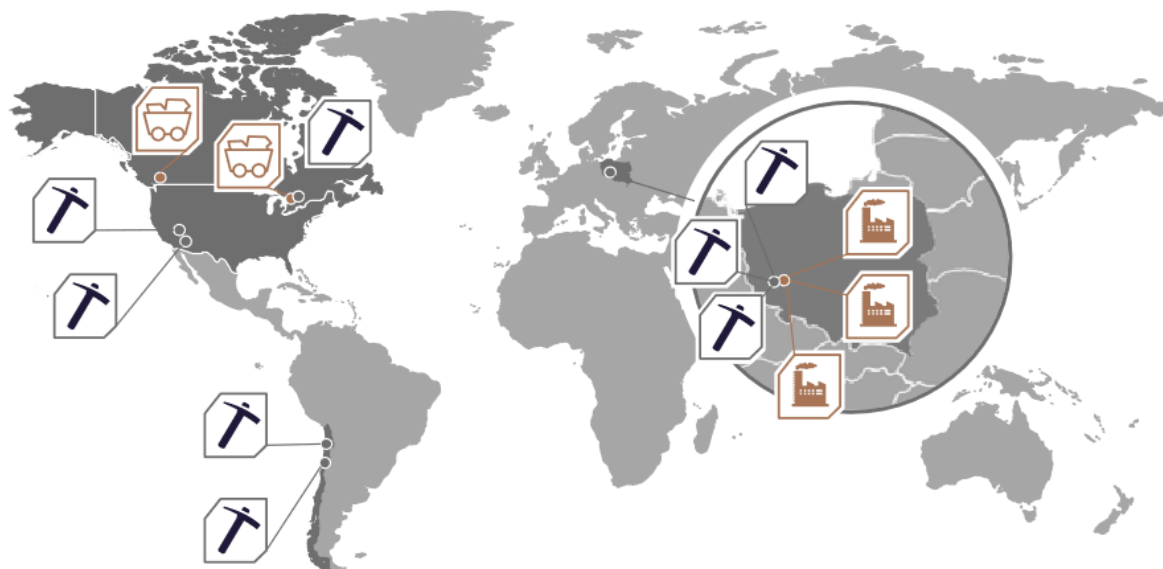




# UNDERGROUND WORKINGS AS A MOST SUITABLE PLACE FOR THE DEVELOPMENT OF MINING TECHNOLOGIES - A CASE STUDY FROM POLISH COPPER MINES

# KGHM Polska Miedź S.A. company



Legend: Mining projects of KGHM Mines of KGHM Metallurgical facilities of KGHM

Seventh  
largest  
copper  
producer\*



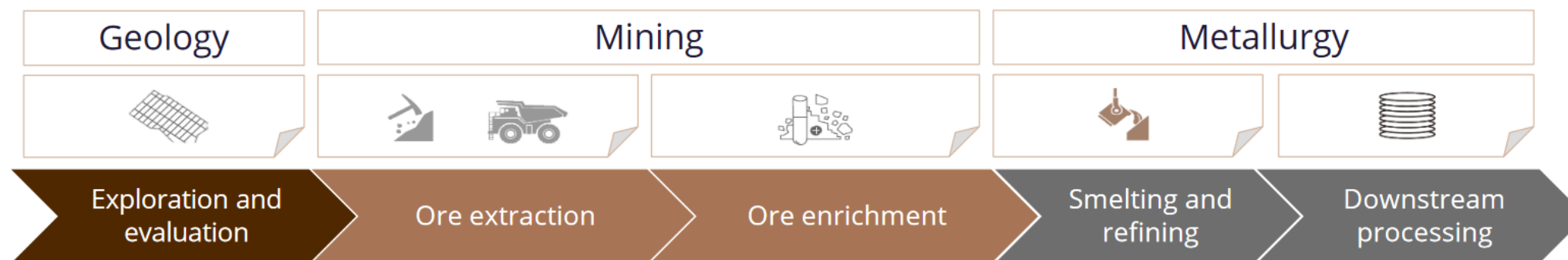
Second  
largest  
silver  
producer\*



\* data for 2020

Other KGHM Group products:

- Molybdenum
- Lead
- Nickel
- Gold
- Palladium
- Platinum
- Rhenium
- Sulphuric acid
- Selenium
- Copper sulphate
- Nickel sulphate



