Grosmont Prolific Carbonate Reservoir: Unravel Subtle Facies Variability through Integrated Evaluation of High Resolution Seismic and Well Data*

Vasilisa Nekhorosheva[1], Fahad Al Hadhrami[1], Tulio Colmenares[1], Maria Balzarini[1], Jeff Lonnee[1], Orlando Ortega[1], Mohamed El-Toukhy[1], and Nikita Krylov[1]

Search and Discovery Article #41302 (2014)
Posted March 31, 2014

*Adapted from extended abstract prepared in conjunction with poster presentation at AAPG 2014 Annual Convention and Exhibition, Houston, Texas, April 6-9, 2014,

[1]Project and Technologies, Shell International E&P, Houston, TX (v.nekhorosheva@shell.com)

Abstract

This is an integrated study using high resolution seismic data and well logs in order to understand rock type distribution in the Upper Ireton Formation in the Shell Grosmont Lease in Alberta, Canada. Upper Ireton is a Late Devonian, Frasnian intertidal platform dolomite at a depth less than 400 meters (Figure 1). It is a highly prolific heterogeneous, fractured reservoir with an angular unconformity and well developed sinkholes at the top.

The Grosmont Platform in Alberta, Canada holds one of the largest heavy oil accumulations in the world. This study is part of Shell's efforts to unlock one of the largest bitumen resources trapped in Devonian fractured reservoirs. Understanding reservoir distribution and facies variability will have a strong impact on recovery efficiency, heat conduction and hence future pilots and development locations. Reprocessed 3D seismic data increased seismic resolution, minimized artifacts and enabled us to image facies changes within the Upper Ireton reservoir subunits which are less than 10 m thick. Reprocessing was focused on refining seismic velocities using well data, statics correction and testing different migration algorithms (Figure 2).

Method

Using FMI and core data, five rock types were identified in the reservoir section: laminated dolomite (bitumen saturated or tight unsaturated), marl, vuggy dolomite, breccia, and calcite. Laminated saturated dolomite is the dominant rock type in the UIRE A and is Shell's main development target. There are thin, unsaturated marl layers within the Upper Ireton section, but they are concentrated in the UIRE B.

Vuggy dolomite was identified in the Nisku and Grosmont. Seismic methods were unable to delineate all the facies described in the core. But the UIRE A reservoir interval showed consistent changes in seismic response, mostly associated with the level of brecciation. Breccia forms continuous layers within the UIRE A which extends over a relatively large area. Layered geometry of UIRE A brecciated section and presence of Hondo evaporite (Borrero, 2010) at the same stratigraphic level to the west indicate that the breccia might be the result of evaporite collapse and hypogenic karsts. Most of the UIRE A is extensively brecciated, while there is a breccia-free layer near the top of the unit.

Calcite and breccia distribution in a cross-sectional view through the 3D seismic study area. Wells may be divided into two categories according to the breccia distribution. One type is characterized by massive breccia and insignificant amounts of laminated dolomite (Category 1 on Figure 3); the other type consists of laminated dolomite with stringers of breccia (Category 2 on Figure 3).

Results

Although the acoustic differences between brecciated and non-brecciated rocks is not significant, detectability on seismic seems to be plausible. The trace shape classification method provided good seismic-to-well calibration results (using core and BHI). The wave form classification map in Figure 3 represents an interval from the upper part of the Grosmont (UGM3C) to the middle of the UIRE A. The map shows seismic facies variability. Well data indicate that red color on the map (higher amplitudes) corresponds to intervals composed of laminated dolomite with thin layers of breccia. Purple colors (lower amplitudes) correspond to massive breccia with layers of laminated dolomite.

An important part of the reservoir characterization is the identification of karst intervals. Sinkholes and other dissolution-related features are clearly detected on seismic. Dissolution features can reach hundreds of meters in diameter and tens of meters in depth in the Nisku and Grosmont formations. Geometric attributes allowed better imaging of sinkholes in the Nisku and karst features in the Grosmont. On the Grosmont level, karst has an almost perfect circular shape, while sinkholes at the unconformity level are of a more irregular form. Alignment of karst features on both levels shows a common genetic association to tectonic elements like faults and fractures.

