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MOBILE SCANNING SYSTEMS IN THE SITE INVENTORY OF OPERATIONAL MINES - EXAMPLE OF THE MIKOSZOW AND STRZELIN GRANITE MINES

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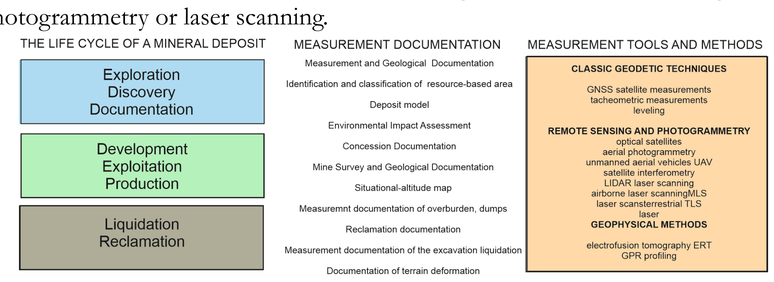
INTRODUCTION

At each stage of the deposit management, mining engineers, geologists, surveyors, environmental protection specialists deal with: acquisition, storage, processing and sharing of data describing deposit parameters, parameters operation and environmental parameters. Until now, open-pit mine maps have been created using conventional mine maps measurements with low point density, which often resulted in poor map accuracy. New mapping techniques have been successfully incorporated into modern operations mining around the world. For obtaining high resolution images commonly three types of space and airborne remote sensing techniques are used: satellites, manned aircrafts and UAVs as well as taking measurements in the geodetic field classical methods, using photogrammetry or laser scanning.

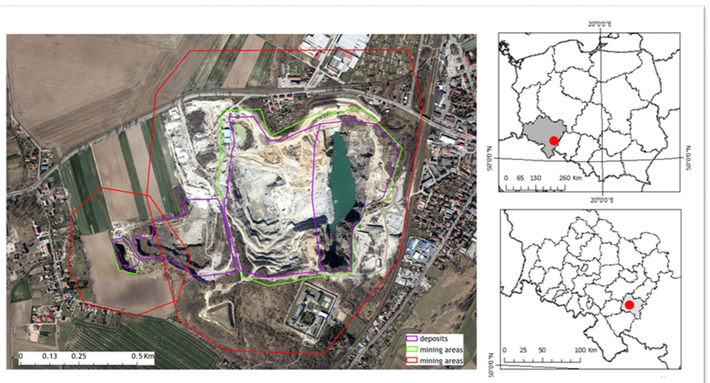


Use of spatial measurement data in the life cycle

Nowadays, hybrid sensors such as Mobile LiDAR Systems (MLS) are bringing additional benefits value for registering large open pits by offering flexible solutions in terms of accuracy, point density and access to impassable areas. An inventory of various terrestrial laser scanning techniques was carried out (TLS, MLS) to produce high resolution maps for use on everyone the stage of mining activity in opencast mines, including: exploration and deposit exploration, preparatory and release works, exploitation, transport, processing of minerals as well as reclamation and development of the post-mining area. Application of mobile robots (UAV, UGV), advanced analytics (BIG DATA, artificial intelligence), cloud computing, data visualization modeling spatial, etc. enables the acquisition of reliable data, and after their processing information needed by decision-makers in the mining company.

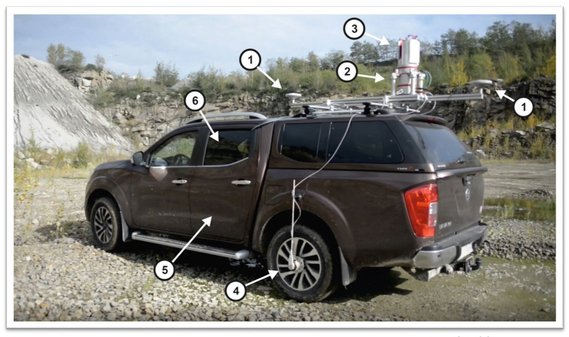
RESEARCH AREA

Granite deposits were selected as the subjects of the experimental research Mikoszów and Strzelin located in the south-west out skirts of the city of Strzelin administratively owned by Strzelin commune, Strzelin poviat and voivod ship Lower Silesia.
Until 2016, the deposit was mined with the use of a mixed wall-shortwall system with parallel advancement of the mining front. The deposit was extracted by drilling and blasting with the use of explosive materials and short and long drillholes.



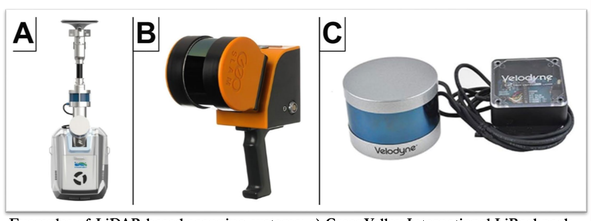
Location of the study area

MATERIALS AND METHODS

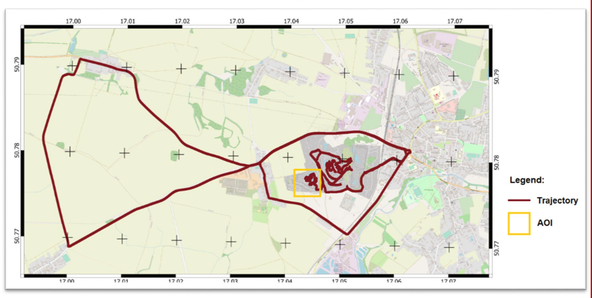


Mobile laser scanning system w trakcie pracy w wyrobisku: (1) GNSS antenna; (2) IMU; (3) Riegl VZ-400i scanner; (4) DMI; (5) power unit (inside the vehicle); (6) driver and control unit – computer with installed software and its operator (inside the vehicle).

