



Activity Report of WP3.3

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SITE DESCRIPTION AND DATA OF THE KGHM CUPRUM

Site services, Characteristics and Data

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1 Aim and Introduction

This report provides an overview of the features, properties and services for the conceptual underground laboratory located in active copper mine in Poland. This facility is characterised as “conceptual” because at the moment there is no separate facility like UL in KGHM Mines, but still, there are some plans to set up an underground research facility, after the termination of regular excavation in some parts of the mine. Data and description of the site presented herein are related to UL which could be built in Polkowice-Sieroszowice mine. The feasibility study of such an object was prepared during the BSUIN project. It must be mentioned that the building of such a facility will be very useful, because, a lot of research is performed at the moment in KGHM mines in real in-situ conditions, within active mining pannels. Such an approach provides the best reliability of results because methods and equipment are tested in real conditions but at the same time is cause risk for researchers and disturb the production process. Still, many international projects are currently performed under such conditions.

The aim of this document is to support marketing, project planning/execution, business, and innovation development by the proper description of the site. General site information, including current use and access to the research site, is followed by information on the potential of research, innovation and cooperation possibilities, and the onsite support, including the database. The bedrock geology, hydrogeology, and hydrochemistry data and properties are described in detail.

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2 Overall description of the KGHM CUPRUM UL

2.1 Location

2.1.1 Geographical settings

Conceptual KGHM CUPRUM UL (at the moment this is at the stage of the feasibility study) is located in Polkowice-Sieroszowice mine which is located in Lower Silesia Voivodship in South-West part of Poland (Fig. 1). This mine is situated about 100 km North-West from Wrocław (capital city of this region). This site is placed relatively close to the Czech and German borders.

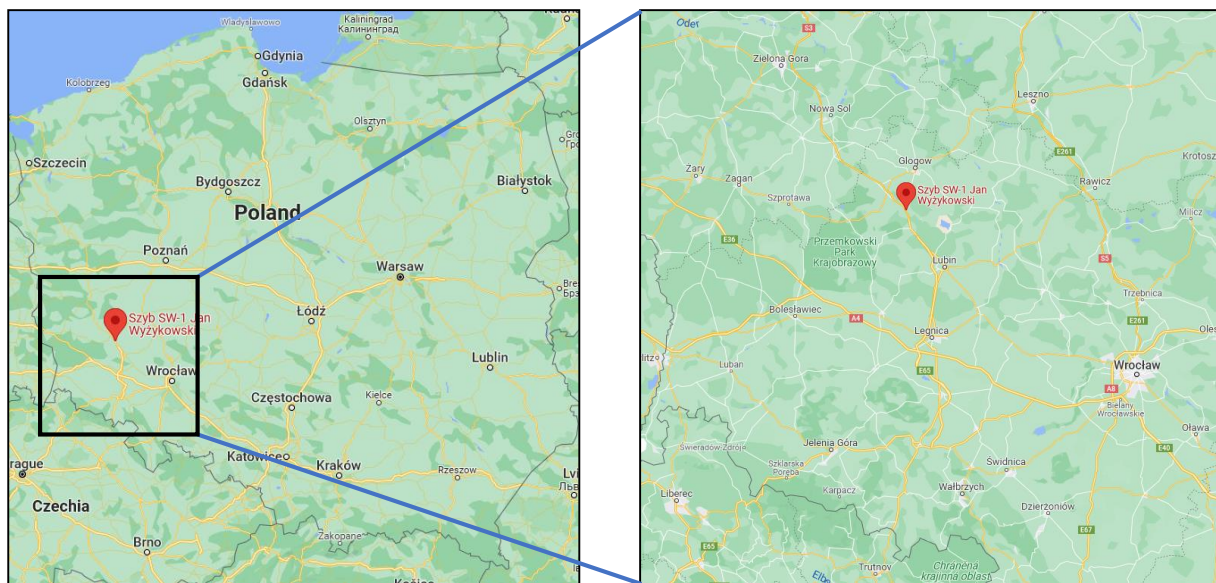


Figure 1. Location of Polkowice-Sieroszowice Mine.

