



XXVII FIG CONGRESS

11-15 SEPTEMBER 2022
Warsaw, Poland

Volunteering
for the future –
Geospatial excellence
for a better living

Measuring, Protecting and Spreading the Knowledge About Underground Cultural Heritage with the Usage of Modern Technologies

Agnieszka Ochałek

Tomasz Lipecki, Wojciech Jaśkowski and Mateusz Jabłoński

AGH University of Science and Technology (Poland)

Faculty of Geo-Data Science, Geodesy, and Environmental Engineering

ORGANISED BY



PLATINUM SPONSORS



UNDERGROUND CULTURAL HERITAGE

UNDERGROUND OBJECTS
NATURAL AND
ANTHROPOGENIC ORIGIN -
HAD AN ENORMOUS
INFLUENCE ON THE
DEVELOPMENT OF
UNDERGROUND
CONSTRUCTION AND
ARCHITECTURE

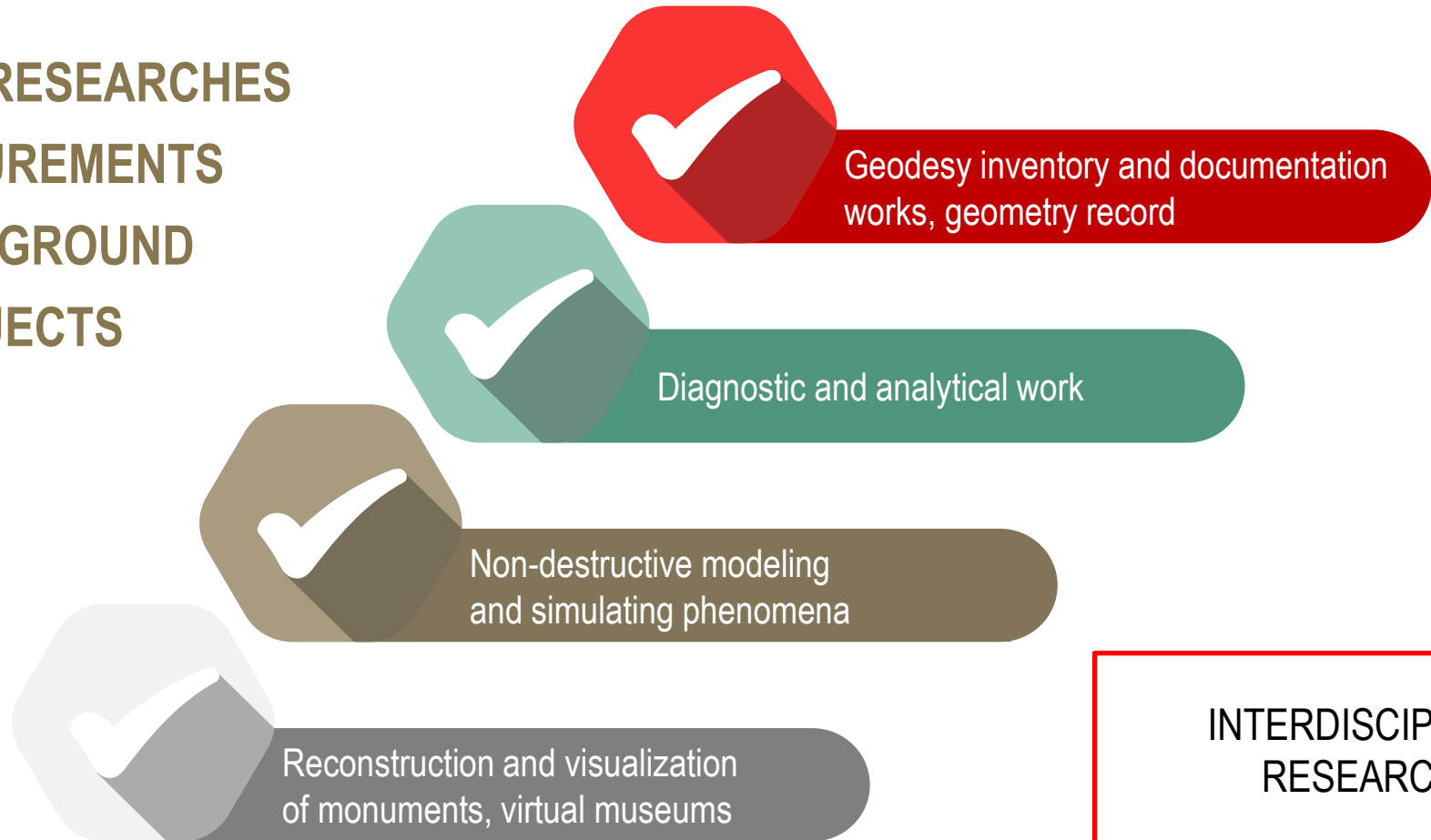
ROCK MASS STABILITY
MUST BE VERIFIED
BEFORE THE
UNDERGROUND TOURIST
ROUTES ADAPTATION
PROCESS



