UNEXMIN

AN AUTONOMOUS UNDERWATER EXPLORER FOR FLOODED MINES

UNEXMIN FIELD TRIALS AND GEOLOGICAL EVALUATION OF THE TECHNOLOGY

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NEMO 33, UNEXMIN FINAL CONFERENCE

26TH SEPTEMBER 2019

This project has received funding from the European Union's Horizon 2020research and innovation programme under grant agreement No 690008.

FIELD TRIALS

To test the working prototype robot capabilities under real-life (mine) conditions:

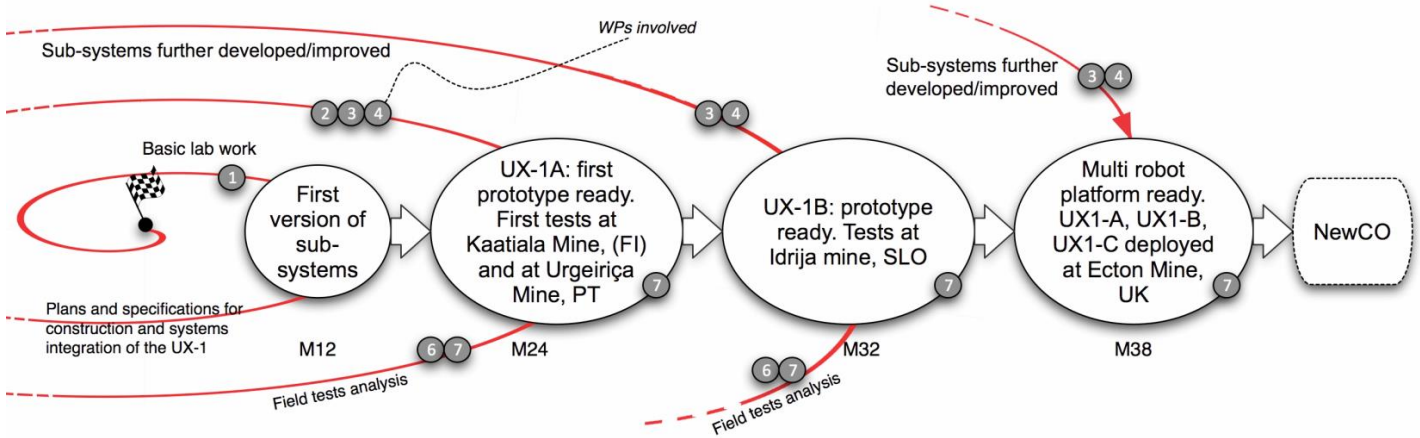
Kaatiala (Finnland)

Idrija (Slovenia)

Urgeiriça (Portugal)

Ecton (UK)

Molnar Janos (Hungary)



To demonstrate how this technology can address the needs of customers and end-users

- **Pictures, movies, fly-through animations etc.**
- **Geological data (mainly from Ecton)**
- **Demonstration datasets**
- **Physical and virtual reality models of surveyed mines**

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Kaatialan Louhos
Louhostie
Louhostie
Louhostie
Louhostie


INESCTEC
LINUX


NO ADMITTANCE


Let's go to Idrija


JAŠEK- BORBA
III. OBZ


MESTO UMIKA PRED TRANSPORTOM
LINEXMIN


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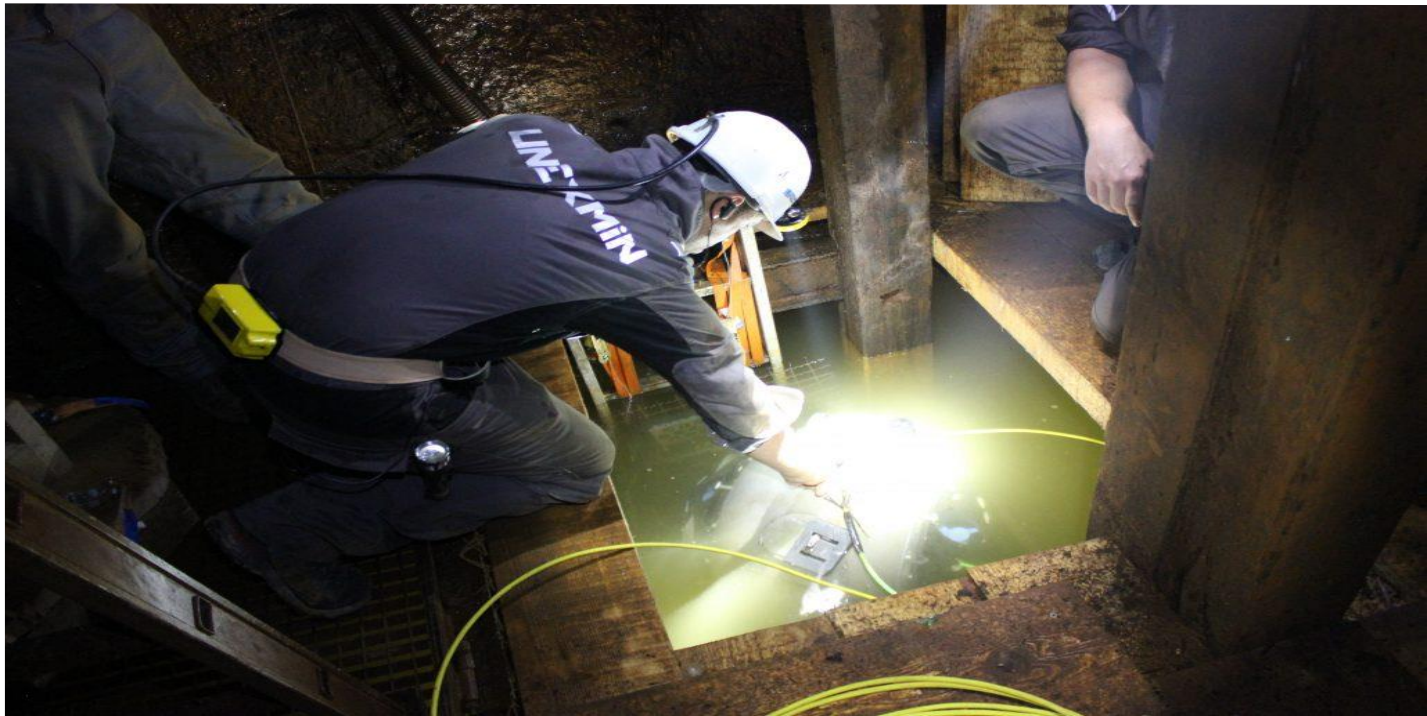