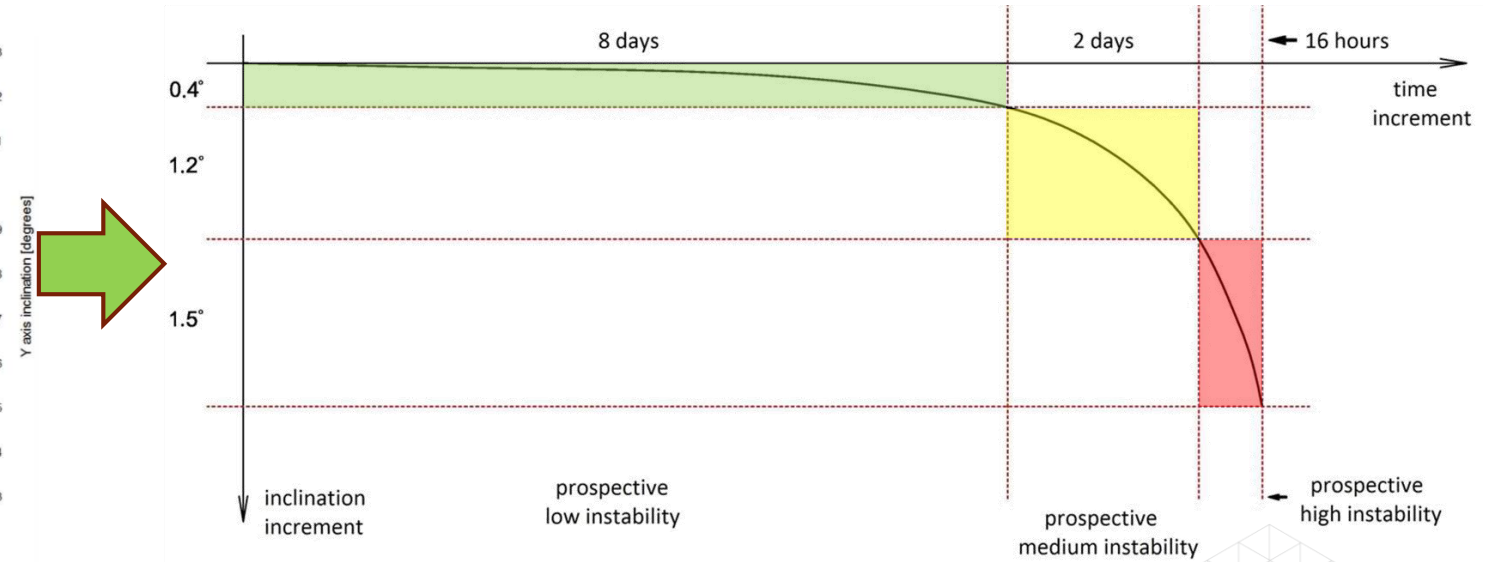
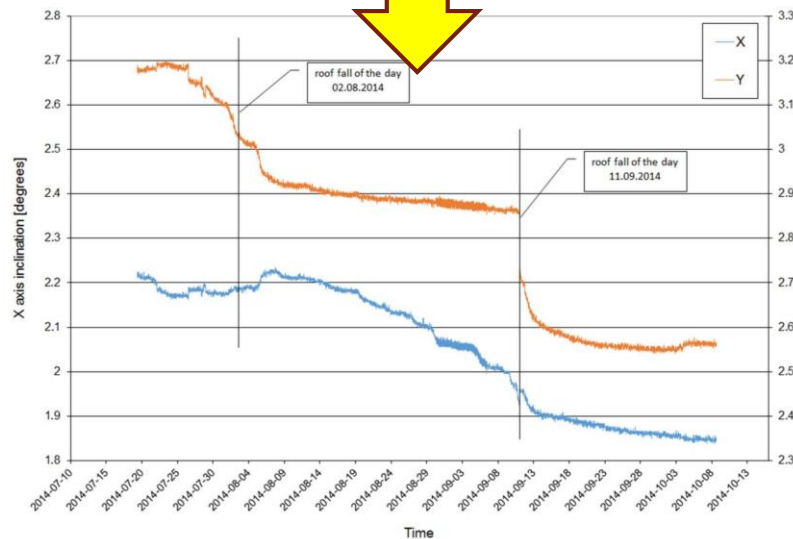
# Stability monitoring systems – CNS sensors



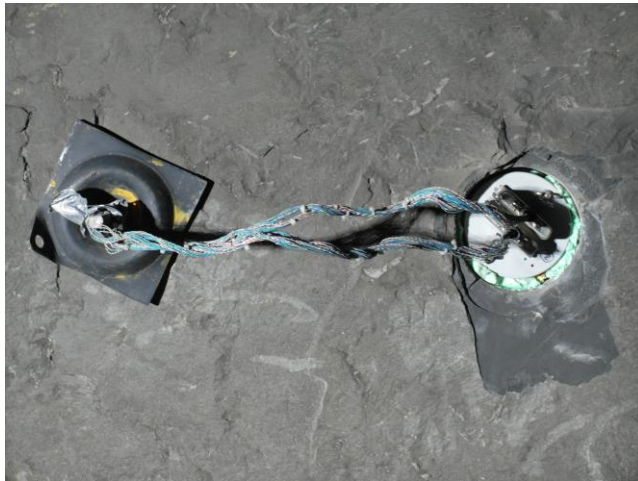
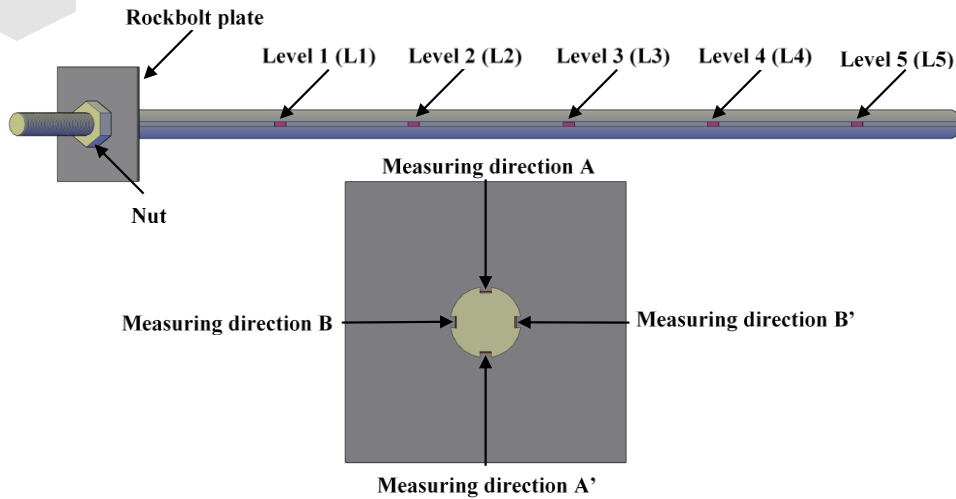
According to the Author's experience due to variety of strength parameters of rocks and the stochastic nature of rock disintegration, **it is impossible to draw a reliable conclusion** in terms of dependence between the velocity of roof deflection and roof fall hazard **based only on theoretical or laboratory analyses**.

