



Tom Daley, Barry Freifeld, Tony Siggins

11. SEISMIC AND MICROSEISMIC MONITORING¹

11.1 Introduction

The Naylor-1 monitoring completion, a unique and innovative instrumentation package, was designed and fabricated at Lawrence Berkeley National Laboratory (LBNL). The intent was to deploy a suite of instrumentation for monitoring subsurface reservoir conditions. The instruments included pressure-temperature gauges, fluid sampling equipment at multiple depths, multi-use seismic sensors, and a packer for zonal isolation. All the instruments needed to fit into a small diameter mono-bore with an additional restriction due to a casing patch above the reservoir zone. The deployment method chosen was semi-permanent (retrievable), using 0.75" diameter "sucker" rods typically used for oil field pump jacks. Instrumentation was installed between

¹ This work was partially supported by the GEOSEQ project undertaken for the Assistant Secretary for Fossil Energy, Office of Coal and Power Systems through the National Energy Technology Laboratory, of the U.S. Department of Energy, under contract No. DE-AC02-05CH11231.

26 September and 14 October, 2007 in the pre-existing borehole Naylor-1. Figure 11.1(a) shows a schematic of the Naylor-1 instrumentation layout, and Figure 11.1(b) shows deployment operations. Three U-tube geochemical samplers were deployed, with one located near the top of the residual CH₄ gas cap and two located beneath the gas-water contact. The 21 geophones (Figure 11.1(c)) were used to perform three distinct seismic measurements—high resolution travel time (HRTT), walkaway vertical seismic profiling (WVSP), and microseismic monitoring.

11.2 High resolution travel time (HRTT) monitoring and offset VSP

The active seismic programme using the Naylor-1 sensors included high resolution travel time (HRTT) monitoring using sensors located at reservoir level and walkaway vertical seismic profiling (WVSP) using a string of nine vertical geophones located above the Waarre reservoir horizon. The surveys conducted are summarised in Table 11.1. The six locations used for conducting HRTT measurements and the 22 shot point locations used in the WVSP surveys conducted in April 2008 and May 2008 are shown in Figure 11.2.