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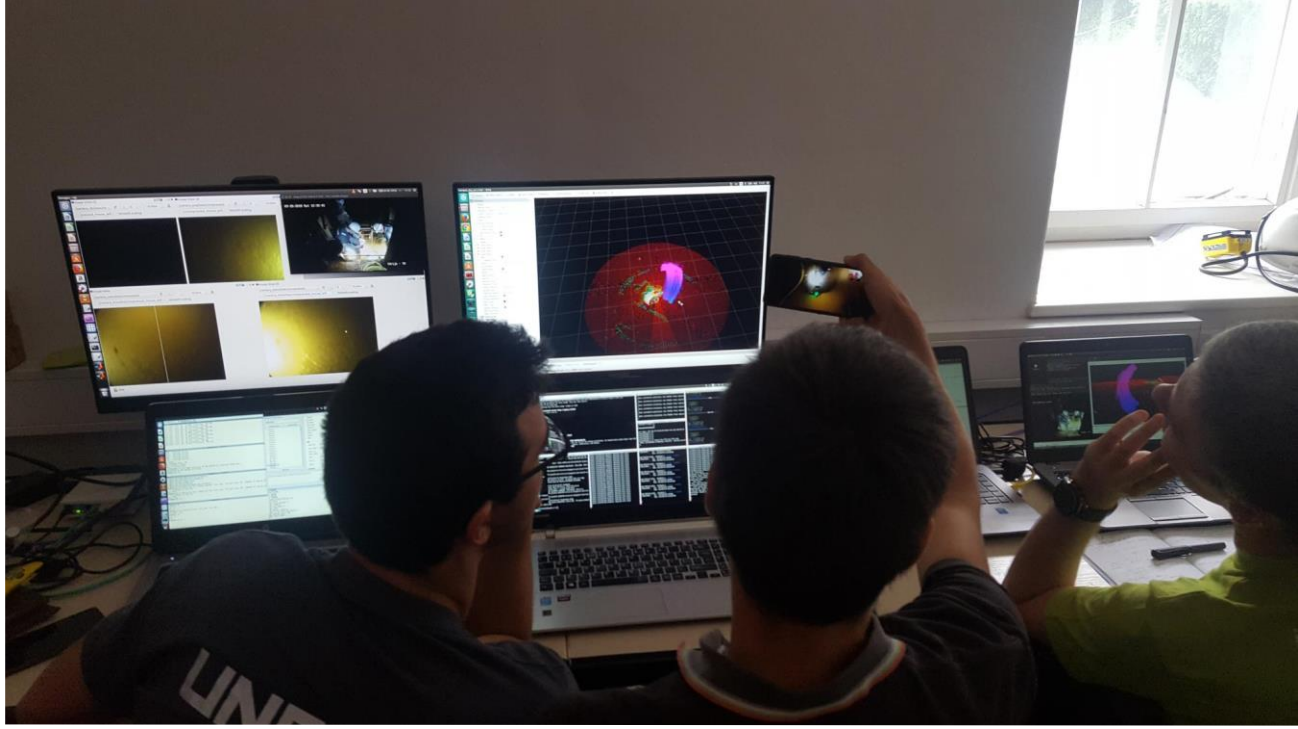


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WWW.UNEXMIN.EU
MISKOLCI EGYETEM
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LPR
4coders
GEO-MONTAN

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ECTON ADIT
DRIVEN 1774
REOPENED 1984


ECTON ADIT
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4200-072 Porto
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CAUTION !
UN3481
CARGO AIRCRAFT ONLY

8 TB of data collected in 4 mine trials.

(average ~200 GB per hour)

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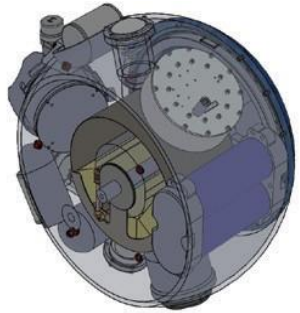
UNEXMIN SCIENTIFIC INSTRUMENTATION

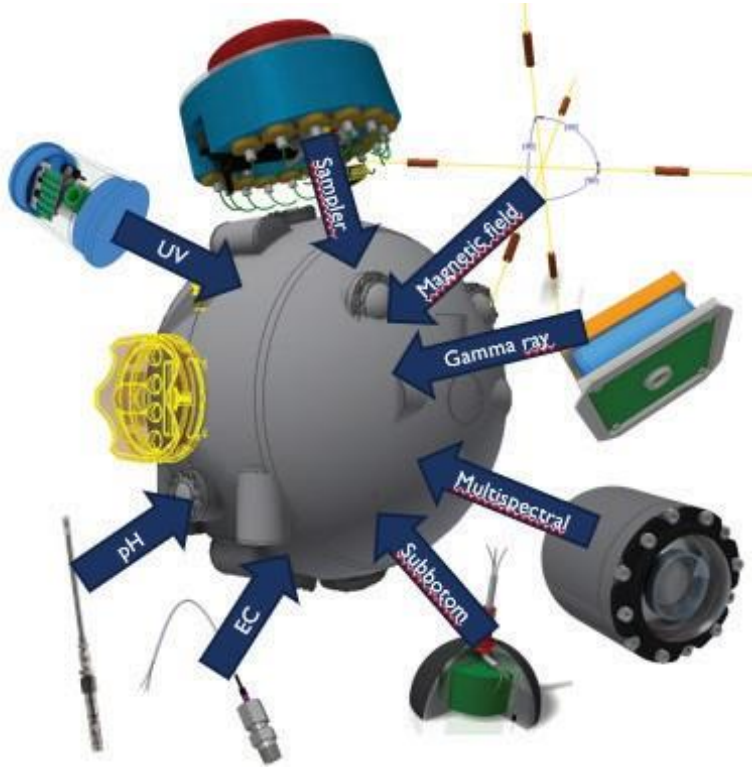
NAVIGATIONAL INSTRUMENTATION

- Multibeam sonar
- Scanning sonar
- Digital Cameras (5)
- Structured Light System (SLS)
- Doppler Velocity sensor (DVL)
- Inertial Navigation System (INS)
- Scanner and lasers

SCIENTIFIC INSTRUMENTATION

- pH and electrical conductivity units
- Temperature and pressure sensors
- W ater sampler (16 samples, 7 ml / sample)
- Magnetic field units
- Gamma-ray counter
- Sub-bottom profiler
- Multispectral camera (14 bands, 405 – 850 nm)
- UV fluorescence camera





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SCANNING SONAR AND STRUCTURED LIGHT SYSTEM

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- Obtain point cloud of open spaces (i.e. for future drilling plan, calculating dewatering costs etc.)
- Detect and measure orientations of geological structures (dip, strike, folds etc.)
- Create virtual reality model of mine

