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Title A SWEPT-FREQUENCY BOREHOLE SOURCE FOR CROSS-BOREHOLE AND INVERSE VSP IMAGING

ABSTRACT

A swept-frequency borehole seismic source which has the strength and radiation pattern to suit it for either inverse VSP or cross-borehole imaging has been constructed and tested. The source concept consists of isolating a portion of the borehole fluid column from the remainder of the well and driving the isolated section to build up pressure oscillations by resonance. The length of the isolated portion is changed to vary the resonant frequency. The source radiates an approximately isotropic P-wave whose total energy is comparable in magnitude to that created by a surface vibrator truck. Strong shear waves are also generated.

The source has been tested over a frequency range of 30 to 120 Hz, but the design can be operated from 15 to 150 Hz. Because the driven section of the borehole is isolated, strong tube waves are not generated. No damage to the casing-cement bond has been observed after prolonged operation of the source at a fixed depth, yet a single sweep of the source from 30-120 Hz has produced a robust wavefield with good signal-to-noise properties at a cross-well distance of 4000 feet.