INCREASED INTEREST
IN UNDERGROUND
MUSEUMS AND TOURIST
ROUTES ALL OVER
THE WORLD

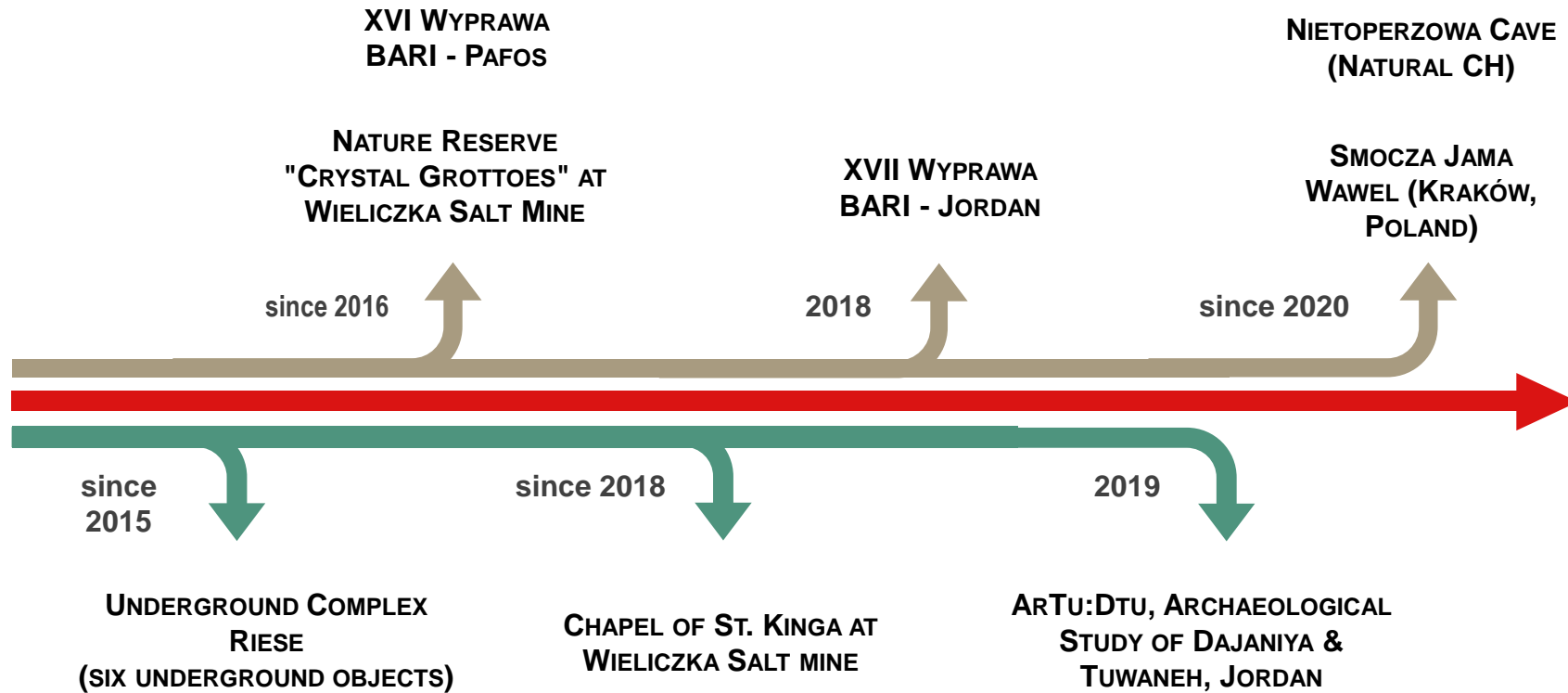
ROCK MASS PROCESSES
CASE THAT EACH
UNDERGROUND FACILITY
NEEDS TO BE INVENTORIED
AND CONTROL

