Dynamic Mesh Optimisation for geological representation of highly heterogeneous reservoirs

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This project will focus on the development of a method to generate unstructured meshes that conform to a given geological representation based on a blueprint without prior discretisation, and thereby speeding up model generation as well as enabling to adjust the geological precision based on flow behaviour. This project will be developed within the context of the Imperial College Finite Element Reservoir Simulator (IC-FERST). IC-FERST incorporates state-of-the-art technology for porous media flow simulation, including unstructured dynamic mesh optimisation (DMO), high order element methods and surface-based representation of complex reservoir architecture. Applications of IC-FERST are numerous and include simulation of CO_2 sequestration, hydrocarbon recovery, groundwater flow, contaminant transport, geothermal and magma flow.

The geological representation for IC-FERST uses a surface-based modelling approach in which all heterogeneity is represented by its bounding surfaces, free from a grid. These surfaces are created based on meaningful geological information decided a priori by the geologist. This approach limits flexibility for the mesh generation as all the geology considered must be respected by the mesh, making it challenging in some cases to generate a mesh. The generation of conforming geological meshes has been extensively studied for complex geological models and it remains a very difficult challenge due to the many length-scales to be considered. However in some cases all the length scales might be important while in others some may be safely ignored, but this geological precision is not known before running a flow simulation. . The objective of this PhD is twofold: (i) enable the generation of complex geological models based on surface-based modelling by developing a robust approach based on DMO and blueprints that allows the user to adjust the geological precision during to the simulation, and (ii) study the impact of dynamically changing the geological precision on the accuracy of the results and potential speed up while providing accurate results.

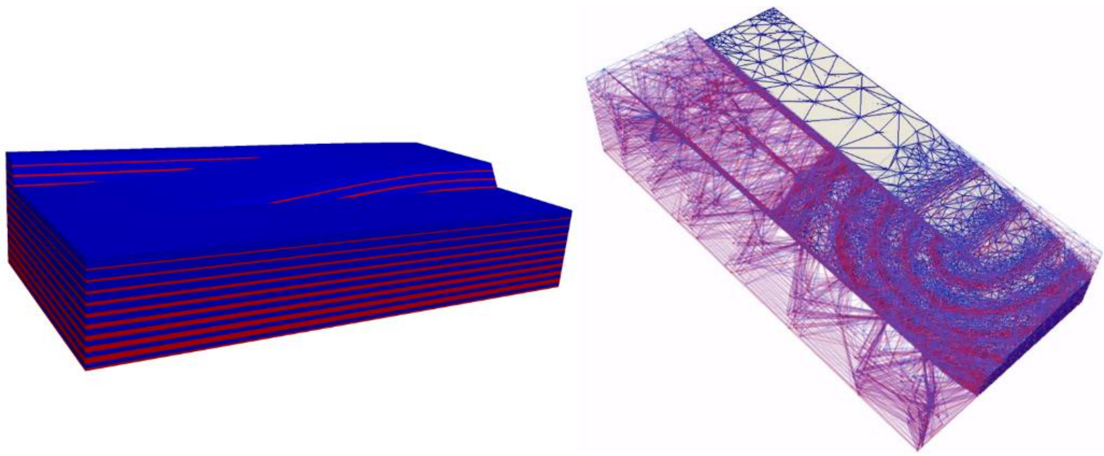

Fig. 1: Left: meshless heterogeneity blueprint coloured by permeability (red: high; blue: low) representing a relay ramp of a layered reservoir. Right: IC-FERST flow simulation showing optimized mesh of varying resolution coloured by wetting-phase saturation (red: high; blue: low). It can be seen how, the importance of an accurate representation of the geology could be variable across the domain.

Applicants should have a good degree in an appropriate subject (e.g. earth science, physics, mathematics or engineering) and a strong interest in computational modelling. The project is hosted by the highly successful NOvel Reservoir Modelling and Simulation (NORMS) group and will involve extensive interactions with other research groups within the ESE department and internationally. Skills developed during this project will include multiphase porous media flows, high performance computing, CAD modelling, geological modelling, linear and non-linear solvers, dynamic mesh optimisation techniques and unstructured meshing technologies. The candidate will have the opportunity to develop their career and profile by presenting at conferences and publishing in high impact journals.

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