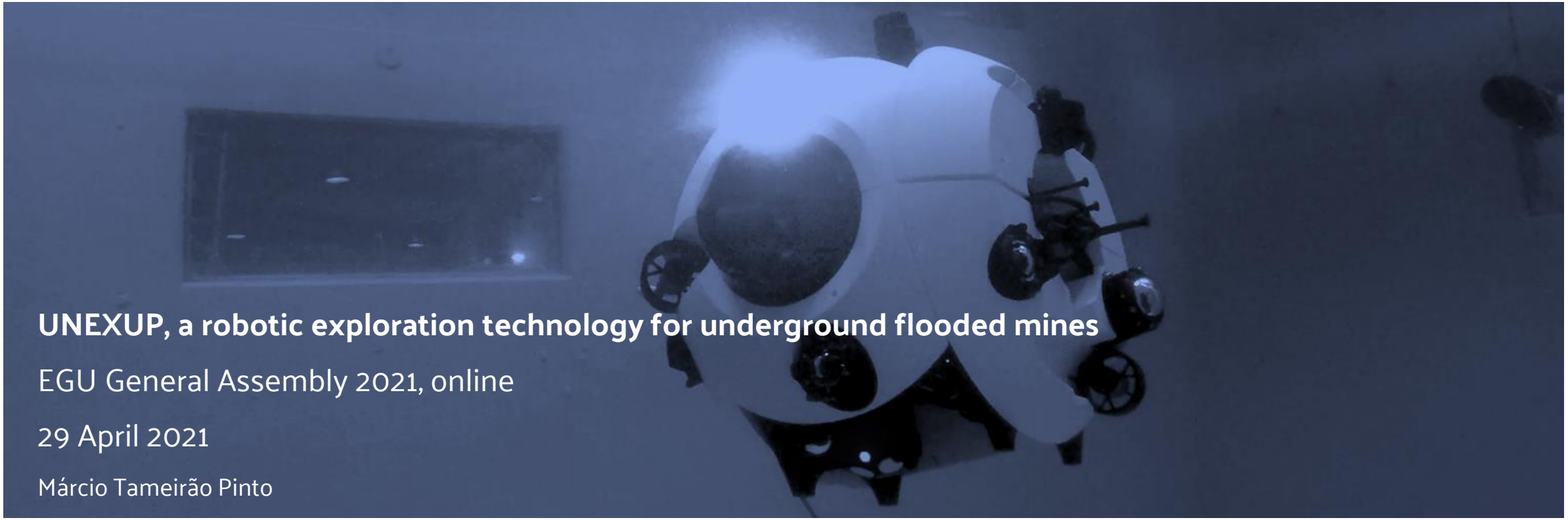
UNEXUP



UNEXUP, a robotic exploration technology for underground flooded mines

EGU General Assembly 2021, online

29 April 2021

Márcio Tameirão Pinto

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UNEXUP Overall Details

- Co-funding: EIT RawMaterials
- Start date: January 2020
- Duration: 36 months
- Context: Direct continuation of the Horizon 2020 UNEXMIN project (https://www.unexmin.eu/)
- Output: A new robot-based raw materials exploration / mine mapping service for underground flooded mines and other underwater environments

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Consortium partners – three knowledge pillars