The data were recorded for the entire area of the Mikoszów mine and its vicinity. The recording process was performed with the use of the Riegl VMZ 400i hybrid laser scanning system set in the radar mode and Handheld Mobile Laser Scanning Velodyne VLP-16



Examples of LiDAR-based scanning systems: a) GreenValley International LiBackpack DGC50, b) GeoSLAM ZEB Horizon, c) Velodyne VLP-16 with and interface box.

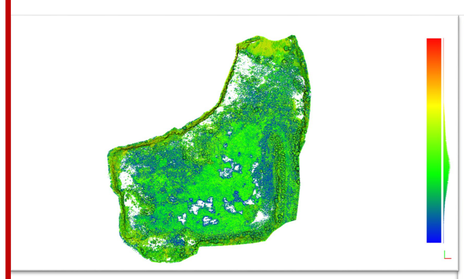


Sketch of the MLS data acquisition trajectory

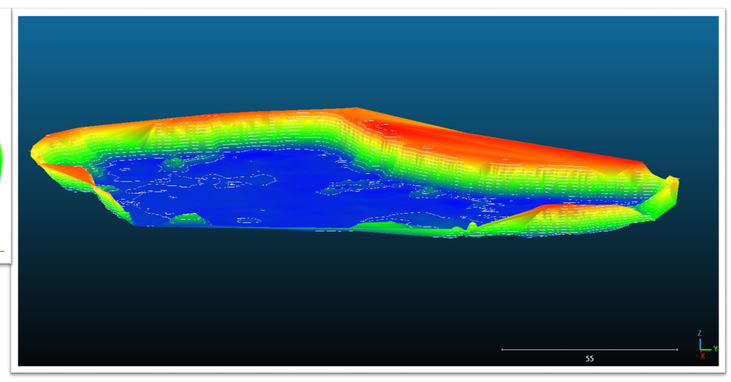
RESULTS

THE NUMERICAL MODEL OF THE EXCAVATION CAN BE USED FOR:

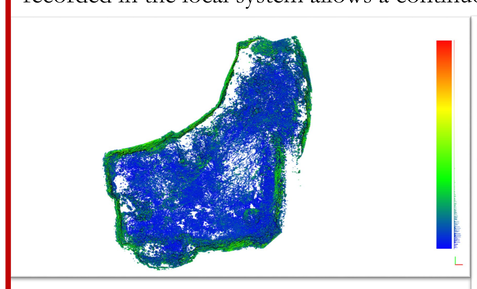
- **DESIGNING MINING WORKS**
- **COMPLETION OF THE NUMERIC MAP**
- **CALCULATION OF THE VOLUME OF THE REMOVED OVERBURDEN / SELECTED RAW MATERIAL**
- **ANALYZES OF THE GEOMETRY OF THE EXECUTED SLOPES AND OPERATING LEVELS**



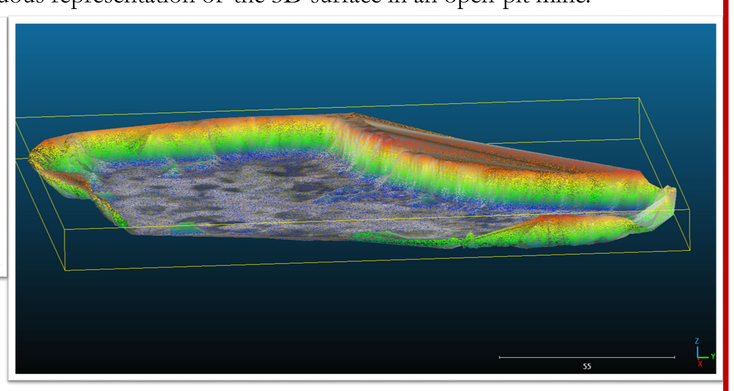
Top view of the point clouds: Riegl MLS VMZ 40i . Colors represent intensity value in a 7-bit range.