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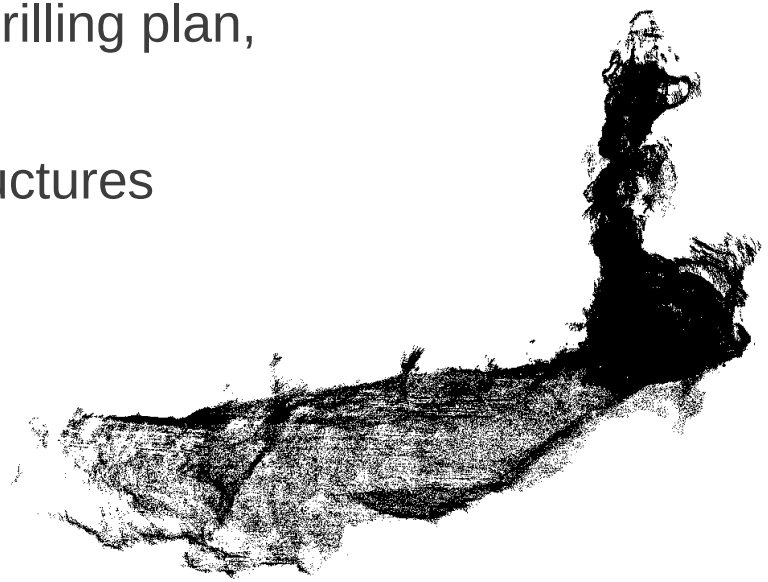
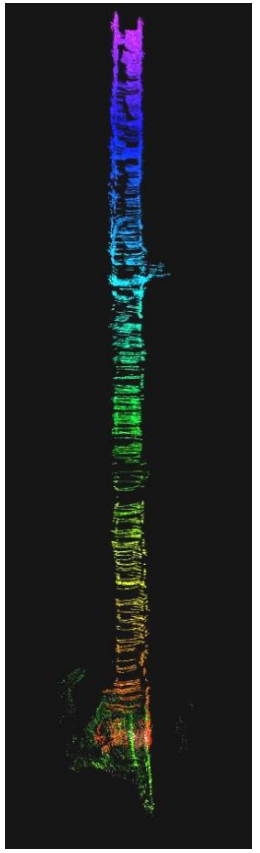
- Huge amount of data
- A lot of pre-processing is required (i.e. removal of echoes)





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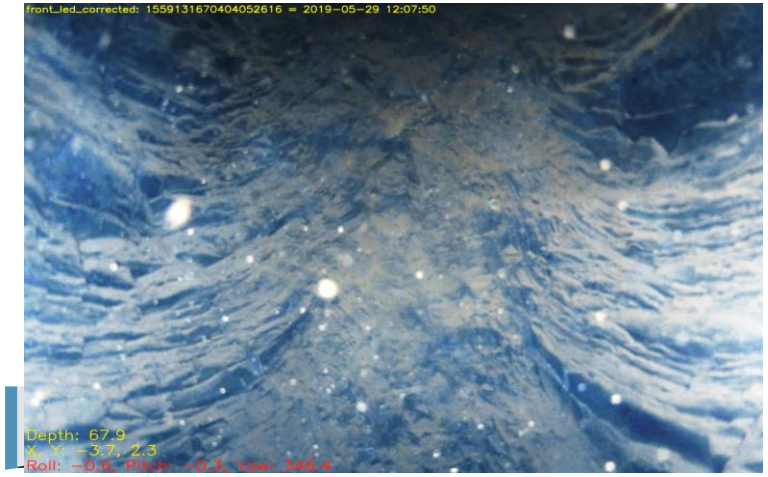
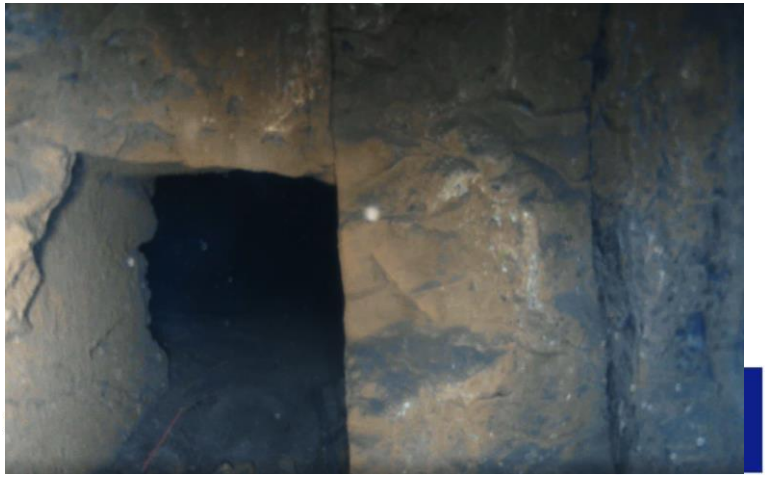
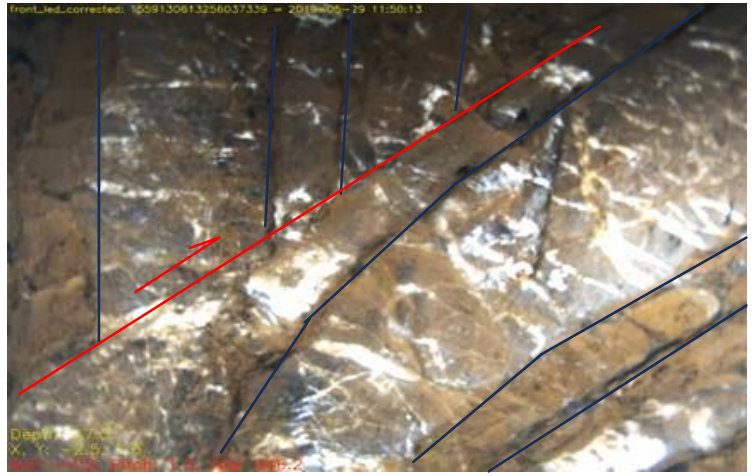
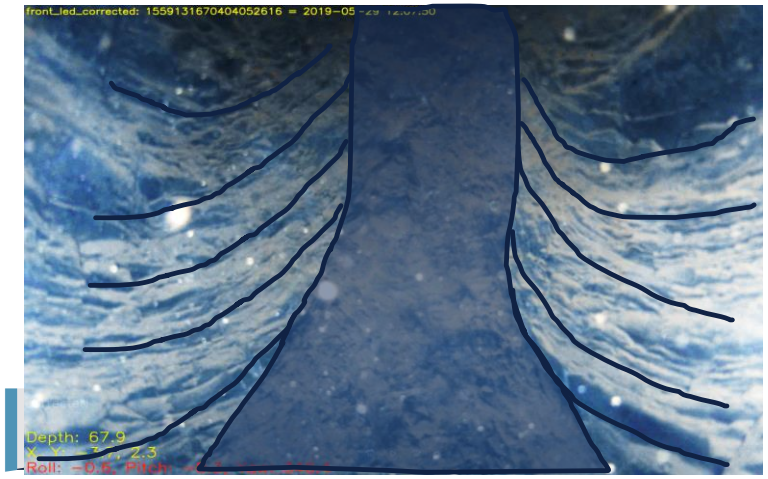
VISIBLE LIGHT CAMERAS

