GŁÓWNY INSTYTUT GÓRNICTWA

MINE WATERS IN USCB, POLAND - POTENTIAL SOURCE OF RAW MATERIALS? OVERVIEW, CASE STUDIES AND EXAMPLES WITH RELEVANT DATA.

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Introduction

1. A brief history of coal mining in USCB, Poland – from the begining, industrial revolution to mine closure and restructuring actions.

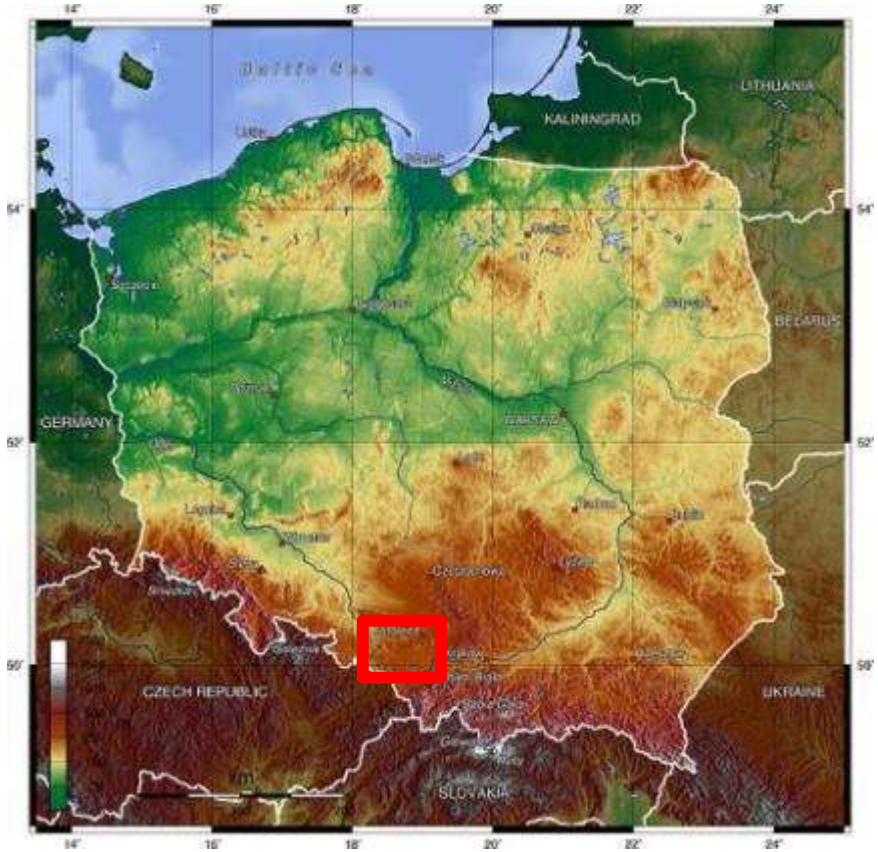
2. Dewatering mechanisms, environmental impact of mine waters from coal mining in Poland.

3. Quality and quantity of mine waters - overview of polish cases.

4. Abandoned coal mines – environmental liabilities, post mining related assets.

COAL MINING IN USCB - HISTORY IN BRIEF.

- Coal has been mined in Upper Silesia since 1540 (from the surface); first underground coal mine has started the exploitation around 1750 (coal mine Murcki in Katowice).
- By the end of 1980's Polish coal production was at an all-time high, reaching 180 Mt in 65 mining areas.
- Since 1989, 34 of the 65 hard coal mines have been abandoned; according Polish State Mining Authority 22 underground mines (26 minefields) are still working and coal production steadily decrease – now is reaching about 50 Mt (at the end of 2020).
- 94% national production of coal is concentrated in USCB.



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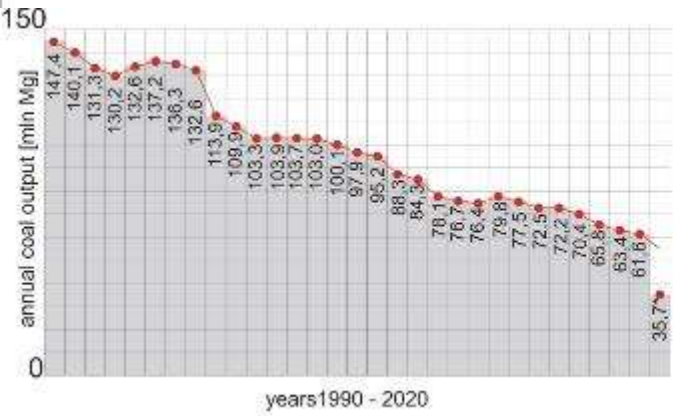
30 YEARS OF TRANSITION IN USCB.