Coordinates: 51.605° North, 16.024° East

2.2 Use and Access

2.2.1 The original purpose and current use

From the beginning, this site was developed as an underground copper mine. This mine has been operated since the '80s. Plans predict that this mine will be active in the next 30 years. Nowadays, annual ore production reaches 11 mln tons and the total area of the mine (underground operations) exceeds 170 km². Employment reaches 4,000 people. The room-and-pillar mining method is employed for exploitation. Mine is still under development and currently, the depth of exploitation reaches 1,200 m below surface level. It should be noted that apart from copper ore there is also a deposit of rock salt which is also exploited, although annual production is relatively small ca. 0.2-0.3 mln tons.

The BSUIN project has selected the best place to create an underground laboratory. The concept of the Underground Laboratory assumes its location in the underground space within an active copper

mine with all possible implications related to the exploitation process and local geotechnical conditions. Two concepts for an underground laboratory have been developed:

- a) Laboratory for non-mining applications (relatively small dimensions; size do not change significantly during UL operation)
- b) Laboratory for conducting research on new technologies in mining, tunnelling, geomechanics etc. (large area; geometry changes with the progress of exploitation).

More information on this subject can be found in the activity report A4.2 (Design of Underground Laboratory Prototype complying with requirements and best practices in deep copper mine conditions).

2.2.2 Available infrastructure

In Polkowice-Sieroszowice mine are hundreds of kilometres of different types of excavations that are still available and driveable. It is the result of a long time of mining operations (above 30 years) and a large scale of copper ore exploitation (millions of tons per year). Part of the mine is shown in Fig. 2. Prepared workings serve many different functions e.g. transportation, ventilation. There were also prepared special chambers for other necessary openings e.g. workshops, warehouses, parking's etc. These kinds of facilities have different shapes and dimensions, depending on requirements.

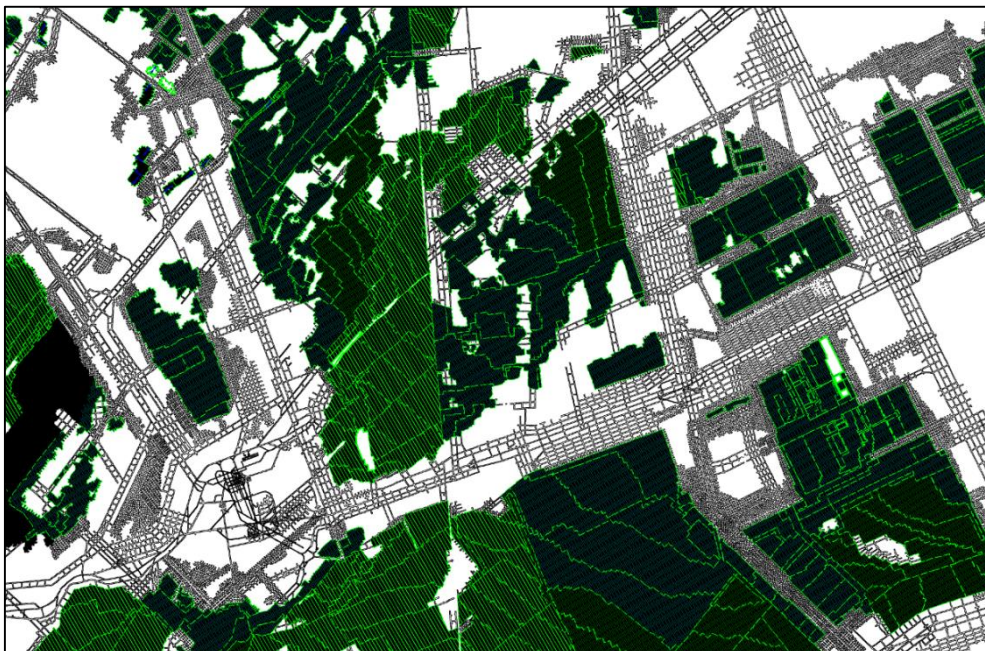


Figure 2. Fragment of Polkowice-Sieroszowice mine.

