

September 28, 2017

***“Integrating AVO Analysis with Poststack Seismic Approaches to Better Understand Complex Faulting / Fracturing in the Niobrara Formation”***

**Abstract:** Dr. James Applegate\*, Travis Brown, Doug Paul, Filip Soos

Although largely overshadowed in recent years by the liquid rich Eagle Ford and Permian resource plays of Texas, the Niobrara of Colorado and Wyoming maintains immense potential in liquids and gas. The Late Cretaceous Niobrara Formation is considered a hybrid resource play in which healed and open fracture systems exist. Identifying and understanding the distribution of these fault and fracture systems can have significant impact on the resultant Estimated Ultimate Recovery (EUR). The objectives of this study are fourfold:

1. To investigate the prestack character over a portion of a speculative Weld County, Colorado 3D seismic survey in order to identify fault and fracture systems using Amplitude vs Offset (AVO) techniques.
2. To integrate the AVO findings with traditional poststack analysis and attributes to delineate the fault and fracture systems and to differentiate between open and closed systems.
3. To combine prestack and poststack attributes to break down the unfaulted portions of the reservoir into definitive rock classifications.
4. To recommend drilling orientations and generate initial well plans incorporating the results of the AVO and poststack analysis.

An AVO study over a portion of a speculative 3D in Weld County, Colorado identified anomalies in the prestack response within and around the Niobrara Formation. The linear nature of these anomalies were interpreted as fracture / fault systems. As the AVO analysis progressed, cross plots revealed that the anomalies had significantly differing AVO properties. The results in grid and volume form were compared to poststack seismic attribute analysis results. This served to differentiate closed or healed fault / fracture systems from open systems. The lineaments were interpreted in poststack space and rendered in 3D to better understand the relationships to the reservoir. Prestack attributes such as Lithology Factor, Porosity Factor, and Fluid Factor were calculated and correlated to poststack analyses such as Coherence, Spectral Decomposition, and Wavelet Analysis. This yielded the classification and mapping of stratigraphic units within the Niobrara Formation. Well plans were then designed considering optimal orientation to the fracture systems and vertical placement within the most promising stratigraphic units.

The authors' thanks to GeoKinetics, Inc. and Geophysical Pursuit, Inc. who provided the seismic data for this study; and to SeismicUtensils, LLC and SeisWare International, Inc. who provided the software used.

## Our Presenter

### *Jim Applegate*



Dr. Applegate is CEO/Managing Member of SeismicUtensils, LLC and Applegate Exploration, LLC. SeismicUtensils was founded with partner, Filip Soos. SU develops and sells specialty geophysical software including AVO-Detect. Applegate Exploration is a consulting, exploration, and training company.

Jim has worked in exploration for small to large companies and consulted for a number of years. For more than 15 years, he was a 'school marm' at Boise State University (Founder of geophysics program, Head of Geology & Geophysics Department), Colorado School of Mines (Associate Professor & Founding Director of the Exploration Research Lab), University of Louisiana – Lafayette (Professor & Founding Director of the Energy Institute), and University of Adelaide, Australia (Professor & Acting Director, National Centre for Petroleum Geology & Geophysics). He was the first Professor of Petroleum Geophysics in Australia. He holds patents in areas ranging from well logging to EM exploration. He has taught and consulted on every continent except Antarctica. Current activities include multiple exploration projects, developing and marketing software, presenting training/mentoring courses, and consulting.

Jim holds the degrees of Geophysical Engineer, MSc and PhD, Geophysical Engineering from Colorado School of Mines. He is a Member of SIPES and RMAG; an Emeritus Member of SEG and AAPG; and an Honorary Member of DGS and CSM Alumni Association.

Jim holds the degrees of Geophysical Engineer, MSc and PhD, Geophysical Engineering from Colorado School of Mines. He is a Member of SIPES and RMAG; an Emeritus Member of SEG and AAPG; and an Honorary Member of DGS and CSM Alumni Association.