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Reflection processing of crosshole GPR data

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Crosshole ground-penetrating radar (GPR) surveys are frequently used for obtaining a detailed understanding of the subsurface as it is required in many hydrological and engineering applications. Such surveys are typically evaluated based on various tomographic approaches resulting in smoothed models of the governing subsurface physical parameters. On the contrary, reflection-based imaging methods provide information on subsurface structures by interpreting distinct reflection events originating from subsurface interfaces. Therefore, both methods provide complementary information for subsurface characterization. However, the additional information originating from reflected events is rarely used to improve the interpretation of crosshole GPR data sets.

We present a processing approach for crosshole GPR data that provides a subsurface image of the reflected energy between two boreholes. Our approach is largely based on concepts known from crosshole seismic imaging at the reservoir scale. Our major processing steps include the application of fk-based wavefield separation of up- and down going events and the application of a generalized form of the Kirchhoff integral to migrate the reflected energy back to its origin. We evaluate our processing approach using synthetic examples of varying complexity and demonstrate its applicability to a field data example recorded at a well known geophysical testing site. Furthermore, we compare our reflection processing result with the results of a travel-time tomography.