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Shear-wave seismic reflection processing - the importance of velocity analysis

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Based on our experience, one of the most important steps in processing shear-wave seismic reflection data is the velocity analysis. In unconsolidated materials a very fine velocity analysis is more essential for S-waves than for P-waves because shear-wave velocities vary over several orders of magnitude and can change very quickly laterally and with depth. Velocities between 100m/s in glaciolacustine/marine deposits (clay-sized silts) and 1200m/s in stiff diamicton (till) were encountered in recent surveys. Shear-wave velocities have the large advantage of not being changed by the phase of the pore content such as the groundwater table.

We present two fundamentally different methods for velocity determination: 1) velocity semblance analysis based on hyperbolic reflection move-out on common midpoint (cmp) gathers and 2) Local Phase – Local Shift (LPLS) method which automatically estimates the reflection slope (local static shift) in the time-frequency domain of cmp gathers. Published in 2020, the latter method can be used for automated processing and substantially saves processing time.

Processing steps in preparation for velocity analysis (independent of the chosen method) include frequency filtering, trace equalizing and muting. We show velocity semblance images from different geological settings (glacial, postglacial) and from different shear components and discuss differences. Information gained besides shear velocities include mapped reflectors and located diffractions. Using those examples, we demonstrate how combining all information using visualisation techniques enhances interpretation of such data sets.