Standard workings, which are intended to transport and ventilation, have a trapezoid cross-section (Fig. 3). Part of these openings can be repurposed for other functions in the future when become useless for mining operations.



Figure 3. Transportation gallery.

It is worth mentioning that Polkowice-Sieroszowice mine is connected underground with two other copper mines belongs to the KGHM Polska Miedź SA.

Polkowice-Sieroszowice has an extensive and reliable ventilation system which ensures the proper amount of fresh air for whole active workings. This system is also used for the removal of all toxic gases that can appear in mine (gases from rock mass, diesel machines, other processes e.g. welding). Depth of exploitation and geothermal gradient which in this is 35 m/1°C causes that rock temperature in some areas reaches 50 – 60°C, therefore the ventilation system is also equipped with air-condition to provide the proper temperature of the air. The ventilation system consists shafts, coolers, fans, ventilation workings and dams.

In relation to the ventilation hazards, implemented safety systems are based on the self-rescuer which is a mandatory part of PPE for all underground staff. Additional, some parts of the mine, are equipped also with rescue chambers. Each of the chambers is prepared for 40 people and provides fresh air for 6 hours. Chambers are also equipped with a communication system and additional self-rescuers.

This mining site is supplied with electricity from two independent sources with an automatic switch-on system. The electric system is designed in this way to provide a high level of reliability. Typical voltages that are available underground are 230 V and 6 kV. Other types and levels of voltage (AC, DC) can be provided by means of electric devices like transformers, inverters etc.

The mine is equipped with a dewatering system. This system contains water pipelines, drainage holes, pumps, water storage and water dams. Part of the water from the dewatering system is used for technological purposes. Drinking water is available as bottled water supplied from the surface.

2.2.3 Current ownership and organisation

KGHM CUPRUM Sp. z o. o. R&D is a member of KGHM Polska Miedź S.A. Capital Group. KGHM CUPRUM is wholly owned by KGHM Polska Miedź S.A since 1st January 1993. On 9th January 2009 the Ministry of Economy granted KGHM CUPRUM the status of research and development centre.

KGHM CUPRUM prepared a conceptual project of the underground laboratory which can be developed in the Polkowice-Sieroszowice mine.

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2.2.4 Underground access

As was mentioned before, there is not available underground laboratory in Polkowice-Sieroszowice mine yet. Nevertheless, there is the possibility to use some underground facilities and structures for other purposes (tests, researches) on the basis of special approval issued by mining management. KGHM CUPRUM can provide technical support during the approval process.

Access to the underground workings is available by shafts only. There are 10 shafts in the Polkowice-Sieroszowice mine. Shafts are used for transport materials, machines and people and/or ventilation purposes. Thanks to the connections with other KGHM total number of available shafts is 27 (one is under construction). Shafts have diameter 6.5 m (older) and 7.5 m (newer) with depth from 650 m up to 1,200 m under the surface level. Parameters of elevators and shafts allow to transport underground large and heavy equipment (in some cases large equipment must be disassembled and transport in separate parts).

2.2.5 Commuting

Polkowice-Sieroszowice mine is placed 3 km north of the Polkowice town and approximately 125 km from Wrocław, the capital of Lower Silesia. You can get to the site by car from Wrocław in less than 2

hours via the A4 motorway and/or the S3 interregional road. There are also lots of local roads available. The nearest airports are in Wrocław-Strachowice (120 km), Zielona-Góra-Babimost (100 km) and Poznań-Ławica (130 km). The nearest regional airport is located 20 km in Lubin. Other available options are Berlin Brandenburg Airport at distance 230 km or Praha Airport ca. 250 km. There is also the possibility to use train from Wrocław Central Train Station to Lubin. It takes ca. 1.5 hours. Bus connections are available as well, among others from Wrocław, Lubin, Zielona Góra.

