Simulation of Acidizing Treatments in Carbonate Reservoirs

Jens-Oliver Schwarz[1], Liping Cheng[1], Juergen Becker[1], Sven Linden[1], Andreas Wiegmann[1], and Tom Cvjetkovic[1]

[1]Math2Market GmbH, Kaiserslautern, Germany.

ABSTRACT

Reactive transport processes in rocks play a major role for a large range of issues in the earth sciences. Examples range from the generation of ore deposits to the remediation of polluted industrial sites. In the upstream part of the oil and gas industry, reactive transport is of special interest in applications of acidizing treatments in carbonate reservoirs. The injection of an acidizing fluid in carbonate reservoirs triggers carbonate dissolution. Depending on the relative rates of fluid advection, diffusion, and reaction, specific dissolution structures develop. The heterogeneity of the reservoir rock, i.e. the individual pore structure also influences the developing dissolution structures. Therefore, engineering applications should evaluate the response of carbonate reservoirs prior to their field scale treatment by expensive field tests. Here, we introduce a new 3d model for the simulation of reactive transport to provide a cost-effective alternative for such evaluations. The reactive transport model uses the digital rock physics (DRP) package of GeoDict to model the dissolution of carbonates in 3D. The workflow consists of iterating through a loop of (i) calculating the flow field in the pore space by solving the (Navier-)Stokes equation, (ii) simulating advective transport and diffusive transport of the chemical reactants and (iii) simulating the carbonate dissolution rate based on the reactant concentration at the fluid / host rock interface. Steps (i) and (ii) are already implemented in the DRP suite of GeoDict but step (iii) is a new development. The simulation of the carbonate dissolution reaction is written in Matlab and then implemented in GeoDict's DRP workflow via our Matlab interface GeoLab. The Matlab routine computes the local rates of carbonate dissolution based on the local concentration of chemical reactants at the fluid / solid interface. The local chemical concentration is a complex function of (1) the chemical reactants entering the computational domain, (2) the advective transport and diffusive transport of these and (3) the consumption of the reactants by the chemical reaction. Carbonate dissolution develops different structures depending on the relative rates of advection, diffusion, and chemical reaction. We use this behavior to evaluate our numerical model by checking if the model can reproduce these dissolution structures for the corresponding conditions. First numerical results are in good accordance with reported observations.