Uniquely Identifiable DNA-Embedded Silica Nanotracer for Fractured Reservoir Characterization

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The objective of this study was to develop and evaluate a type of uniquely identifiable nanoparticle tracer to map fracture networks without ambiguity. DNA-tagged nanotracers were synthesized by first adsorbing synthetic DNA molecules onto the surface of plain silica nanoparticles of around 140 nm diameter, and then coating the particles with a silica outer layer to protect the DNA from harsh environmental conditions. Heating and flow experiments were conducted to evaluate the durability of silica as a protective material for DNA molecules. DNA-embedded silica nanoparticles were injected through packed sand at various temperatures and analyzed in the effluent in order to test whether the DNA-silica nanotracer could flow successfully through porous medium while maintaining the integrity of the DNA. This paper summarizes the advantages and limitations of DNA-embedded silica nanoparticles as reservoir tracers, and discusses possible approaches to adjust the DNA-silica nanotracer to achieve more favorable properties for fractured reservoir analysis. As tracers, the nanoparticles would be useful in geothermal, oil, or gas reservoirs.