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ABSTRACT

The Josef exploration drift was established in the 1980s for the underground exploration of gold deposits, the largest gold deposits in Central Europe. From 2005 to the beginning of 2007 the drift was transformed into an educational and research facility. The Josef Underground Educational Facility is intended to be a multidisciplinary workplace. Its main use consists of teaching, in 1-3 day blocks, focusing on underground structures, rock mechanics, material testing and engineering geology.

INTRODUCTION

The Josef Underground Educational Facility (Josef UEF) is a new Faculty of Civil Engineering, Czech Technical University in Prague (CTU) facility which opened in June 2007. The facility is located near the Slapy dam close to the villages of Čelina and Mokrsko in the Příbram district.

The Josef UEF is employed primarily for the teaching of students from the CTU and other universities. Other activities include research and cooperation on projects commissioned by the private business sector. The range of activities provided by the Josef facility is unique not only in the Czech Republic but throughout the whole of Europe.

The construction of the facility was inspired by similar underground training centers in other European countries and the USA. Underground facilities run by universities provide a high level of practical education for students in real conditions and contribute to closer cooperation between universities and the world of business.

The reasons for establishing a new, modern underground educational facility as part of the CTU, resulted from the following:

- The need for the further development of experimental research at universities, particularly with regard to material engineering, environmental geotechnics, geology and hydrogeology in a natural, "in-situ" environment
- The present lack of facilities (at a convenient distance from Prague) for the practical training of students in engineering-geological and geotechnical investigation skills and underground mapping
- The establishment of this workplace will contribute towards closer collaboration between universities and outside institutions
- There are a number of closed, so far unexploited minor underground workings currently available in the Czech Republic the utilization of which for such purposes is self-explanatory.

BASIC DESCRIPTION OF THE JOSEF GALLERY

The Mokrsko-Čelina area in which the Josef Gallery is located is part of the Jílové gold bearing zone (Morávek, 1996). The Josef exploration gallery was excavated as part of renewed prospecting activities, which commenced in 1981 (Fig.1). It was decided, however, that mining operations would be discontinued since ore extraction and dressing would result in the devastation of an area of outstanding natural beauty and recreational potential and consequently, in 1991, operations came to an end. In 2000, the entrance portals were plugged with concrete to prevent access to the underground areas.

The Josef exploration gallery is cut in a NNE direction across the Veselý hill rock massif. The total length of the main drift is 1700m, with a cross-section of 14-16m^2. The overlying rock thickness is 90–110m. Two parallel tunnels lead from the

entrance portals, each having a length of 40m and a cross-section of 40m^2. The main exploration gallery is connected to various exploration workings by numerous insets, which follow ore formations and provide access to two further levels. The total length of the galleries is approximately 8km; 90% of the breakings are not lined. The end of the main gallery is connected to the ground surface by means of an unsupported 90m vent.

