

# Acid mine process in Polish coal mines, the Niwka-Modrzejów coal mine example.

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## ABSTRACT

*Applicability of chemical data and hydrogen, oxygen and sulphur stable isotope analysis in water and sulphate ions for identification of acid mine process in the Niwka-Modrzejów Coal Mine are reported.*

## 1. INTRODUCTION

The acid mine process is one of the most significant environmental challenges and a major source of water pollution worldwide (Ahmed 1974; Frost 1979; Younger 1995; Wood at all 1999). It can be responsible for problems of ground and surface water pollution. Particularly acid mine processes constitute a notable problem at mines, either operational or abandoned. One of the most intensive examples of the acid mine process was discovered in the Niwka-Modrzejów Coal Mine of the Upper Silesian Coal Basin (USCB). In this paper the diagnosis of this problem is presented by means of investigations of the chemical data and the isotopic compositions of hydrogen ( $\delta^2\text{H}$ ), oxygen ( $\delta^{18}\text{O}$ ) in waters and of sulphur ( $\delta^{34}\text{S}$ ), oxygen ( $\delta^{18}\text{O}$ ) in sulphate ions is presented.

## 2. ANALYTICAL METHODS

The concentration of sulphates was determined in the Central Mining Institute in Katowice by a gravimetric method, the concentration of iron using ICP-AES method. The isotopic compositions of waters ( $\delta^2\text{H}$ ,  $\delta^{18}\text{O}$ ) were measured at the Academy of Mining and Metallurgy in Cracow, by standard methods described by Gat and Gonfiantini (1981). The samples of water were filtered and sulphate was precipitated as  $\text{BaSO}_4$  by  $\text{BaCl}_2$  solution acidified with  $\text{HCl}$ .  $\delta^{34}\text{S}$  and  $\delta^{18}\text{O}$  in sulphates were measured at M. Curie-Skłodowska University in Lublin by mass spectroscopy on  $\text{SO}_2$  and  $\text{CO}_2$  gases, respectively (Hałas, Szaran 1999; Mizutani 1971).



## 4. RESULTS

### 4.1 CHEMICAL COMPOSITION OF WATERS FROM THE ACID MINE PROCESS

The acid mine processes in the Niwka-Modrzejów Coal Mine have been recognised for about fifty years (Fig. 2). One of the drainage systems in the old mine workings is located at the level of 100-130 m. Waters from this level have pH values between 2,5 and 3,8 and temperature of about 20°C. Concentration of iron ions reaches up to 1350 mg/dm<sup>3</sup> and of sulphate ions up to 4440 mg/dm<sup>3</sup>. In the Niwka-Modrzejów Coal Mine, sulphates from the oxidation process of sulphide minerals (pyrite, marcasite) were dissolved into mining waters. The results can be represented by the following reactions:

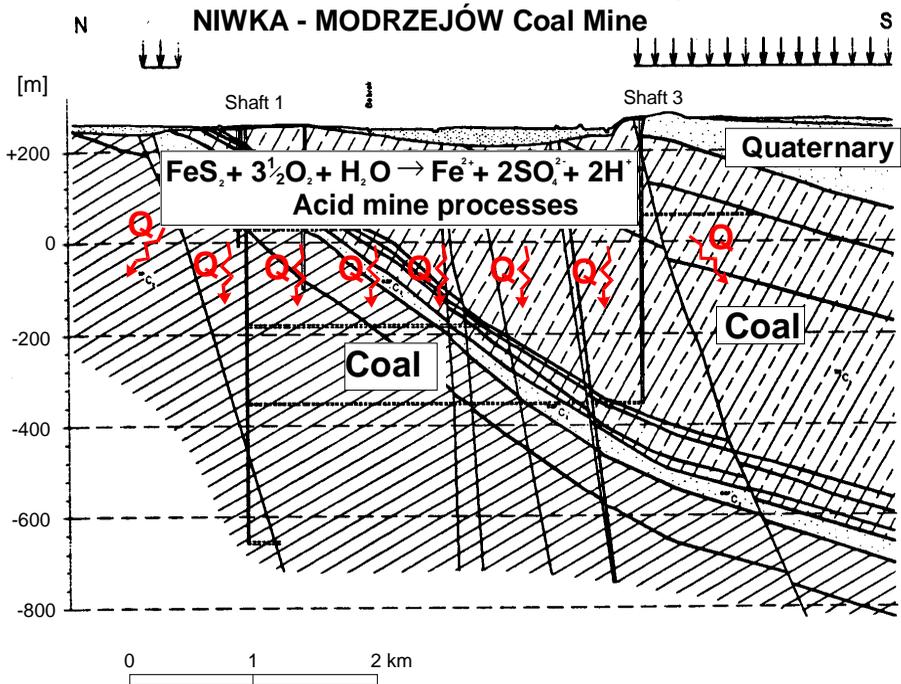
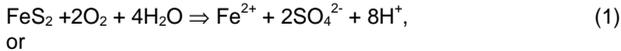