AIMS OF THE RESEARCHES AND MEASUREMENTS AT UNDERGROUND CH OBJECTS



**INTERDISCIPLINARY
RESEARCHES**

EXPERIENCE IN RESEARCHES AND MEASUREMENTS AT MANY DIFFERENT CULTURAL HERITAGE OBJECTS



RIESE COMPLEX



Fig.1. Complex Riese, Poland.
Source: Own graphic design



Fig. 2. Flooded drifts of Włodarz Complex.
Source: own archive.



Fig. 3. Measurement with a TLS methodology in the Włodarz Complex.
Source: own archive.

OSÓWKA COMPLEX

- ➔ Field Measurements:
TLS, Tacheometry,
GNSS positioning
- ➔ Point Cloud post-
processing, Georeference
3D modeling, geometry
analysis
- ➔ Attempt to answer the
hypothesis - whether all
the complexes were
built to be connected
with each other?

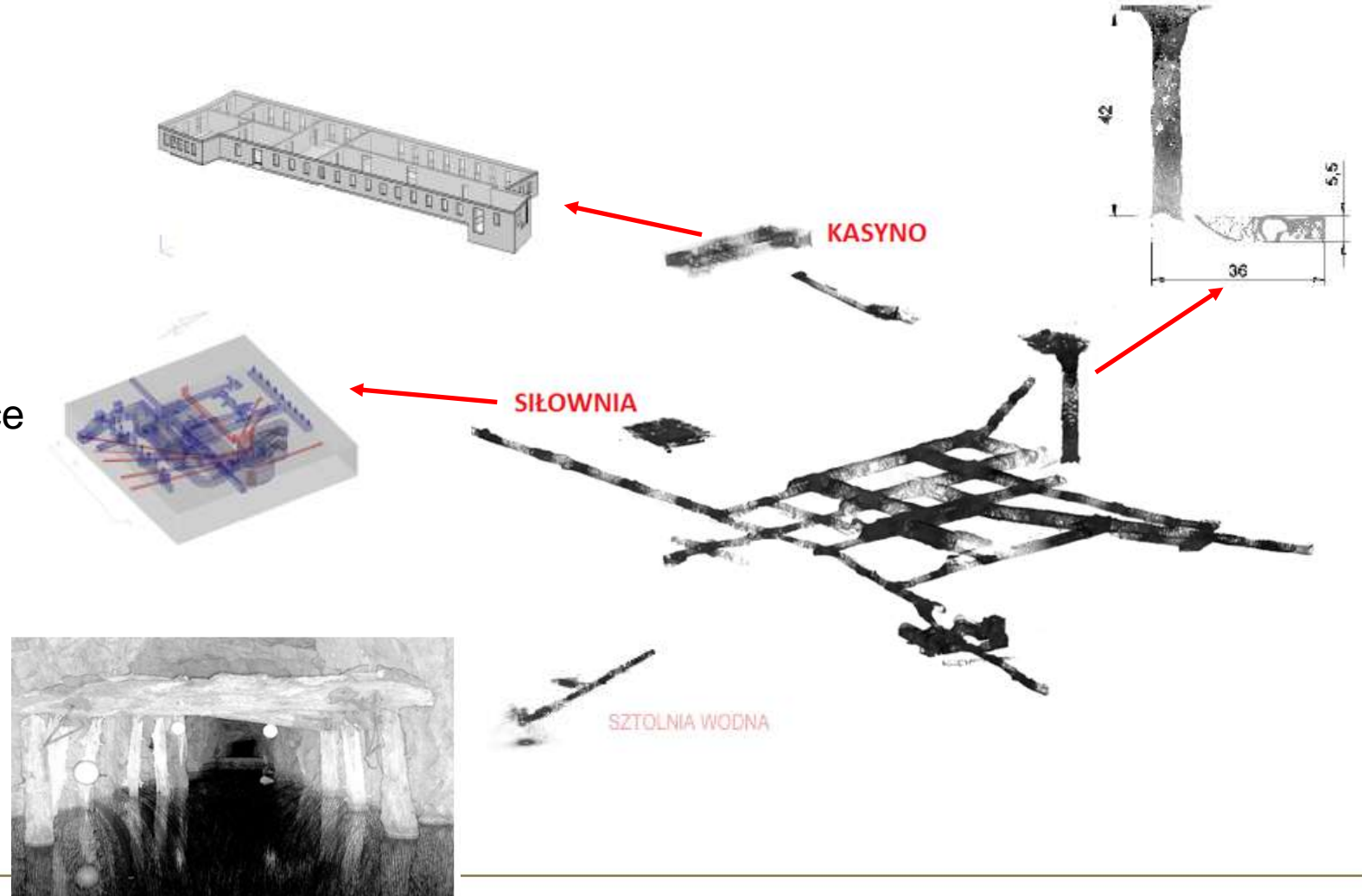


Fig. 4. Osówka Complex documentation.
Source: own archive.

WŁODARZ COMPLEX – MEASUREMENTS WITH GEOSLAM ZEBHORIZON HANDHELD LASER SCANNER



Enables the simultaneous location of many machines and terrain mapping within a range of up to 100 m

Indoors and outdoors

Ultimate mounting flexibility

Fig. 4. GeoSLAM ZEB Horizon.
Źródło: <https://geoslam.com>



Fig. 5. Measurement with a GeoSLAM ZebHorizon in the Włodarz Complex.
Source: own archive.



Fig. 6. Measurement with a TLS methodology in the Włodarz Complex.
Source: own archive.

➡ All measurements, thanks to the use of a handheld scanner, took 2 days. If only a stationary scanner was used during the measurements - the measurements would be significantly longer and could take up to a week due to the fact that the object was large. The measurement with the Zeb Horizon scanner itself took few hours, and the post-processing of data in the GeoSLAM Hub + Draw program was several hours.

