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Full-waveform modelling and inversion of wide-aperture seismic data from the Polish Basin

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The GRUNDY 2003 experiment, situated in central Poland, was targeted at recognition of the pre-Zechstein strata within the Polish Basin, as well as filling the gap in existing industrial seismic profiles. The Zechstein in the Polish Basin is a serious obstacle for seismic signals, thus for a successful investigations relatively low-frequencies and wide-apertures were used. In the 50 by 10 km rectangular area ca. 800 RefTek 125 ‘‘Texan” stations with 4.5 Hz geophones were deployed, forming high-density central line (receiver spacing 100 m, 50 km long, referred as G01 line) and additional 4 parallel profiles. 37 shot points were fired with the mean charge of 50 kg of chemical explosive. The previous interpretation flow of this dataset was based on the first-arrivals (3D traveltime tomography) and NVI reflections (CDP stacking) only. In order to utilize also the secondary arrivals, including the WA reflections, we choose the frequency domain full-waveform inversion (FWI) method to obtain both the structural image and detailed velocity model. The wide-aperture content of our data leads to a redundant wavenumber coverage which can be partially removed without loss of information by limiting the inversion to few frequencies only. The inversion proceeded by stepping from 4 Hz to 13 Hz frequency and used the model inferred for one component as the starting one for the next frequency. Despite the low-fold character of our data, the final FWI results are of a good quality, even in the shallower parts. The high-pass filtered version of the results is comparable to the one obtained by the prestack Kirchoff depth migration, however, the migrated image suffers more from the low-fold character of our data down to ca. 3 km depth than the FWI model. The validity of the FWI velocity model was also confirmed by the comparison with the well velocity survey. When comparing the FWI with the forward ray-tracing modelling, which is a typical tool for interpreting crustal-scale data, we may note that although

the FWI method is computationally expensive, the efforts to produce the structural and velocity model are much less than using the trial-and-error modelling.