Investigating clogging mechanisms during the reinjection of geothermal fluids using high pressure microreactors

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Geothermal fluids are often loaded with mineral and organic particles in suspension, dissolved organic and mineral compounds, various additives, bacteria and heavy metals, etc. The presence of these compounds poses significant problems, in the short term on the sustainability of geothermal energy production and the maintenance of injectivity and, in the long term on the stability and continuity of the resource[1]. As the migration and deposit of fines concern numerous industrial applications, the physics of colloidal particles transport in porous media has been widely studied. However, most of these studies are based on macroscopic measurements which do not make it possible to correctly describe the physical and geochemical phenomena involved at the microscopic scale, and are not sufficient by themselves to choose a suitable remedial solution.

Studies of transport mechanisms at pore scale with microfluidic devices have expanded due to their importance in many engineering applications such as oil and gas production, groundwater pollution or wastewater treatment. Their advantages and ability at providing mechanistic insights into larger-scale flow and transport phenomena have contributed to the advancement of research, particularly in the field of geosciences. Lately, the development of high-pressure microfluidic has permitted to extend the use of microreactors to high pressure and high temperature (HP/HT) conditions[2]. Besides the access to pore scale information, this tool allows the study and characterization of geofluids flows in representative conditions (in term of pressure and temperature) of deep underground systems.

Hence, we choose to use in this study high pressure microfluidic devices[2,3] to access local information and bring elements of comprehension to the industrial problem of particles retention in geothermal wells during the reinjection of geothermal fluids.

This approach allows studying the kinetics, mechanisms and regimes of deposit formation at the pore scale at P/T conditions representative of geological conditions (25 < T(°C) < 80 and 30 < P(bar) < 120). Several key elements will be investigated, in particular the determination of the link between the different characteristics involved: the hydrodynamic forces, the physico-chemical conditions, the petrophysical properties (porosity and permeability) of the medium, its network, the surface roughness of the pores as well as the nature, the size and the concentration of the particles present. Consequently to these injectivity experiments at HP/HT conditions, predictive transport-deposit-damage laws and adapted remediation solutions will be proposed in order to optimize the durability of the geothermal systems.

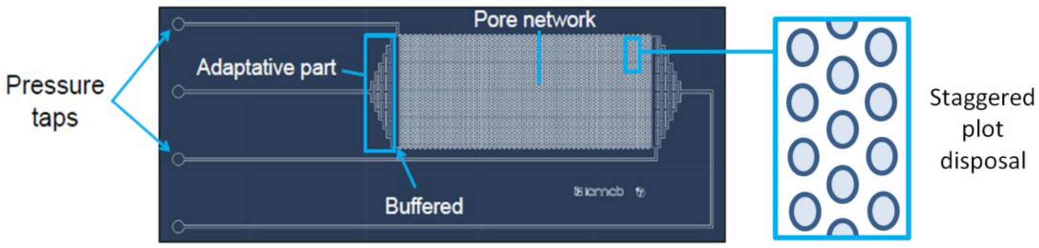

Figure 1 Design of silicon-pyrex micromodels used in the study (simple pore network with staggered plot pattern).

This work will allow a better prediction of the flows and the adaptation of remediation solutions to prevent/mitigate losses of injectivity/productivity of wells in the context of geothermal energy. The characterization process in the laboratory will be improved through a better interpretation of the experimental results obtained with HP microfluidic devices as well as an optimization of the simulation tools through a relevant description of the macroscopic properties of the flow and transport.

References

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