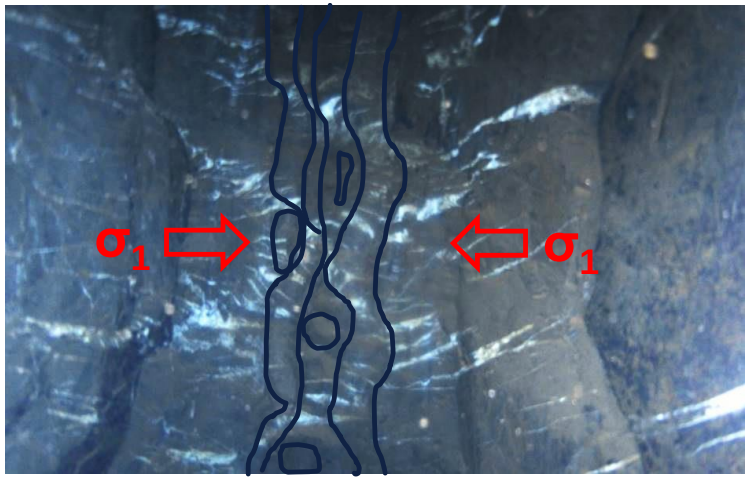


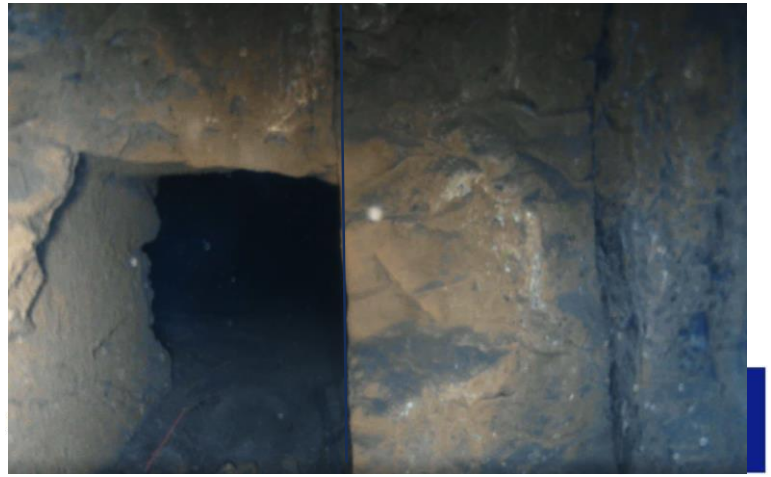


VISIBLE LIGHT CAMERAS









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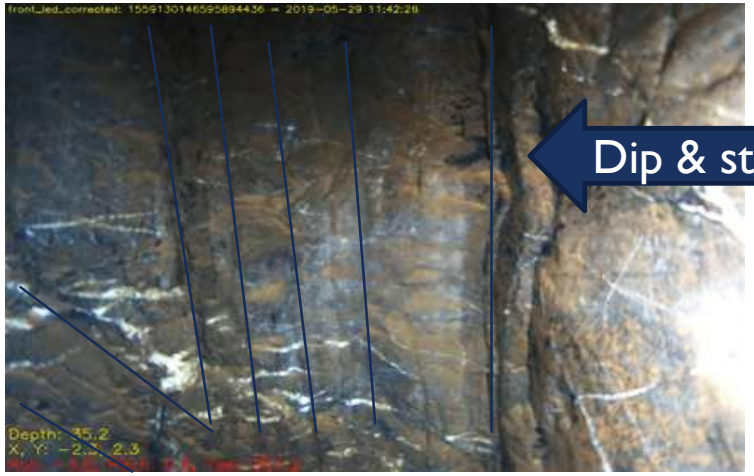

