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Travel-Time Tomography and Synthetic Study of reflection and refraction seismic Data from Mt. Erzberg, Styria, Austria

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The detection, and mapping, of subsurface cavities is an important task, primarily because the potential collapse of a cavity poses a hazard to infrastructure and residents. Cavities can be created naturally through chemical erosion or man-made, including tunnels from abandoned mining, old basement structures from demolished buildings, tunnels created for illegal activities, and cavities produced through a nuclear weapon test.
Whether filled with air, or water, the material contrast of a cavity to the surrounding rock, or soil, is typically strong enough to provide a significant signal in many geophysical measurements. The challenge lies in the size-to-depth-ratio of most cavities, which is at, or below, the resolution capacity of most geophysical methods.

In this study we show the results of a travel-time tomography from reflection and refraction seismic data collected in an open pit mine at Mt. Erzberg, where maps indicate a roughly 4 m wide and 25 m deep tunnel from abandoned subsurface mining. The obtained P-wave velocity model shows lateral and horizontal heterogeneities caused by the different lithologies of dry, less-fractured bedrocks, ore bodies or carbonates, but no cavity since the resolution of the tomography is limited to approximately 23 m depth. However, the obtained velocity model serves as a sophisticated starting model for a synthetic study, where seismograms are calculated with a visco-elastic FD-algorithm that also accounts for topography (Robertsson et al., 1996).
The implementation of a synthetic cavity into the starting model allows a basic comparison of seismograms with and without the presence of a subsurface cavity and therefore an analysis of characteristics that are produced and can be expected by a cavity within the seismograms. This analysis helps to understand what phases and sensitivities are present in the real data and generally, if the cavity was detected by our seismic survey.
This fundamental evaluation of our data is decisive for the planned full-waveform inversion in order to obtain a high-resolved velocity model showing the subsurface cavity.