In turn, **based on long-term continuous underground measurement** of roof deflection **it is possible to determine instability hazard zones** what was done in all underground copper mines in Poland.

A newly developed inclinometric system, tested in in-situ conditions was successfully implemented in regular operation in KGHM mines.

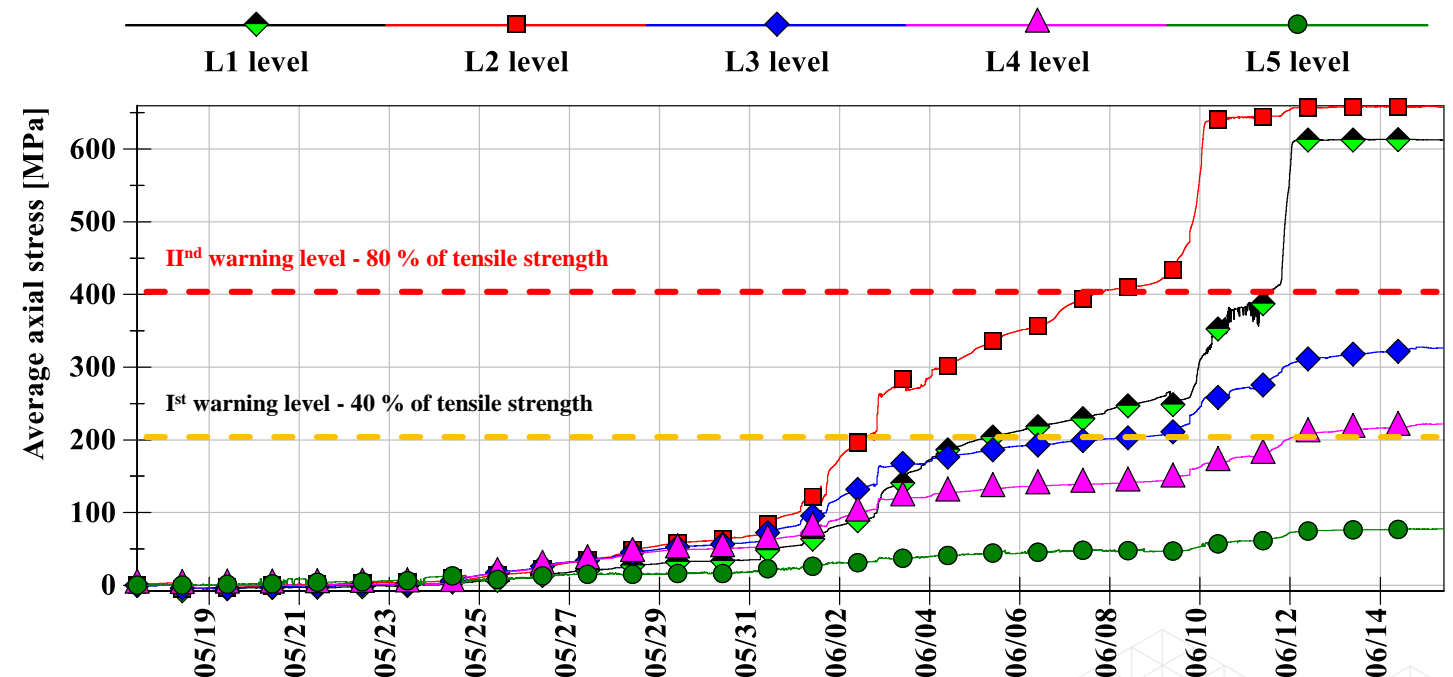


# Stability monitoring systems – Instrumented rock bolts

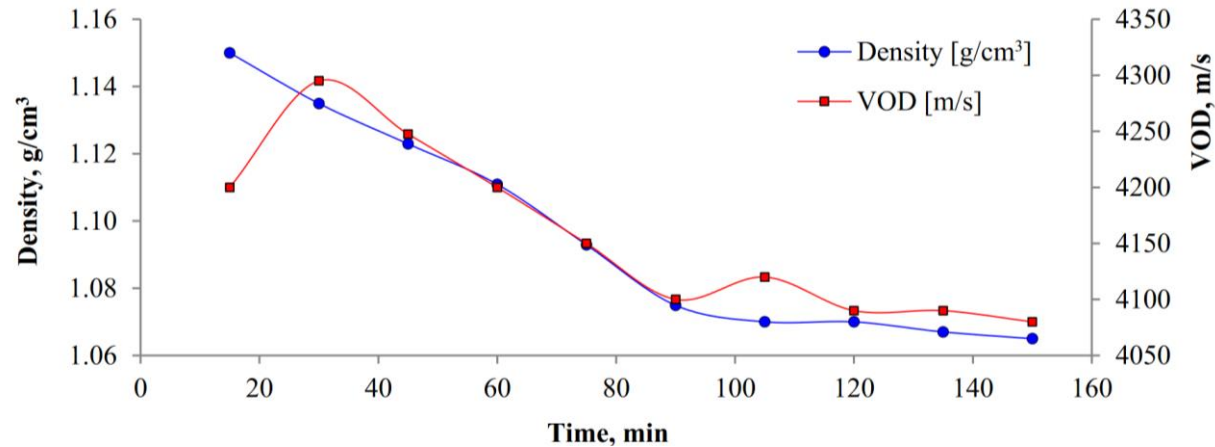


On the basis of detailed in-situ stress analyses, the warning levels for rock bolt support were determined.

