

Mapping and modelling of collapse sinkholes in soluble rock: the Münsterdorf site, northern Germany

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Münsterdorf is a small village in the north of Hamburg, located along the northern rim of a salt diapir. The Permian rocks are uplifted and overlying rocks such as the cretaceous limestone, normally in several kilometres depth, have been pushed up close to the surface. In Münsterdorf, the cretaceous limestone can be found in around 20 m depth, and about 2 km further south, cretaceous limestones are quarried in a large open-pit mine.

Since 2004, collapse sinkholes form on a sporting ground in Münsterdorf, with a frequency of about 1 per year, about 2-3 m in diameter and 3-5 m deep. The collapse sinkholes do not reach the underlying limestone, but seem to be related to accelerated dissolution in that formation. Above the cretaceous limestone, quaternary gravels and glacial marls provide a non-soluble, but permeable and heterogeneous cover of about 20 m thickness.

We have mapped the sporting ground and its vicinity with gravity (GRAV), electrical resistivity imaging (ERI), self-potential measurements (SP), and ground-penetrating radar (GPR). While GRAV and SP is fairly unspectacular, the ERI profiles indicate a significant change in the surface layer, from thin and irregular in the northern part to thicker and more homogeneous in the southern part of the sporting ground. GPR profiles confirm this result.

With numerically modelling the evolution of flow and porosity in the cretaceous limestone, we discuss the potential cause of the sinkhole formation and its sudden onset.