

Using Electromagnetics to Delineate the Distribution of Proppant in a Hydraulically Fractured Reservoir

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Despite recent advances in hydraulic fracturing and monitoring technologies, there are still many unknowns; chief among them is the extent and distribution of proppant within the reservoir. Here we investigate the potential of introducing highly conductive particles into the proppant and imaging the location of the proppant using electromagnetic surveys. Simulating expected responses, and thus determining if the technique is viable, requires upscaling the physical property structure from a millimeter scale to a meter scale. This upscaling can be completed using analytical or semi-analytical methods such as effective medium theory, or it can be done numerically by formulating upscaling as a parameter estimation problem. Both approaches provide valuable insight into bulk the electromagnetic properties of a doped, fractured reservoir, and the lessons taken from each strengthen our understanding of the electromagnetic characterization of such a reservoir. This understanding is essential for designing a survey capable of detecting the proppant, and once the data have been collected, for approaching the inverse problem.