Identification of mine waters in the southern Upper Silesian Coal Basin (Poland) by $\delta^{34}S$ and $\delta^{18}O$ in sulphates

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The Upper Silesian Coal Basin (USCB) is located in the southern part of Poland. The differences in origin of waters and geological conditions resulted in wide range of salinity and the chemical composition of mine waters (Rożkowski, 1995; Pluta, Zuber,1995). Studies of the mine waters in the southern part of the USCB show that the waters in twelve coal mines (Borynia, Jankowice, Jastrzębie, Krupiński, 1 Maja, Marcel, Morcinek, Moszczenica, Pniówek, Silesia, Zofiówka Żory)* are practically sulphate-free (Pluta, 1999). Waters flowing into other four mines (Anna, Chwałowice, Rydułtowy, Rymer) contain sulphates. Their concentrations reached ca. 5.0 g/dm^3. Such sulphates can be used to identification some mine waters in the twelve coal mines of the southern part of USCB.

Since 1983 the industrial wastes have been utilised in the mine workings of the USCB (Mazurkiewicz, Piotrowski, Tajduś, 1997), as the fire and methane protection agents. Wastes from energy plants and from coal mines contain sulphates. Studies of different wastes utilised in mine workings point toward the possibility of identification of sulphates by isotopic data. Table 1 and 2 show $\delta^{34}S$ and $\delta^{18}O$ from sulphates of different wastes produced in power plants of the southern part of the USCB (Łaziska, Rybnik, Bielsko-Biała, Czechowice-Dziedzice Power Plant). Generally these values resulted from different technologies of their production.

Table 1 $\delta^{34}S$ and $\delta^{18}O$ sulphates from fly-ashes of coal burning

Power Plant	$\delta^{34}S$ [‰]	$\delta^{18}O$ [‰]
Łaziska	+4.60	+22.82
Rybnik	+4.31	+27.67
Bielsko-Biała	+3.82	+27.94

* name and number of the coal mine before 1990

Table 2 $\delta^{34}S$ and $\delta^{18}O$ sulphates from desulphurization processes in Power Plant

Power Plant	$\delta^{34}S$ [‰]	$\delta^{18}O$ [‰]
Łaziska	+1.22	+15.38
Rybnik	+1.91	+12.99
Rybnik	-0.51	+15.60
Czechowice-Dziedzice	-2.71	+14.16

Sulphates from the fly-ashes of coal burning are enriched in heavy isotope ^{18}O coming from the atmospheric oxygen (Krouse 1980). $\delta^{18}O$ ranges from ca.+23‰ to ca.+28‰. Sulphates of wastes resulting from the desulphurization processes in power plants have oxygen isotopic data from ca.+13‰ to ca. +16‰. $\delta^{18}O$ values resulted from atmospheric oxygen (ca. +23‰), limestone (ca. +30‰) and water (ca. -10‰) which are used in these processes.

Sulphates from the flotation tailings of coal (the Jankowice and the Krupiński Coal Mine) have isotopic data of sulphates shown in Table 3. $\delta^{18}O$ values enriched in lightly isotope ^{16}O of water used in flotation processes (ca. -10‰). $\delta^{34}S$ values, like as in fly-ashes of coal burning, come from pyrite or markasite of the Carboniferous formation.

Table 3 $\delta^{34}S$ and $\delta^{18}O$ sulphates from flotation tailings

Coal Mine	$\delta^{34}S$ [‰]	$\delta^{18}O$ [‰]
Jankowice	+4.85	-3.15
Krupiński	+6.40	-2.32

Sulphates found in some mine waters in the Chwałowice and the Marcel Coal Mine have the sulphur and oxygen isotopes shown in Table 4. $\delta^{34}S$ and $\delta^{18}O$ values in sulphates of the waters from Miocene are similar to those found in gypsum and anhydrite of evaporates of this formation in Poland (Kasprzyk, 1997; Bukowski & Szaran, 1997). Sulphates in mine waters from Carboniferous formation have isotopic data enriched in heavy isotopes. $\delta^{34}S$ values are from ca. +25‰ to ca. 35‰ and $\delta^{18}O$ from ca. +14‰ to ca. 19‰ suggest bacterial reduction of sulphates (Thode, 1991).

Table 4 $\delta^{34}S$ and $\delta^{34}O$ sulphates from mine waters of the Chwałowice and Marcel Coal Mines

Coal Mine	$\delta^{34}S$ [‰]	$\delta^{18}O$ [‰]
Chwałowice	+20.25	+11.05
Chwałowice	+22.23	+11.10
Chwałowice	+31.96	+15.64
Chwałowice	+34.92	+17.36
Chwałowice	+35.30	+19.11
Marcel	+25.00	+14.04
Marcel	+29.27	+16.27

Sulphates found in some mine waters of the Borynia, Jankowice, Marcel and Morcinek Coal Mines have the sulphur and oxygen isotopes shown in Table 5. The isotope data $\delta^{34}S$ and $\delta^{18}O$ show that some of sulphates are typical for sulphide oxidation processes. The original material comes from sulphides (hydrogen sulphide and minerals: pyrite, markasite).