Now with the use of newly developed instrumented rock bolts, it is possible to track stress changes and indicate when and where roof instability may be expected. Such analyses are not possible with the use of for example numerical modelling, due to the lack of reliable data about the current rock mass strength.



# Testing of explosives – verification of parameters

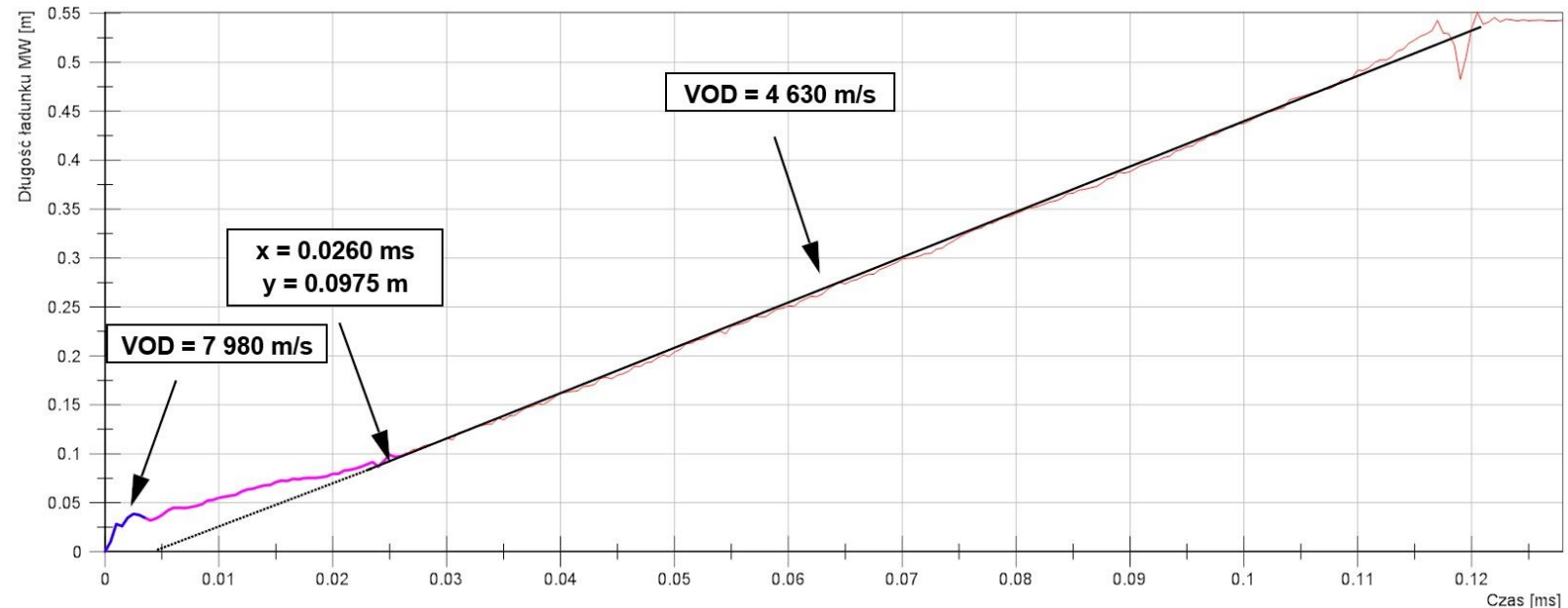


The efficiency of the excavation process as well as the effectiveness of rockburst prevention is strictly related to the performance of explosives used during blasting works.