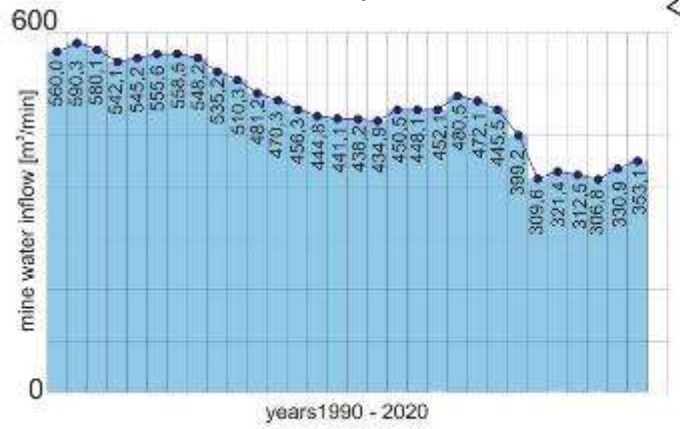


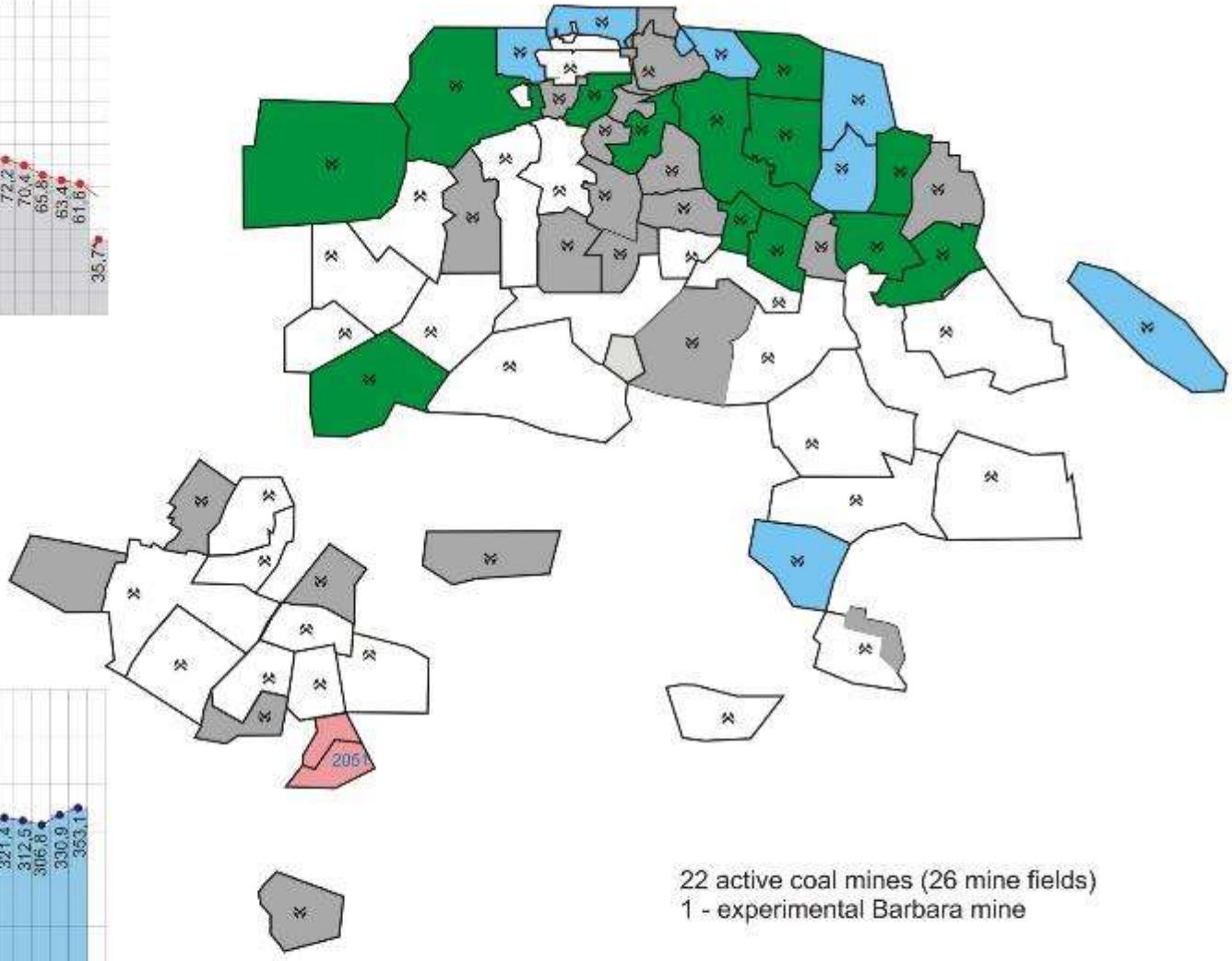
Mine closure

Dewatering of abandoned mine

Mine flooding

Planned exploitation

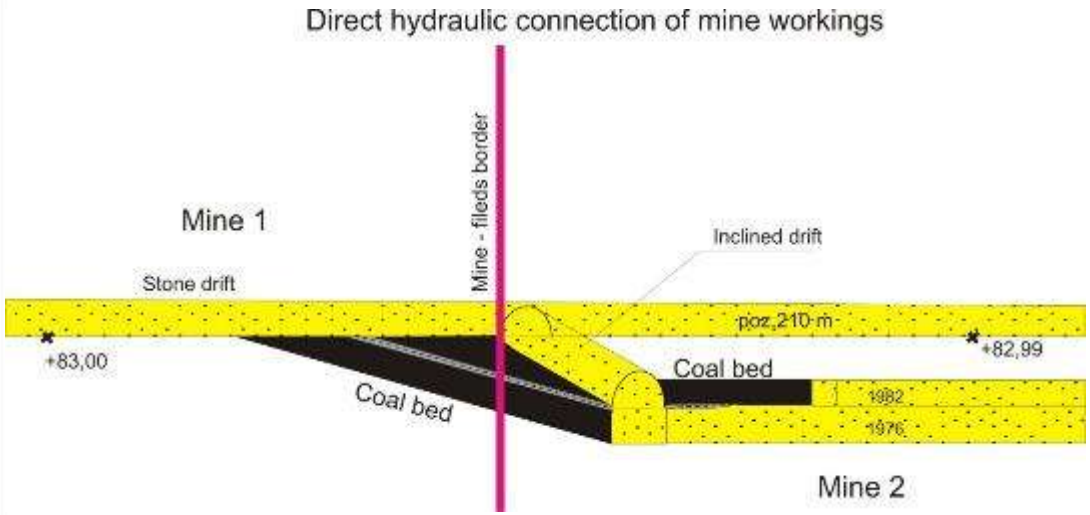


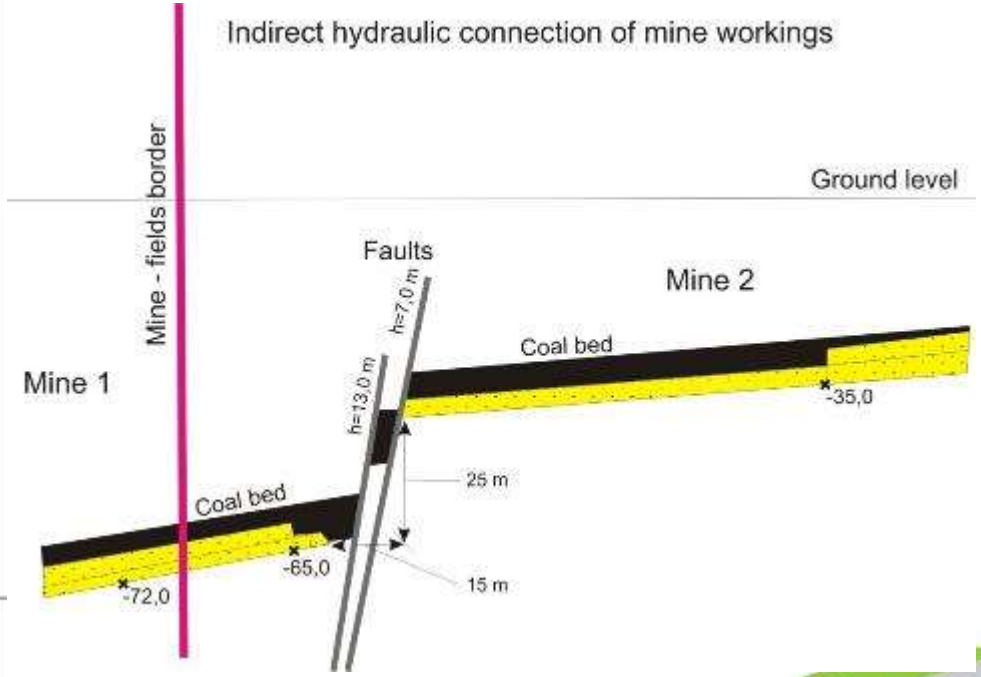


22 active coal mines (26 mine fields)
1 - experimental Barbara mine

1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020

DEWATERING MECHANISMS





In USCB most of the mines (working and abandoned) are potentially hydraulically interconnected, either directly or indirectly by drifts, roadways, boreholes or intact coal barriers of limited thickness.

The objective of dewatering is to maintain the level of water in the abandoned mine under level of the 'over-spill' connection to the adjacent working mine.

This criterion is codified in Polish geological and mining law.

Hydrogeologists and miners from abandoned mines are engaged in recognizing of that 'over – spill' connections and determinate permissible water level for each mine.

