MASSIVE FRACTURING OF TIGHT GAS-BEARING SANDSTONE RESERVOIRS IN THE PICEANCE CREEK BASIN, COLORADO

by

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**ABSTRACT**

Nuclear and massive hydraulic fracturing (MHF) projects in the Piceance Creek basin, Colorado, are aimed at recovering appreciable fractions of the large volumes of gas in place in low-permeability, discontinuous sandstone units of the Mesaverde and Fort Union Formations. Most of the gas-bearing rock consists of lenticular channel-fill sandstones. Although an average individual lens exhibits 2 interconnections or interpenetrations along its length, only a fraction of the gas in place in a 640-ac area is even tenuously interconnected. Successful massive fracturing projects will connect larger amounts of the gas in place to the well bore, and will greatly increase the rate of production. Project Rio Blanco, a nuclear gas stimulation experiment, and the Rio Blanco MHF experiment, are in the evaluation and fielding stages, respectively. Project Rio Blanco involved the simultaneous detonation in May 1973 of three 30-kt nuclear explosives placed about 400 ft apart vertically in a single well bore. Current information indicates an unpredicted lack of communication among breccia chimneys produced by the detonation. Plans are underway to use a different reentry technique to obtain data from the lower chimneys. Until these data are available, no judgment can be made as to the success or failure of the experiment.

The Rio Blanco MHF experiment is being fielded about 1 mi north of the Project Rio Blanco nuclear well. The MHF experiment is an attempt to stimulate a 1,300-ft section of Fort Union and Mesaverde gas-bearing sandstones equivalent to the section fractured in the Rio Blanco nuclear well. Results from Rio Blanco MHF experiment will not be available for about 18 months. At that time, a comparison will be made between the efficiencies of nuclear and massive hydraulic fracturing.

**GEOLOGY OF THE PICEANCE CREEK BASIN**

**TIGHT GAS-BEARING SANDSTONE UNITS**

**Geology of the Basin**

A conceptual model of the Upper Cretaceous and lower Tertiary basin has been developed. This model is based upon a study of the literature, the rock on outcrop along the basin margin, and the information developed from the oil and gas wells drilled in the basin. The complex regression of the Upper Cretaceous sea produced a sequence of bar, lagoonal, and deltaic sandstone bodies that characterized the transition between the marine Mancos Shale and the fluvial Mesaverde Group. Sandstone bodies of this transitional sequence have sufficient continuity so that when they are encountered in areas where they have sufficient permeability and contain hydrocarbons, they are commercial reservoirs.

Above the transition facies is a coal-bearing coastal swamp to fluvial facies termed the Neslen facies. Sandstones in this sequence generally exhibit poor continuity. Sandstones of the Neslen facies commonly are associated with coals and are generally gas-bearing in the central portion of the Piceance Creek basin. They pose a serious production problem because of their low permeability and because of their lack of continuity.

Above the Neslen facies occurs the Farrer facies, the upper part of the Cretaceous Mesaverde, generally represented by fluvial channel sandstone and shale. These sandstone units are characterized by low permeability and poor continuity and hence constitute a problem in commercial development. Above the Farrer facies is the Paleocene Fort Union Formation. In the southern part of the basin, this formation contains a coarse-grained basal sequence termed the Ohio Creek Conglomerate. In the northern part of the basin, the Fort Union is more typically a sand-shale sequence rather than a conglomerate. Genetically, Fort Union sandstone beds are of point-bar and channel origin. The permeability of the Fort Union sandstones and conglomerates is highly variable. Unfortunately, there seems to be an inverse correlation between the occurrence of high permeability and hydrocarbons. In general, when hydrocarbon-bearing, these sandstones exhibit low permeability, and the point-bar