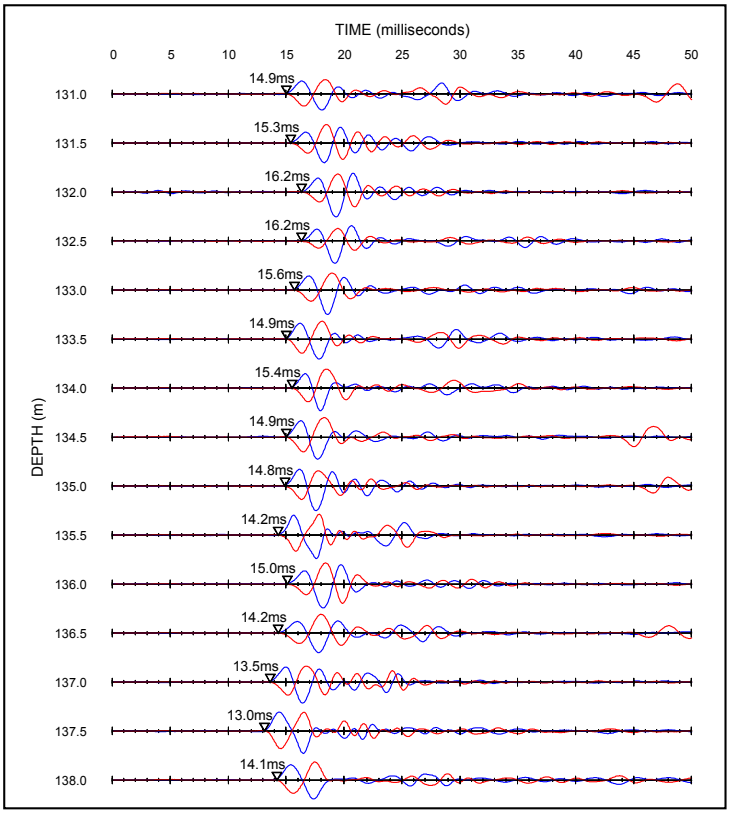
Borehole seismic surveys are carried out to measure compressional (P) and shear (S) wave velocities of soils or rock surrounding a borehole or between boreholes. The method is carried out either downhole or crosshole depending on the location of the geophone sensors and seismic source. Borehole P and S wave velocity results can be used to determine elastic moduli of soil and rock for earthquake assessment of site response and liquefaction potential, evaluate foundation conditions for machine vibratory loads, determine material damping characteristics, define geological boundaries, locate voids or anomalies in geological layering using tomography mapping, analyse embankment stability, and assist in determination of design parameters for structures.

Downhole seismic surveying can be carried out during the drilling program before piezometer installation in either open or cased holes, or at the conclusion of drilling operations. In practice, a triaxial geophone receiver package is lowered down the drillhole to the initial survey depth and locked against the drillhole wall. For deep exploration wells, a high pressure receiver package can be used to depths in excess of 1000 metres.

At the ground surface, a vertical mechanical source such as a sledge hammer, seismic shotgun, or weight drop is used to generate a compressional wave. This vertically incident compressional wave arrival is recorded by the vertical geophone in the receiver package and stored digitally in the seismograph. For downhole shear wave measurements, a wooden or metal beam is held fixed to the ground surface and impacted on each end to produce shear waves of opposite polarity. These horizontally incident shear wave arrivals are recorded by two horizontal geophones in the receiver package. Once the compressional and shear wave data have been recorded at a depth point, the receiver package is moved to the next depth position and the procedure repeated.



Crosshole seismic surveying measures the seismic velocities of materials between two drillholes. The vertical drillholes are typically placed 3 to 10 metres apart. In order for accurate velocities to be determined, drillhole deviation studies are typically carried out using an inclinometer. The receiver package is the same as that employed in downhole seismic surveying although two packages are often employed in instances where three drill holes are available.

Frontier Geosciences has developed a unique crosshole seismic source that can be deployed in small diameter drillhole lining, such as a Slope Indicator casing with an ID of 2.32" (59 mm). This allows surveys to be carried out in existing drillholes that have been installed for soil or rock movement monitoring. The source is reversible, allowing uphole and downhole shear waves to be generated.

Crosshole field procedure consists of lowering the geophone packages and source to the initial survey depth. The source is locked against the casing wall, and a down-going impact is initiated. The incident shear wave is recorded on the vertical geophone of the receiver packages, and is digitally stored in the seismograph. The up-going impact is similarly recorded and stored. The source is then disengaged and lowered with the receiver packages to the next recording position where the procedure is repeated.

Seismic wave arrivals are plotted on depth sections with the reversed shear wave traces plotted on the same datum to facilitate arrival time picking and phase correlation of events. Velocities are calculated and similar values grouped into layers based on distinct compressional and shear wave velocities.