2.3 Research, innovation and cooperation possibilities

2.3.1 Innovation and research

Research and development work, as well as production activities, are carried out in the mines owned by KGHM. This allows technical solutions to be tested in difficult mining conditions to ensure that the expectations in terms of durability, quality and reliability are met.

In mines, excavations are used for various purposes, including improving the technology of excavations, blasting works, or ground handling, best suited to the local mining and geological conditions. This is supplemented by a rock mechanics laboratory established as a part of KGHM CUPRUM surficial facilities in Wrocław. In example KGHM CUPRUM conducted research in relation to the rock stress measurement in the roof by means of instrumented rock bolts. There are also regular test of using explosives by means of VOD recorder.

2.3.2 National and international cooperation

The CUPRUM R&D Centre cooperates with many national and international organizations, including companies from the mining industry, industry, research institutions and universities. Many domestic and foreign projects are carried out in the KGHM CUPRUM R&D. KGHM Polska Miedź S.A. and Polkowice-Sieroszowice are involve with some projects as well.

Foreign projects are aimed at, inter alia, increasing the degree of innovation, and thus increasing the competitiveness of European industry, some of them include:

- a) Next-Generation Carbon Neutral Pilots For Smart Intelligent Mining Systems (NEXGEN-SIMS),
- b) Bright Concepts For A Safe And Sustainable Digital Mining Future (IlluMINEation),
- c) Intelligent Production Management In Underground Mining (SIMS),
- d) THING – subTerranean Haptic InvestiGator,
- e) Integrated Process Control based on Distributed In-Situ Sensors into Raw Material and Energy Feedstock,
- f) RMsManager. Raw Materials Manager Course,
- g) Timegated Raman for Exploration T-REX,

- h) Supply of BATTERY minerals using lignin nanoparticles as FLOT collectors (BATTERFLAI),
 - i) Training trainers in East and Southeastern Europe (TrainESEEv.2),
 - j) Continued education program in rock engineering for deep mines (Safe Deep Mining),
 - k) A Master education project dedicated to mineral resources and sustainability (OpenYourMine),
 - l) VirtualMine – a modelling tool for Wider Society Learning (VirtualMine),
 - m) Developing superior technical infrastructure throughout EIT RawMaterials community to Foster technologies and methodologies for re-activation of former mine sites (Re-Activate),
 - n) Smart Hard Rock Mining System (RockVader)
 - o) Baltic Sea Underground Innovation Network (BSUIN)
- and many others

Also, national projects are performed onsite. Some of them are listed below:

- a) Genesis and course of anthropogenic and natural deformations of the terrain in post-mining areas of the former brown coal mine “Babina”,
- b) Integrated natural stones processing system. Pro-ecological production line based on the idea of sustainable development and adapted to be operated by disabled people,
- c) Development of the innovative technology of non-ferrous metals enrichment by using the pre-concentration system based on the artificial intelligence algorithms (no. POIR.01.01.01-00-0884/20-00),
- d) Manufacturing of graphene layers on copper connections for electronic applications (GLC-Connect) (no. POIR.04.01.02-00-0103/17),
- e) Automatic system for monitoring the influence of high-energy paraseismic tremors on the surface using GNSS/PSInSAR satellite observations and seismic measurements (no. POIR.04.01.04-00-0056/17),
- f) Comprehensive technology for the management of the carbonate part of flotation tailings from the current production of KGHM Polska Miedź S.A. and the production of innovative materials for construction (FLOT-BUD),
- g) The innovative system of wireless communication in pillar-chamber workings in underground mines (WILDCAT),
- h) Design of drilling and firing patterns by the use of IT tool developed for the LGCB copper mining conditions (PROMETEST),
- i) Innovative methods of the deep ore deposits access (I-MORE),
- j) Other.

The KGHM CUPRUM R&D Centre belongs to the European Underground Laboratories Association.

2.4 Support at the site and available database

2.4.1 Project handling, competencies and quality control

KGHM CUPRUM R&D Centre can provide support in project management and data transfer between Polkowice-Sieroszowice and potential stakeholders. Nevertheless, each of stakeholders must be aware that all of the activities that will take place in underground workings need approval and authorisation of mining management including access to the different databases.

