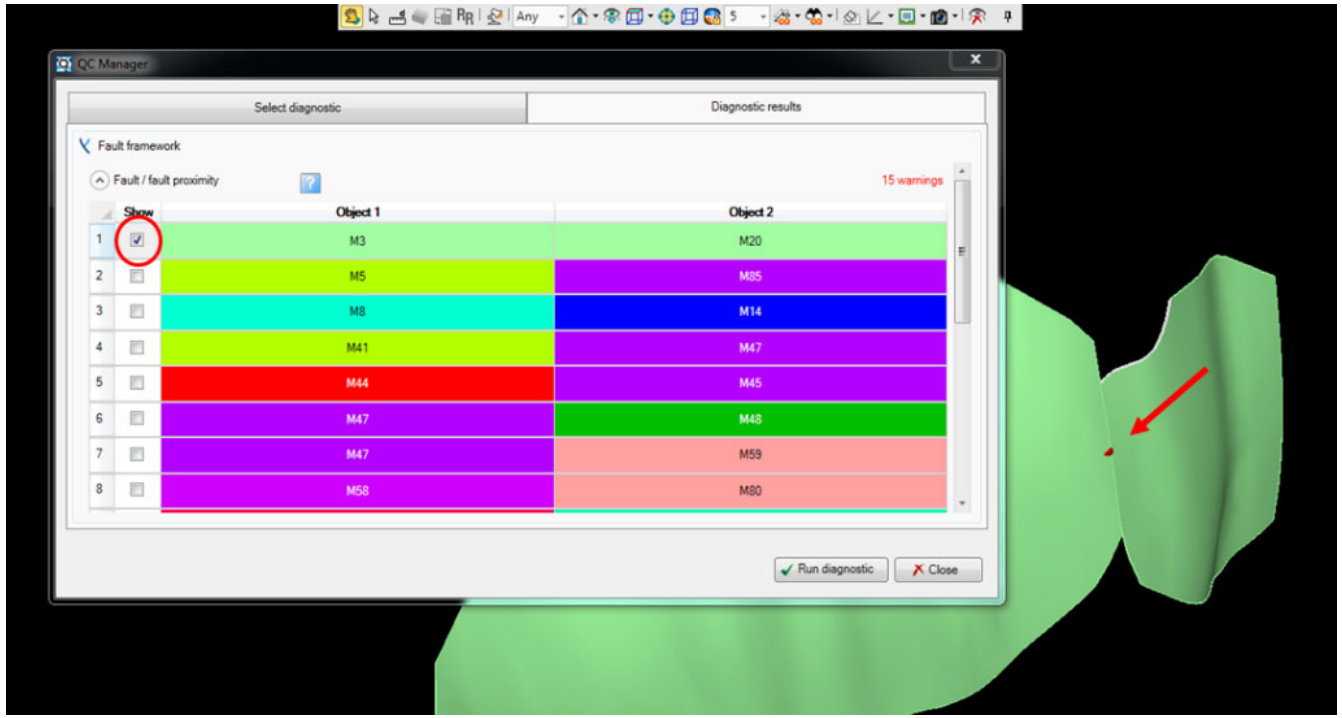
QC Manager (1)

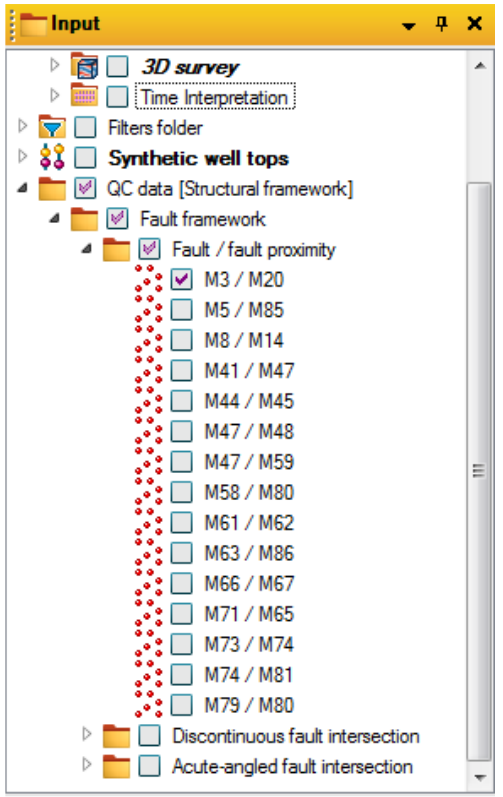
QC Manager provides options that let you investigate specific issues in a structural framework fault model.



QC Manager (2)

In the **3D** window, with the associated error locations, you can select and display fault pairs that have issues. Error data points also are stored in the **Input** pane.

