



SPE 110333

Microseismic Monitoring of a Re-Stimulation Treatment to a Permian Basin San Andres Dolomite Horizontal Well

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This paper was prepared for presentation at the 2007 SPE Annual Technical Conference and Exhibition held in Anaheim, California, U.S.A., 11–14 November 2007.

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Abstract

The results of a microseismic monitoring of a multi-stage re-fracturing treatment of a Permian Basin San Andres dolomite interval in an open-hole horizontal well will be presented in this paper. The treatment well has a horizontal well trajectory of approximately 3,000 feet within the reservoir section and had been extensively acid fractured during earlier production enhancement operations. The microseismic mapping objectives of the re-fracturing treatment for each of the stages were to characterize the azimuthal orientation of the fractures, the length of each wing, fracture height, and overall stimulation effectiveness.

The study discusses mapping microseismic events in a challenging re-fracturing environment. The microseismic activities generated during a re-fracturing treatment may be very low in acoustic energy and detection may be problematic, compared to the acoustic energy released during initial hydraulic fracture propagation. In this study, few microseismic events were detected, and this data indicates that the previously propagated fractures created preferential paths for fluid flow thus reducing the propagation of a new fracture network. In fact, for the stage located the furthest from the monitor well, no microseismic events were detected. This was consistent with an Instrument Magnitude Analysis performed on the located microseismic events from the other stages that showed events further than 1,400 feet away from the monitor well were not detectable.

A chemical packer was used for zonal isolation, and ball-activated sliding sleeves were used for selective injectivity for each stage along the horizontal well in the re-fracturing treatment. The operation of the sliding sleeves, for each stage and the ball drops, generated compressional and shear events which were detected by the geophone array in the monitor

well. This confirmed that the instrumentation was able to detect events between the treatment well and monitor well in this job and that the microseismic events induced during the re-stimulation treatment were at a much lower energy. The low-energy events that were located confirmed the ball-activated sleeve worked correctly and the induced fractures stayed in zone. However, the source locations detected did not delineate clear linear propagation of hydrofractures from the wellbore but described a complex fracture network.

Introduction

Reservoir microseismic monitoring provides insights into spatial and temporal variations in the stress field.¹ Microseismic activity can be induced by stimulation, production, injection and regional tectonic processes. The microseismic mapping results for a 3,000-ft open-hole horizontal well trajectory with a stimulation treatment target of five fractures located 700 to 1000 ft apart are discussed in detail in the sections below.

The target well trajectory is along a 75-ft San Andres dolomite interval possessing porosity in the range of 5-15%. The goals of the mapping were to characterize the azimuthal orientation of the fractures, the length of each wing, fracture height, and overall stimulation effectiveness. The characterization, conducted during October 2006, was difficult since this portion of reservoir had been extensively acid fractured during earlier production enhancement operations, decreasing the number of microseismic events which could be located.

Overview of the Permian Basin San Andres Dolomite West Welch Unit

West Welch Unit is in one of four large waterflood units in the Midland Basin Welch Field in the northwestern portion of Dawson County, Texas.² The Welch Field was discovered in the early 1940s and produces oil from a stratigraphic trap under a solution gas drive mechanism from the San Andreas Formation at approximately 4,800 ft. The field has been under waterflood for almost 40 years and a significant portion has been infill-drilled on 20-acre spacing.

The San Andres formation is a Guadalupian age dolomitized ramp carbonate unit that is one of the most prolific hydrocarbon reservoirs in the Permian Basin. In the Midland Basin, the San Andres formation is overlain by the Grayburg formation and underlain by the Spraberry formation.