Unfortunately, parameters which may be used to describe the Energy of detonation like the Velocity of Detonation, are sensitive to any changes of the environment.

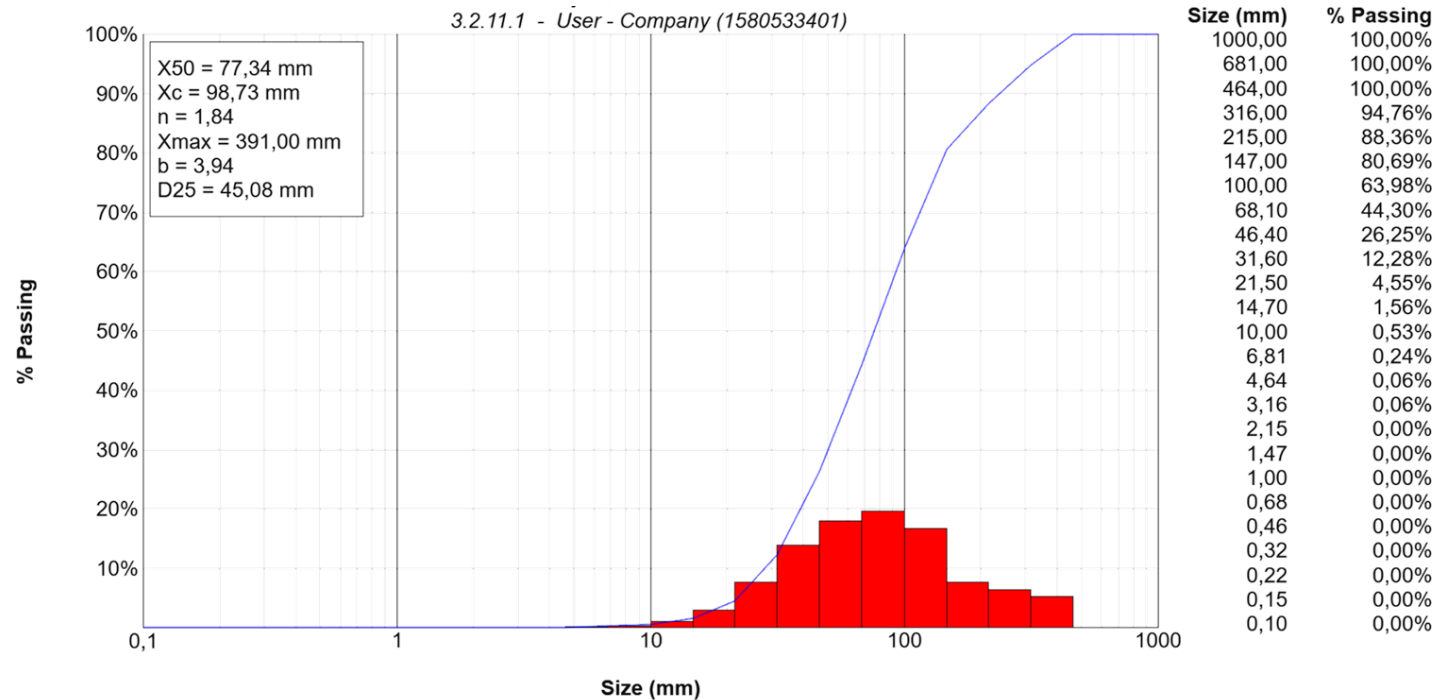
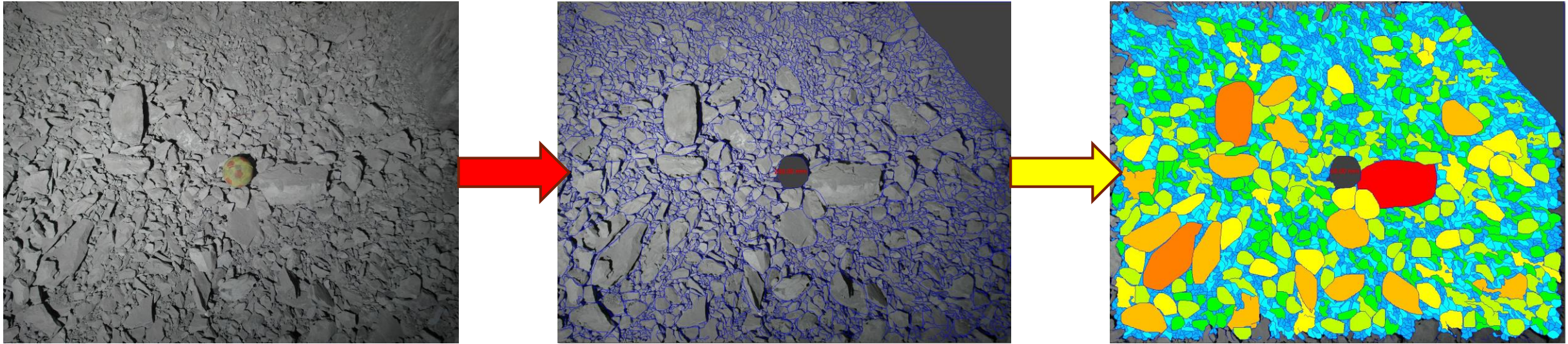
Temperature, humidity, and diameter of a charge are factors which affect the „power of explosion”

In such a case, most of the measurements performed in control laboratory conditions are not cover results obtained in in-situ conditions.

