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Structural Earth Modeling as a Basis for Formation Evaluation log Processing in High-Angle/Horizontal Wells

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Abstract

Many of the concepts used in petrophysics and formation evaluation (FE) were developed when wells were typically drilled vertically, assuming horizontally layered formations. In this situation, so called “bed boundary effects” occur at the boundary between two different formation layers, where the volume of investigation of the measurement sensor is covering both layers. The significance of the effect depends mostly on the vertical resolution of the sensors.

In High Angle/Horizontal wells, the wellbores cut the formations at lower angles and the bed boundary effects becomes much larger. The significance of the effect will not only depend on the resolution of the sensor but also on the angle at which the wellbore cuts the formation. FE-log processing with the target to determine “true” formation properties has to consider the local geometry between borehole and formation. To do this, a structural Earth model is required.

Lithological boundaries, bed boundaries, faults, and fractures can be identified on electrical, density or gamma ray azimuthal images of the borehole wall as they are planes that intersect the wellbore. We present an approach to enhance image interpretation capabilities by modeling the structural information from an image and applying a classification scheme. Azimuth and dip is interpreted from the images and is used together with wellbore azimuth and deviation to set up a structural Earth model around the wellbore. The volume of the structural model around the borehole is restricted to the depth of investigation of the FE sensor. The classification may be changed for each individual plane to obtain a realistic structural Earth model.

The structural Earth model was used as a basis for inversion of resistivity measurements. The inversion result is evaluated using ratios between the saturation determined from the measured resistivity and the inverted resistivity.