

# An original and useful approach to mesh a discrete fracture network

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Modeling mass and heat transfers in fractured media is a challenge. That is due to the geometrical complexity of the discrete fracture network (DFN) and the remaining input data uncertainties. As an illustration, in the field of CO<sub>2</sub> sequestration or oil reservoir production, transfers have to be modeled at the scale of reservoirs ( $\sim 10\text{km} \times 10\text{km} \times 100\text{m}$ ) using  $100\text{m} \times 100\text{m} \times 10\text{m}$  grid cell sizes, [1]. However, fractures are finely characterized on well logs and outcrops (at a scale of few meters). From this characterization a DFN can be built and may contain over  $10^6$  fractures. Analogous issues are to be addressed for hydrology and geothermal applications. Direct numerical simulations accounting for the DFN geometry remain still impossible at the reservoir scale. In practice, upscaling approaches are used to determine equivalent transfer parameters at the grid cell scale. The number of fractures belonging to a grid cell and respecting data from characterization scale may be close to  $10^3$  fractures. This number is more tractable and direct numerical simulation may be used at this step. Nevertheless, considering the complexity of the DFN geometry, it still remains to simplify the DFN mesh, considering assumptions about the details of the flow [2, 3, 4]. In order to test the accuracy of these assumptions, reference numerical simulations must be carried out using a mesh which accounts for the detailed DFN geometry [5]. The goal of this contribution is to present an original 3D DFN mesh approach allowing to get high fidelity reference simulations and allowing to test further simplifications required by applications.

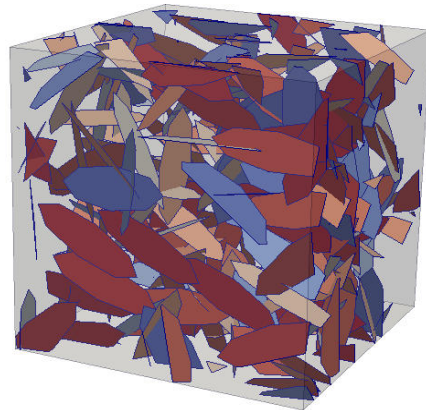


Figure 1: Local view of a Discrete Fracture Network.

The basic difficulty is to mesh each fracture accounting for the intersections with the others, especially if a conformal mesh is desired. The original idea is to decompose each DFN fractures into a set of connected closed outlines including each fracture intersection segments. Special focus is put on common outlines boundaries to generate a conforming Delaunay triangulation (COQ). Advantages of this mesh are to be conform and to closely respect the geometry of the DFN and the topology of the intersection network. These outlines are easy to mesh.

Depending of a neighborhood area, contour discretization points are moved or created to model the intersection points

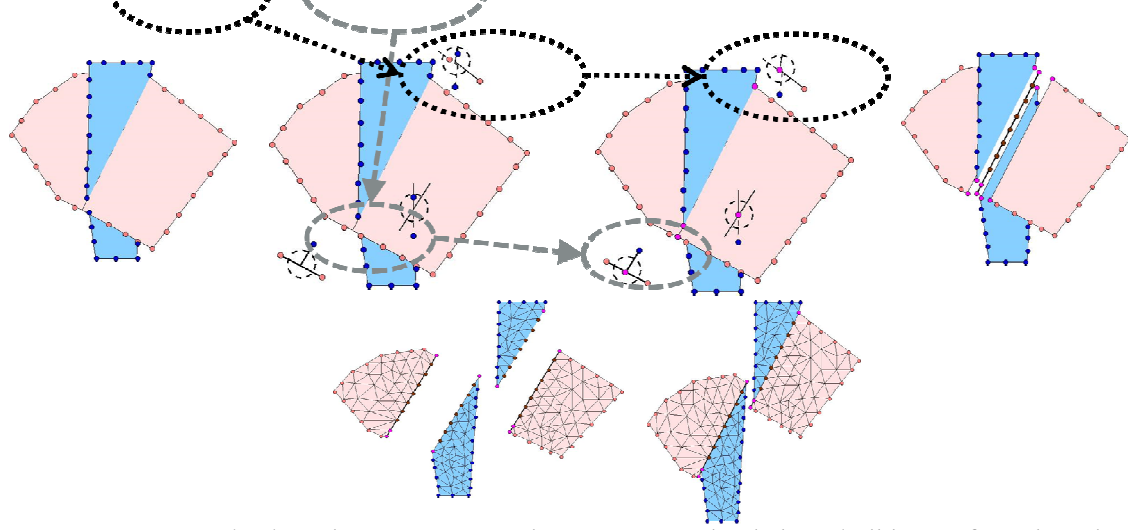


Figure 2: Fractures are “broken” into easy top mesh components that help to build a conformal mesh using standard meshing tools.

In a next step, using this mesh, some fluid flow simulations of interest can be performed.

## References

- [1] M. Verscheure, A. Fourno and J.-P. Chils. Joint Inversion of Fracture Model Properties for CO<sub>2</sub> Storage Monitoring or Oil Recovery History Matching. OGST Rev. 8th International Conference on Porous Media & Annual Meeting page 2/2 IFP Energies nouvelles, 67, 221235, (2012).
- [2] A. Fourno, C. Grenier, A. Benabderrahmane, F. Delay. A continuum voxel approach to model flow in 3D fault networks: a new way to obtain up-scaled hydraulic conductivity tensors of grid cells. Journal of Hydrology, 493, 6880, (2013).
- [3] N. Khvoenkova and M. Delorme. An Optimal Method to Model Transient Flows in 3D Discrete Fracture Network, IAMG 2011.
- [4] B. Noetinger, N. Jarrige, A quasi steady state method for solving transient Darcy flow in complex 3D fractured networks J. Comput. Phys. 231(1), 2338, (2012).
- [5] JR De Dreuzy, G Pichot, B Poirriez, J Erhel. Synthetic benchmark for modeling flow in 3D fractured media. Computers & Geosciences, 50, 5971, (2013). GRAP