Isotope data of sulphates have been used in identification of mine waters (Figure 1). The investigations of $\delta^{34}S$ and $\delta^{18}O$ values in sulphates can be applied to assessments of water hazard in coal mine workings and to studies of the sources of sulphates in discharged coal mine waters.

Table 5 $\delta^{34}S$ and $\delta^{18}O$ sulphates from mine waters of the Borynia, Jankowice, Marcel, Morcinek CMs

Coal Mine	$\delta^{34}S$ [‰]	$\delta^{18}O$ [‰]
Borynia	- 5.24	+ 1.25
Borynia	- 5.84	+ 0.75
Borynia	+ 5.21	+ 6.14
Marcel	+ 4.26	+ 1.22
Marcel	+ 3,81	+ 1,37
Morcinek	- 4.67	+ 1.47

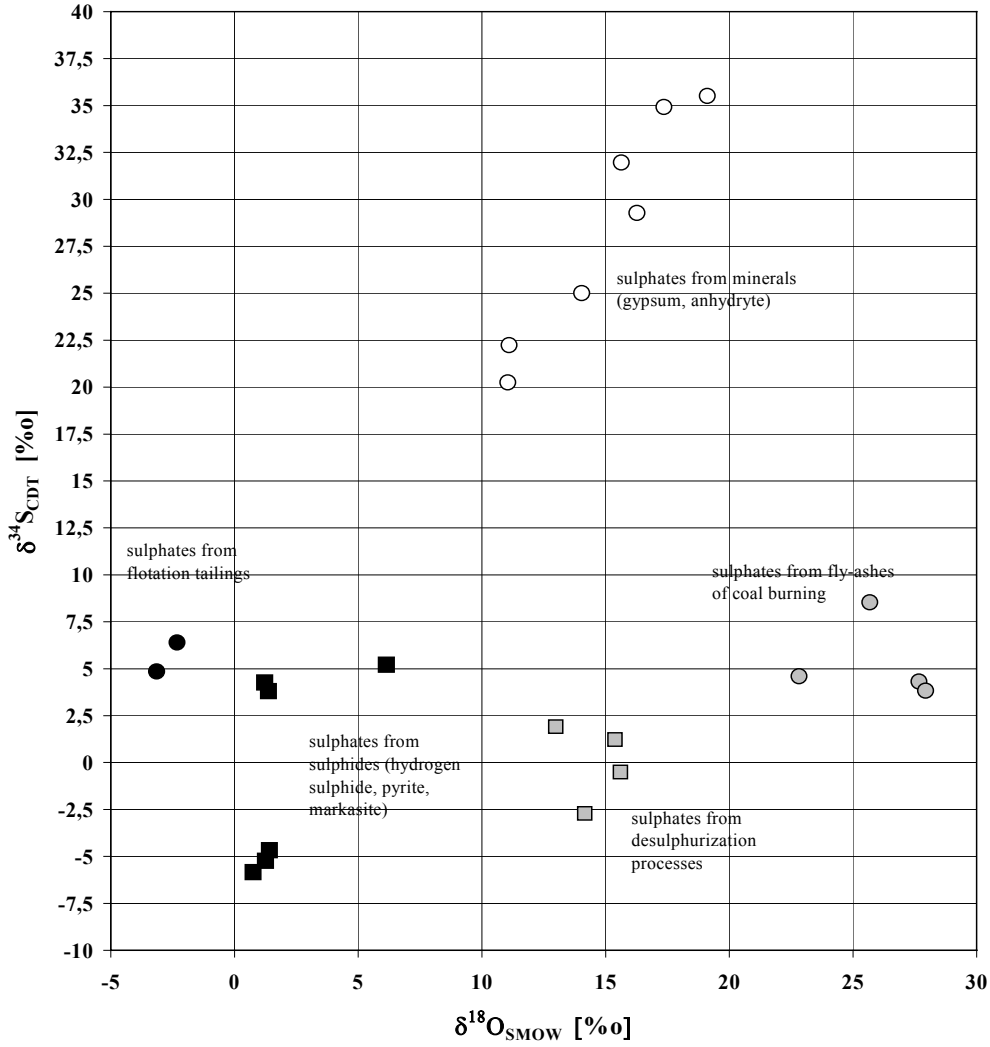

Figure 1 Plot of $\delta^{34}S$ versus $\delta^{18}O$ for sulphates from mine waters of the southern part of USCB

ACKNOWLEDGEMENTS

The author is grateful to Professor S. Hałas from UMCS in Lublin for fruitful discus
sions. Studies were financed from CSS in Project No. 2561/T.12-9/99

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