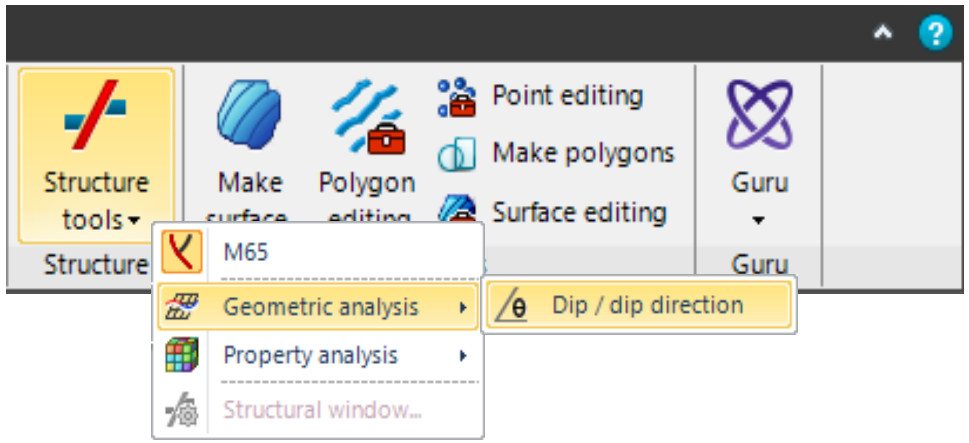


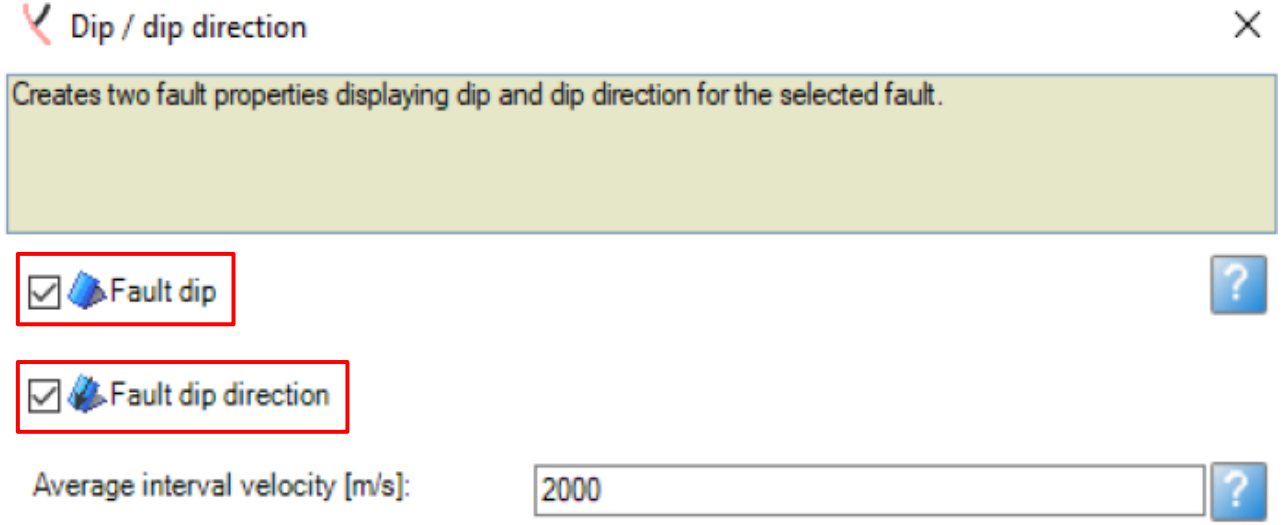


NExT
A Schlumberger Company

Dip / dip direction (1)

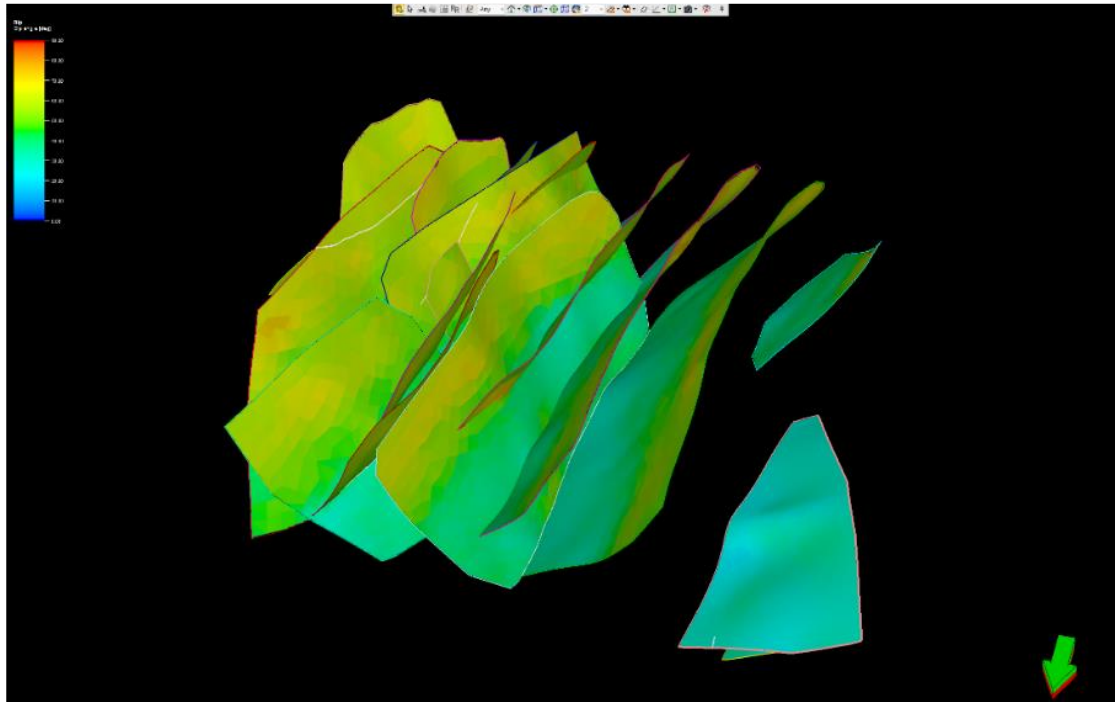
The operation analyses and computes the dip and dip direction of fault faces in a geocellular grid.



