Description  Geothermal energy from hot rock layers inside the Earth’s crust is a promising sustainable energy source. Heat recovery takes place by circulation of a production fluid into the (man-made) fracture network inside the geothermal reservoir (Fig. 1; top). However, the thermal interaction between cold production fluid and hot rock is highly non-trivial due to the complex geometry of the fracture network (Fig. 1; bottom). Hence, determining the most effective flow for optimal heat recovery remains a big challenge. Topic of the graduation project is gaining a deeper understanding of this thermal interaction.

Goal and approach  The thermal interaction is to be investigated by direct visualization of the paths by which heat transfer takes place. These “thermal paths” are the thermal analogies to streamlines and thus enable heat-transfer visualization in the same way as streamlines enable flow visualization.\textsuperscript{1} Crucial is that this method admits heat-transfer visualization throughout the entire reservoir, i.e. in both fractures and rock, and thus offers insight into the way heat flows from the hot rock to the production fluid at a far more fundamental level than conventional methods based on temperature. The general research plan is as follows:

- Numerical simulation of velocity and temperature field in a representative 2D fracture network by way of a commercial flow solver (e.g. FLUENT or COMSOL).
- Development of dedicated data-processing algorithms for the construction of the thermal paths in the entire reservoir from the simulated velocity and temperature fields by e.g. the post-processing functionality of FLUENT or COMSOL and/or with MATLAB.
- Thermal reservoir engineering by way of the thermal-path methodology:
  - Visualization of the thermal interaction between production fluid and hot rock.
  - Determination of the thermal-path configurations for optimal heat recovery.
  - Manipulation of the thermal-path configurations via the inlet flow conditions.

Figure 1: Geothermal plant and close-up of typical underground fracture network (top); typical thermal interaction between cold production fluid and hot rock (bottom).

Contact: dr.ir. M.F.M. (Michel) Speetjens, m.f.m.speetjens@tue.nl

\textsuperscript{1}M.F.M. Speetjens, A generalised Lagrangian formalism for thermal analysis of laminar convective heat transfer, Int. J. Thermal Sci. 61, 79-93 (2012)