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Characterization of a solid waste landfill through geophysical data fusion

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A detailed characterization of the landfill geometry, the waste volume and composition, and the water saturation within and outside the landfill body is critical for an adequate environmental management. To overcome the limited spatial resolution of direct investigations into landfills, geophysical methods have proven to resolve subsurface properties with high spatial resolution in a non-invasive and cost-efficient manner. The joint inversion of different geophysical datasets became increasingly popular in various fields of application since it solves quantitatively for the parameters of interest. Built upon a recently developed framework considering Archie's law and a time-averaging equation for the seismic slowness, we present here the petrophysical joint inversion (PJI) of electrical and seismic data collected along three profiles at the "Heferlbach" landfill located close to Vienna (Austria). We use the PJI framework to simultaneously invert apparent electrical resistivities and seismic traveltimes to solve for quantitative estimates for porosity, water saturation and air content. Our results show that the shallow geometry of the landfill with an average thickness of 3.5 m is clearly resolved by subsurface areas characterized by an air content of approximately 40 %. Based on the resolved saturation, we were able to identify the known aquifer underneath the landfill (average saturation of 25 %) that is lying on top of an aquiclude formed by tertiary sands. Within the landfill body, the saturation is approximately 10 to 15 %, which is in agreement with available data from the site. The resolved porosity model shows significant lateral variations (between 40 and 60 %) at shallow depths (< 3 m) suggesting a varying degree of compaction of the waste and different types of waste. Our results demonstrate the potential of the proposed PJI to enhance geophysical investigations of landfills by providing plausible quantitative estimates for parameters of interest with an adequate spatial resolution.