

## Examples of the Development of Sinkholes above Flooding or Flooded Salt Mines in Central Germany and Ways of Remote Detection of Areas with a Potential Risk of Fall

In contrast to the karst formations that have been formed by natural subsidence on chloridic and sulfate salts for long geological periods the term Sinkhole is connected to the presence of mine openings. In view of the salt mining industry the formation of a sinkhole represents the most extreme form of damages due to mining.

In the stage of the formation a sinkhole is characterized on the surface by sharp breaking edges. The depth of these forms of breaking can reach down to more than 100 m. It is clear, that the sudden breaking of the roof up to the surface represents a considerable risk of danger for people, buildings and infrastructure and that solutions were sought to predict such processes spatially and temporally.

In the salt hill, the formation of sinkholes is at first connected to subsidence processes in the salt rock. Reasons for subsidence processes in a large scale are especially the following::

- inflows of solution from open systems, i. e. with connection to weeping rocks, that are kept short for long periods by pumping up the brine, as a result of which finally considerable amounts of dissolved salt are transported away and referred to the present structure of the mine workings for a long time, large additional openings arise in the saliferous layers.
- strong, generally escalating inflows, more or less referred to a local area, that cause the flooding of the mine openings. According to present observations, volumes of more than 750,000 m<sup>3</sup> represent a more critical factor here.

The conditions for the formation of sinkholes can be described as follows:

- *Formation of an opening filled with air or brine with mainly vertical extent*  
The formation of such an opening is supported by the existence of upturning geological structures, as they appear, for example, by the Staßfurt Saddle or in the area of salt domes. Furthermore, the vertical alignment of mine openings that connect the individual bank levels is important. In case of the considered examples, the volume of these opening structures, causing the formation of sinkholes, have been estimated to be between 15.000 and 900.000 m<sup>3</sup> s. .
- *Shallow depth of the extractions*  
In addition, the depth of the extraction, that has an effect on the development of the opening structures, is important for the formation of a sinkhole. It can be shown, that the risk for forming a break that reaches up to the surface will be higher for decreasing depths of the extractions, that in certain respects, naturally depends also on the more probable appearance of brine inflow.