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Discrete Fracture Networks in the Niobrara and Codell: from Outcrop Surveys to Subsurface Reservoir Models

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ABSTRACT:

Heterogeneity of an unconventional reservoir is one of the main factors affecting production. Well performance depends on the size and efficiency of interconnected fracture "plumbing system" developed during multistage hydraulic fracking. Complex natural fracture networks can significantly increase the size of the stimulated reservoir volume, provide additional surface area contact, and enhance permeability. To understand the complexity of natural fracture network within the Niobrara Formation a dataset comprised of fracture plane orientations and fracture intensity variations was acquired. The application of LIDAR (Light Detection and Ranging) and photogrammetry allowed for collection of a high fidelity, high confidence geotechnical dataset. The purpose was to use an outcrop as an analog to the subsurface for improved reservoir characterization. Multiple fracture sets were identified. Listric faults associated with negative flower structures show increased fracture intensity near the fault zones. Fracture sets remain consistent throughout the interbedded chalks, marls, and limestones. However, there is an apparent variability of fracture spacing associated with changes in lithology. In order to better analyze fracture patterns and fracture drivers a geological model consisting of structural framework, lithofacies model, and discrete fracture network (DFN) was developed. The information gained from modeling should serve to improve reservoir characterization in the subsurface and result in better well planning and placement.

Speaker Biography:

Alena is currently a PhD candidate and a Research Assistant at Colorado School of Mines. Prior to joining School of Mines she obtained her Bachelor’s and Master’s Degrees in Geophysical Engineering from Gubkin State University of Oil and Gas, Moscow, Russia. Seismic interpretation and inversion became the area of her expertise after Alena earned a Master’s Degree in 2010 and proceeded with her professional career in the oil and gas industry. Her work experience includes 8 years with Gazprom, Schlumberger, ExxonMobil, Chevron, and Ursus E&P. Alena’s goal is successful integration of multidiscipline research teams of geoscience experts focused on reservoir characterization. She also developed and taught a new graduate level course at Colorado School of Mines (field trip, lectures, and labs). Course included field data collection and further application for the reservoir (geological) modeling. It was designed

to help students gain some experience working in multidisciplinary team by integrating geology, geophysics, and petroleum engineering. Alena's research focus is natural fracture prediction and modeling for unconventional reservoirs. This includes understanding of fracture drivers (such as structural deformations and fracture prone facies) through the creation of geological model in order to identify the "sweet spots" for the Wattenberg Field. Her major interest is focused on the Facies and Fracture Models, incorporating petrophysics, rock physics, Discrete Fracture Networks (DFN), production data, seismic inversion results, and outcrop analysis along with the core interpretation.

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