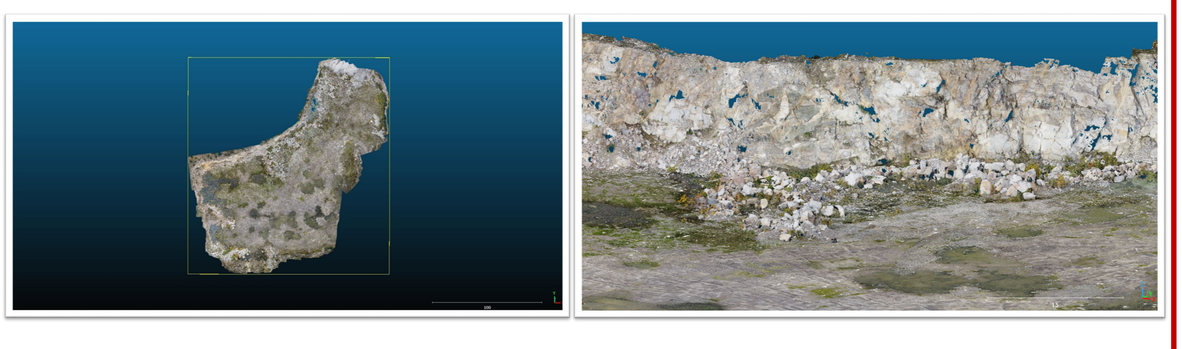
The analyses demonstrate that mobile LiDAR measurement techniques provide input data that ensure that the constructed 3D mine models are georeferenced in the chosen EPSG coordinate system. The SLAM point cloud recorded in the local system allows a continuous representation of the 3D surface in an open-pit mine.

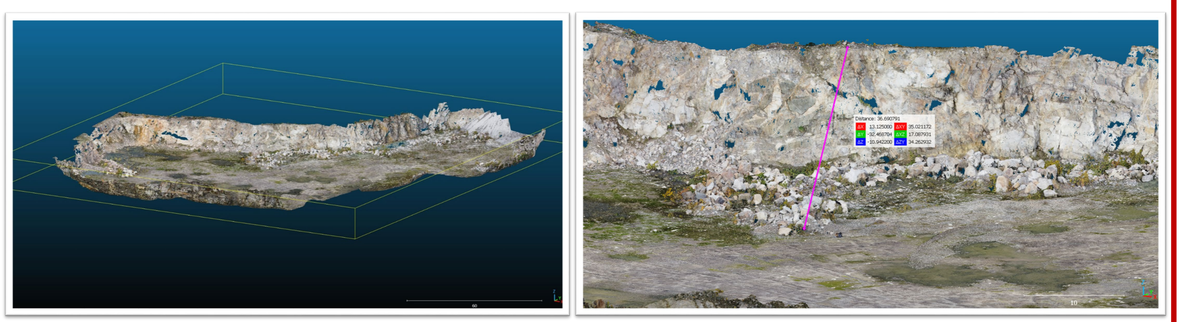


**Top view of the point clouds: handheld Velodyne SLAM.
Colors represent intensity value in a 7-bit range.**



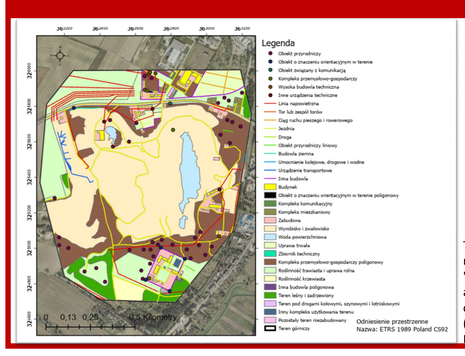
Data obtained with the use of this method may be successfully used in 3D modeling the geometry of an excavation, or in planning or monitoring the progress of mining operations, with respect to both compact rock (such as granite in this case, which may be mined in the form of both blocks and aggregate), and bulk minerals.





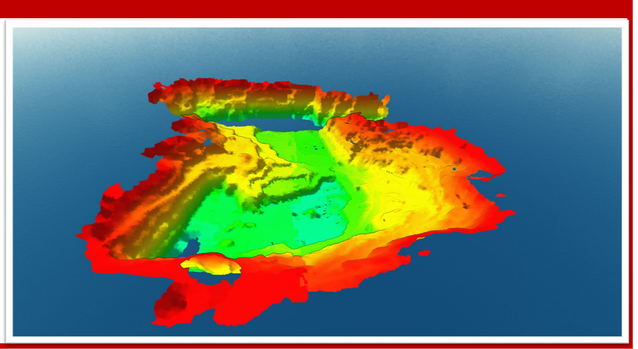
Examples of visualization of measurement data

DISCUSSION AND CONCLUSIONS



Topographic map of the mining area of the "Strzelin" granite mine against the background of an orthophotomap (P. Bęś 2022 - Praca Inżynieska)

Measurements made in the Mikoszów opencast mine clearly show that the integration of the MLS LiDAR technique and the handheld SLAM LiDAR allows for the development and updating of the 3D model of the excavation in real time based on the presented methodology. The resulting high-resolution point cloud allows the design, inventory and powering of the mine's big-data database in line with the idea of industry 4.0.
The use of LiDAR techniques in the analyzed mine allows for comfortable and quick acquisition of 3D information about the excavation in the mine's life cycle, which can be used at every stage of mining activity in opencast mines, including: for searching and recognizing the deposit, in preparation and development works, during operation and reclamation and development of the post-mining area



Model 3D kopalni granitu "Strzelin" wygenerowany w programie Global Mapper (P. Bęś 2022– Praca inżynierska)