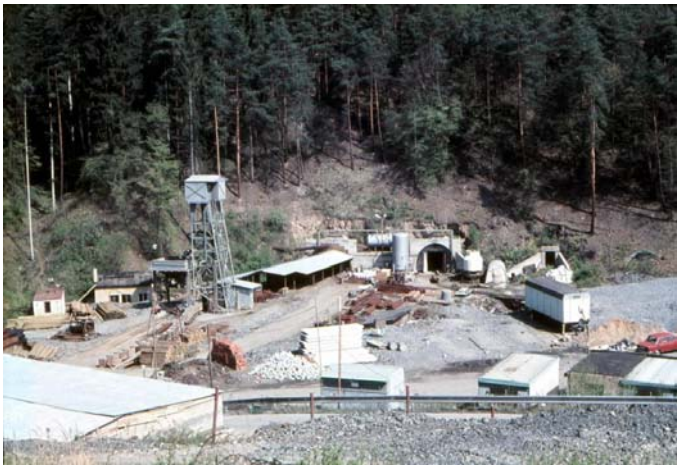

Fig.1. The Josef gallery entrance during the prospecting period

The Josef gallery was excavated as part of the exploration of the Psí hory gold-bearing district, which is located mainly in the Proterozoic Jílovské belt, in rock of more than 600 million years old. Central Bohemian Pluton granitoid rocks subsequently penetrated these rocks during the Variscan orogenesis. The Jílovské formation consists of a 1-6km wide and up to 70km long belt of volcanic and subvolcanic rocks stretching to the south-west of Jílové u Prahy containing other gold mining areas in addition to Psí hory (Jílové u Prahy, Štěchovice-Slapy, Smolotely-Horní Líšnice). Historically, the most important mining activity was concentrated in the vicinity of Jílové u Prahy.

In the Psí hory area, the Jílovské belt consists of volcanic rocks of both basic and acidic composition (basalts, andesites, dacites and rhyolites) in the central area with subvolcanic plagiogranites at its eastern edge and gold bearing acidic to intermediate tuffs (Fig.2).

The overburden consists of a volcanic-sedimentary formation consisting mostly of tuffs and tuffitic shales. To the west, the Psí hory mining district extends to the margin of the biotitic-amphibolic granodiorite of the Central Bohemian Pluton.

Towards the end of the 20th century the Psí hory district was systematically explored in connection with the potential revival of gold mining. There are two gold-bearing deposits in the area – the Čelina deposit, mined as early as in the middle ages, and the Mokrsko deposit. The Čelina deposit and the eastern Mokrsko ore-zone are situated in the tuffs and volcanites of the Jílovské belt. Most of the western Mokrsko ore zone lies in the granodiorite of the Central Bohemian Pluton.

The gold reserves in this area are some of the richest in Europe. According to recent estimates, local deposits contain up to 130t of the precious metal. The gold mineralization is concentrated in quartz veins and is mostly very fine grained. The average gold content in the rock is no higher than 2g/t, which explains why the Mokrsko deposit escaped the notice of medieval miners; its potential was only fully recognized as late as in the nineteen eighties.

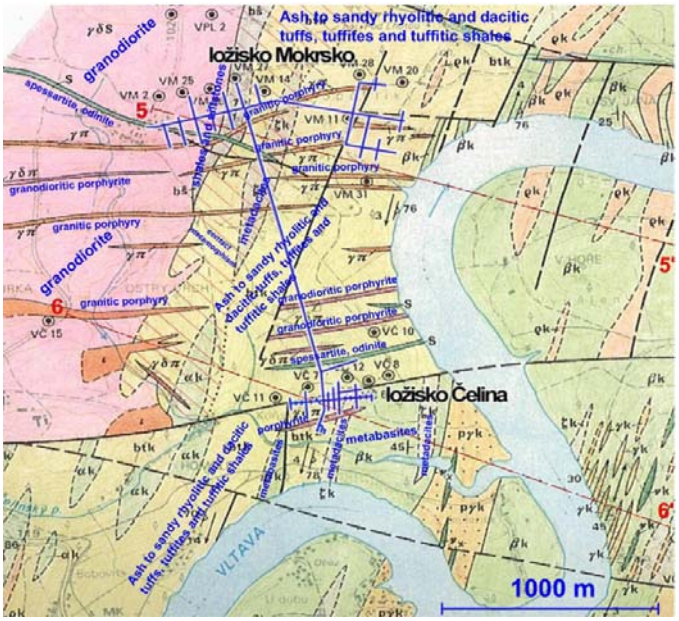

Fig.2. Geology of the Josef Gallery

At the end of the last century, the revival of gold mining in this area was seriously considered; however, the highest concentrations of gold occur at depths of up to 300m meaning that the gold would have to have been exploited by open-pit mining. Moreover, the separation of the gold would have required the use of the environmentally unfriendly cyanide process. Consequently, commercial gold exploitation is not currently envisaged and is not likely in the near future.

