Tectonics in salt deposits – a challenge in exploration and mining

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The influence of tectonic structures on salt deposits in terms of exploration and mining shall be introduced using the example of a potash deposit in Central Germany which is affected by Miocene volcanism.

This potash deposit has a Permian (Zechstein) age. The deposit is part of the Central European Basin and dominated by several syn- and anticlines. The Zechstein formations are overlain by up to 1.000 m of Triassic sandstone and partially by limestone. Therefore the bedrock is tripartite into an under- and overlying competent part and incompetent salt in between. Correspondingly to this fact the rock mass reacts differently under tectonic stress (Hessmann & Schwandt, 1981). The focus in this paper lies on the salt formation that is characterized by halokinetic and halotectonic movements caused by overburden load (pressure) and tectonic impulses. There have been several tectonic phases during the Mesozoic and Cenozoic with different influence on the deposit.

Carnallite deformation is common in potash seams showing thickening, thinning and fold structures because of different properties of carnallite, sylvite and halite. Water-containing minerals, as for example carnallite, are the most mobile. Halite shows lower viscoplasticity, while anhydrite reacts as nearly solid rock (Schwandt, 2005). Internal dissolution and recrystallization processes dominate metamorphosis which is leading to various facies associations within the potash seams. The majority of brines occurring in the deposit are the result of solution metamorphism, or in rare cases, they are connate water (Herbert *et al.* 2007). Connate water can derive from the cap rock or the basement.

The youngest tectonic influence on the deposit is caused by Miocene basalts which lead to extensive mineral reactions within the potash seams (Fig. 1). The intrusion of basaltic dykes in the Zechstein evaporates yielded to rigid behaviour of the salt and created subparallel trending joints with varying thicknesses from < 1 mm to > 30 mm. They can either be mineralized by halite, sylvite or carnallite or occur as basalt dyke (Jahne *et al.* 1983, Hessmann & Schwandt 1981). Because of a fast cooling illustrated by an up to mm-thick glass coat the boundary between rock salt and basalt is very sharp. So in most cases there are no interactions between halite and basalt. Preliminary geochemical investigations of the basalts show that most volcanic rocks are foidites.

Near the basalts so called "crystal salt" is common. It is coarse grained halite indicating a recrystallization due to water supply. These zones of depletion are framed by sylvite and carnallite (Fig. 1). In rare cases small crevices remain in the salt and are preserved, e.g. an open dry cave of about 100 m³, described by Pippig (1992).

Mining under all those circumstances requires exploration programs to determine the composition of potash seams and to minimize the risk potential caused by basaltic dykes and big fault zones which are sometimes connected with formation fluids. For all those reasons a geological model has to be established and updated. Therefore several data have to be taken into account. Those include drillings from surface and underground, seismic and ground radar data as well as magnetic and gravimetric perceptions.

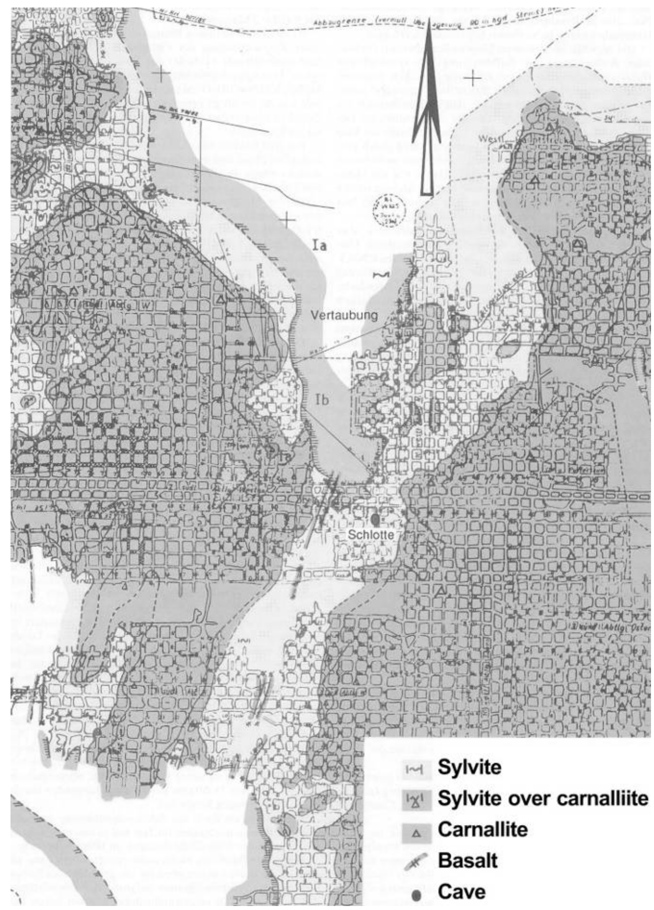

Fig. 1.: Lithofacies along basalt dyke, Pippig (1992)

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