G Fractures in Reservoir Simulation

As discussed earlier, maps of permeability enhancement factors can then be used in single porosity flow simulation; where the effective grid block permeability is the product of the matrix and fractures permeability.

The porosity and permeability of the matrix and fractures is handled separately in dual porosity simulations (Warren & Root, 1963). Information is also required on the potential for fluid transfer between the matrix and fractures.

This so-called shape factor is related to the size of the unfractured matrix blocks and is often used as a tuning parameter in history matching against well pressure tests. The dual porosity approach can be fraught with complications, especially the estimation of the shape factor (Bourbiaux, et. al., 1999)

Another approach is to generate discrete fracture networks and use the geometrical interactions of the fractures to determine effective fracture permeability (Oda, 1985).

Alternatively simulations of flow through discrete fracture networks and matrix material can be calibrated against well pressure tests (Rawnsley & Wei, 2001). The calibrated models can then be used to calculate equivalent grid block permeability and porosity of fractures for use in reservoir simulation.

H Example

The techniques discussed on the previous two boards can be used to generate fracture networks that honour the available geological data and are controlled by the parameters discussed earlier (15). Box 16 shows a model of a shallow carbonate dome comprised of a number of geomechanically distinct layers. The curvature map shown in box 17 was used as a control on the likelihood of fractures developing, and parameters such as azimuth were used to control the orientation. The fractures are bounded by multiple layers and cross cut by regional "jointing" (18).

The generated fractures can be analysed in a number of ways. The connectivity of the fractures can be assessed by generating a grid honouring the fractures and using a "flooding" technique (19). The interaction of wells with the generated fractures can be assessed and compared with measured fracture data in wells (20). The fracture network can also be subdivided into appropriate grid blocks and the fracture surface area measured (21). Assuming a constant aperture, the volume of the fracture void space can be calculated and, using the volume of the grid block the fracture porosity can be determined.

J References

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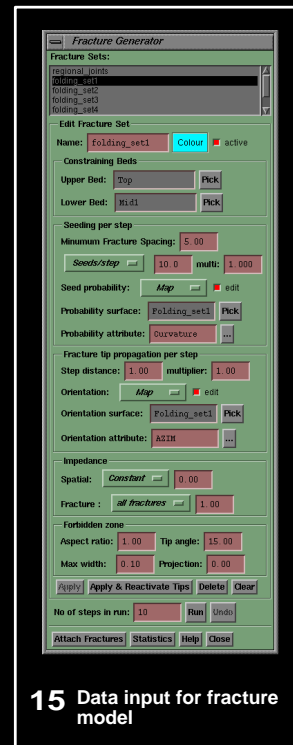
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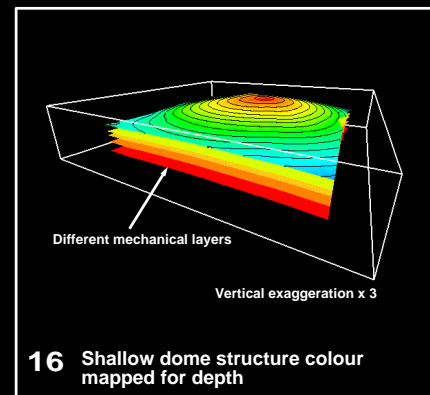
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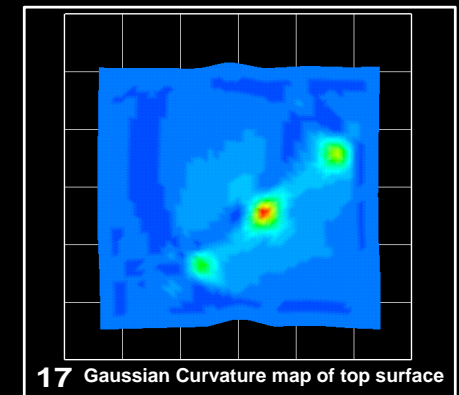
15 Data input for fracture model

I Conclusions

Structural modelling has a key role to play in the understanding and simulation of fractured reservoirs. In the early interpretation stages structural modelling can be used to test structural validity and explore geological concept.

Analyses of static and dynamic geometric parameters can provide direct input to reservoir simulators. Alternatively, this information can be used to generate geologically realistic fracture networks that can be visualised and exported for use in third party simulators.

16 Shallow dome structure colour mapped for depth

Different mechanical layers

Vertical exaggeration x 3

17 Gaussian Curvature map of top surface

Vertical exaggeration x 3
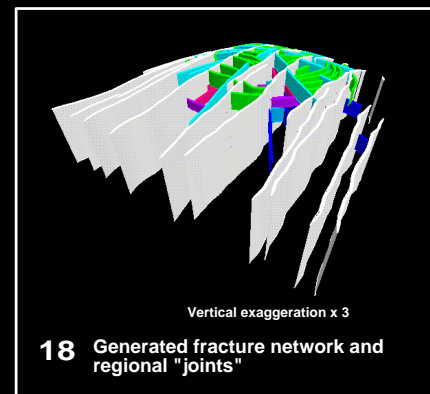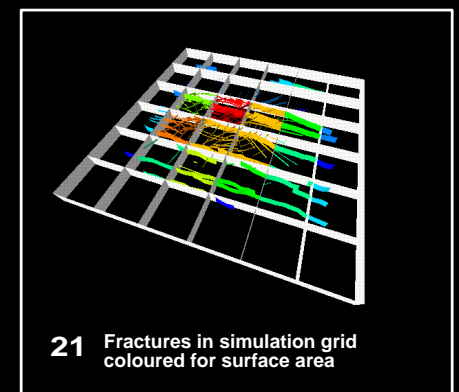
18 Generated fracture network and regional "joints"
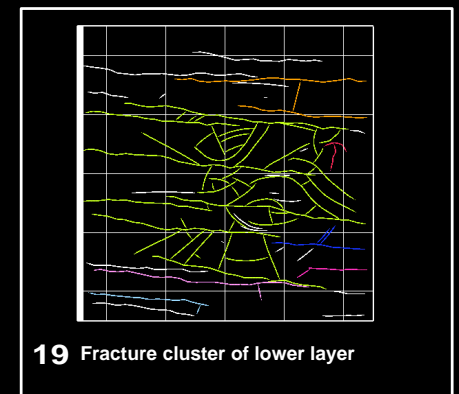
19 Fracture cluster of lower layer

Fracture intersections

Deviated well

Horizon and fault intersections
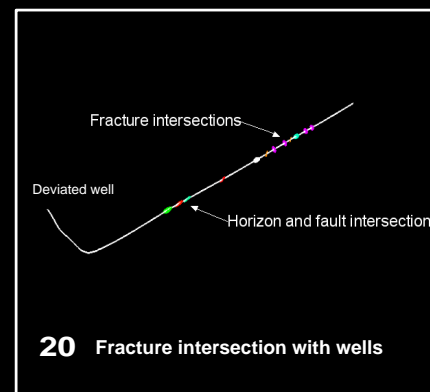
20 Fracture intersection with wells

21 Fractures in simulation grid coloured for surface area

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