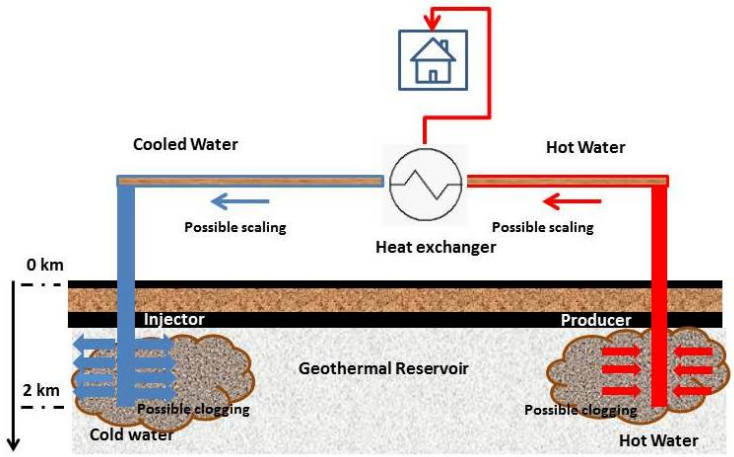

A network model for geothermal energy (MEP)

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General introduction

In a fossil fuel free future many renewable energy sources are required to provide suffient energy to society; one of these sources is geothermal energy. The idea of geothermal energy is illustrated in the figure. Cold water is injected by an injection well in the subsurface[1], pumped through the subsurface and heated. The warm water (of about 80°C) is recovered by the production well and used to generate power.

Circulating the water through the subsurface from injection to production well requires pumping energy. The subsurface can be viewed as a spunge: it consists of solid material (the rock grains) and void space (the pores). The typical dimensions of a single pore are of the order $10^{-6} - 10^{-3}$m. Together the pores form a pore network; fluid flow through this network is possible, provided enough pressure is applied.

Project description

Due to the injection of cold water in the subsurface, chemical equilibria may change. As a result, minerals dissolved in the water precipitate on the rock grains. Due to this process the pore network gets clogged and higher pumping power is required to keep the fluid circulation going. At a certain point the pumping energy exceeds the heat extracted; further operation of the geothermal doublet is not viable anymore and the operation has to be terminated. The aim of this project is to model this clogging process and to investigate how it can be influenced.

We will use a network model consisting of single pores, modelled as tubes, connected by nodes to describe the subsurface. Transport of minerals through the network is describe using a reaction convection diffusion equation in the nodes. The mineral concentration in the tubes is modelled via a reaction equation; changing mineral concentrations in these tubes may lead to precipitation or dissulotin of minerals and consequently to changing tube radii, which in turns influences the flow pattern. In this way, we will investigate the influence of a few selected minerals on the flow through the network.

Literature

1) Geochemistry, groundwater and pollution, C.A.J. Apello and D. Postma, CRC Press (2005)
2) Transport phenomena, R.B. Bird, W.E. Stewart and E.N. Lightfoot, Wiley (2006)

[1]The temperature of the earth increases with increasing depth at a rate of about 30°C per kilometer.