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Multidisciplinary Analysis of Tight Gas Sandstone Reservoirs, Almond Formation, Siberia Ridge Field, Wyoming

Abstract

The completion of a recent Gas Research Institute study (GRI -00/0026) allowed for significant insight into the controlling mechanisms for gas production in Siberia Ridge Field, southwestern Wyoming. The purpose of the study was to characterize the Almond Formation (Cretaceous) in Siberia Ridge Field to better understand controls on productivity and to compile this information for use as an analogue in similar tight gas sandstone reservoirs. Of particular interest was the role that natural fractures play on productivity, because this reservoir's average porosity ranges from eight to ten percent and matrix permeability is in the micro-darcy range. The Siberia Ridge Reservoir Characterization (SRRC) study comprises full-field geoscience, petrophysical and engineering analyses and the results of a GRI cooperative research well. As an industry partner in this study, Amoco Production Co. committed to drilling and completing a well to test a "sweet spot" hypothesis as well as gather data utilizing a comprehensive log and well evaluation suite that is generally unavailable in developed areas. The Siberia Ridge Unit #5-2 well (Sec. 5, T21N – 94W) commenced drilling in late 1997 and was successfully completed in February 1998 for an IP of 2.56 MMcfd and 240 BWPD on a 32/64" choke. The well was directionally drilled to intersect a predicted system of natural fractures interpreted primarily from well data.

Gas production in Siberia Ridge Field is quite variable, with EURs averaging 1.8 BCF and ranging from less than 0.5 BCF to nearly 20 BCF. At the beginning of the study it was unknown whether the locations of productive sweet spots were controlled by increased natural fracturing, by better matrix quality, or by completion practices.

Geological facies analysis and petrophysical data were mapped along with production data to determine productive trends. Several horizons within the 3-D seismic survey were picked, and isopach derivative maps were made. Coherency analysis was run on several horizons to determine the location of any significant linear features. The combination of depositional, petrophysical, and structural data revealed that mapped areas of better petrophysical properties generally indicated better production, even though the range in reservoir quality is very small.

Fullbore Formation Microimager (FMI) and core data from three wellbores were used to characterize the natural fracture system. These fractures appear to be related to the regional extension fracture network and are ubiquitous in the wellbores studied. Natural fracture density was found to be mostly a function of wellbore depth, lithology, and deviation as well as a function of linear feature proximity. Rather than providing increased conductivity to natural gas in the reservoir intervals, natural fractures were found to provide increased relative permeability to water in the deep Almond. The presence of natural fractures is not thought to be a significant factor in gas production; rather, proper well completion practices were found to be critical to well performance.

The enhanced understanding of the Almond reservoir in the Siberia Ridge Field provided by this multidisciplinary study can be used by the operator to improve drilling, completion and production practices, ultimately impacting well economics by decreasing risk and increasing recoverable reserves.

Biographical Sketch

STEPHEN STURM is a lead geologist with Schlumberger Holditch-Reservoir Technologies in Denver, Colorado. He has worked for Schlumberger since 1994 when it acquired Intera Information Technologies.

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Steve began his career with RPI International in Boulder, Colorado in 1984 as a research geologist and petrologist participating in regional stratigraphic and reservoir evaluation studies in Wyoming, North Dakota, Colorado, and New Mexico. In 1989 through 1991, he worked on damage assessment and clean-up recommendations on the Exxon Valdez and BP American Trader oil spills, and environmental and economic appraisal of the Oman Coastline.

After joining Intera in 1991, he worked on numerous characterization and simulation studies including reservoirs in Rocky Mountain basins, Kuwait, Norway, Venezuela, Mexico, and Chile. Following acquisition of Intera by Schlumberger in 1994, he continued working with multi-disciplined reservoir characterization project teams on fields in Western Siberia, China, Indonesia and Mexico, as well as the Williston and Greater Green River Basins. From 1997 through 1999 he held the position of lead geologist and project manager on the GRI characterization of the Almond Formation in the Siberia Ridge Field, Greater Green River Basin, Wyoming.

Steve holds an MS degree in geology from the University of North Dakota, Grand Forks and a BA in Earth and Environmental Sciences from Queens College (CUNY), New York. ■