VIZUALIZATION AND WORKING ON THE POINT CLOUD OBTAINED BY GEOSLAM

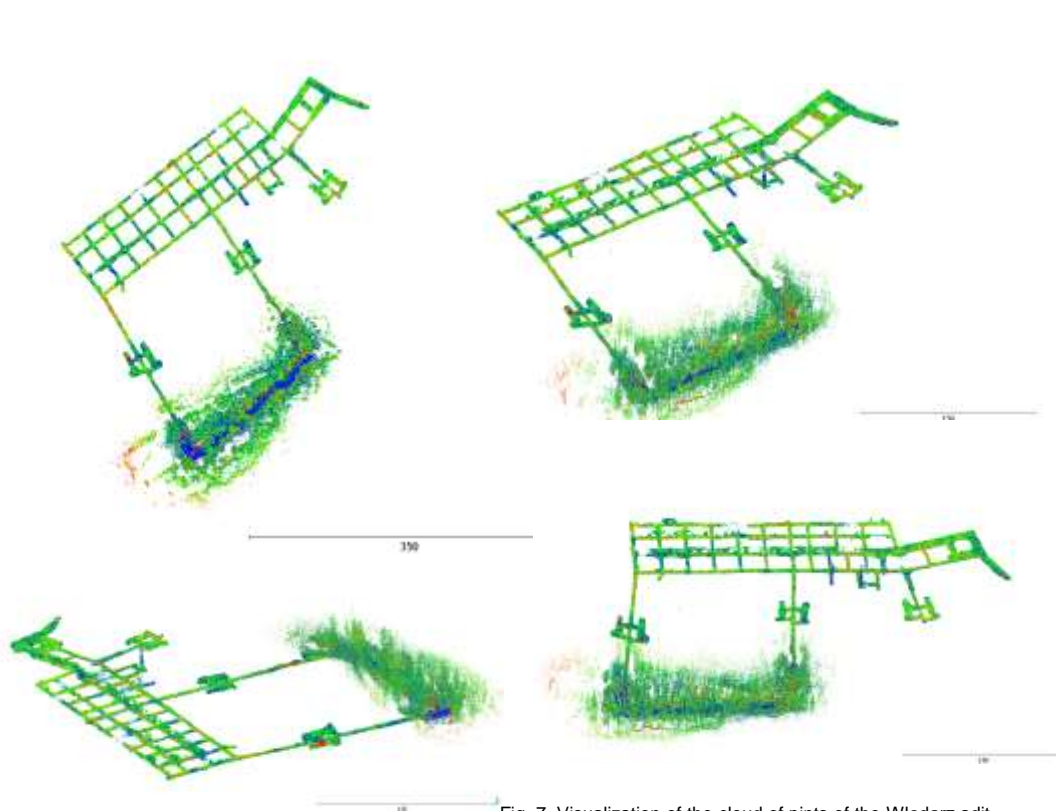


Fig. 7. Visualization of the cloud of pints of the Włodarz adit.
Source: own archive

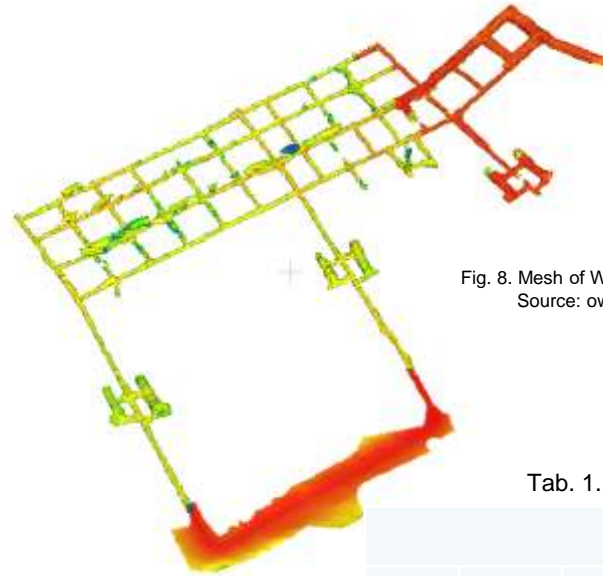


Fig. 8. Mesh of Włodarz Complex.
Source: own archive

Tab. 1. Data from geodetic inventory of Włodarz Complex

Włodarz Complex						
Number of entries	Length [m]	Surface [m2]	Cubature [m3]	Shaft	Height m.a.s.l	Concrete surface