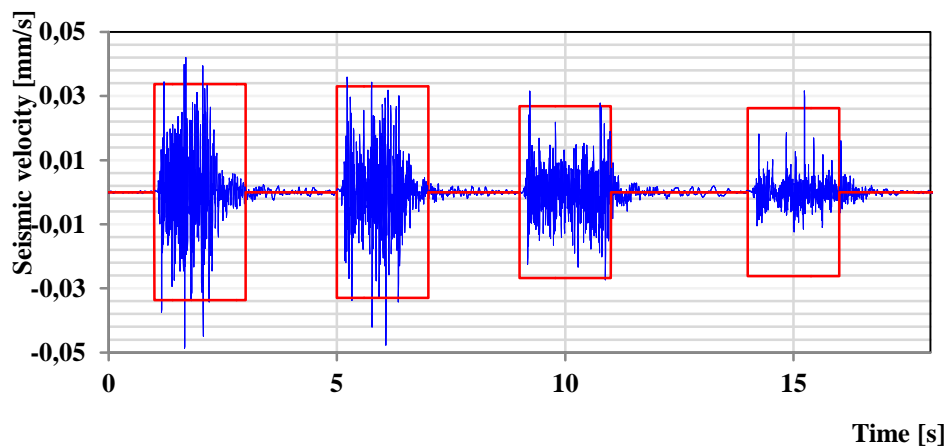
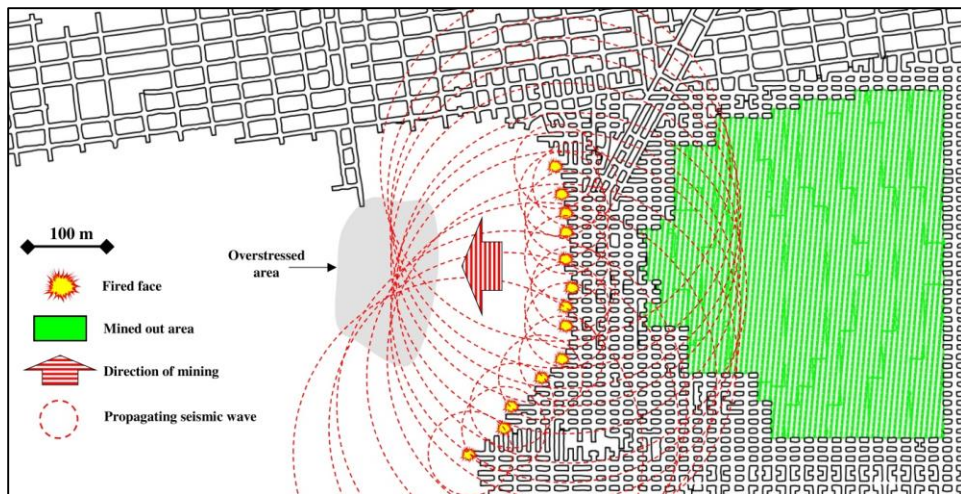




