High enthalpy geothermal reservoir modelling and optimisation using dynamic mesh optimisation and surface-based modelling

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The main objective of this project is to study and optimise high enthalpy geothermal reservoirs using 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, high order element methods and surface-based representation of complex reservoir architecture. 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, as opposed to heterogeneity being populated on pre-defined, close-to-rectangular grids in conventional modelling approaches. Applications of IC-FERST are numerous and include simulation of CO_2 sequestration, hydrocarbon recovery, groundwater flow, contaminant transport, low enthalpy geothermal and magma flow.

High enthalpy geothermal reservoirs are the only non-intermittent renewable source of electricity so can provide a baseline supply . However, managing and optimising such reservoirs is challenging there are many uncertainties in both the geological modelling and the numerical modelling must capture complex coupled thermal-hydrological-mechanical-chemical processes. The first step in this project will be to include phase change so IC-FERST can capture the evolution of steam in high enthalpy reservoirs. The project will then focus on using IC-FERST to increase the precision and accuracy of the modelling, including (i) identification of the steam table so only supercritical fluid is produced, (ii) modelling the injection of cool water into a hot, dry reservoir, (iii) inclusion of small-scale geological features which may have a high impact on production and (iv) reactions with the porous media resulting in variations in petrophysical properties.

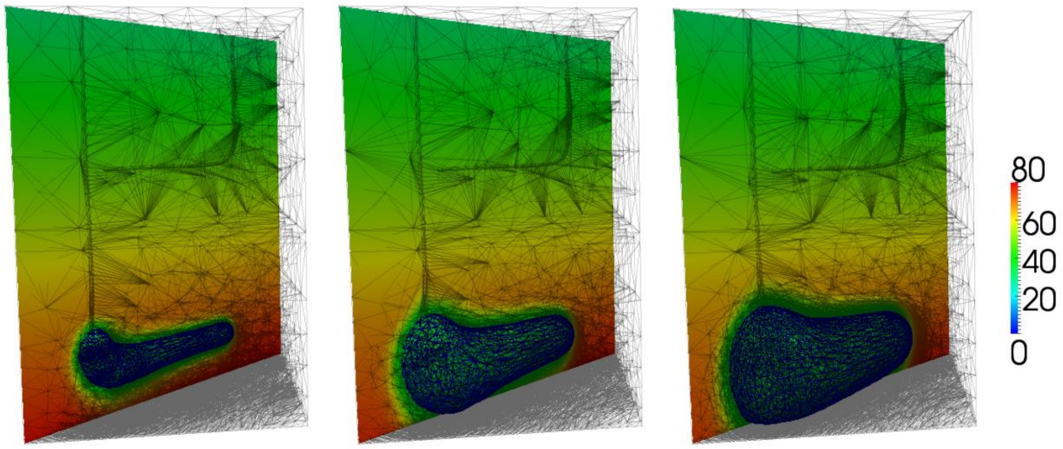

Fig. 1: Low enthalpy geothermal reservoir with a doublet system. The injector, (left well) introduces water at a lower temperature. The mesh is adapted as the low temperature water is being injected in the system: (Left) Adapted mesh, temperature field and isosurface at 36 C after 18 years production. (Centre) Adapted mesh, temperature field and isosurface at 36 C after 66 years production. (Right) Adapted mesh, temperature field and isosurface at 36 C after 110 years production.

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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