THE PLAN TO EXPLOIT THE JOSEF UNDERGROUND GALLERY

The idea of exploiting the Josef underground gallery originated as early as 2003. Following extensive discussions and consideration of the information available, the management of the CTU gave its support to the Faculty of Civil Engineering's plan to establish the Josef UEF as a CTU multidisciplinary workplace. Unlike a number of foreign underground laboratories, the CTU workplace is not single topic-oriented; the size of the Josef underground gallery and its geological diversity allow the participation of a wide spectrum of those interested in experimental research. Since Josef is to be a university workplace, its primary mission is the

education of young scientists – specialists in their respective branches. It is envisaged that the Josef facility will significantly improve the level of practical instruction provided by the Faculty of Civil Engineering. One of the facility's most important areas of activity will be collaboration with outside institutions in solving topical problems concerning construction engineering, ecological engineering, the verification of new building technologies and materials etc. The underground educational facility will eventually provide space for the specialized instruction and training of building company staff (shotcrete technology, bolt lining and anchorage, operation of modern building machinery and devices, health and safety training etc.).

A further use for Josef will be in providing facilities for domestic and international single- as well as multi-disciplinary research projects; the size of the Josef underground exploration gallery allows the performance of large and complex experiments. The designers of the Josef project have gained extensive experience in the exploitation of underground workplaces as part of their research participation in a number of international projects assigned by the European Union. Such experience has shown that performing experimental projects in underground facilities sets high financial demands and that without EU grant support such projects would not be practically feasible in the Czech context. It is envisaged that the Josef Facility will allow a wide range of interested parties to work on their research projects in ideal underground conditions and, moreover, that good value for money will attract academic institutions from other EU member states.

PROJECT IMPLEMENTATION

In 2004, the CTU signed a contract of cooperation with the Metrostav civil engineering company in which both parties agreed to build a joint workplace to be known as the Josef UEF. At the same time, Metrostav undertook to put the Josef gallery into operation at its own expense.

In March 2005, a loan agreement concerning the Josef underground exploration gallery was concluded between the CTU and the owner of the Josef gallery, the Czech Ministry of the Environment (MŽP). In August 2005, Metrostav removed the concrete plugs blocking the entrance to the main gallery.

In September 2005 the Prague Mining Rescue Service carried out a detailed survey of the Josef complex concluding that: "The condition of the Josef underground complex allows its use as an underground educational and research facility".

In February 2006 CTU concluded a lease contract with the owner (Lesy CR s.p.) of the land concerned (15,000m^2). At the same time, negotiations on the purchase of the land commenced. Based on the results of the above-mentioned survey, Metrostav designed a project concerning the commissioning of the underground facility.

In April 2006 CTU won a European Structural Funds JPD3 grant to cover the funding of the first two years of the trial instruction of students specializing in geotechnics and geodesy.

A building permit was granted on 21st July 2006 and Metrostav began work on the reconstruction of the underground areas on 21st August 2006.

Discussions with the designer of the underground areas of the Josef UEF, IKP Consulting Engineers, and experts from Metrostav resulted in a decision to cater primarily for student instruction needs in the first phase of the reconstruction project (drifts totaling 8.6km in length) by converting a section of the main gallery and the western part of the Čelina zone (Fig. 3).

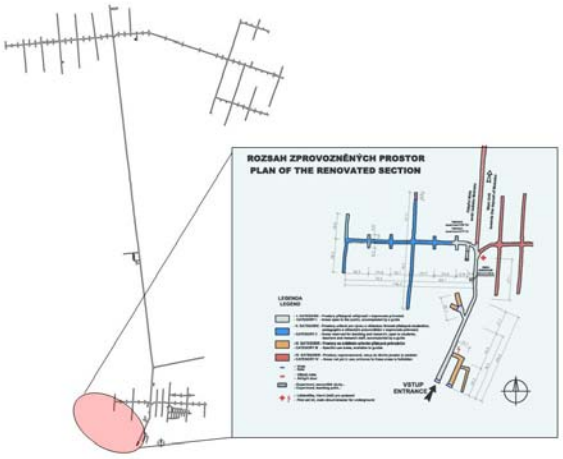

Fig.3. The Josef gallery – reconstructed underground complex to be used for educational purposes

Work concerning the commissioning of the underground areas of the facility was completed at the beginning of 2007 upon which, following final official approval, Metrostav handed the underground complex over to the CTU.

