Numerical study on the interaction of solid grains with fluid in the production of natural resources

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Many problems could occur in the subsurface during the production of natural resources are related to movement of sand grains, e.g. sanding. In the production of methane hydrate, sand grains are produced in the defluxion of intergranular methane compound and flow out with the methane through the production lines. When hydraulic fracturing is attempted in hydrocarbon or geothermal reservoirs, solid grains called proppant could be used with the fracturing fluid to keep the induced hydraulic fractures open. Although it is important to understand behavior of solid grains in the fluid flow, little study has been done to simulate the interaction of solid grains with fluid in pores and fractures. In the present study, we simulate solid-fluid interaction using the smoothed particle hydrodynamics (SPH) method.

At first, we simulate fluid flow with small sand grains in porous media. We make several models with different viscosity and shape of grains, and calculate relative permeability changes. The results show that the viscosity of fluid and shape of sand grains have great impact on permeability in porous media.
Next, we simulated the floating of micro sands by drag force from fluid flow. We make a sand mount composed of small grains, and flow fluid in upper part of it. In case of low pressure gradient, no grain floats above the mount. In high pressure gradient, however, a few grains are uplifted by fluid flow. This result indicates the possibility of prevention of sanding by controlling flow rate

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