- Research

GeoZS
Geološki zavod Slovenije

INESCTEC
TECHNOLOGY & SCIENCE
ASSOCIATE LABORATORY PORTUGAL

- Education

MISKOLCI EGYETEM
UNIVERSITY OF MISKOLC

POLITÉCNICA

- Industry

LINEXMIN
GEOROBOTICS

LPRC LA PALMA RESEARCH CENTRE

4coders

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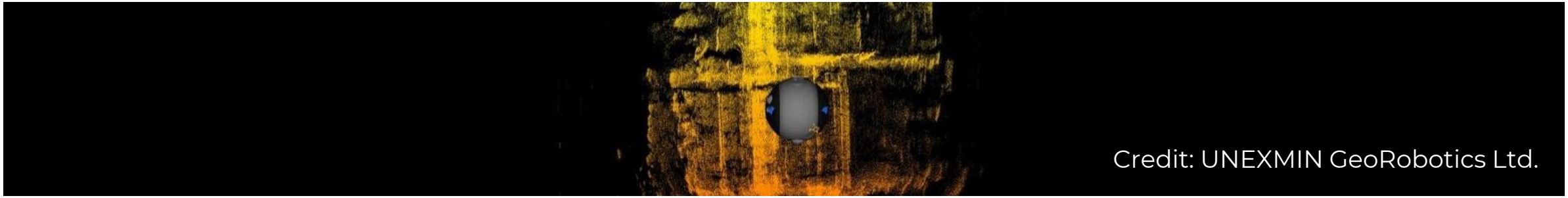
Project Context

EU dependence on the import of raw materials → Closed mine sites in Europe → Abandoned/ underground mines contain valuable mineral resources → Many of them are now flooded* → Lack of information on status and layout

*over 11,000 already catalogued



Credit: UNEXMIN GeoRobotics Ltd.

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Work Packages

- **WP0: Market strategy and business development portfolio**
  - Market analysis
  - Strategic plan for commercialization
  - Business plan development
  - Customer relations
  - Business risk management

Go-to-market and business strategies will be defined in 2020, updated accordingly during the project's lifetime

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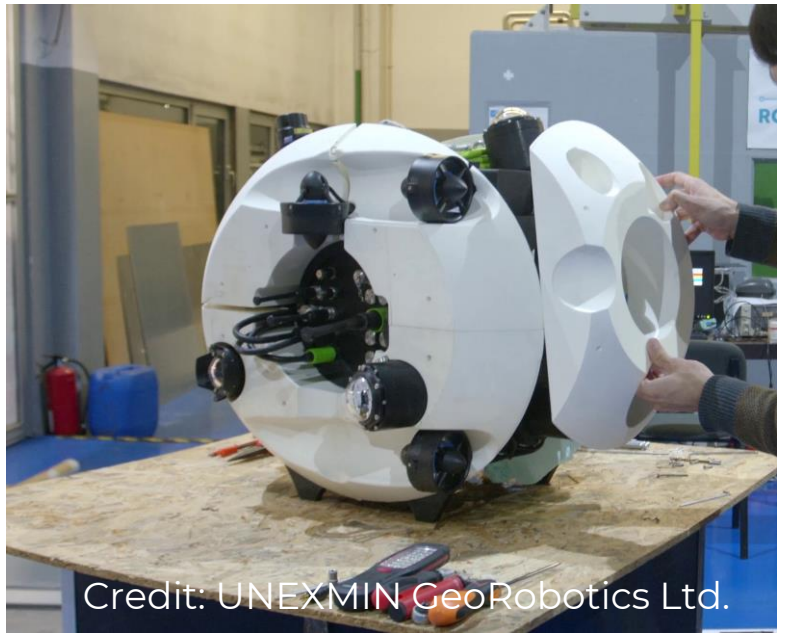
Work Packages

- **WP1: Technology upscaling and development**
  - Commercial upscaling of UX-1 prototypes
  - Development of a modular deep water prototype
  - Further development of scientific instrumentation and tools
  - Extending robot exploration capabilities
  - Ground control station and ground support systems
  - Post-processing software upgrades
  - Testing components


Credit: UNEXMIN GeoRobotics Ltd.