Fig. 2. Location of the acid mine processes in the Niwka-Modrzejów Coal Mine on the hydrogeological cross-section

Table 1. The chemical composition of waters from old mine workings at the 100-130 m level in the Niwka-Modrzejów Coal Mine

Data	pH	Fe <sup>3+</sup> + Fe <sup>2+</sup> mg/dm <sup>3</sup>	SO <sub>4</sub> <sup>2-</sup> mg/dm <sup>3</sup>
1979	2,8	360	3940
1980	3,1	620	4378
1981	3,0	393	4316
1982	3,4	385	3380
1985	2,9	250	3790
1986	2,5	288	2400
1987	2,6	495	2556
1988	2,6	720	4440
1990	2,5	1350	3890
2002	3,8	695	2660

#### 4. 2. ORIGIN OF WATERS AND SULPHATES

The mining waters at the level 130 m have the isotopic composition:  $\delta^2\text{H}=-66\%$  and  $\delta^{18}\text{O}=9,3\%$ . These data indicate that waters in the Niwka-Modrzejów Coal Mine originated from the infiltration in the last hydrogeological cycle (Zuber, Grabczak 1985, Pluta, Zuber 1995). The isotopic compositions of sulphur and oxygen in the sulphate ions was:  $\delta^{34}\text{S}=+6,17\%$  and  $\delta^{18}\text{O}=+4,04\%$ . These results show that the oxidation process of sulphide minerals: pyrite or marcasite took place in the old mine workings.  $\delta^{34}\text{S}$  in sulphates of pyrite or marcasite from the Carboniferous formations of the Upper Silesian Coal Basin is between  $+3,48\%$  and  $+9,12\%$  (Pluta 2002).

#### 5. PREVENTION OF THE ACID MINE PROCESSES

Prevention methods aim to eliminate the process of sulphide oxidation. The rocks containing the sulphide minerals must be separated from oxygen. The potential risk of acid mine drainage can be reduced by the storage of large quantities of wastes from energy plants in old mine workings (Pluta at all 2002).

#### 6. CONCLUSIONS

In mining waters at the level 100 -130m of the Niwka-Modrzejów Coal Mine pH, is between 2,5 and 3,8, temperature about 20°C, concentration of iron ions reaches up to 1350 mg/dm<sup>3</sup> and sulphates up to 4440 mg/dm<sup>3</sup>. The composition of sulphur and oxygen in the sulphate ions was:  $\delta^{34}\text{S}=+6,17\%$  and  $\delta^{18}\text{O}=+4,04\%$ . This oxidation process of sulphide minerals (pyrite or marcasite) can be reduced by the storage of wastes in the old mine workings.

Acid mine processes in polish coal mines of the Upper Silesian Coal Basin can be identified by chemical data and the isotopic compositions of sulphates ( $\delta^{34}\text{S}$ ,  $\delta^{18}\text{O}$ ).

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