Conclusion

In conclusion, improved seismic data (higher Freq., high S/N ratio, attenuated artifacts) and use of various attributes enabled better integration of well data and improved our ability to predict subtle facies variability away from the wells.

Reference Cited

Borrero, M., 2010, Hondo evaporate within the Grosmont Heavy Oil Carbonate Platform, Alberta, Canada: MS thesis, University of Alberta, Canada.

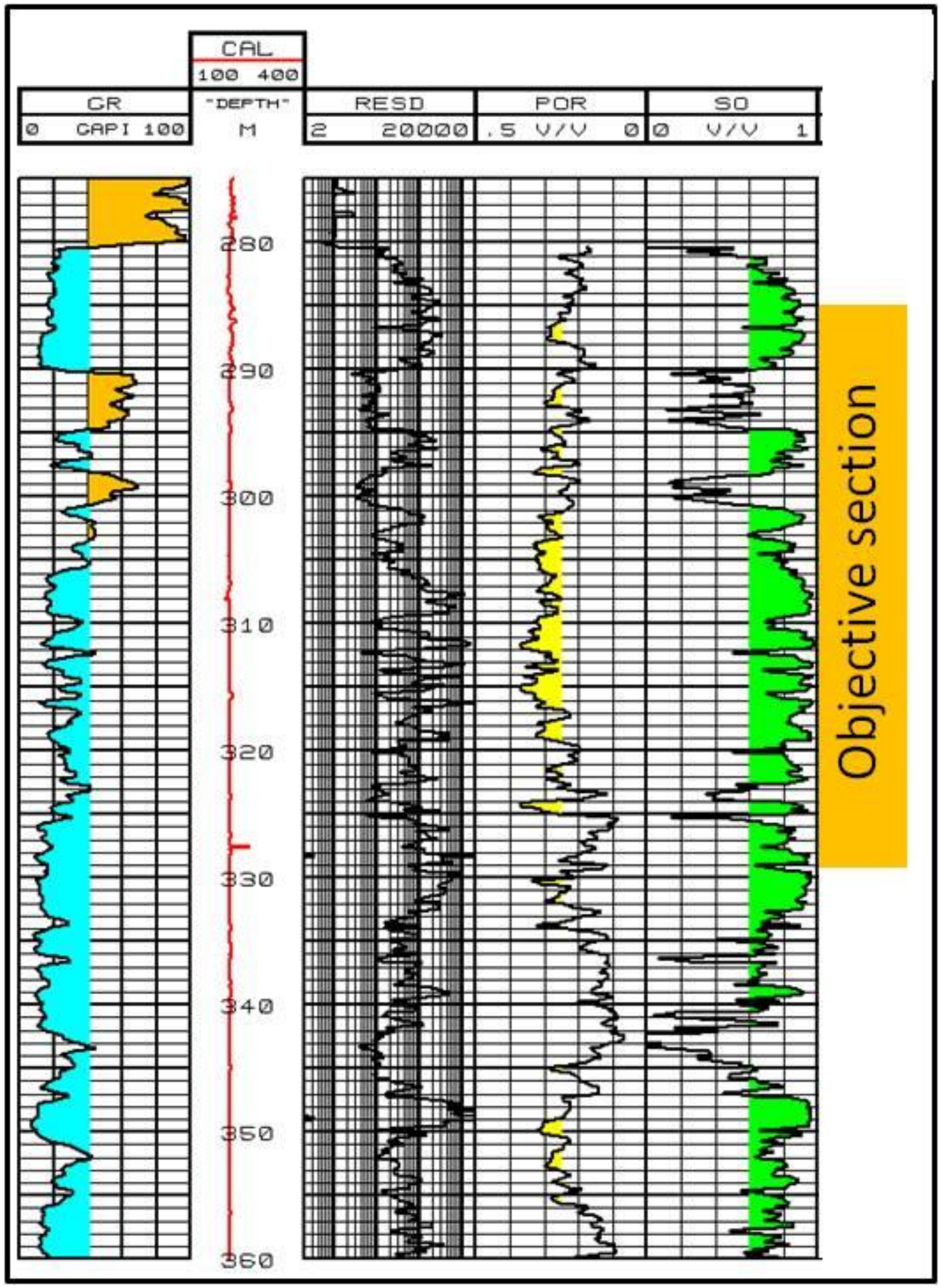

Figure 1. Shell Grosmont lease type log.