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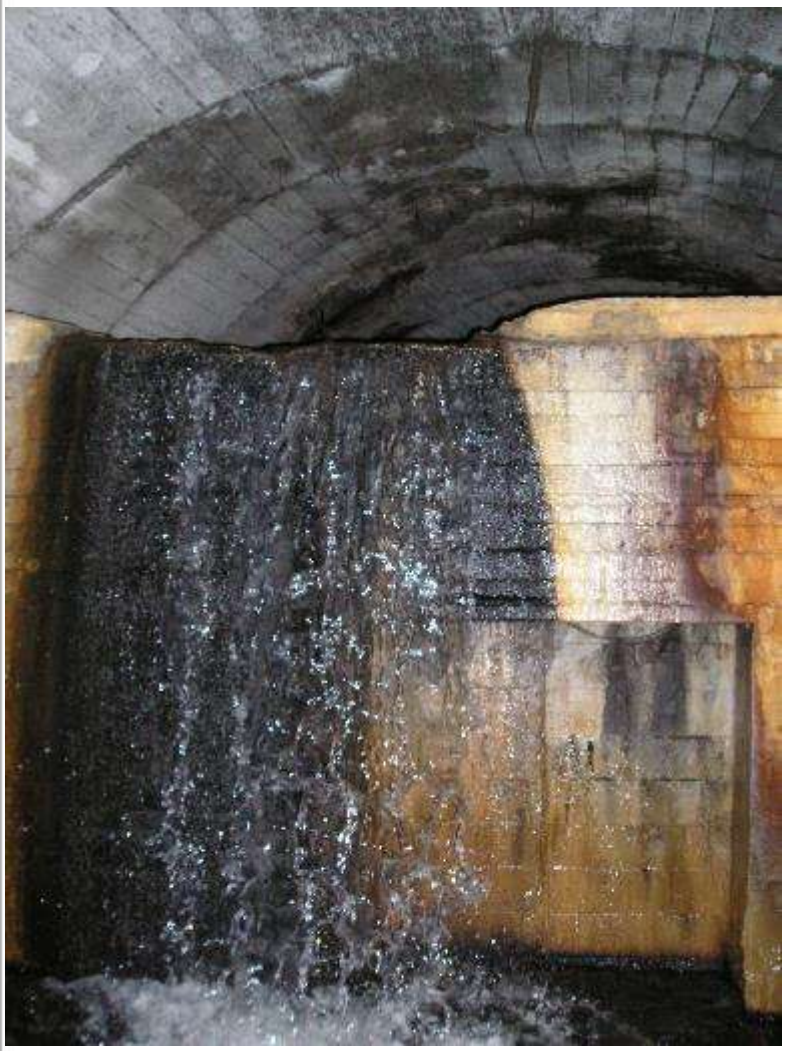
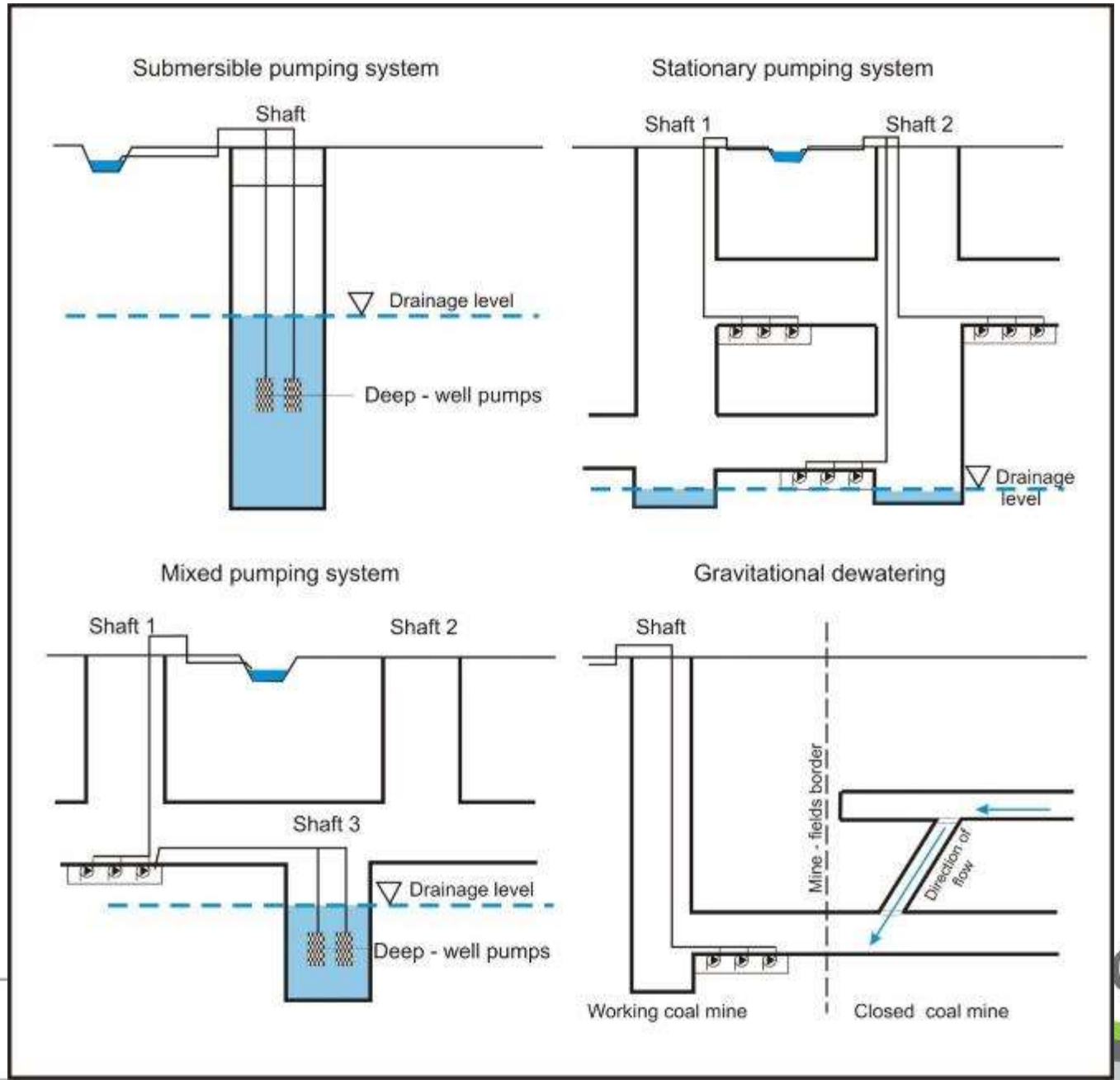
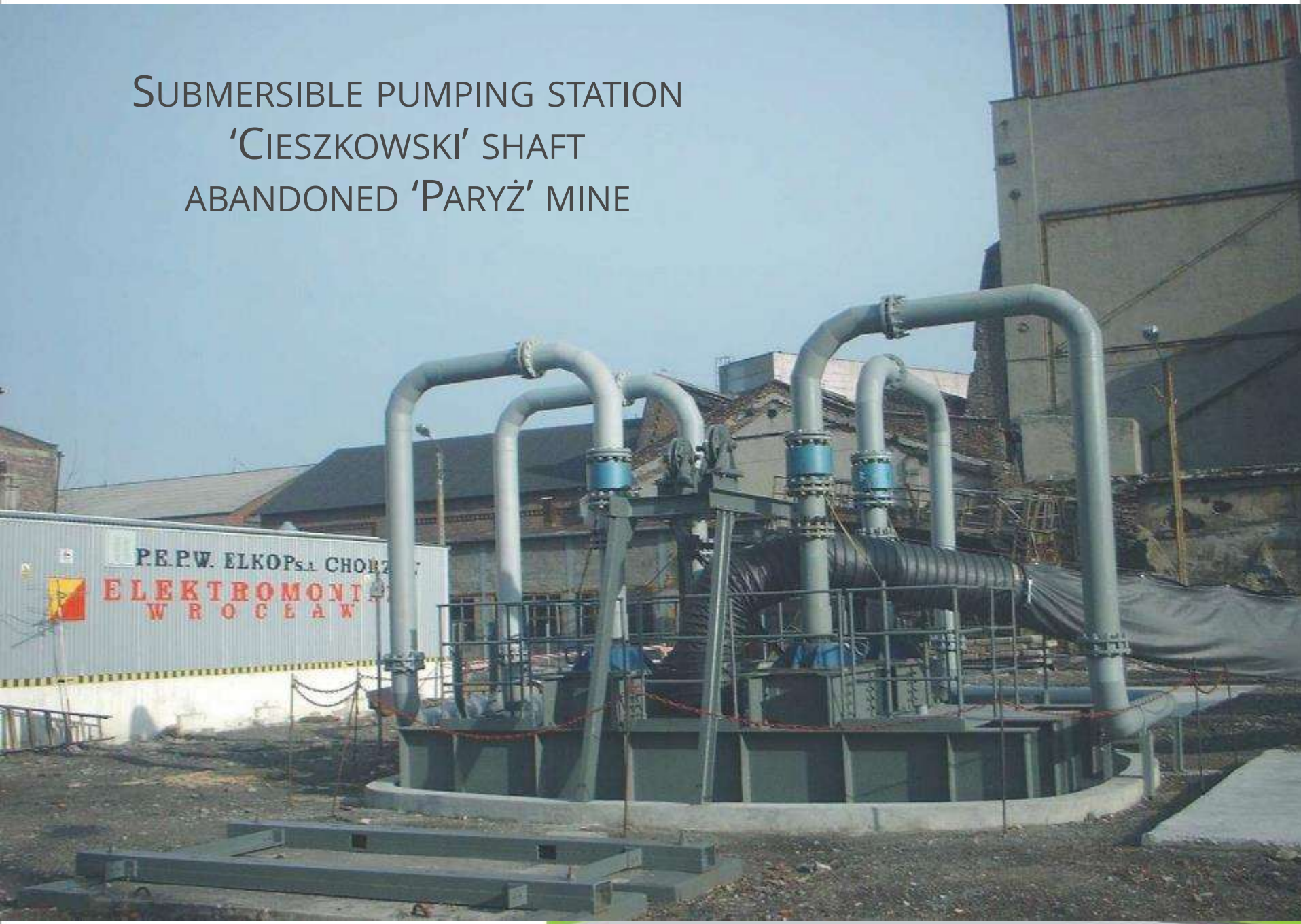
OVER – SPILL CONNECTION



