Coherence-based GPR diffraction imaging and inversion

Alexander Bauer¹, Benjamin Schwarz², and Dirk Gajewski¹

¹Institute of Geophysics, University of Hamburg, Hamburg, Germany (alex.bauer@uni-hamburg.de)
²GFZ German Research Centre for Geosciences, Potsdam, Germany (bschwarz@gfz-potsdam.de)

In both seismic and electromagnetic imaging the diffracted wavefield has gained importance in recent years. While seismic data is often acquired for a large range of different source-receiver offsets, ground-penetrating radar (GPR) acquisitions are mostly (near-) zero-offset. This characteristic inhibits the use of reflected waves for the estimation of depth velocities, which in turn increases the importance of a reliable imaging and characterization of the diffracted wavefield. In this study, we adapt a coherence-based workflow originally designed for seismic wavefields to ground-penetrating radar (GPR) data, which often exhibit similar wave propagation phenomena. The first step of the proposed workflow is the coherence-based imaging of the often predominant reflected wavefield, which in the second step is adaptively subtracted from the original data, resulting in an approximation of the diffracted wavefield. In the third step, we characterize the previously revealed diffracted wavefield by means of wavefront attributes, namely slopes and curvatures. In the fourth and final step, these wavefront attributes can be used for the estimation of depth velocities by means of wavefront tomography, an inversion scheme that provides both the localization of scatterers and a smooth velocity model of the subsurface. We demonstrate the wide applicability of the suggested workflow on two GPR field data examples provided by the USGS – one recorded in the aftermath of Hurricane Sandy on the shores of Long Beach Island, New Jersey, the other capturing the internal structure of Wolverine Glacier, Alaska.