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Long term monitoring of karst processes using SIP

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Sinkholes are depression or collapse structures caused by dissolution in the subsurface or subrosion processes and occur in a vast variety of geological settings. Due to their generally abrupt onset they pose a considerable threat to people's safety and can cause severe economic loss, especially in highly populated areas. Commonly, sinkholes are linked to the heterogeneities in the soluble sediment and to anomalies in groundwater flow.
A better understanding of sinkhole genesis is essential to develop an early warning system for sinkhole formation and thereby reduce their risk. With this intent the joint project SIMULTAN studies sinkholes and their side effects in order to develop sensors and multi-scale monitoring methods.
We study the solution process of gypsum and limestone as well as the accompanying processes and their relation to hydrologic and geohydraulic constraints from a petrophysical point of view within the framework of SIMULTAN. The focus lies on measurements of the complex, frequency dependent electrical conductivity of rocks in karst areas. These measurements are conducted in the laboratory as well as in the rural municipality Münsterdorf in northern Germany. Münsterdorf has recurrent sinkhole events within a restricted area. Linking laboratory and field measurements we constructed a measuring cell where we can simulate karst processes and monitor accompanying effects on petrophysical parameters.
The systematic laboratory measurements of the complex electrical conductivity were conducted on samples of loose sediments fully saturated with pore fluid of different ionic composition (e.g. calcium carbonate, calcium sulfate and/or sodium chloride). The results indicate that it is possible to estimate effects of higher gypsum or lime content in the ground water or pore water respectively using complex electrical conductivity. This includes both the karstificable sediments as well as the adjacent, non-soluble sediments.
In Münsterdorf monitoring of karstification and subrosion processes on a field scale is carried out with a stationary measuring system. This consists of a measuring array in two 25 m deep boreholes located 5 meters apart. The results of these measurements, particularity the phase shift, indicate that solution processes in the contact area of the subterranean chalk and Quaternary loose sediments are taking place and can be detected.