Physical modeling of anisotropic domains: Ultrasonic imaging of laser-etched fractures in glass

Robert R. Stewart[1], Nikolay Dyaur[1], Bode Omoboya[1], J. J. S. de Figueiredo[2], Mark Willis[3] and Samik Sil[4]

Physical modeling, using ultrasonic sources and receivers over scaled exploration structures, plays a useful role in wave propagation and elastic property investigations. This paper explores the anisotropic response of novel fractured glass blocks created with a laser-etching technique (Figure 1). We compare transmitted and reflected signals for P- and S- waves from fractured and unfractured zones in a suite of ultrasonic experiments. The unaltered glass velocities are 5801 m/s and 3448 m/s for P and S waves, respectively, with fractured zones showing a small decrease (about 1%). We estimate high Qp values of about 1000 for the glass. Signals propagating through the fractured zone have decreased amplitudes and increased coda signatures. Reflection surveys (zero-offset and variable polarization and offset gathers) record significant scatter or diffractions from the fractured zones. There are hints of frequency dependence on fracture density. The coda signature may also be an indicator of the fracture orientation and density. The glass specimens with laser-etched fractures display a rich anisotropic response.

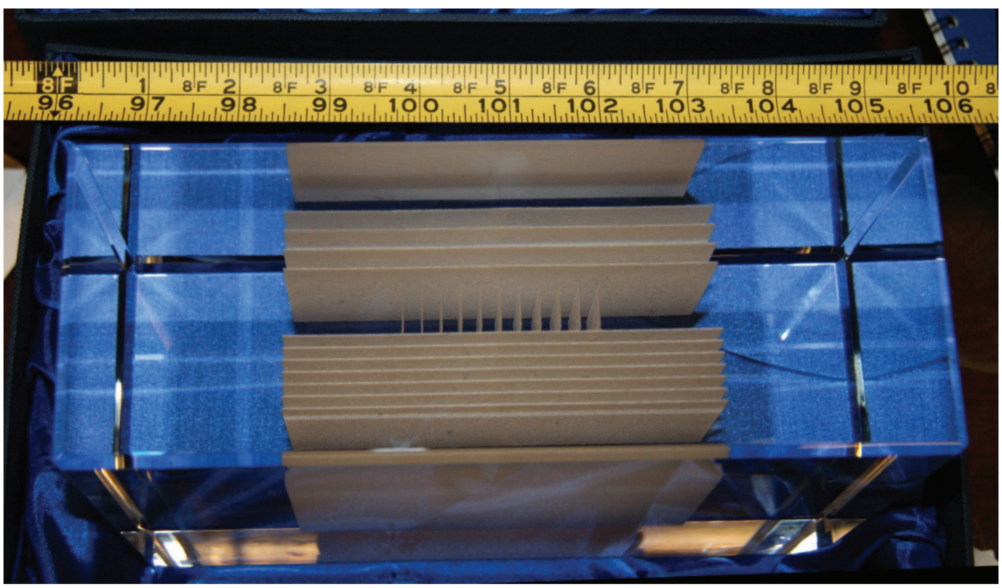

FIG. 1. Photograph of a laser-etched glass block created to simulate the fractured Bakken shale.

[1] University of Houston
[2] Unicamp-Brazil and University of Houston
[3] Formerly ConocoPhillips, Houston now Halliburton
[4] ConocoPhillips, Houston