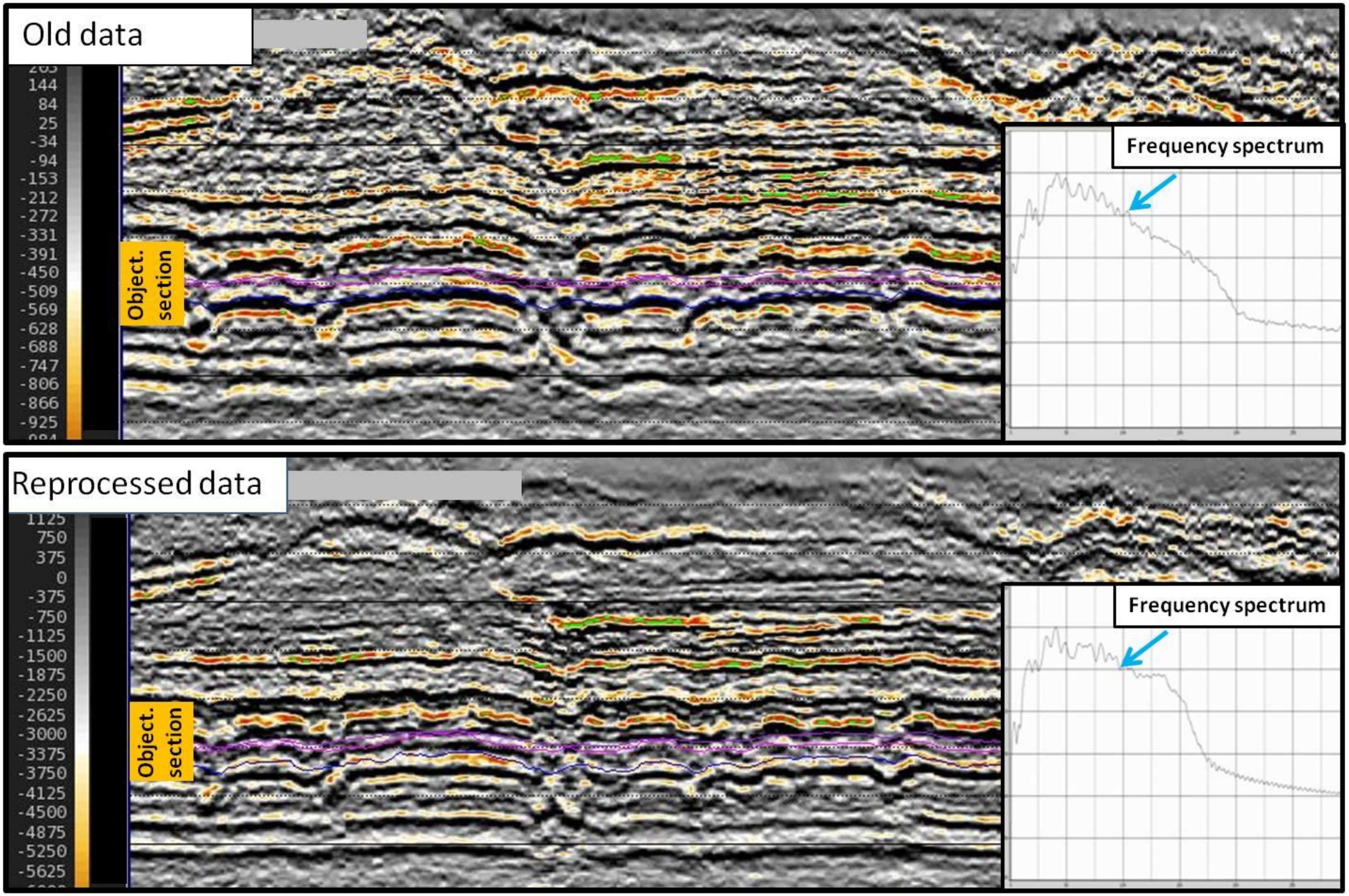

Figure 2. High resolution seismic data reprocessing results. Curves on the side show the amplitude and frequency spectrum of the data. Reprocessed data has over 200 hertz frequency and stable amplitude.