DEWATERING SYSTEMS



Submersible pumping station 'Cieszkowski' shaft abandoned 'Paryż' mine



SUBMERSIBLE MOTOR PUMP FOR MINE DRAINAGE

Total head H = 500 m
Pump capacity Q = 8,6 m^3/min
Power rating P = 820 kW
Lenght (motor+pump) 10 m
Weight 8 tonnes

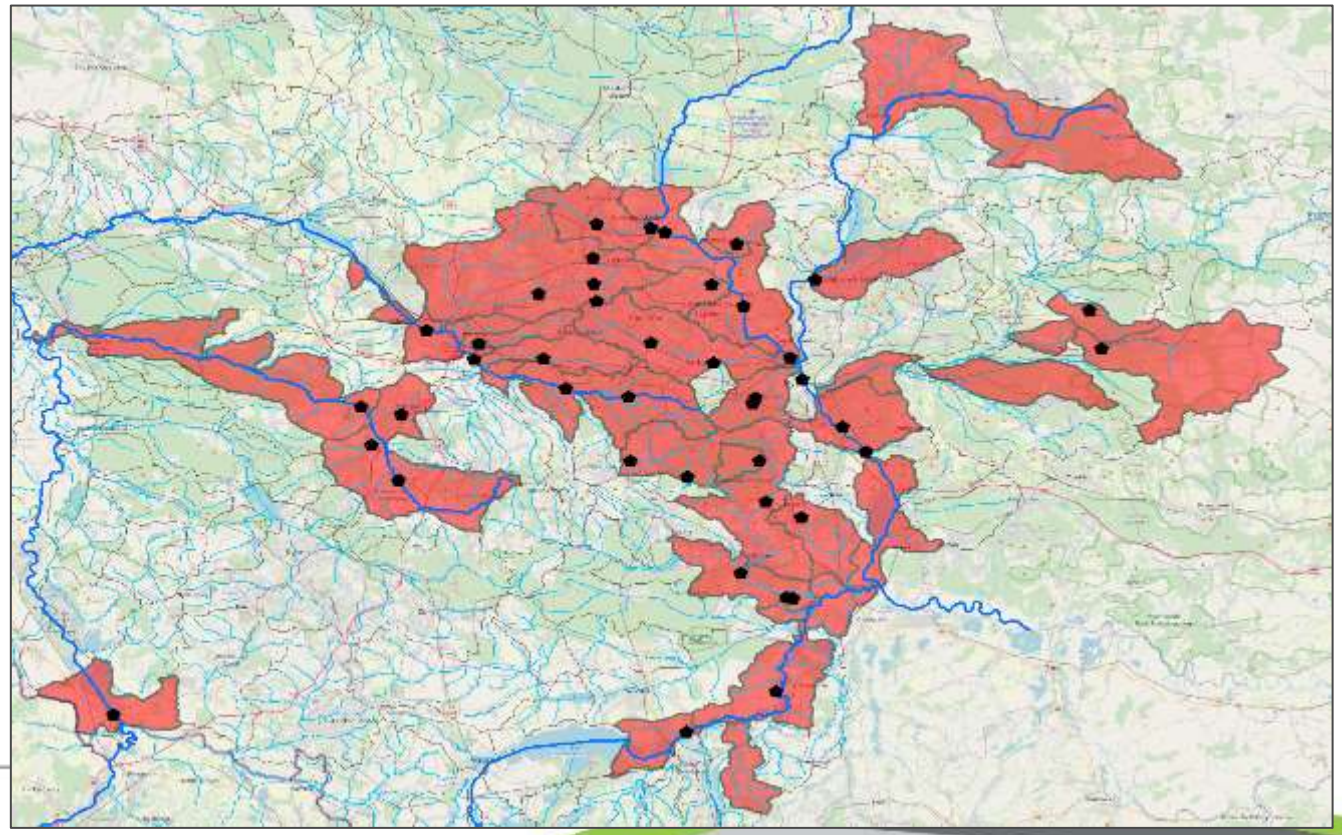
http://www.ksb.com
http://www.ritz-pumpen.de

STATIONARY PUMPING

System comprises pumps located in an underground plant room in a partially dewatered mine.
Such system requires continued ventilation, staffing and mechanical infrastructure in the shaft and mine.

ENVIRONMENTAL IMPACT OF MINE WATERS

The pumped water from abandoned mines is discharged into tributaries of the upper Wisła (Vistula) and upper Odra (Oder) river basins, causing more regional contamination issues related, in the main, to sulphate, chloride, and suspended solids (mostly iron oxyhydroxide flocs).