Fig.4. View of a gallery intersection during reconstruction

Fig.5. Replica of wooden support system

Subsequent development of the facility will proceed according to a time schedule set out in the JPD3 project. January 2007 saw the inauguration of a pilot instruction project and in June 2007 the Josef UEF was officially opened at a ceremony attended by a host of international and local dignitaries. In September 2007 the underground complex saw the commencement of regular instruction following specially designed CTU study plans. It is envisaged that over 300 students will take advantage of the Josef facility in the first year of teaching (Pacovský, 2006). Teaching programs concerning underground structures commenced at the Josef UEF at the beginning of the academic year 2007/2008. The courses are distinctively practically oriented, thus providing students with a unique opportunity to take real measurements and perform real experiments in an authentic environment (Figs. 5 and 6).

Fig.6. Practical course in underground geodesy

In order to provide support for both the practical and theoretical parts of the various teaching courses several innovative features have been installed in the underground complex with more in the pipeline. The geotechnical features installed to date include:

- a convergence polygon where students have the opportunity to learn and practice measurement techniques and to study their role in the NATM method
- a contact stress measurement demonstration as an element of the wider geotechnical monitoring process
- several blast hole patterns to demonstrate various blasting techniques
- rock and soil bolting and nailing demonstrations
- a replica of an historic wooden tunnel support system (1:1 scale, Fig. 5)
- an exhibition of mining equipment

Student visits to the facility vary according to course requirements and are organized at several levels. A typical first visit to the UEF will aim to provide the student with an initial practical insight into issues involving soil and rock mechanics and underground structures.

As the course progresses, the student returns to Josef for further practical training at which time the number of students is limited allowing each student more tutor time and resources to successfully complete the various demanding tasks involved in the course (e.g. drilling etc.).

The Josef Gallery is particularly suitable for experimental work on bachelor and diploma theses. Teaching programs are provided by three Faculty of Civil Engineering CTU departments - the Centre for Experimental Geotechnics and the Geotechnics and Special Geodesy Departments (Fig. 6).

Fig.7. Practical rock mechanics and underground structures course

RESEARCH AT THE JOSEF FACILITY

The Josef UEF provides ideal conditions for in situ research requiring direct contact with the rock massif.
Currently the CEG is involved in the TIMODAZ (Thermal Impact on the Damage Zone around a Radioactive Waste

Disposal Vessel in Clay Host Rocks) project which is supported by the EU 6th Framework Program.

The aim of the research is to investigate the effects of long-term thermal load on lining stability; the concept behind the research i.e., to determine the "ideal" form of spent nuclear fuel transformation technology in the mid- to long-term, follows extensive global discussion on this theme. Any eventual spent fuel transformation technology will require the safe removal of spent fuel from deep underground disposal. The extreme long-term functioning of the lining around the disposal vessel is one of the premises for the safe removal of spent fuel canisters from the engineered barrier. The long-term effects of heat could well bring about a severe reduction in the stability of the lining caused either by deterioration in the strength properties of the lining material or by the occurrence of deformations resulting in a collapse in the shape of the lining.

The experiment will consist of two physical tunnel lining models which will simulate two extreme cases of the effects of temperature on lining stability:

- An underground silo experiment at the CEG laboratory
- An "in situ" experiment at the Josef facility

The in situ experiment will simulate a thermally loaded lining (90°C) which is not permitted to deform towards the rock massif and which therefore will experience an increase in stress. Long-term continuous measurement performed on the fully-instrumented model will prove whether or not stresses exceeding the strength properties of the lining material are likely to develop within the lining.