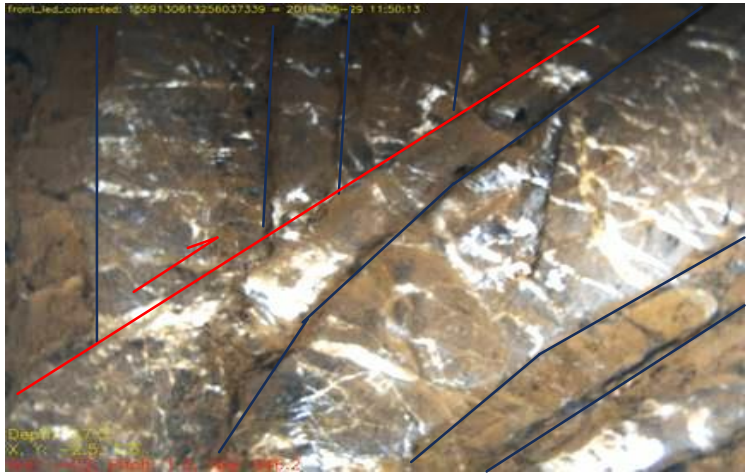

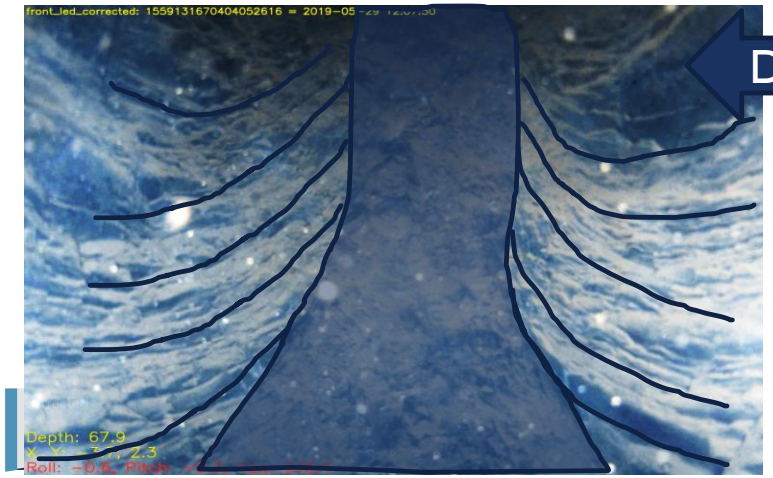

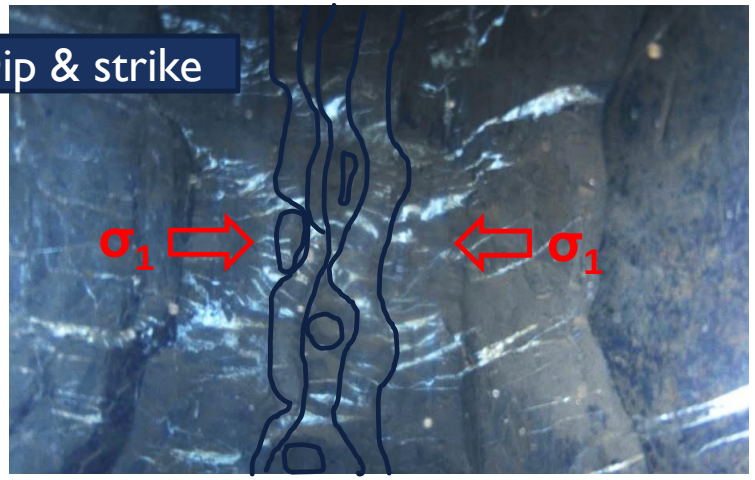

VISIBLE LIGHT CAMERAS

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- Geologists can identify rock types
- Together with orientational data geologists can approximate orientations (dip and strike, folds, fault planes etc.)
- Observe obstacles, debris, rockfalls, blocked passages, assess the condition of support etc.
- Identify exposed bedrock for other target analysis (i.e. multispectral)

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- Manual processing
- Assessments might not be very precise
- Not very useful in muddy water or in large openings

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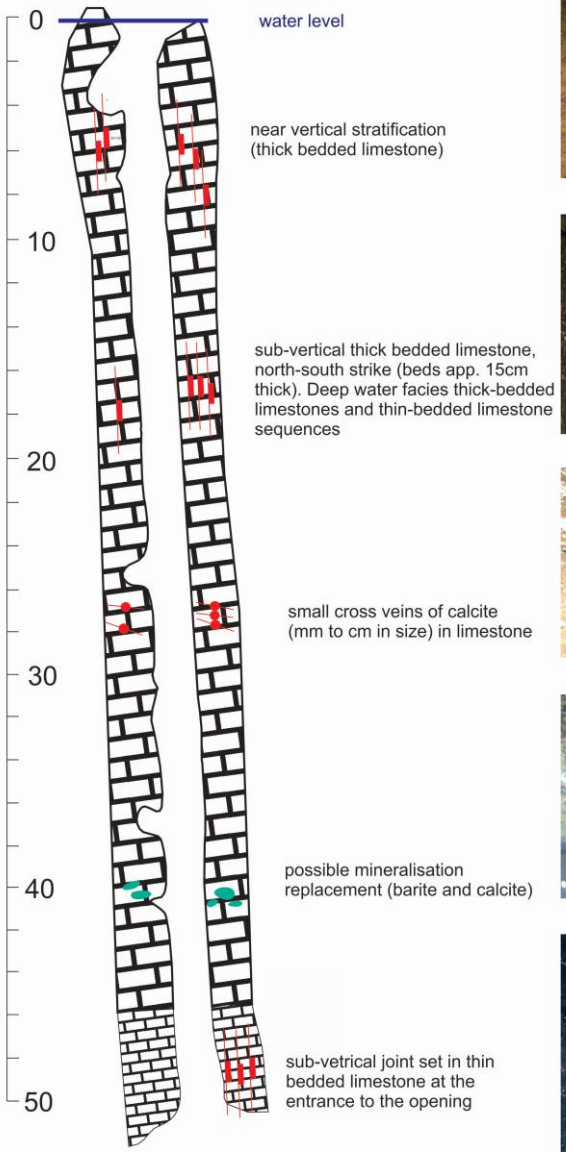
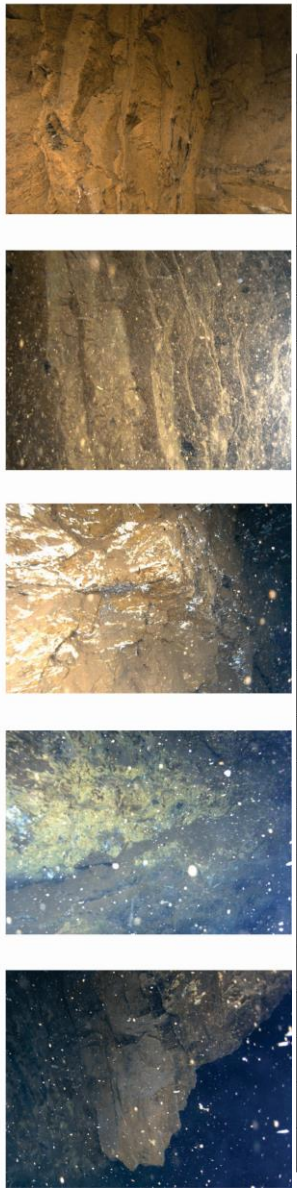
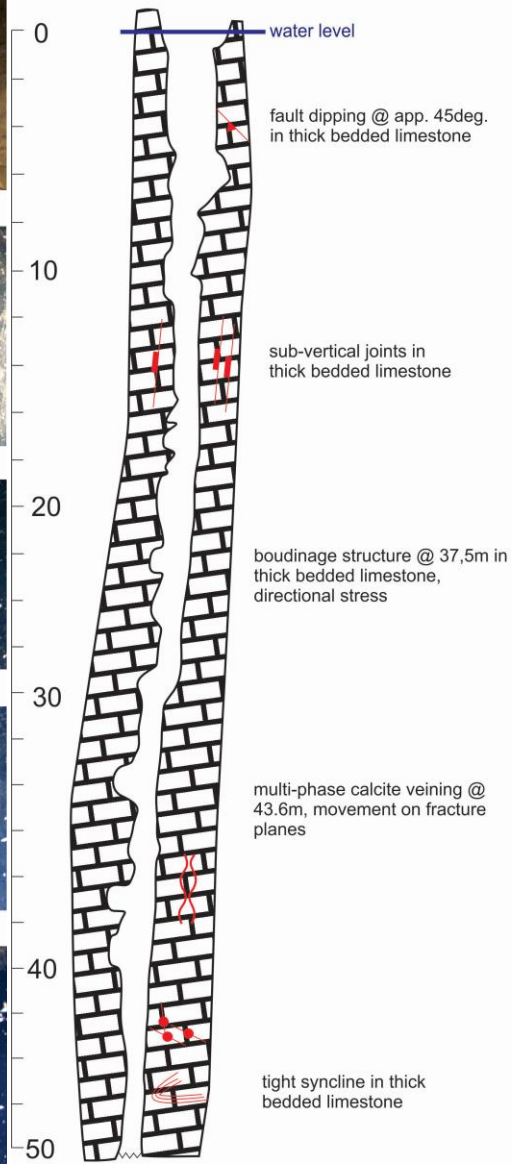
Cross section of the Pumping shaft

