Sinkhole Formation Over Flooded Potash Mines - Case Studies
From the Motherland of the Potash Industry

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During the 140 year history of potash mining several events of dramatic loss of mines by sudden water or brine inflow, some initiated and/or followed by rock bursts, unusually high subsidence at the surface and/or sinkhole formation, have occurred. Sinkholes also occur over mine fields that were systematically flooded after the end of mine production in the East German sites during the sixties and seventies. Both these genetically different collapse structures presently influence the land use and/or the safety at the surface. For example, in the city of Stassfurt, where the cradle of the potash industry was, total subsidence amounts to more than 6 m during the last 100 years. Recent subsidence rates are still up to 17 mm per year over an area of approx. 20 km². This has severely influenced infrastructure and modern city development.

In general, the causes of sinkhole formation have been due to the previous lack of theoretical knowledge and practical experience in the mechanical as well as solution kinetics behaviour of potash and salt rocks during the first decades of underground extraction.

However, sinkhole formation is not a rock mechanical or dissolution problem alone. Investigation of all events indicates that a hierarchic system of primary causes and secondary interaction processes exists. The primary dissolution process inside the mine horizon is dependent on the chemistry of the solution and its interaction with the extracted rocks, the inflow rate and the mine layout, including the geometry of the pillars. The increase of the brine filled mine volume by continuous dissolution of the pillars up to the saturation equilibrium leads to a destabilisation of the overburden. Whether this destabilization process leads to sinkhole formation depends mainly on the depth of the brine filled mine and the structure of the overburden strata.

These processes have been investigated by back analysis and will be explained by several case studies. With our knowledge today we are now able to recognize previous mistakes in the extraction technology of the former miners (mine layout, extraction rate, geometry of pillars) and can now much better assess information about the geological situation (lithology and thickness of aquiclude, tectonics, hydrogeology) and its importance to sinkhole formation.

The main result of this back analysis has been to prioritize the order of different influence parameters. This is a helpful tool to prevent brine inflows in potash and salt mines under production and to carry out safe flooding strategies for abandoned mines.

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