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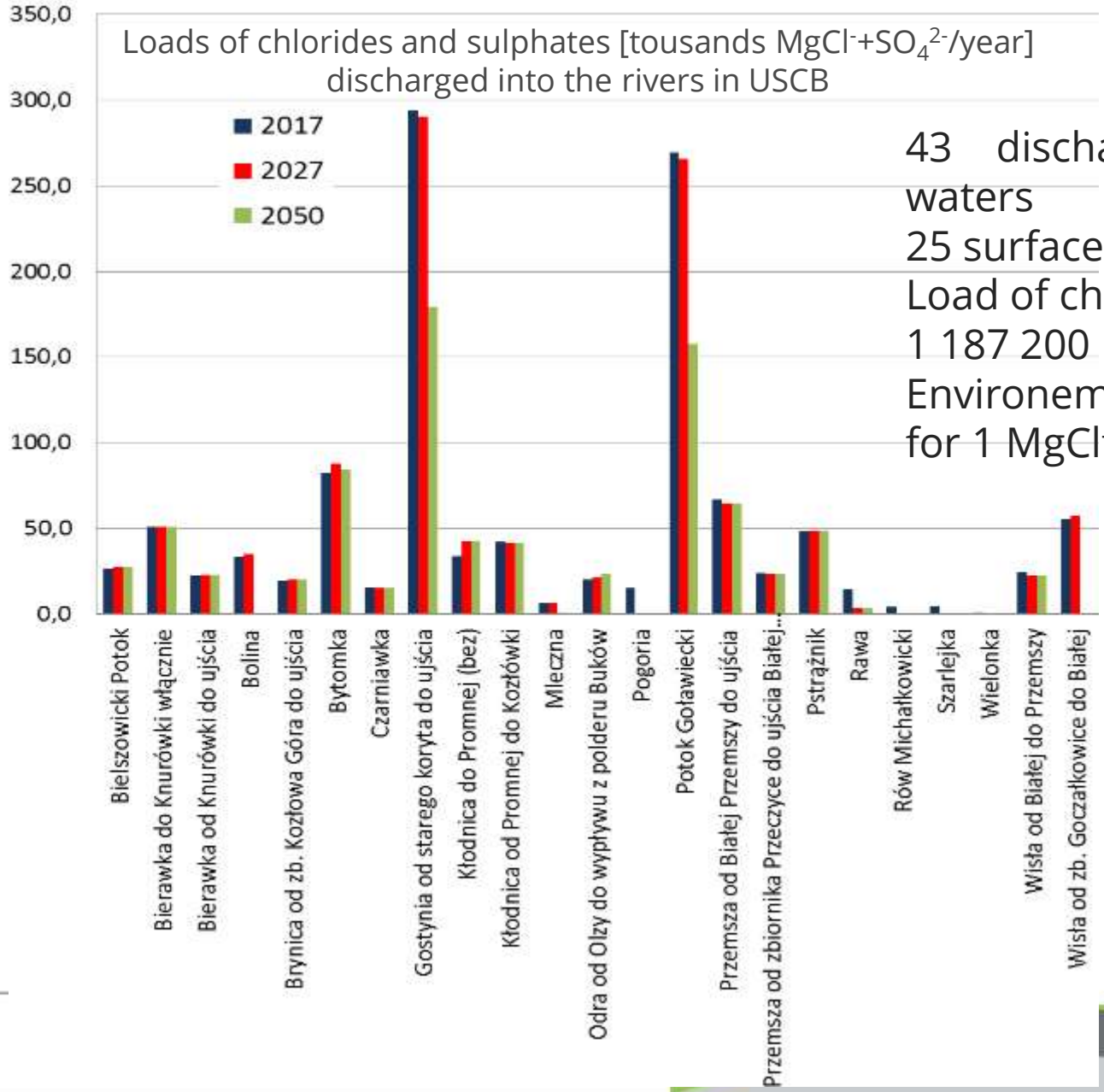
ENVIRONMENTAL IMPACT OF MINE WATERS

In mining areas in USCB there is a general tendency for increasing mineralization with depth; the anion composition tends to evolve along a sequence that is typical for the Silesian coalfields: $\mathbf{HCO_3^- \rightarrow SO_4^{2-} \rightarrow Cl^-}$

Down to a depth of 1200m the highest concentration of chlorides occur – up to 65 000 $mgCl^-/l$
sulphates ranges from 250 – 2800 mg/l
pH is circum neutral due to hydrogeochemical conditions and occurence of triassic alkaline Ca-rich rocks.

In total **150 m^3/min** of mine waters from abandoned mines and **250 m^3/min** of mine waters from active coal mines is pumped into rivers in USCB. This gives 210 millions of m^3 discharged per year (mostly saline waters).

ENVIRONMENTAL IMPACT OF MINE WATERS



43 discharge points of mine waters
25 surface water bodies
Load of chlorides and sulphates:
1 187 200 $MgCl^-+SO_4^{2-}$/year
Environemtal fee: 50 PLN (≈12 €) for 1 $MgCl^-+SO_4^{2-}$.