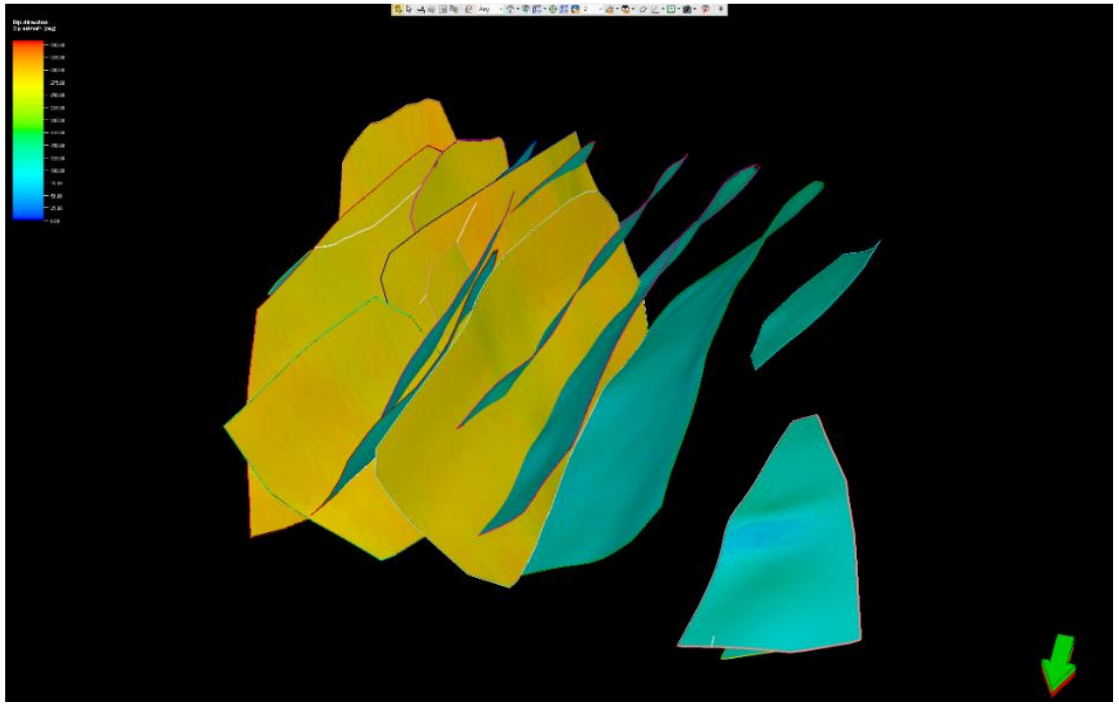


Dip / dip direction (2)

Output of the Dip operation



Output of the Dip direction operation



Exercises and workflow example videos

- Exercise: Build the fault framework.
- Workflow example video: Build and QC the fault framework.
- Exercise: Use the **QC Manager** to identify problematic areas.
- Workflow example video: Use the *QC Manager* tool to identify problematic areas.
- Exercise: Assess the fault-fault intersections.
- Workflow example video: Correct problems identified by **QC Manager**.

Summary

In this module, you learned about:

- the types of faults you can find in nature
- the Fault framework modeling workflow in **Petrel**
- quality control and optimization techniques to improve a fault model

Learning game: Fault modeling (1)

Instructions:
There are several questions. Select the correct answers.

Learning game: Fault modeling (2)

What are the three steps in Fault framework construction?

a. Model the faults, weld the faults and truncate the faults

b. Input the faults, model the faults and weld the faults

c. Model the faults, truncate the faults and weld the faults

d. None of the answers above is correct

Learning game: Fault modeling (3)

How do you use multiple sources of input data to define the faults?

a. Add ‘Input’ columns to the **Fault relationships** tab

b. Add ‘Input’ columns to the **Multiple sources data** dialog box

c. Add ‘Input’ columns to the **Fault framework** dialog box

d. All the answers above are correct

Learning game: Fault modeling (4)

When can you edit the fault relationships in a Fault framework?

a. Before you run the Fault framework process

b. After you run the Fault framework process

c. While you run the Fault framework process

d. Before and after you run the Fault framework process