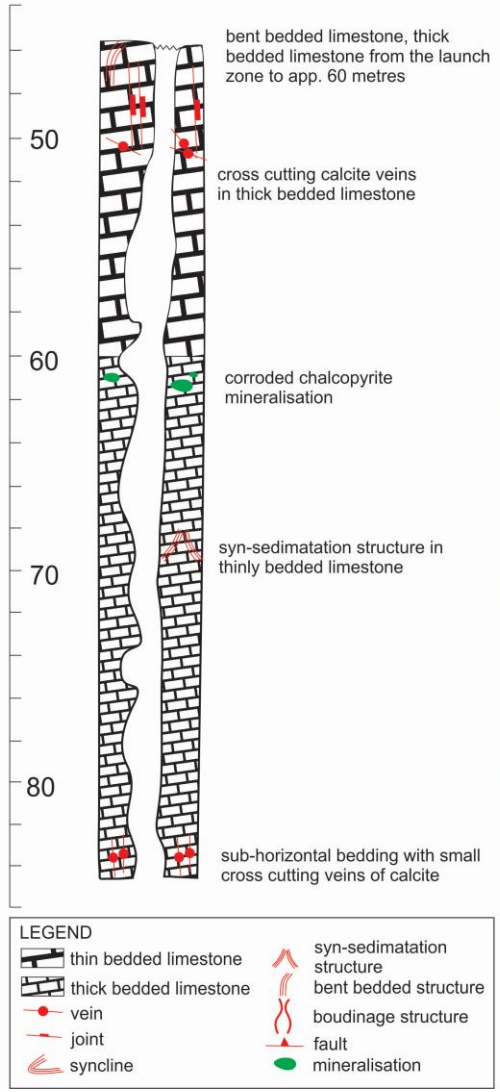


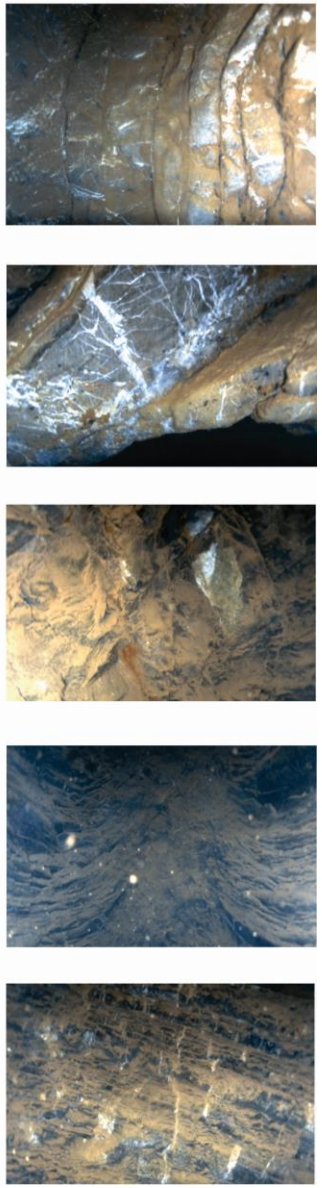


Cross section of the Winding shaft (upper part)



Cross section of the Winding shaft (lower part)





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PH, EH, THERMOMETER, WATER SAMPLER

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- To detect physical and chemical composition of mine water in the case of future dewatering
- To detect possible hydrothermal or anomalies of electrical conductivity (in the case of hydrothermal activities, CO_2 degassing through active faults etc)

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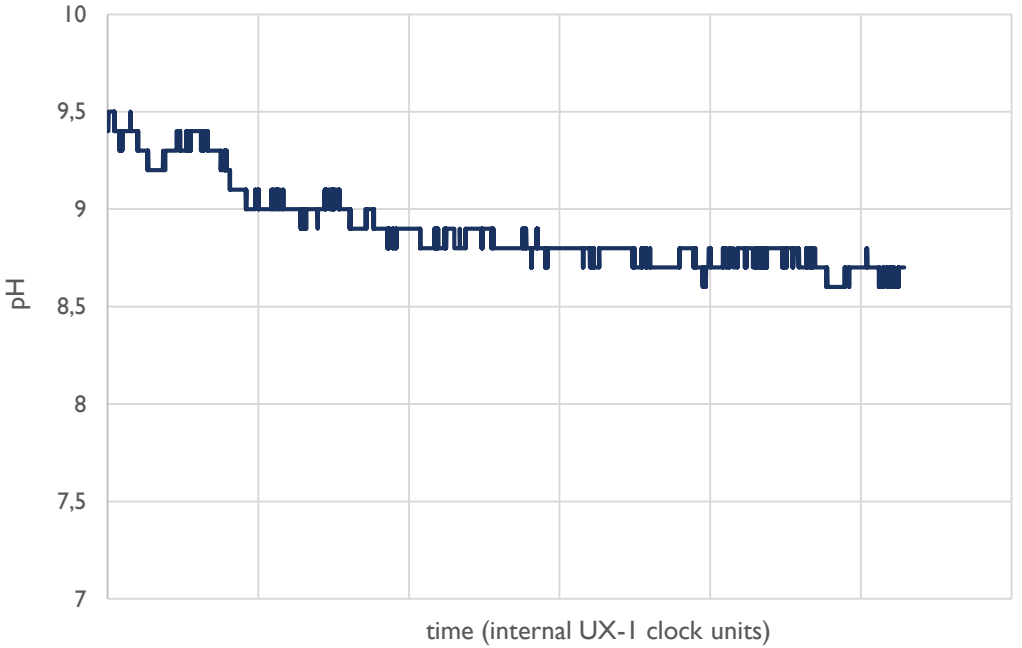
- pH electrode must be calibrated regularly to obtain accurate measurements
- Only small amount of water can be sampled



