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Comprehensive Analysis of Clastic Heavy Oil Reservoirs using Microresistivity Images and Dielectric Dispersion Logs

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In the heavy oil fields of north-east Alberta, reservoir evaluation is carried out by drilling, coring and logging numerous, closely-spaced, vertical wells, which are evaluated for geological and petrophysical information. Due to the short drilling season, operators often undertake very demanding drilling programs, typically involving hundreds of wells, multiple rigs and dedicated logging units. The resulting data needs to be interpreted rapidly and efficiently, in order to develop a thorough understanding of the following reservoir properties:

- lithofacies and environment of deposition
- reservoir architecture and channel orientation
- thickness of pay and bitumen saturation

Until recently, a complete interpretation over the reservoir required the acquisition of full core and wireline logs in every well. Historically core analysis has been the preferred method for lithofacies analysis and obtaining bitumen saturations. However, advances in interpretation techniques, combined with new wireline logging technology, means that a thorough evaluation is now possible with a reduced coring program, combined with the acquisition of triple-combo data, microresistivity images and dielectric dispersion logs from all wells.

The microresistivity images can be used to rapidly define lithofacies within the logged interval. However, it is important to correlate these results against core in a representative number of wells. This is now easy to do using new interpretation techniques which allow the image data to be interpolated to present a ‘fullbore’ resistivity picture of the borehole wall. Furthermore, a slice of the 3D image data can be taken in any azimuth to create a ‘slabbed’ picture which is directly comparable to the real core. Reservoir architecture and channel orientation can be determined after a detailed sedimentological interpretation of the dip data. This can then be used to refine reservoir models and create paleoflow maps. Finally, and perhaps most importantly, the dielectric dispersion data can be used to compute a continuous, accurate and salinity independent water filled porosity. This can be used in combination with total porosity values to calculate a high resolution bitumen volume. By combining all of these analyses together, a comprehensive interpretation can be rapidly produced, using log data alone (Fig 1). Core will still be required, indeed it is integral to the overall reservoir evaluation process, but the number of cored wells can be significantly reduced without sacrificing the key information needed for obtaining a complete understanding of the reservoir.

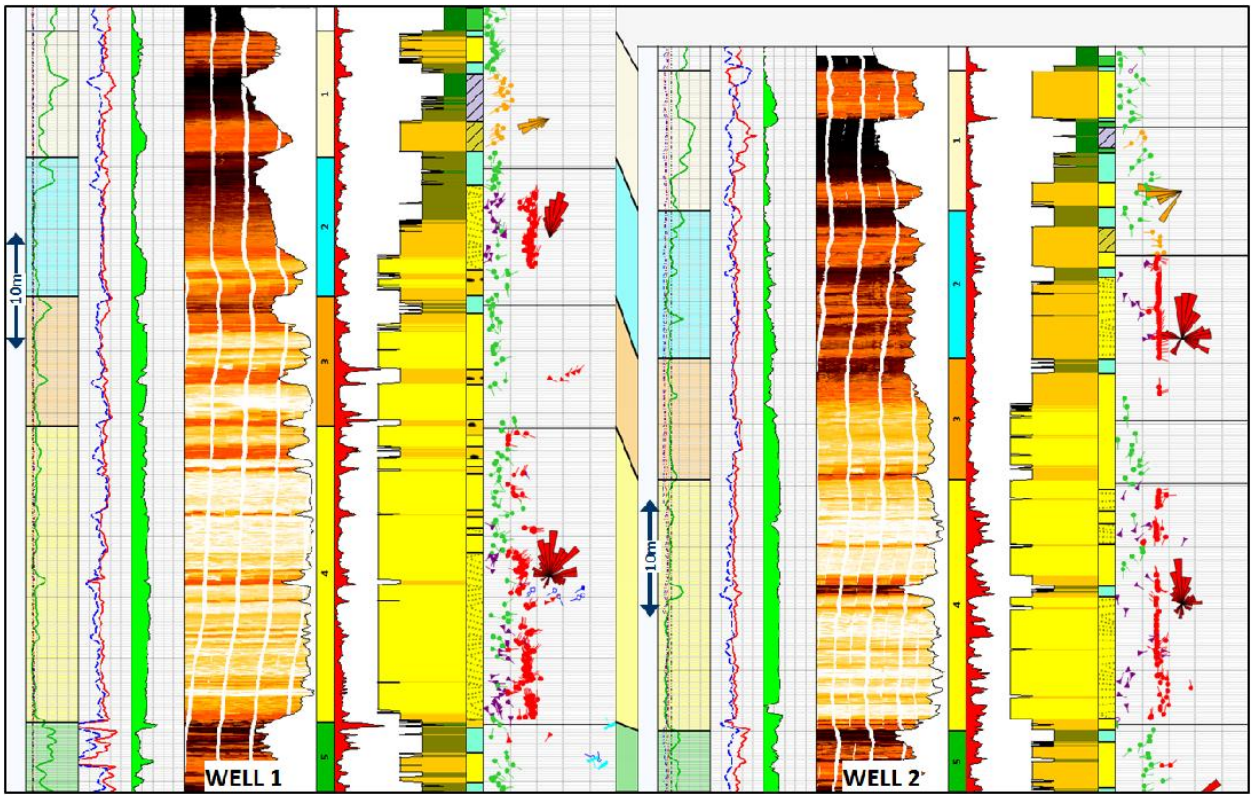

Fig 1. Example of a comprehensive interpretation from a McMurray reservoir, using microresistivity images and dielectric dispersion data. Track three shows continuous weight percent bitumen values (in green). Track six shows a proxy for sedimentary sorting (in red) and a microresistivity derived electrofacies column. The tadpole data in track eight shows interpreted cross beds and IHS, which help define paleoflow directions and channel thicknesses.