EGU21-15350
https://doi.org/10.5194/egusphere-egu21-15350
EGU General Assembly 2021

Simulation of a seismic survey with combined surface and in-mine data acquisition for imaging steeply dipping ore veins

Olaf Hellwig and Stefan Buske
TU Bergakademie Freiberg, Institut f. Geophysik u. Geoinformatik, Freiberg, Germany (olaf.hellwig@geophysik.tu-freiberg.de)

The polymetallic, hydrothermal deposit of the Freiberg mining district in the southeastern part of Germany is characterised by ore veins that are framed by Proterozoic orthogneiss. The ore veins consist mainly of quarz, sulfides, carbonates, barite and flourite, which are associated with silver, lead and tin. Today the Freiberg University of Mining and Technology is operating the shafts Reiche Zeche and Alte Elisabeth for research and teaching purposes with altogether 14 km of accessible underground galleries. The mine together with the most prominent geological structures of the central mining district are included in a 3D digital model, which is used in this study to study seismic acquisition geometries that can help to image the shallow as well as the deeper parts of the ore-bearing veins. These veins with dip angles between 40° and 85° are represented by triangulated surfaces in the digital geological model. In order to import these surfaces into our seismic finite-difference simulation code, they have to be converted into bodies with a certain thickness and specific elastic properties in a first step. In a second step, these bodies with their properties have to be discretized on a hexahedral finite-difference grid with dimensions of 1000 m by 1000 m in the horizontal direction and 500 m in the vertical direction. Sources and receiver lines are placed on the surface along roads near the mine. A Ricker wavelet with a central frequency of 50 Hz is used as the source signature at all excitation points. Beside the surface receivers, additional receivers are situated in accessible galleries of the mine at three different depth levels of 100 m, 150 m and 220 m below the surface. Since previous mining activities followed primarily the ore veins, there are only few pilot-headings that cut through longer gneiss sections. Only these positions surrounded by gneiss are suitable for imaging the ore veins. Based on this geometry, a synthetic seismic data set is generated with our explicit finite-difference time-stepping scheme, which solves the acoustic wave equation with second order accurate finite-difference operators in space and time. The scheme is parallelised using a decomposition of the spatial finite-difference grid into subdomains and Message Passing Interface for the exchange of the wavefields between neighbouring subdomains. The resulting synthetic seismic shot gathers are used as input for Kirchhoff prestack depth migration as well as Fresnel volume migration in order to image the ore veins. Only a top mute to remove the direct waves and a time-dependent gain to correct the amplitude decay due to the geometrical spreading are applied to the data before the migration. The combination of surface and in-mine acquisition helps to improve the image of the deeper parts of the dipping ore veins. Considering the limitations for placing receivers in the mine, Fresnel volume migration as a focusing version of Kirchhoff prestack depth

migration helps to avoid migration artefacts caused by this sparse and limited acquisition geometry.