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UV CAMERA

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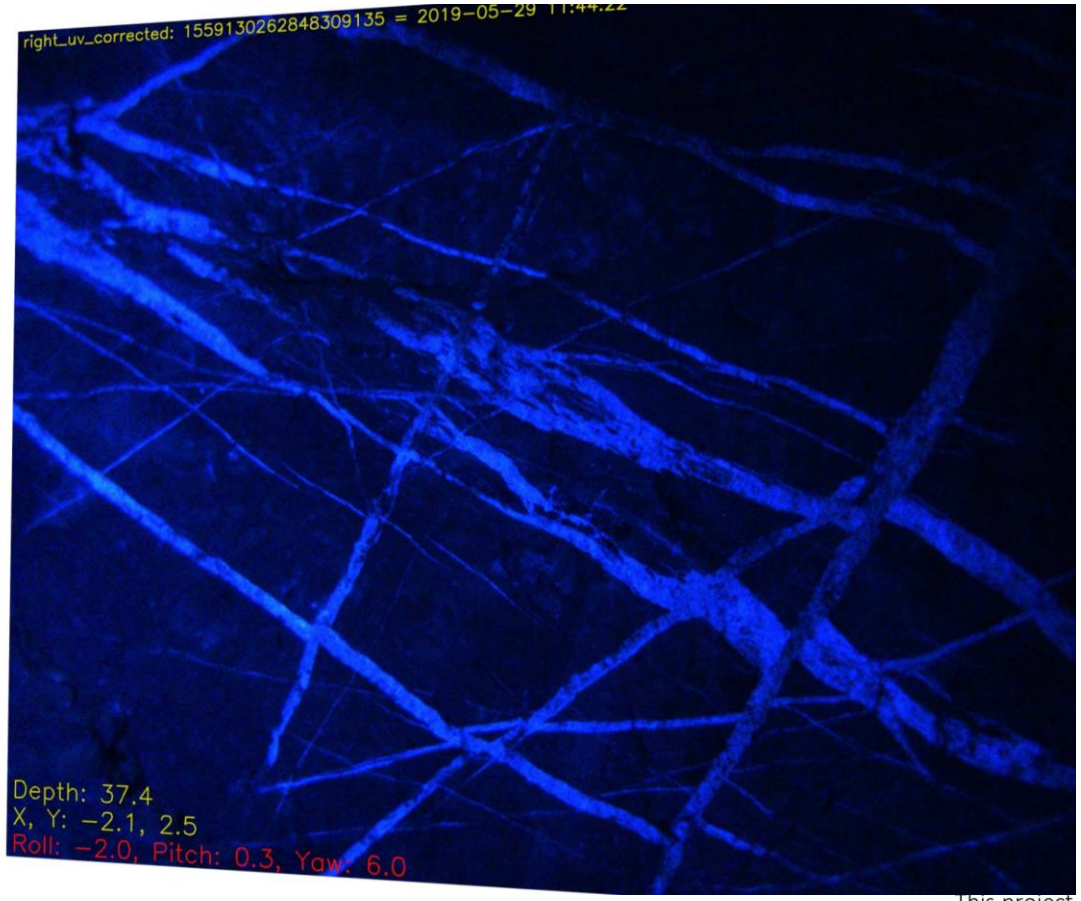
UV CAMERA



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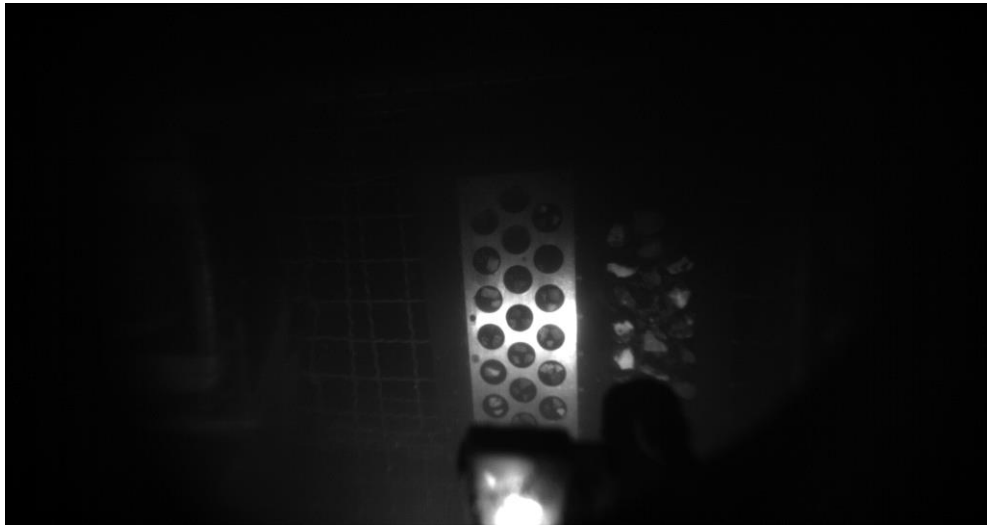
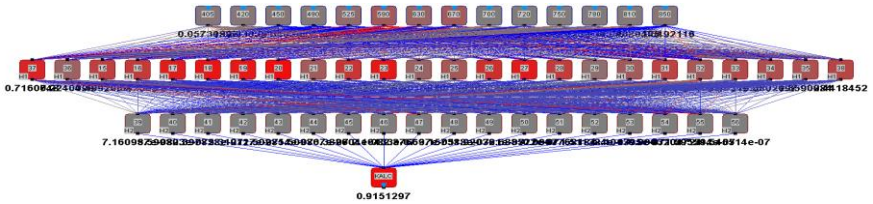
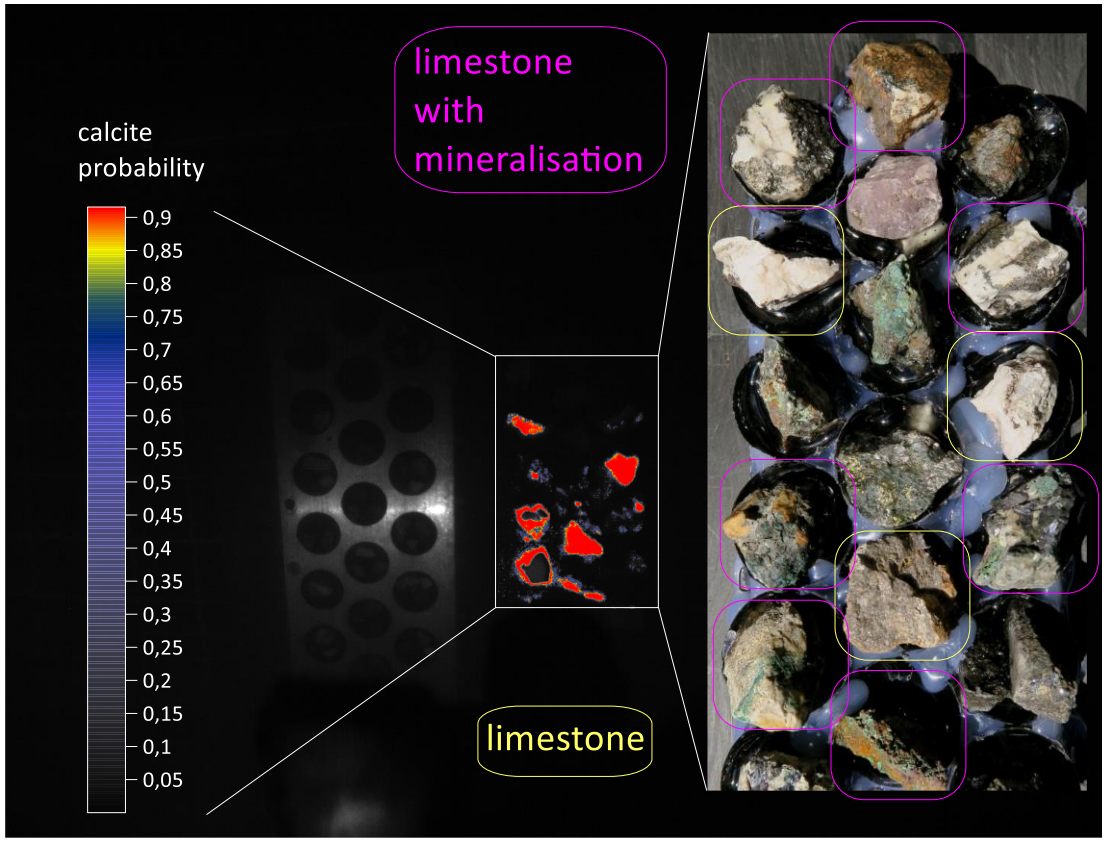
MULTISPECTRAL CAMERA (14 BANDS)







