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Reflection seismic imaging of buried shallow salt structures – examples from ongoing case studies in Northern Germany

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In the North German Basin salt tectonics generated a wide range of evaporite structures since the Upper Triassic, resulting in e.g. extended salt walls, salt diapirs, and salt pillows in the depth range up to 8 km. Due to their trap and seal properties these structures were in the focus of hydrocarbon exploration over many decades, leading to an excellent mapping of their geometries below 300 m in depth. During salt rise Rotliegend formations were partly involved as a constituent. Some structures penetrated the salt table, some also the former surface. Dissolution (subrosion) and erosion of the salt cap rock by meteoric water took place, combined with several glacial and intraglacial overprints. Finally the salt structures were covered by pleistocene and holocene sediments. This situation partly resulted in proneness for ongoing karstification of the salt cap rock, leading to e.g. local subsidence and sinkhole occurrence at the surface. The geometry, structure and internal lithology of these shallow salt cap rocks are widely unknown. Expanding urban and industrial development, water resources management and increasing climate change effects enhance the demands for shallow mapping and characterization of these structures regarding save building grounds and sustainable water resources.

Results of shallow drilling investigations of the salt cap rock and the overburden show unexpectedly heterogenous subsurface conditions, yielding to limited success towards mapping and characterization. Thus, shallow high-resolution geophysical methods are in demand to close the gaps with preferred focus of applicability in urban and industrial environments. Method evaluations starting in 2010 geared towards shallow high-resolution reflection seismic to meet the requirements of both depth penetration and structure resolution. Since 2017 a combination of S-wave and P-wave seismic methods including depth calibrations by Vertical Seismic Profiling (VSP) enabled 2.5D subsurface imaging starting few meters below the surface up to several hundred meters depth in 0.5-5 m resolution range, respectively. The resulting profiles image strong variations along the boundaries and on top of the salt cap rock. Beside improved mapping capabilities, aim of research is the development of characteristic data features to differentiate save and non-save areas.