# Performance of explosives – rock fragmentation

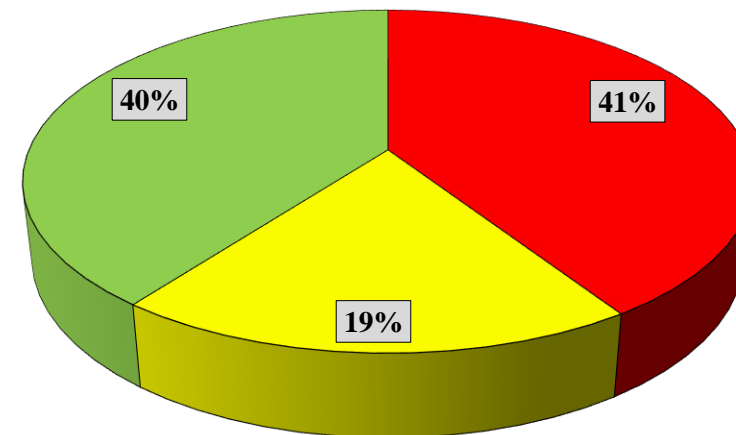


# Improvement of rockburst prevention

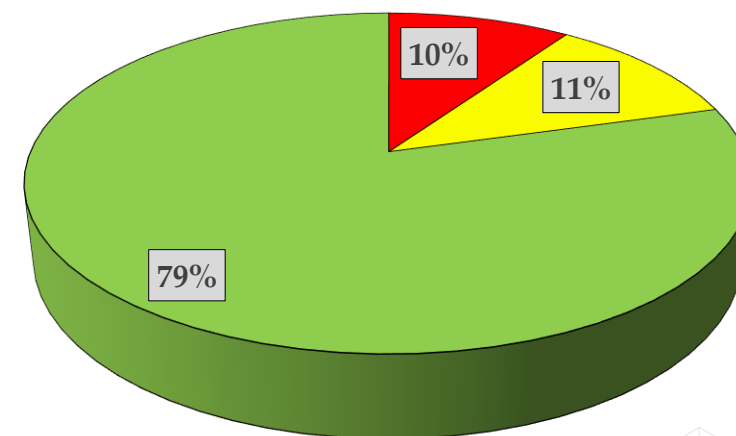


Effectiveness before  
modifications

■ Ineffective ■ Moderately effective ■ Highly effective

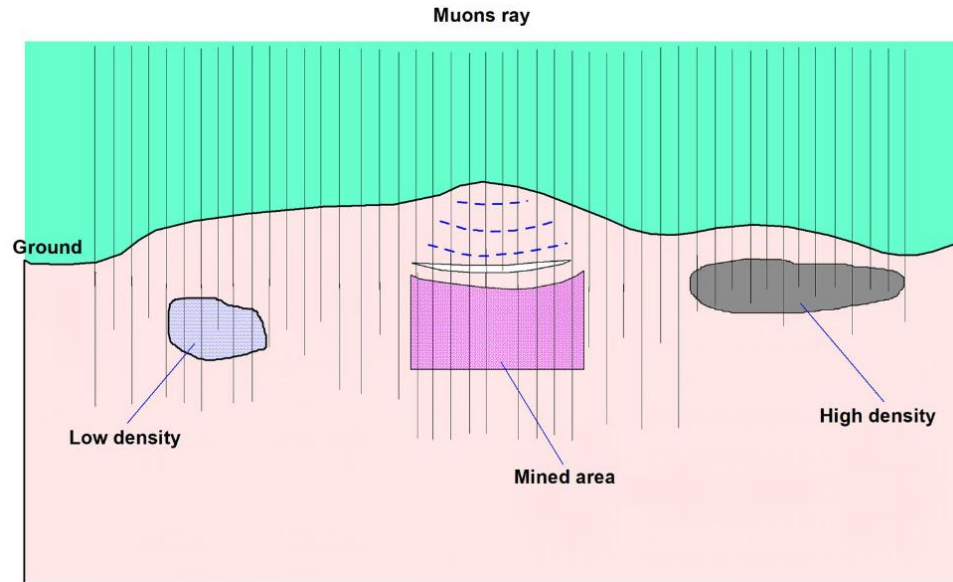


Effectiveness after  
modifications



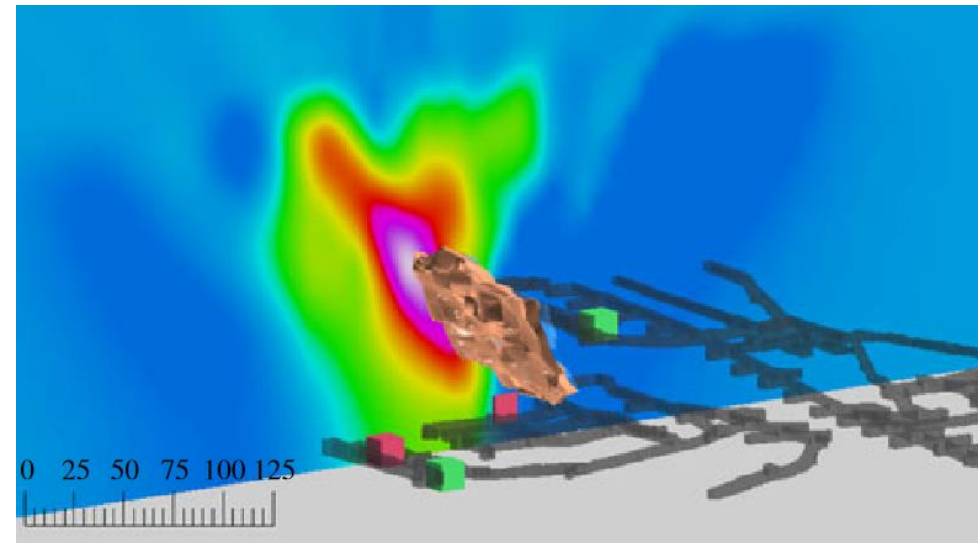
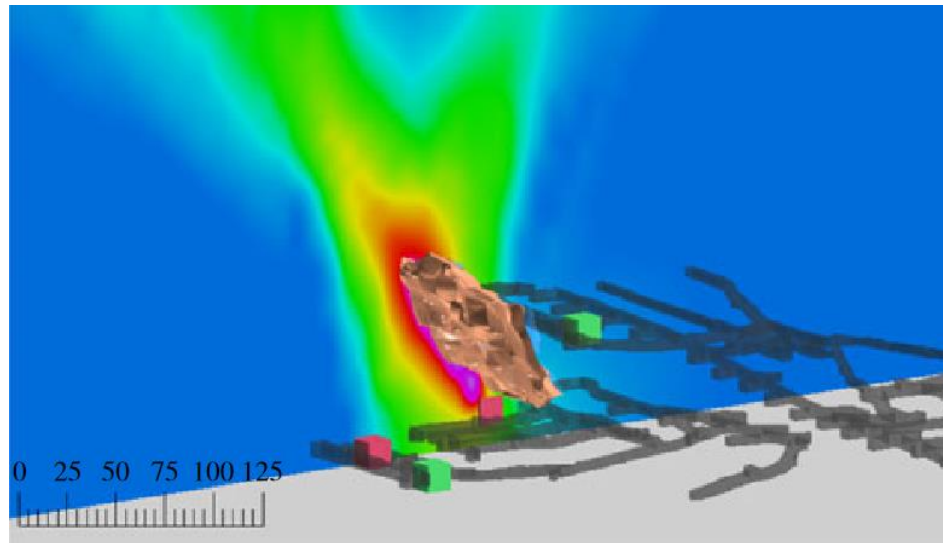