4	2955	10 996	40 520	length: 47m diameter: 6m	496 m - 503 m	Under 1%

WIELICZKA SALT MINE (POLAND)

**CONVERGENCE
MEASUREMENTS**

**MEASUREMENT
OF HORIZONTAL
AND VERTICAL MOVEMENT**

- precise leveling
- precise polygonization method enhanced by gyroscopic measurements
- terrestrial laser scanning



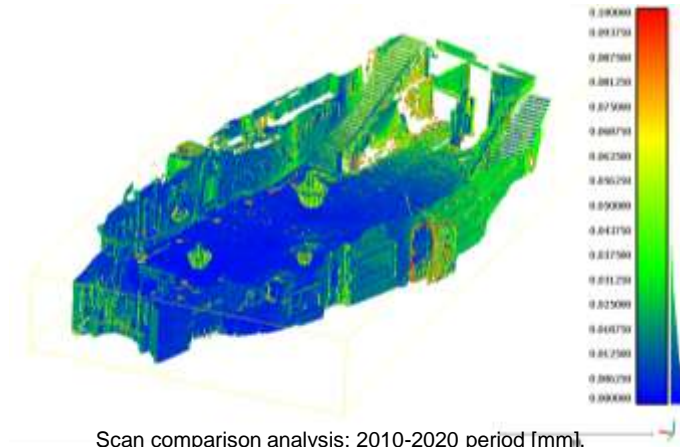
8. Measurements in the Chapel of St. Kinga.
Source: own archive.



