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title: **Damming of water inflows in the western section of the "Wieliczka" Salt Mine as an example of one of the methods used for eliminating water hazards in salt mines**

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Water hazard as well as the methods of its control in salt mines must be considered in a different manner than in other areas of mining mineral resources.

This results from that fact that salt is easily dissolved in saline mineral waters. Even the proverbial drop of salt water can have a catastrophic impact for the mine's existence.

In the history of Polish salt mining there are known cases of water penetrating into a mine and its complete flooding. In 1907, two mines were completely flooded in Inowrocław, and in 1911 the shaft Wapno I in Wapno, in 1977 the salt mine in Wapno was also flooded (Lisiecki, 2007). These mines had exploited the Cechsztyn deposits on salt diapirs which are surrounded by rock formations strongly aquiferic and usually under full hydrostatic pressure.

The saline deposits existing in the pre-Carpathian depression belonging to the Miocene formation are less endangered by flooding than the Cechsztyn deposits in central Poland. This is due to their specific geological structure, the impermeable loam existing in the vicinity, and the relatively shallow deposition leading to the fact that the hydrostatic pressure of water inflowing to the mine is not as high (Tarczyński, Batko, 1961).

In spite of this, in the past, water penetrated into the mine and could have caused catastrophic consequences. In such a manner water forced its way through into the Wieliczka Salt Mine between the years 1868–1879, to the Kloski traverse at level V and the Colloredo traverse at level IV (Wójcik, 1992).

Miners have developed methods combating water hazards occurring in salt mines during the many centuries of their experience with floods.

The basic safety rule is not to allow water access into the mined excavations. Therefore, all drilling and mining works should be performed with greater care and in strict compliance with regulations for conducting works in water hazard conditions. Whereas the basic condition for the correct management of mining and drilling works is both the good knowledge of the geological structure of the deposit as well as its environment. In the past, however, mining works were not always conducted with full consideration of water hazards. Especially when it comes to corridor excavations where exploratory drilling works were not always conducted before executing drilling works and the used drilling equipment was not fitted with tools allowing efficient closing of drilled waters.

From among the many methods applied for liquidating water hazards the most efficient one is the method for damming inflows. However, to apply this method certain conditions have to be fulfilled:

- the orogen in the area of the inflow must be well examined,
- a small perforation of the orogen with mined excavations in the area of the inflow.

The flooding of the western border of the Wieliczka Salt Mine may serve as a good example to present, on the one hand, the mistakes in the art of mining which in effect lead to the penetration of water into the mine, and on the other hand, the existence of favourable geological and mining conditions for constructing water dams. In this part of the mine, the deposit was cut with several corridor excavations (Fig. 1). In August 1959, while working in the western section of the mine, at the end of level VI, during the process of executing a horizontal test bore 6-67 towards the north, the water bearing layer was drilled causing water to penetrate into the salt mine at a max. volume flow of 58 m^3/h.

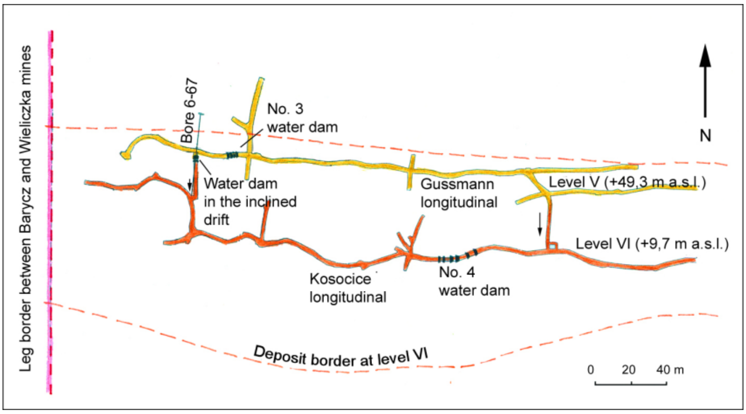

Figure 1. Location of water dams no. 3 and 4 in the western section of the Wieliczka Salt Mine.

The NaCl contents in the inflow was between 200–290 g/dm^3 (Sękiewicz, Markowski, 1963).

Protective works were immediately executed aimed at limiting the inflow, i.e. decreasing the water hazard in this section of the mine.

The outflow was closed off by means of water dams (Fig. 1):

- Loam and concrete dam (No. 4) built in the Kosocice longitudinal at level VI,
- Concrete dam built in the inclined drift between levels V and VI,
- Block-loam-concrete dam (no. 3) constructed in the Gussmann longitudinal at level V (Fig. 2).

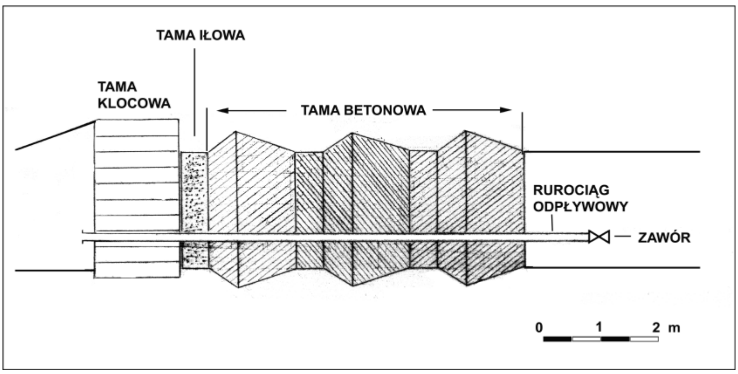

Figure 2. Structure section of the block-loam-concrete water dam in the Gussmann longitudinal (Level V).

Dam no. 3 was built due to the appearance of leaks in the dam located in the inclined drift and due to the insufficiency of the applied cementing processes.

Virtually, it was never possible to maintain the tightness of the dams for a longer period, and therefore, the dams have undergone cement tightening processes several times. A pipe system has been constructed at dam no. 3, level V, and dam no. 4, level VI, with fitted valves and manometers checking the pressures of the brine behind the dams (Sękiewicz, Markowski 1963). The pressure, until December 1961, at dam no. 3 was maintained between 0.20–0.25 MPa; at dam no. 4 between 0.63–0.85 MPa. Then, the pressure began to rise between reaching max. value 2.18 MPa (dam no. 3) and 2.65 MPa (dam no. 4), and then gradually began to drop coming at present to 0.42 MPa (dam no. 3) and 0.81 MPa (dam no. 4) (Water dam control book, 1965–2009).

The water dam complex at levels V and VI, in the western section of the mine, can be considered as efficiently closed off from inflows to the mine if not for the problem of the control pipeline system which is susceptible to corrosion. At present, the best solution seems to be the tight liquidation of the system connected with the liquidation of the Kosocice and Gussmann longitudinal sections, while the pressure behind the dams can be checked at the surface by means of a piezometric bore.

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