In case of approval of mining management of the proposed project, on the basis of sign agreement of cooperation, there are possibilities to use specified mining facilities, materials, equipment. The type of equipment and materials and scope of usage is normally specified in the agreement. Similar requirements concern data that are needed.

2.4.2 Database

There are lot of data gathered in the mining departments. Access to the data is limited and available with special approval only. There are the following databases (among others):

- geological, hydrogeological;
- geodesic (e.g. maps);
- geophysics (e.g. recording of seismic activity, radiation);
- other.

Site description data and data properties

3 Site description data and data properties

3.1 Bedrock geological data and properties

3.1.1 Geological data and tectonics

The deposit in this area is classified as a sediment-hosted type of copper deposit. It contains grey sandstone, copper-bearing shales and dolomite. Estimated copper ore sediment thickness varies from 0.2 m to 4.0 m. The average thickness of copper ore deposits is 1.4 m. The immediate roof strata contain calcareous dolomite with an average thickness 10 m. Above the layer of dolomites, anhydrite with thickness varies from 20 to 100 m are present. The floor strata contain quartz sandstones with a thickness between 3.5 m and 17 m (average 8 m). The depth of copper ore deposit is from 800 to 1,280 m below of surface level and the inclination of 2 –5° to NE direction. The geological profile is shown in Fig. 4.

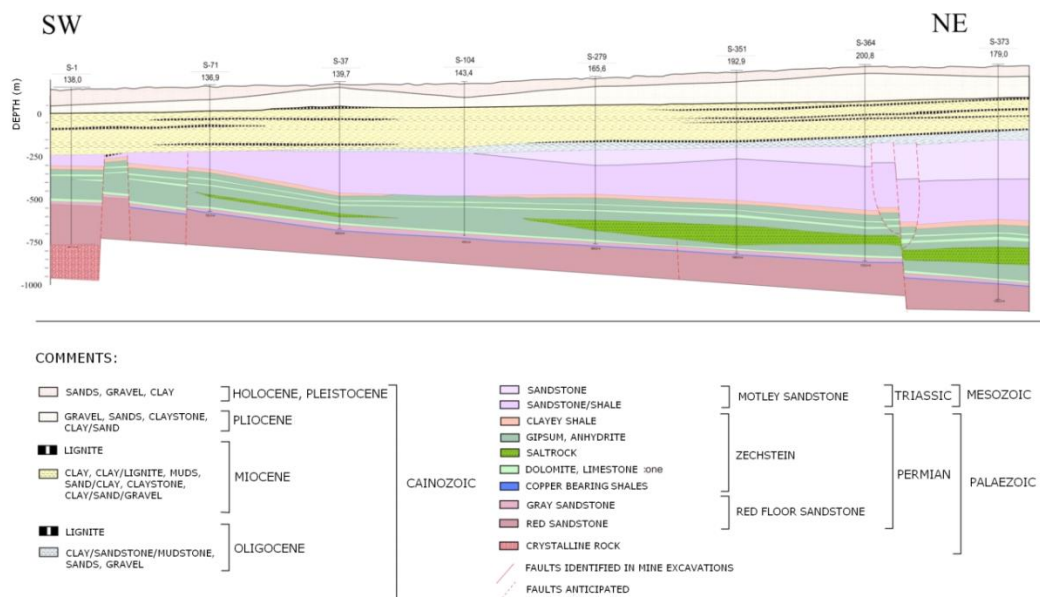


Figure 4. Geologic cross-section of the Polkowice-Sieroszowice mine.

3.1.2 Major rock type(s)

The geological profile includes the following types of rocks:

- fine-grain sandstone,
- clayey shale series,
- anhydrite series,
- rock salt,
- dolomite,
- carbonate series (dolomite, limestone, shale)
- copper ore seam,

- grey and red sandstone.

3.1.2.1 Mechanical properties and conditions

Within rocks that are built copper ore deposit (sandstone, dolomite, shale) weighted average of compressive strength varies from several up to 220 MPa (depending on the location). The average value is ca. 110 MPa. Detailed data can be obtained from KGHM databases provided special approval of mining management.