# Novel technologies – 3D rockmass imaging



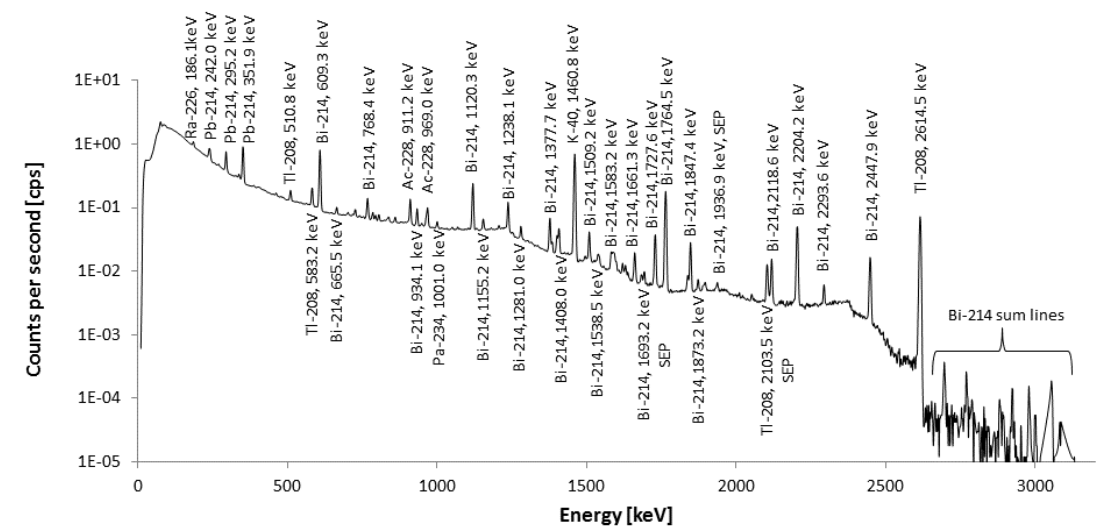
An underground site is also a suitable place for performing innovative non-mining research.

One of the most recent projects aimed at the development and testing of novel exploration methods is the AGEMERA initiative where 3D muography usefulness will be evaluated.

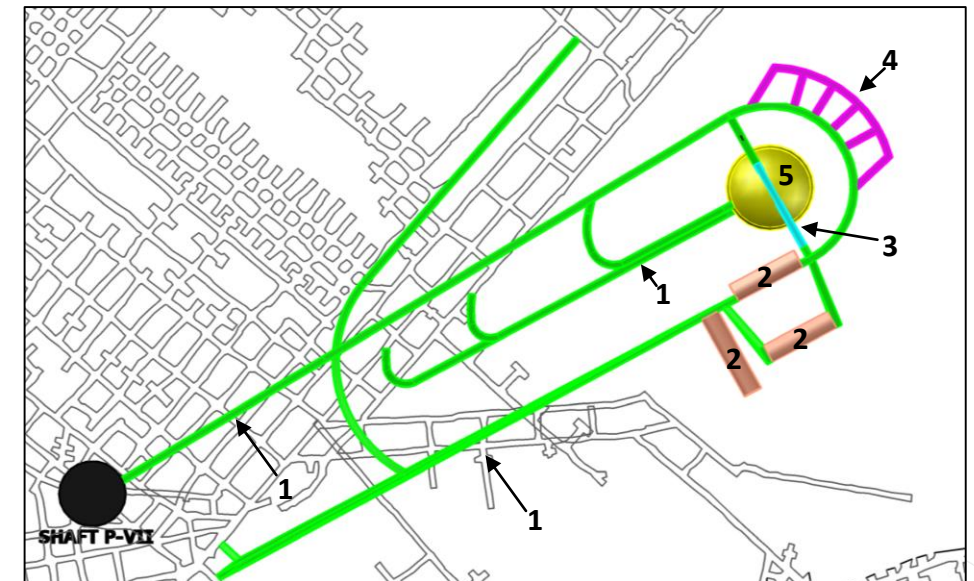




# Physical and astrophysical measurements



Underground space, due to unique environment, offers several opportunities in the field of science, research, and education. Rapid development is visible mainly in the scope of advanced physical measurements deep under the ground surface. This is due to the presence of natural coverage that provides a significant reduction of cosmic ray flux or flux of neutrons when compared to the surface. As a result, numerous underground laboratories aimed strictly at astrophysical measurements have been set up during the last twenty years.





THANK YOU FOR YOUR  
ATTENTION



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