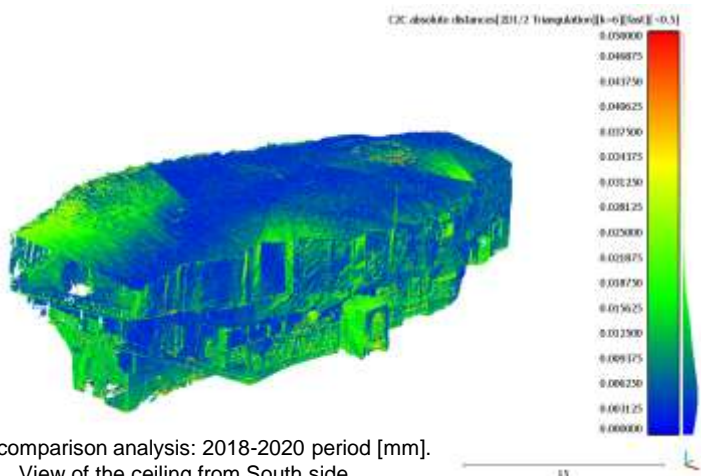
9. Underground giroscopic measurements.
Source: own archive.

WIELICZKA SALT MINE (POLAND)

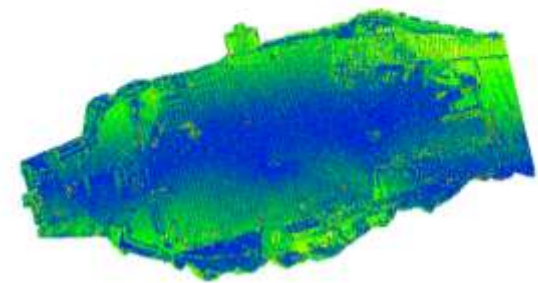
- Five measurement periods: 2010, 2012, 2016, 2018, 2020.
- In the period 2018-20 and 2010-2020, the analyzes carried out revealed the activation of a part of the south-eastern side of the wall, near the stairs.



Scan comparison analysis: 2010-2020 period [mm].
View of the floor from the South-West side.

