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MEETING PAPER

STRESS MEASUREMENTS IN THE PALO DURO BASIN TEXAS PANHANDLE

by

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ABSTRACT

Background, Equipment, and Test Procedures

Hydraulic Fracture Tests were performed at five locations in the Holtzclaw No. 1 well, Randall County, Texas, to determine the magnitude and direction of in-situ horizontal stresses. The rock units tested were a limestone, two salt strata, one anhydrite, and one siltstone. Geophysical logging and borehole televiewer logging were also performed in the hole. Testing performed is summarized in Table 1, while Figure 1 shows the approximate location of the well. The well was drilled and the testing performed as a part of a nationwide program by the U.S. Department of Energy to identify potential locations for a nuclear waste repository in deep geologic formations. Because of this, considerable core was obtained, and extensive logging and testing was performed in the well. Laboratory tests were also available, and considerable background geologic data from the area had been collected and analyzed. This information aided in the selection of test zones and the interpretation of the results.

The Holtzclaw No. 1 well was drilled with standard oil field equipment. Surface casing (10 3/4 in.) was installed to 1,125 ft and an open 8 3/4 in. hole drilled to a T.D. of 2,884 ft using 10.3 lb, salt saturated mud. The well was completed and capped April 1, 1983. Hydraulic Fracture testing began in late November 1983. The delay, during which the hole remained filled with mud, necessitated reconditioning prior to testing, and may have affected pore pressure in some formations.

Hydraulic Fracturing was carried out by Terra Tek, Inc., Salt Lake City, under subcontract to Stone & Webster Engineering Corporation (SWEC). Terra Tek supplied the custom built, dual air actuated (Haskel) pump system and all surface pressure and flow recording equipment. Terra Tek also analyzed the data and calculated the in-situ stresses. Downhole equipment was supplied by Lynes, Inc., Houston, TX, and consisted of a J-type hydrologic test tool utilizing quartz pressure transducers with surface readout and 8.5 ft between packers.

Multiple pressurization cycles were performed in each test zone. Figure 2 shows data from one salt zone, which is typical of that obtained. Minimum horizontal stress was estimated by pressure decline analysis, following the procedures suggested by Gronseth (1982) and Gronseth and Kry (1982). The maximum horizontal stress was estimated using the subsequent breakdown technique (Hickman and Zoback, 1982). Vertical stresses were generally estimated by assuming the overburden weight (vertical stress) equalled 1 psi/ft. Integration of Lithodensity logs from several wells in the Palo Duro Basin (including the Holtzclaw well) give an average overburden weight-to-depth relationship within 1-2 percent of this value. Pore pressures (required for estimating the maximum stress) were assumed to be zero in salt. In the limestone and siltstone, an average pore pressure gradient of 0.434 psi/ft below the water table was assumed. This gradient is consistent with measurements of formation pressure by drill steam tests performed in zones with adequate permeability. The repeat formation tester was run in the test zones, but the rocks were too impermeable to permit measurement of pore pressures with this device. Tensile strength was estimated from the