ACCURATE RESERVOIR MAPPING USING DEEP-DIRECTIONAL RESISTIVITY MEASUREMENTS WITH 1D TO 3D IMAGING INVERSIONS

Abstract:

The reservoir scale deep-directional electromagnetic logging-while-drilling technology is now routinely being used to map boundaries and fluid contacts for strategic geosteering, reservoir navigation, and more recently, for reservoir characterization. Data interpretation is based on inversion algorithms that continuously estimate a local resistivity profile around the transmitter and receiver antennas during real-time interpretation. The assumed resistivity profile can range from a simple 1D layered medium to a complex 3D model depending on the complexity of the reservoir.

In this talk, the imaging inversion approach is presented for reservoir mapping with deep-directional resistivity measurements. By not making any prior assumptions about the reservoir, imaging inversions allow an unbiased estimation of the resistivity profile and can simultaneously resolve reservoir details due to the underlying fine inversion grid. The Gauss-Newton minimization algorithm is adapted for the imaging approach and four different types of imaging inversions are derived: 1D layered medium, 2D along the wellbore, 2D imaging perpendicular to the wellbore (i.e. 2.5D) and full 3D. All inversions are validated with synthetic data and applied to field data.

Reservoirs can be accurately mapped by starting with the simplest inversion and gradually increasing complexity until an inversion can fully reconstruct the measurements, which is then the best possible reservoir map that can be extracted with imaging inversions. Consistency among the inversion results provides confidence that reservoir is correctly mapped. This approach is presented for both synthetic and field data examples, showcasing how the imaging inversions can extract an accurate reservoir map.

Bio:

Michael Thiel is a Principal Research Scientist working with Schlumberger since 2010 after he received his PhD in electrical engineering from the University of Michigan. He is working on inverse problems and interpretation workflows for LWD directional resistivity measurements. He was a 2018/2019 SPWLA Distinguished Speaker and coauthor of a SPWLA Annual Logging Symposium best paper in 2016. He has authored or co-authored eight journal papers and more than 20 conference papers.