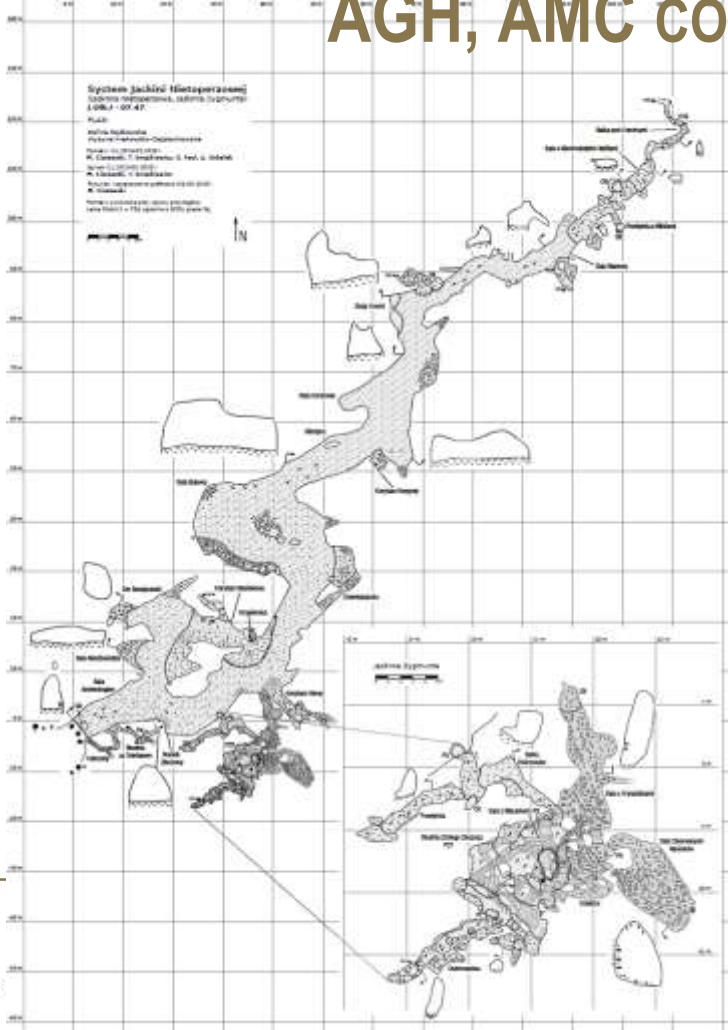


Scan comparison analysis: 2018-2020 period [mm].
View of the ceiling from South side.

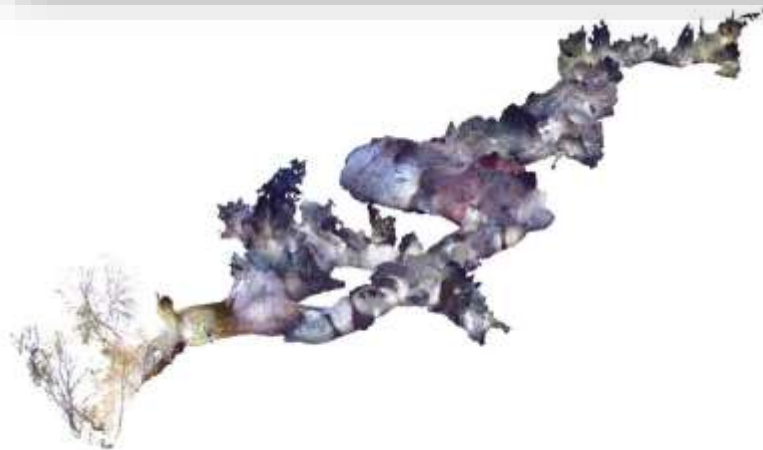


Scan comparison analysis: 2018-2020 period [mm].
View of the floor from South side.

NIETOPERZOWA CAVE - A PROJECT IMPLEMENTED AS PART OF COOPERATION BETWEEN UST AGH, AMC COMPANY AND THE KRAKOW CLUB OF CAVE CLIMBING



https://www.youtube.com/watch?v=TmBflp_fBI



REALLY QUIICK CONCLUSIONS



- ➔ Laser scanning (also handheld) is a universal and non-contact method, combined with classic geodetic techniques, is used in the inventory of both underground mining facilities (mines) and mining facilities with a historical significance.
- ➔ The point clouds created as a result of laser scanning allow for the creation of spatial models of objects, and their post-processing for the implementation of further computer analyses.
- ➔ Handheld scanners (including Zeb Horizon) reproduce underground drifts with sufficient accuracy, making it possible to prepare documentation about historic underground cultural objects. However, it is not recommended for using them for accurate measurements such as deformation evaluation.
- ➔ Geodata can be useful for historians, geophysicists, archaeologists and geologists, which emphasizes the interdisciplinary nature of the research. The projects have also proved to be extremely useful in the social sphere for scientists and museums alike.



XXVII FIG CONGRESS

11-15 SEPTEMBER 2022
Warsaw, Poland

*Volunteering
for the future –
Geospatial excellence
for a better living*

Measuring, Protecting and Spreading the Knowledge About Underground Cultural Heritage with the Usage of Modern Technologies

[Agnieszka Ochalek – aga.ochalek@gmail.com](mailto:aga.ochalek@gmail.com)

Tomasz Lipecki, Wojciech Jaśkowski and Mateusz Jabłoński
AGH University of Science and Technology (Poland)

Thank you very much for your precious time!

ORGANISED BY



PLATINUM SPONSORS