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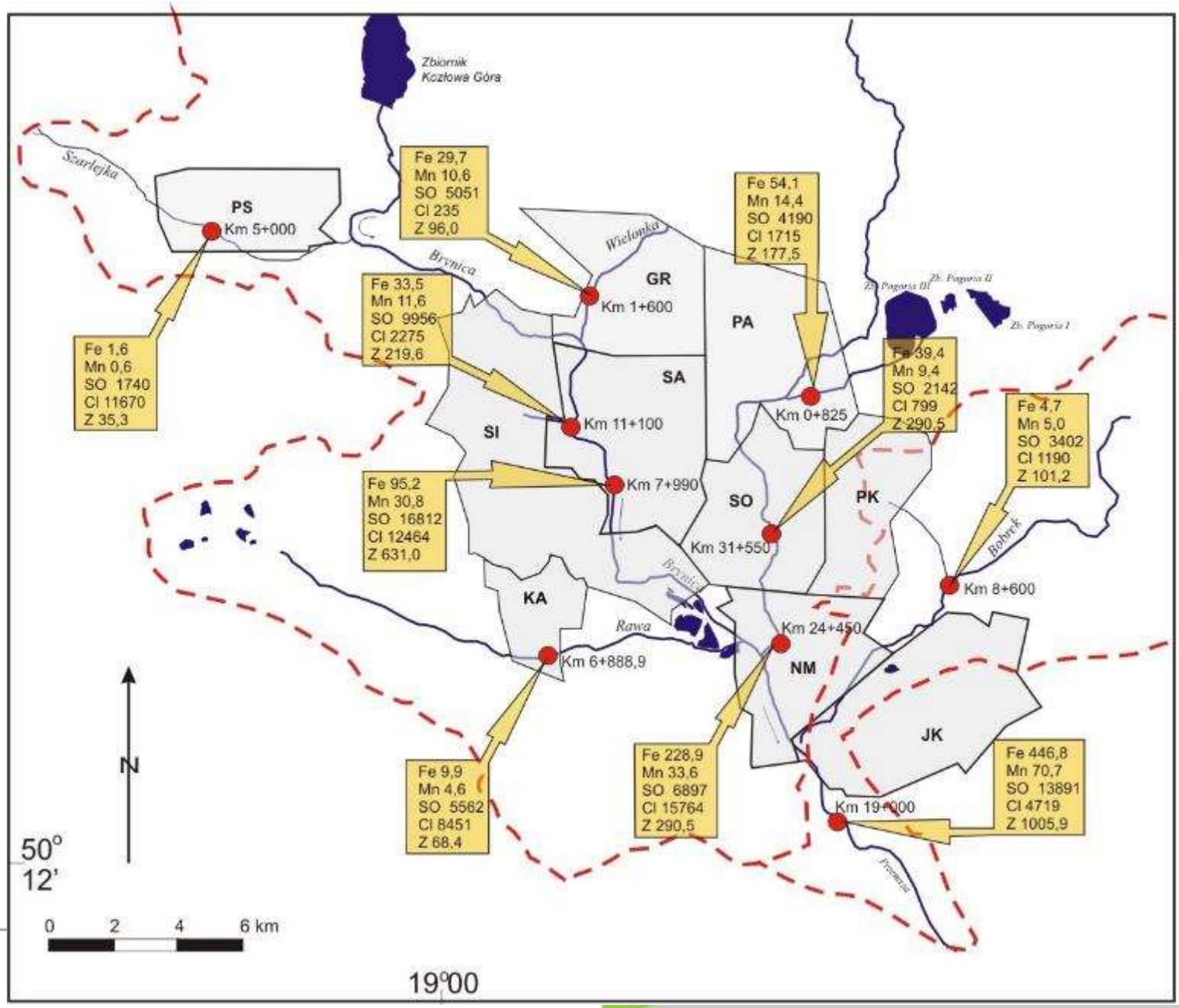
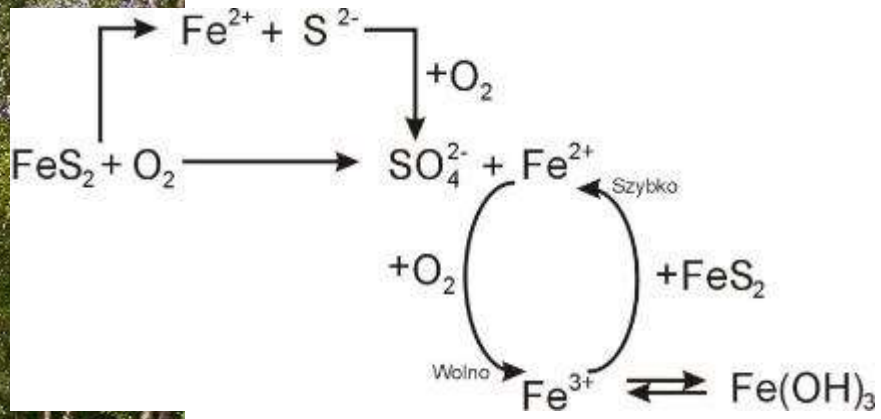
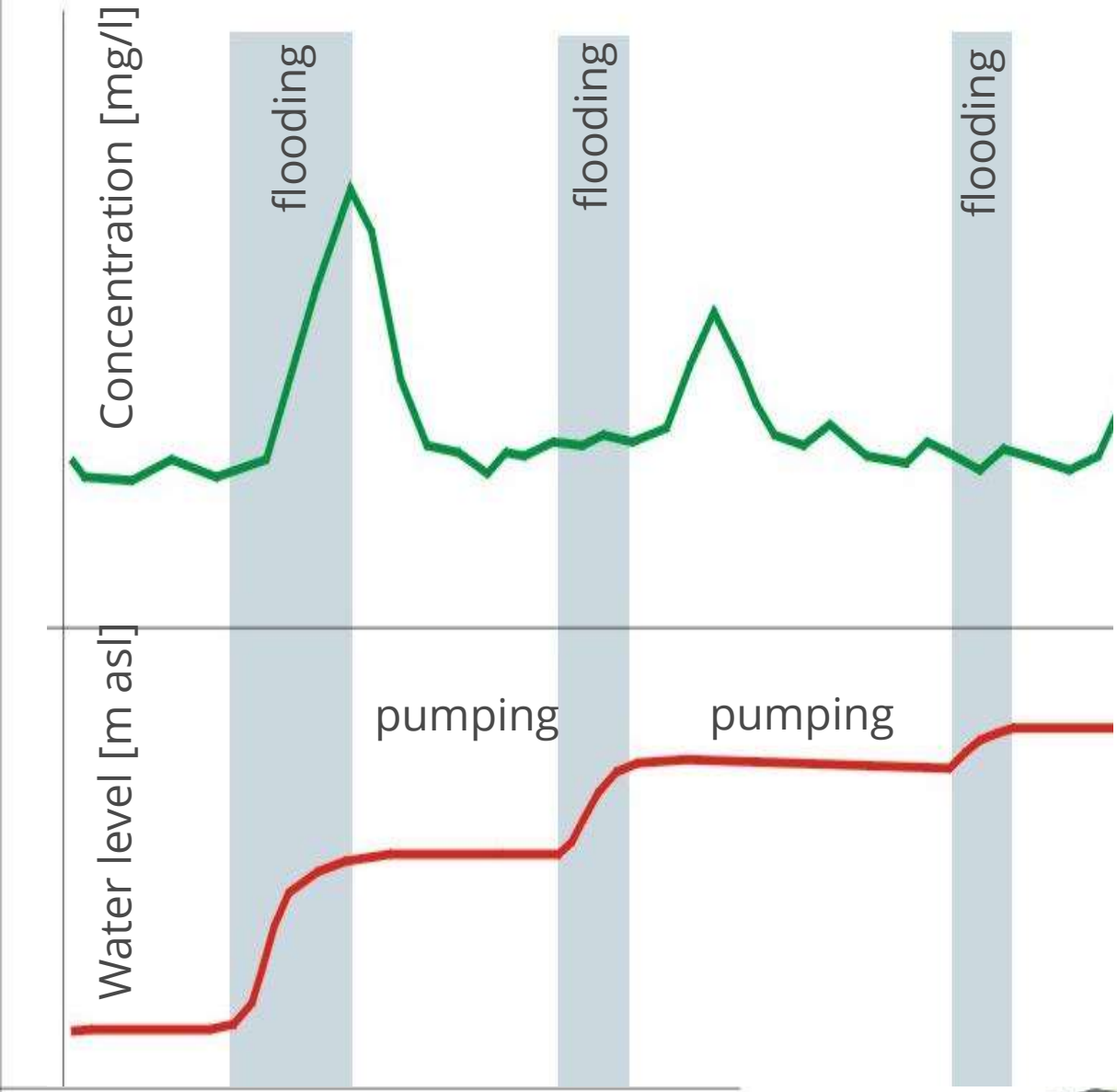
MINE WATER DISCHARGE IN RIVER BASIN



ACID MINE DRAINAGE - IMPACT



FIRST FLUSH MECHANISMS



While coal mine is abandoned, but must be dewatered due to water hazard to adjacent active mine, possibility of flooding parts of excavations is analysed.

During and after flooding the accumulated products of sulphide (dominantly pyrite) oxidation leach into mine water, typically resulting in large increases in iron and sulphate concentrations.

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Ryszard shaft (2001)

Ryszard shaft (2019)

Wetlands on Mortimerowski stream (2001)

Mortimerowski stream (2019)

Mortimerowski stream (2001)

Mortimerowski stream – wetlands affected by AMD (2001)

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USE OF GEOTHERMAL HEAT FROM MINE WATERS – LOW CARBON AFTER LIFE

Mitigation of negative impact of mining and coal footprint reduction is the challenge of Central Mining Institute.