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MULTISPECTRAL UNIT (14 BANDS), UV CAMERA

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- Can detect some minerals
- Can easily detect fluorescent minerals

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- Huge amount of data
- Superimposing of MSU images is hard, because the robot moves and rotates
- Automatic mineral detecting algorithm is not ready yet to be used

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GAMMA RAY COUNTER

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- Can detect increased rates of gamma radiation (useful for detecting U ore, or K-rich rocks, like granites, pegmatites etc.)

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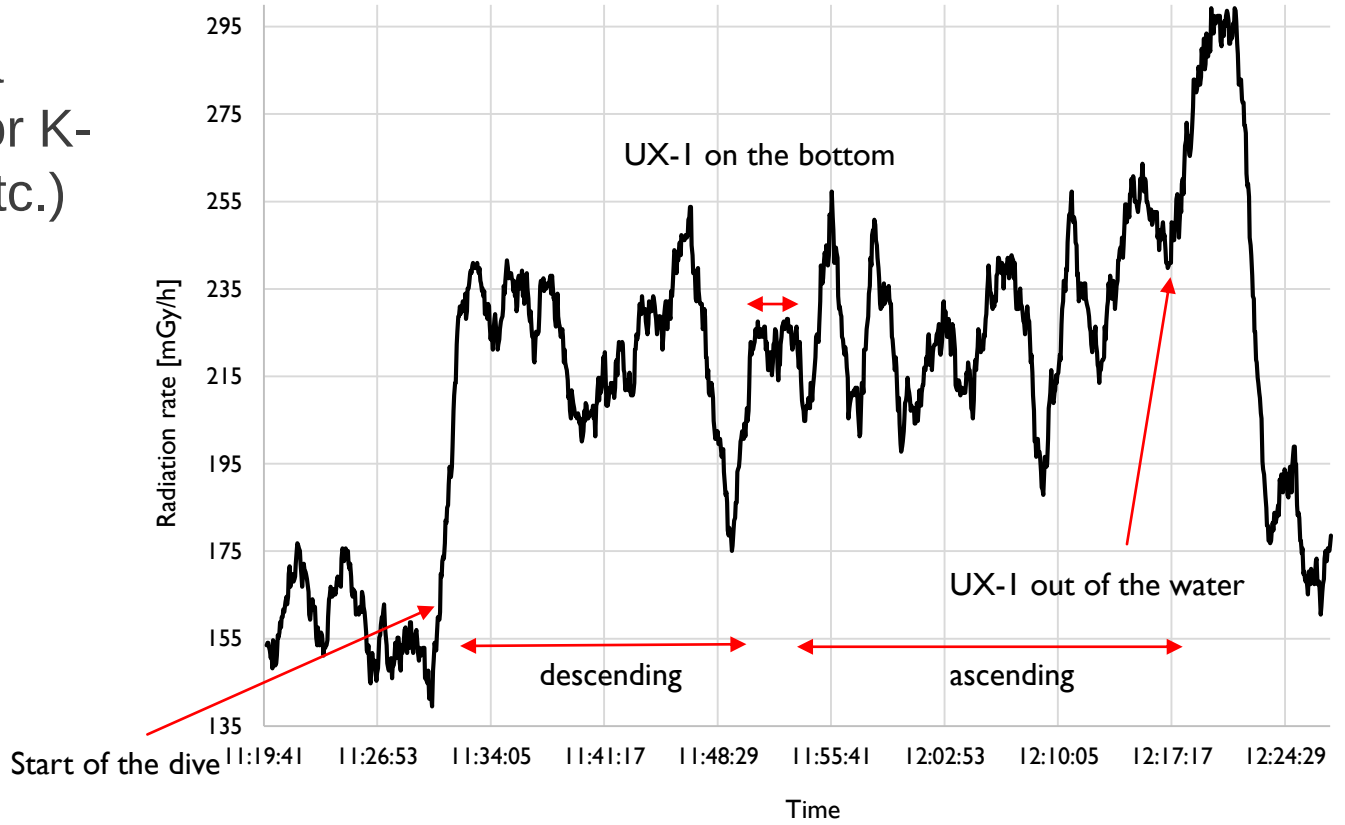
- More tests might be necessary.



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MAGNETIC FIELD METER AND SUB BOTTOM PROFILER

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- Can detect magnetic anomalies which are commonly associated with some ores

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- Is not yet tested in real conditions

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- Can measure bottom floor precisely

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- Didn’t work well during the tests

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UX-1 – WHY IS IT USEFUL FOR MINING COMPANIES ON CURRENT LEVEL OF DEVELOPMENT

- Can detect submerged openings, tunnels and caverns, even in waters with near-zero visibility (for drilling plans).
- In clear waters good visual inspection of flooded parts can be made, allowing geologists to map the geological features on exposed rocks, including estimating orientations (in combination with the data about robot position and orientation).
- Can bring water samples for analysis (in case of dewatering).
- In specific cases, it can assist detecting minerals (in combination with visible, IR and UV light and gamma-ray detector)

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UX-1 ROBOT – SHOPPING LIST FOR THE FUTURE

- Automatic on-board mineral detecting system, integrating different instruments (MSU, UV, Gamma).
- Operational magnetic field measurement system.
- Better point clouds, less false points and echoes (to see some geology).
- Possibility to collect rock samples, measure composition of rocks (i.e. XRF, XRD).
- Less maintenance, fewer operators during dives.
- More precise location and orientation during the dive (perhaps assisted by some sort of feature detection in the mine).

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Thank you for your attention

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