3.1.2.2 Thermal properties and conditions

The geothermal gradient in this area is about 35 m/1 °C. The geothermal cross-section in the mine's overburden is shown in Fig. 5.

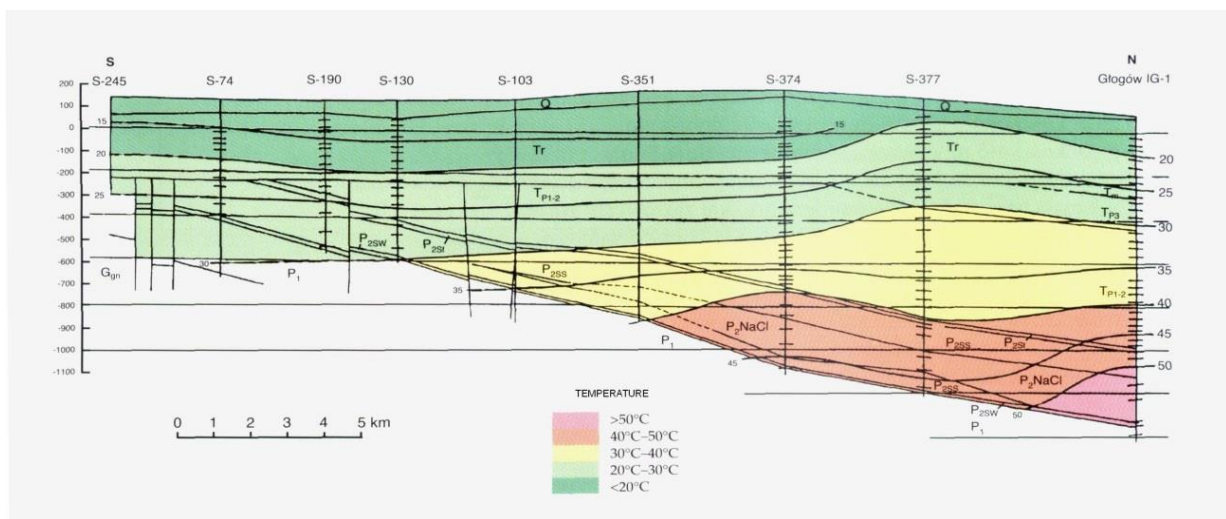


Figure 5. Geothermal cross-section of overburden in Polkowice-Sieroszowice area.

3.1.2.3 Radionuclide data

N/A

3.1.3 Data sources

3.1.3.1 Surface data

Generally available surface data (geodesic, maps, surface objects etc.) can be downloaded from website geoportal.gov.pl. Part of geologic and geophysics data can be downloaded from website of the Polish Geological Institute, www.pgi.gov.pl.

3.1.3.2 Borehole data

General data can be downloaded from Polish Geological Institute, www.pgi.gov.pl. There is a potential possibility to get detailed borehole data from KGHM databases provided special approval of mining management.

3.1.3.3 Underground data

There is a potential possibility to get underground data from KGHM databases provided special approval of mining management.

3.1.3.4 Petrography, geochemistry, rock mechanics, petrophysics and thermal properties

There is a potential possibility to get the above-specified data from KGHM databases provided special approval of mining management.

3.1.3.5 Natural background radiation data

Measurements of natural radioactivity in the salt chamber in the Polkowice-Sieroszowice mine were carried out in 2010 as part of the research as a potential site for the creation of an underground SUNLAB laboratory - two SUNLAB1 laboratories (small laboratory) located in the salt layer and SUNLAB2 (large laboratory) located in anhydrite - as host of the European project LAGUNA FP7 with a liquid-argon detector for physics research. At that time, scientific work showed a very low level of natural background. As part of the BSUIN and EUL projects, measurements of natural radioactivity in the anhydrite layer at a depth of 1014.4 m were performed by a group from the University of Silesia (Poland) and the National Center for Nuclear Research (Poland). The research included in-situ measurements and laboratory analysis of rock samples taken from the investigated location.

