Description of doctoral project and research results achieved to date

The aims of the doctoral project are to improve the model for microbially induced calcite precipitation as proposed by [1] by including advanced experimental insights on relevant processes; to show exemplary approaches to reduce the computational time of the model; to apply the model to help design experimental investigations as well as field scale applications. The results of the research on the model improvement are finished until further experimental insights provide the basis for additional investigations. The results of the investigations of model improvement possibilities are discussed in the published articles [2], [4]. The stays at the NUPUS-partner institution, the Center for Biofilm Engineering at the Montana State University in 2012, 2013, and 2014 facilitated the discussion of the numerical results in context of the experiments and thereby lead to enhanced publications. Investigations to reduce the model’s computational effort have identified several possibilities, first, the convergence criteria of both the linear and the nonlinear solvers and, second, simplifications of the calculations related to the biogeochemical reactions have a significant optimization potential. The potential application of the model to gain insight on how to design laboratory experiments is shown in a study on the effect of initial biomass amount and distribution on the resulting calcite precipitates for various injection strategies in a submitted research article [3]. This study was motivated by the findings of the model improvement [4] as well as experimental investigations on the attachment behaviour of the bacteria used for microbially induced calcite precipitation during the 2014 stay at the Center for Biofilm Engineering. Also, the observed discrepancies between model and experimental results discussed in [2] resulted in an experimental investigation of the relation between porosity and permeability, which was designed during the 2013 stay at the Center for Biofilm Engineering. Finally, the model is applied to field-scale problems in one of the supervised master’s theses.