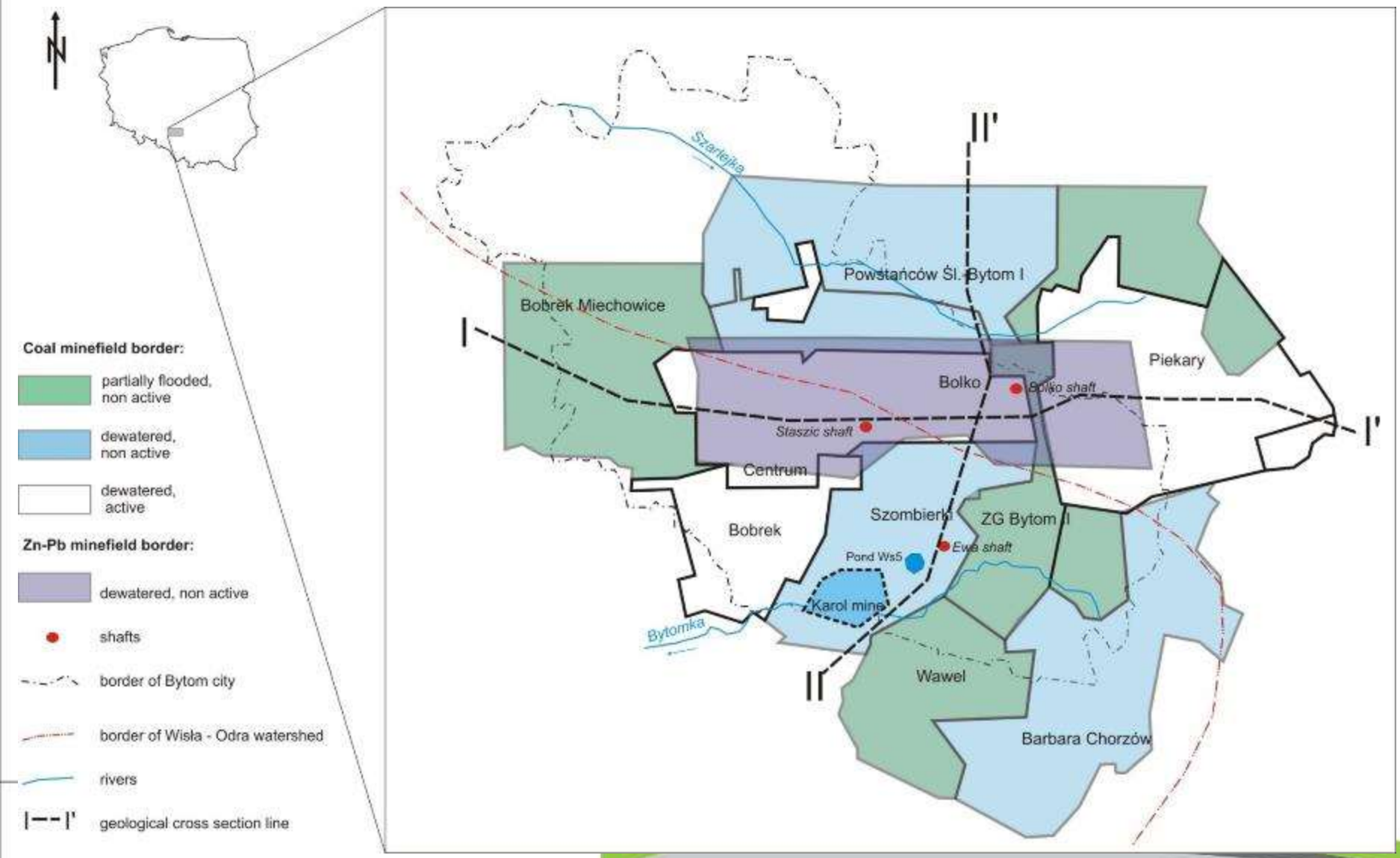
We constantly develop long-term modelling tools, management strategies, technological solutions for water environment impacted by mining.

One of the examples is the project of mine water use for heating.

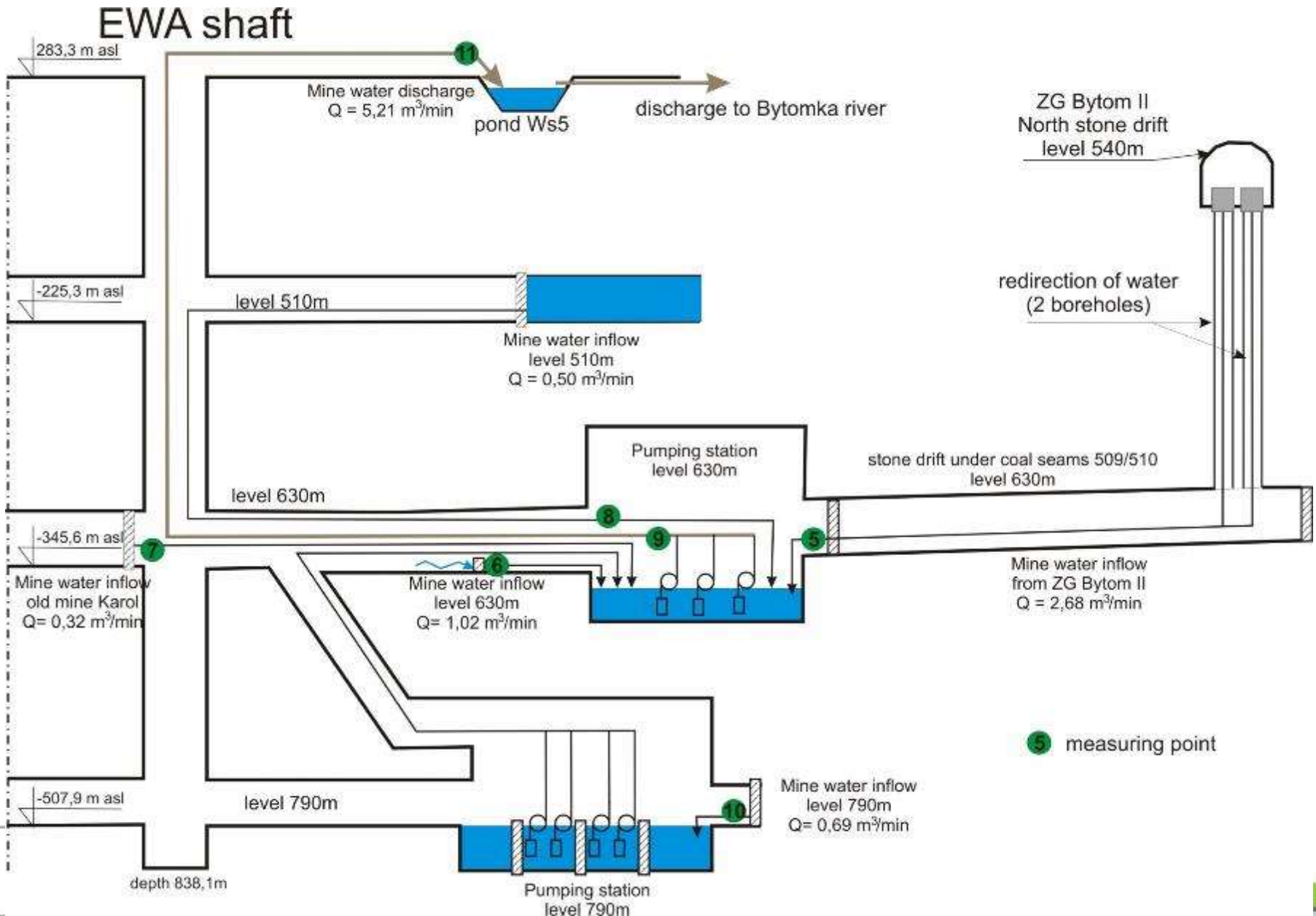
The project was realized in **Bytom Syncline**, in the northern part of USCB. Records of coal mining in this area date back to the 16th Century, with initial shallow workings of coal mines and Zn-Pb ore mines.