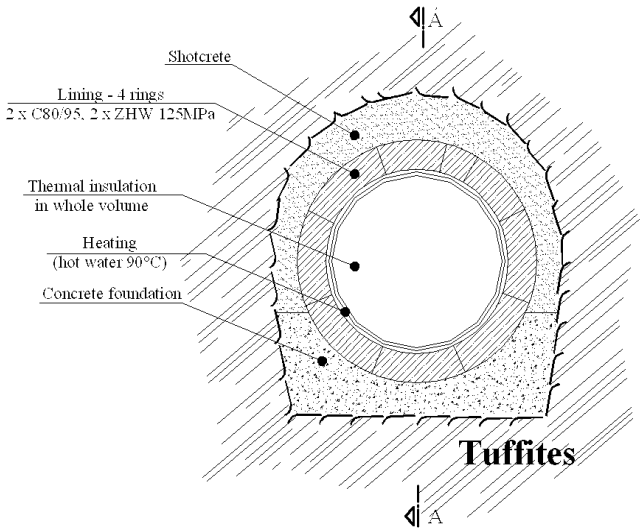

Fig.8. Cross section of an experiment performed as part of the EU TIMODAZ project in a chamber of the Josef Gallery

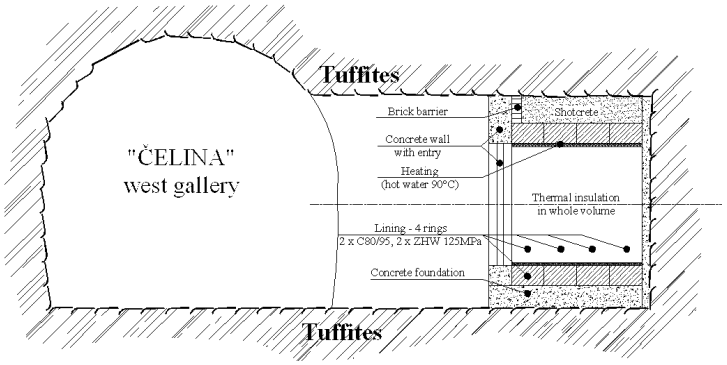

Fig.9. Longitudinal section of the TIMODAZ experiment

A short drift in the renovated part of the Josef gallery (the West Čelina belt) was chosen for the construction and performance of the experiment (Figs. 8 and 9).

The rock environment within which the experiment is being constructed consists of tuffites with high compression strength (230MPa). Thermal conductivity is approximately 3.6W/mK; specific density is approximately 2740kg/m^3.

CONCLUSION

The reconstruction of a part of the abandoned Josef underground workings for practical educational purposes is the first step in an ambitious project to convert the whole of the underground space available. As resources permit, the extensive network of galleries will be transformed to provide the ideal environment for the research involved in domestic and international experimental projects, for the specialized training and instruction of building company staff, and for the demonstration of modern building technologies and products by both Czech and foreign construction companies. The disused two-storey building at the Josef site, which was donated to the Faculty of Civil Engineering by its owner (MŽP) in 2005, will be converted into surface premises to serve the underground educational facility. If the underground area is to be exploited to its full extent, good quality surface premises will be required for use as offices, laboratories, accommodation, storerooms, workshops etc.; therefore plans have been made for the building's complete reconstruction.

The Josef UEF complex is situated in beautiful natural surroundings popular with tourists and negotiations with the local authority resulted in the Josef UEF being included as a feature of an innovative instructive walking trail. Tours of the underground complex can be provided for the general public by appointment.

ACKNOWLEDGEMENTS

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REFERENCES

Morávek, P. [1996]. The Mokrsko Gold Deposit. Gold Deposits in Bohemia: pp. 31–56, Czech Geological Survey, Prague

Pacovský, J. [2006]. The Josef Underground Educational Facility Project. Proc. 9th International Conference on Engineering Education, Puerto Rico, San Juan. pn 3079.

Pacovský, J., Svoboda, J., & Vašíček, R. [2007]. The Josef underground educational facility project. Underground Space – the 4th Dimension of Metropolises – Proc. of the 33rd ITA-ITES Word Tunnel Congress, Prague, CZ, Vol. I, pp 631-634, © 2007 Taylor & Francis Group, London, ISBN 978-0-415-40807-3