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Identification and understanding of colloidal destabilization mechanisms in geothermal processes

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In this work, the impact of clay minerals on formation damage of sandstone reservoirs is studied to provide a better understanding of the problem of deep geothermal reservoir permeability reduction due to fine particle dispersion and migration. In some situations, despite the presence of filters in the geothermal loop at the surface, particles smaller than the filter size (<1 µm) may surprisingly generate significant permeability reduction affecting in the long term the overall performance of the geothermal system.
Our study is carried out on cores from a Triassic reservoir in the Paris Basin (Feigneux, 60 km Northeast of Paris). Our goal being to first identify the clays responsible for clogging, a mineralogical characterization of these natural samples was carried out by coupling X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Spectroscopy (EDS). The results show that the studied stratigraphic interval contains mostly illite and chlorite particles. Moreover, the spatial arrangement of the clays in the rocks as well as the morphology and size of the particles suggest that illite is more easily mobilized than chlorite by the flow in the pore network.
Thus, based on these results, illite particles were prepared and used in core flooding in order to better understand the factors leading to the aggregation and deposition of this type of clay particles in geothermal reservoirs under various physicochemical and hydrodynamic conditions. First, the stability of illite suspensions under geothermal conditions has been investigated using different characterization techniques including Dynamic Light Scattering (DLS) and Scanning Transmission Electron Microscopy (STEM). Various parameters such as the hydrodynamic radius (around 100 nm), the morphology and surface area of aggregates were measured.
Then, core-flooding experiments were carried out using sand columns to mimic the permeability decline due to the injection of illite-containing fluids in sandstone reservoirs. In particular, the effects of ionic strength, temperature, particle concentration and flowrate of the injected fluid were investigated. When the ionic strength increases, a permeability decline of more than a factor of 2 could be observed for pore velocities representative of in-situ conditions. Further details of the retention of particles in the columns were obtained from Magnetic Resonance Imaging and X-ray Tomography techniques, showing that the particle deposition is non uniform along the column.
It is clearly shown that very fine particles as small as 100 nm can generate significant permeability reduction under specific conditions in high permeability porous media representative of the Triassic reservoirs of the Paris basin. These retention mechanisms are explained in the general framework of the DLVO theory.

Participation

In-Person

References

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