

Modeling and Simulation Problems and Challenges in Well-Logging Industry

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The primary goal of oilfield exploration is to identify and quantify hydrocarbon reservoirs and to estimate their producibility. In a typical exploration, a wellbore (about 15 to 30 cms in diameter) is drilled through earth formation to a depth that may extend to a few kilometers. Characterization of earth formation from data (referred to as a “log”) measured by sensors placed inside the wellbore, is a complex problem and no single measurement can effectively do so. Formation properties are estimated by combining measurements from various sensors – mechanical, nuclear, RF, optical, low frequency electromagnetics, acoustic, magnetic resonance, for example. Designing such sensors presents many challenges. At a depth of about 5 kms – a typical well-depth – the sensor has to withstand hostile conditions, such as high temperatures (175⁰ C), high pressure (20,000 psi), corrosive fluid, and high mechanical shocks. Space is highly limited as is the available electrical power. Computationally, the sensors containing many different materials and multiscale geometry need to be accurately and efficiently modeled along with the surrounding medium which is considerably larger than the sensors. These design challenges and possible mitigation methods will be illustrated through several examples. Once a sensor is designed, it is yet another challenge to interpret the data measured by the sensor. Inverse problems associated with many geophysical measurements are often ill-posed, nonunique, and multimodal. Issues pertaining to inverse problems will be briefly discussed.