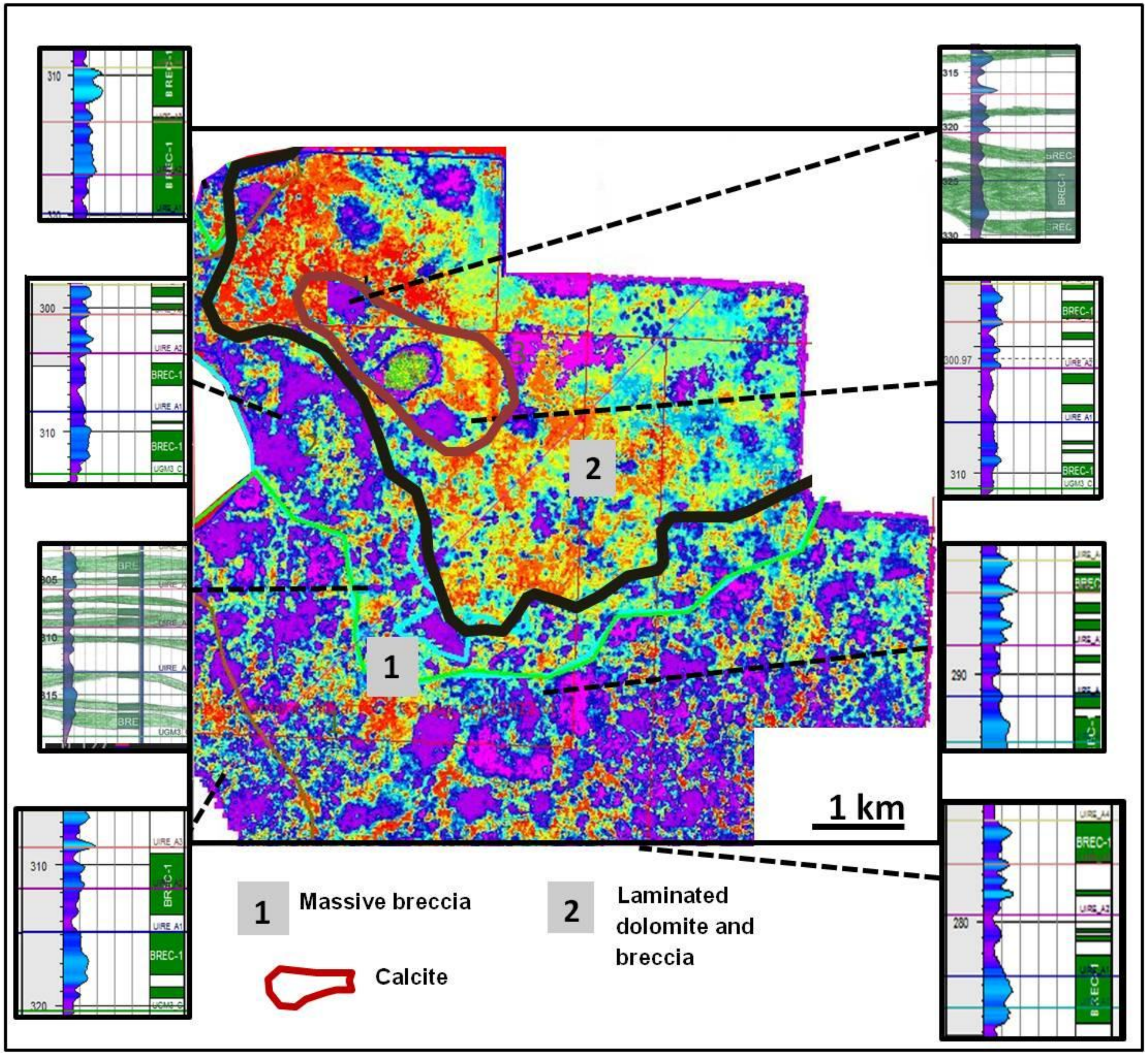

Figure 3. Wave form classification map for the UGM3C to UIRE A4 interval with interpreted rock types, compared to the well data. Red color on the map (higher amplitudes) - laminated dolomite with thin layers of breccia. Purple colors (lower amplitudes) - massive breccia with layers of laminated dolomite.