



Models for evolution of reactive surface area during dissolution and precipitation

Janne Pedersen (1), Espen Jettestuen (1), Tania Hildebrand-Habel (1), Jan Ludvig Vinningland (1), Merete Vadla Madland (2), Reidar Inge Korsnes (2), and Aksel Hiorth (1)

(1) International Research Institute of Stavanger, P.O. Box 8046, N-4068 Stavanger, Norway, (2) University of Stavanger, Petroleum Department, N-4036 Stavanger, Norway

During water flooding of a reservoir, minerals can dissolve and/or precipitate if the injected water is out of equilibrium with the formation. A net mass transfer between solid and fluid will result in a dynamically changing pore space, which in turn may change the permeability and/or the porosity of the reservoir. When secondary minerals precipitate from solution they will form on top of the primary minerals on the pore walls, and hence the reactive surface area of the individual minerals constituting the porous medium will change. This will in turn affect the dissolution/precipitation rates. In this work we study three different models for the evolution of reactive surface areas during flooding of a core with a brine that is in disequilibrium with the rock. The three models differ in the way secondary minerals are distributed on the solid surface: In model I the whole surface area of both primary and secondary minerals is reactive; hence there will be no screening effect when secondary minerals form. In model II secondary minerals form as a monolayer on the primary minerals that will screen primary minerals from the flow. Model I and II represent two extremes regarding the screening effect; namely no screening (model I) and full screening (model II). Model III is motivated from observations of unflooded and flooded chalk using scanning electron microscopy (SEM). In this model secondary minerals are assumed to form preferentially near crystal defects, being e.g. dislocations in crystallographic pattern or grain contacts. Also the rate of precipitation for forming minerals varies for precipitation onto primary (dissimilar) minerals and precipitation onto secondary (similar) minerals.

The three models are implemented into a lattice Boltzmann (LB) based geochemical simulator, and simulation results are compared to results from a 3 years long core flooding experiment with outcrop chalk flooded with 0.219M MgCl₂ at 130°C, as well as SEM studies. Before flooding 98wt% of the core consisted of calcite, and after the flooding less than 20wt% was calcite and ~80wt% was magnesite. When simulating this experiment, the three models give very different effluent profiles. Model I and III fits the experimental curve quite well. We will discuss the three models in light of the experimental results.