The area of mining exploitation (active and abandoned) and dewatering fields covers c. **60 km²** with maximum depth of mining expliotation of c. **900 m bgl (-630 m asl)**.

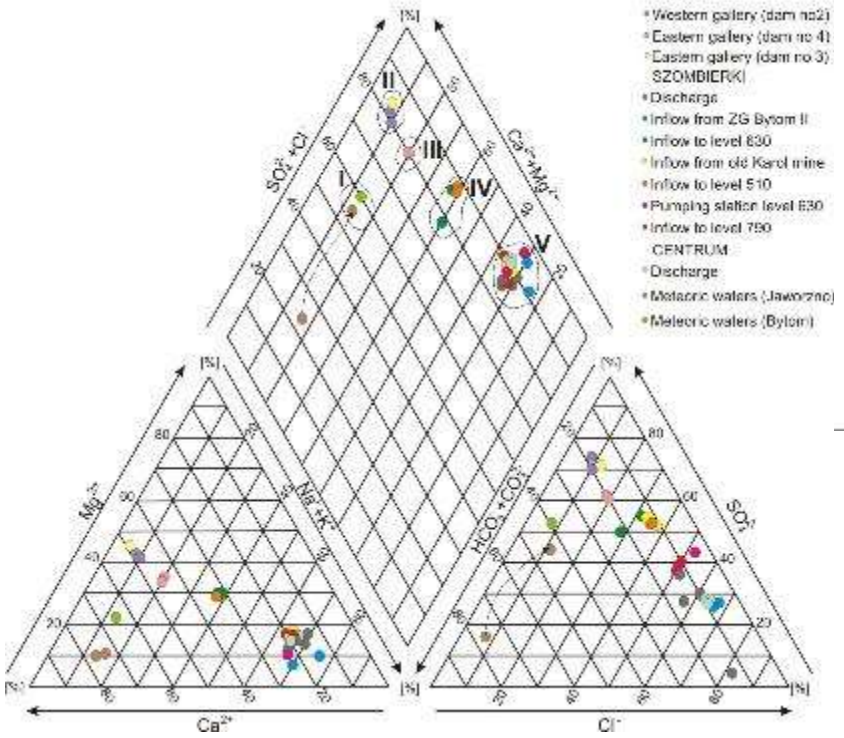
USE OF GEOTHERMAL HEAT FROM MINE WATERS

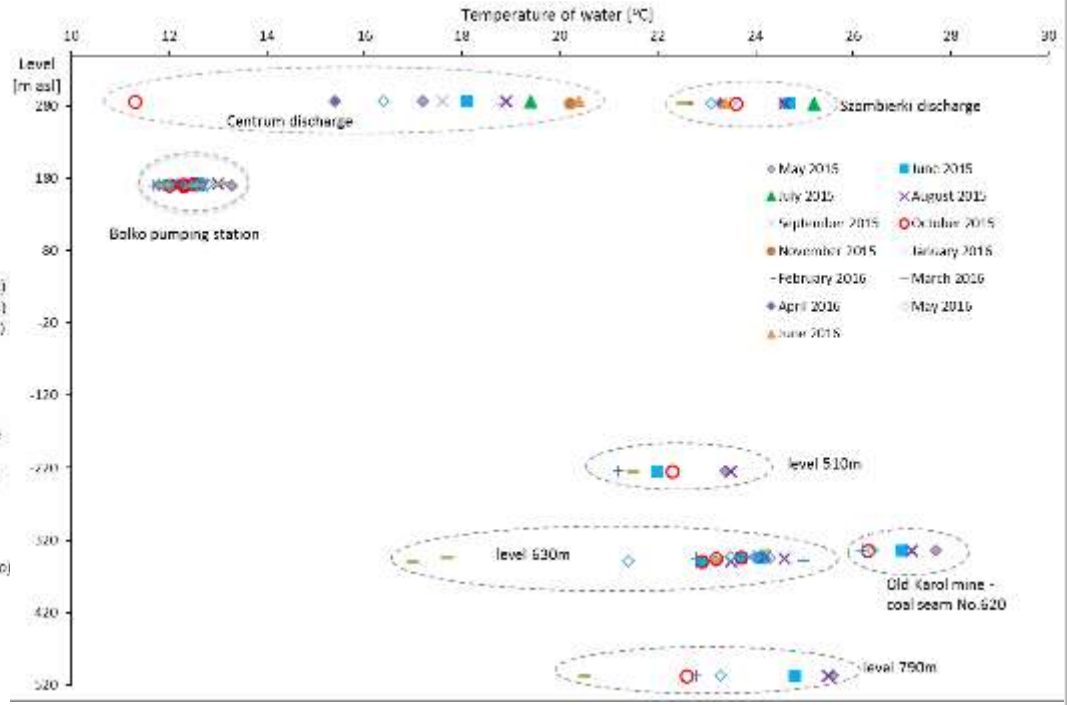


USE OF GEOTHERMAL HEAT FROM COAL MINE



MINE WATER CHEMISTRY FOR THERMAL USE





27°C;

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MINE WATER GEOTHERMAL USE – USCB OVERVIEW

Abandoned mines (dewatering active)	Depth of dewatering [m bgl]	Mine water quantity [l/s]	Temperature of mine water [^{0}C]
Saturn	90	250	14.4
Siemianowice	321	100	16.2
	321	41	16.9
	630	171	23.1
Jan Kanty	270	442	11.3
Boże Dary	183	100	15.0
	413	150	16.5
Niwka-Modrzejów	415	163	18.5
Katowice	485	100	19.5
Kleofas	500	97	18.5
Gliwice	510	99	20.2
Pstrowski	575	153	18.8
	825	108	25.8
Szombierki	630	74	24.5
	790	8	27.6
Powstańców Śl.	500	10	18.0
	650	22	23.7
	760	16	26.5
Dębieńsko	202	55	12.3
	410	68	15.7
	690	38	29.2
Centrum	250	83	16.0
	372	17	18.0
	774	17	23.0
	930	33	27.0

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MINE WATER GEOTHERMAL USE - IMPEDIMENTS

Legal and administrative procedures (polish regulations)

Lack of incentives to use geothermal heat from mine water

Different interests, various models of property rights (use of mine water for different purposes, not only dewatering and discharge);

Financial incentives and technical effort (necessity to use unconventional sources of energy vs. existing infrastructure in urbanized and industrialized areas – waste heat from power station as an example)

The beggining of the CIRCULAR ECONOMY in Poland and change the way of thinking of reduction the coal footprint in environment.

Thank you for your attention

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