

Reliable Density Inversion and Application in Understanding Heavy Oil Reservoir Heterogeneity in WCSB

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Summary

Most of the heavy oil reservoirs in WCSB are heterogeneous. A good understanding of heterogeneity can reduce the risks in both thermal and cold production of heavy oil. In some areas, the lithology may vary from sand-dominated to mud-dominated in just a short distance, and inference from cores may not be reliable. Surface seismic, with its ability to image subsurface laterally and vertically, has potentials to help describe reservoir heterogeneity, and seismic applications in heavy oil reservoir characterization have been seen in the past. In those applications, the reservoir heterogeneity is mapped from seismic and its attributes, both primaries and derivatives, with incorporation of well information. Rock physics study shows that bulk density has a strong correlation with lithology in many heavy oil reservoirs in WCSB. Therefore reliable density attributes can provide direct interpretation of reservoir heterogeneity and be a good supplementary variable in statistical use of groups of seismic attributes. Density information can be extracted from pre-stack seismic data by the commonly used AVO inversion method, but the solution is usually unreliable due to the ill-posed nature of the inversion. Statistical constraints can be used to stabilize the solution, but also make the density attributes highly correlated to primary attributes and diminish the lithology indication. To overcome these issues, an approach is adopted in this study to extract more reliable density attributes and limit the use of statistical constraints. The study emphasizes the direct interpretation of reservoir heterogeneity from density attributes and using correlation of the colored density attributes with wells as QC. Case studies show the effectiveness of this approach and its applications in mapping heavy oil reservoir lithological structures.