Based on the performed measurements, the following values were determined:

- neutron flux,
- gamma-ray flux,
- effective dose rate,
- counts rate,
- the radon concentration in air,
- radioisotopes concentration in rock ($^{234,238}\text{U}$, $^{226,228}\text{Ra}$, ^{40}K) samples.

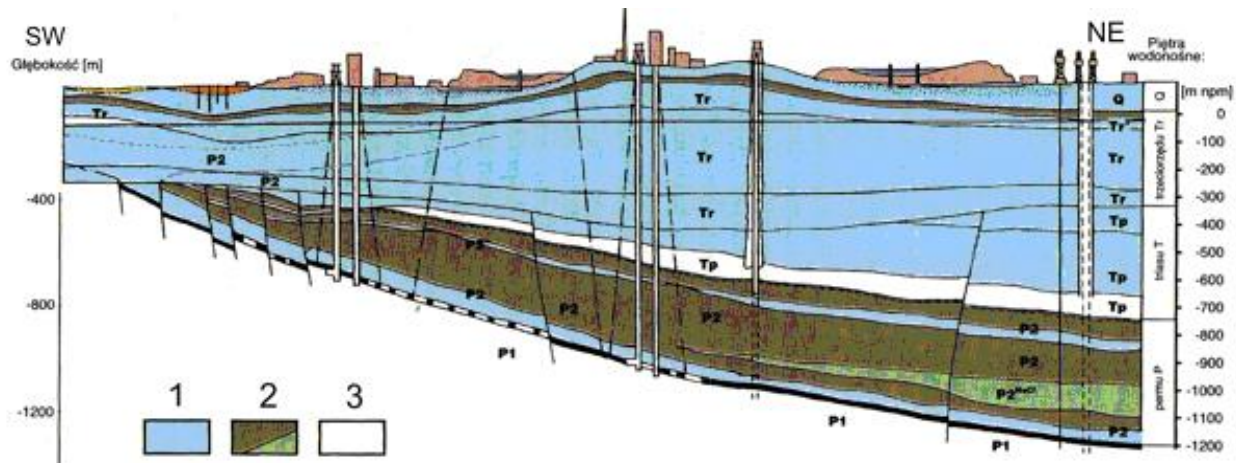
The results of the measurements are included in the report of the EUL project.

3.2 Hydrological data and properties

3.2.1 Hydrogeological data and properties

3.2.1.1 Description of data

Describe if applicable Hydrogeological structures of Polkowice-Sieroszowice area are shown in Fig. 6.



(1 – water deposits, 2 – impermeable deposits, 3 – impermeable but slightly saturated deposit)

Figure 6. Hydrogeological cross-section of copper ore.

There is a potential possibility to get detailed hydrogeological data from KGHM databases provided special approval of mining management.

3.2.1.2 Description of properties

There is a potential possibility to get the above-specified data from KGHM databases provided special approval of mining management.

3.2.2 Hydrogeochemical data and properties

3.2.2.1 Description of data

There is a potential possibility to get detailed hydrogeological data from KGHM databases provided special approval of mining management.

3.2.2.2 Description of properties

There is a potential possibility to get the above specified data from KGHM databases provided special approval of mining management.

4 Summary

The presented Polkowice-Sieroszowice mine is the perspective place for establishing an underground laboratory in the future. It was confirmed by analysis carried out during the preparing concept of the underground laboratory prepared by KGHM CUPRUM R&D Centre. Taking into consideration the size of the mine and the number of different type of structures e.g. workings, chambers etc. there are a significant potential for preparing an underground laboratory that can bring additional profit for the KGHM Polska Miedź S.A. This kind of laboratory can be used internally to develop and test new mining technologies and externally for other branches of industry or science. KGHM CUPRUM R&D was involved in many examinations that were carried out in this site with success. These experiences confirm that this kind of activity is possible and can bring measurable benefits. The development of UL in the future can extend the scope of possibilities and open new research areas. Nowadays underground trials are limited and need to get special permission.