- End of 2020: UX-1 NEO;
- In 2021: New, more complex robot (UX-2);
- 2022: Additional funcionalitites, higher operational level

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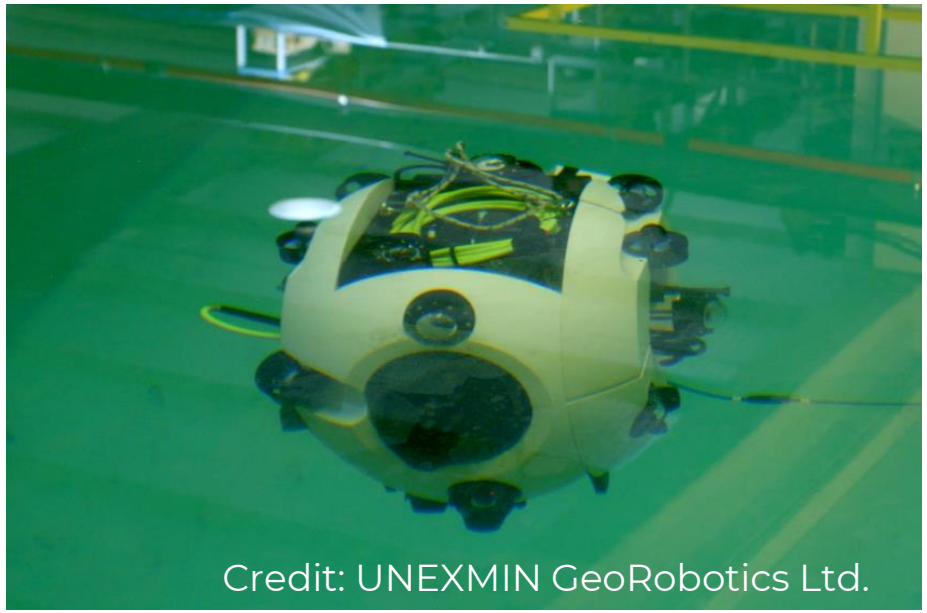
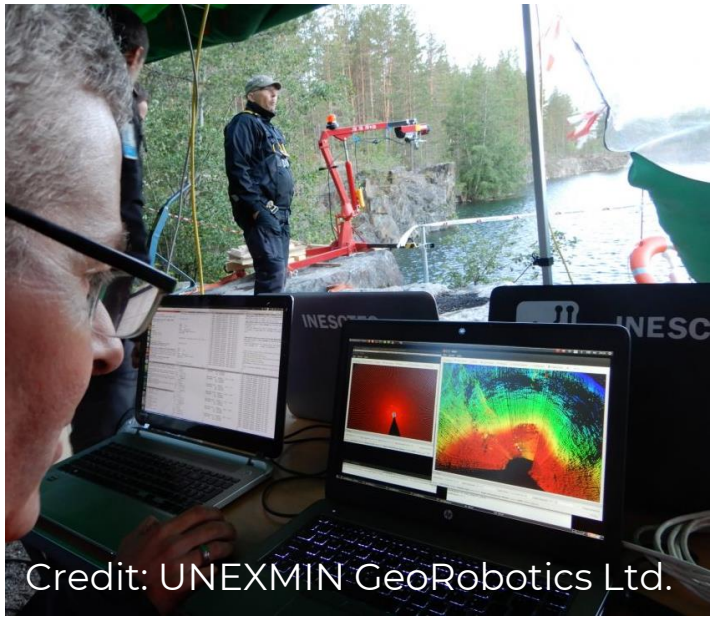
Work Packages

- **WP2: Pilots**
  - Pilot selection
  - Field trial preparations
  - Field trial reports
  - Operations improvement
  - Geoscientific evaluation


Credit: UNEXMIN GeoRobotics Ltd.


Credit: UNEXMIN GeoRobotics Ltd.

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Work Packages

- **WP3: Project management**

Project management will guarantee that the project's tasks, deliverables and outcomes are met in due time throughout the project, in line with the description of work, and in accordance with EIT RawMaterials guidelines.

- **WP4: Communication, dissemination and outreach**
  - Communication and dissemination management
  - Outreach support toolkit
  - Increasing market interest

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UNEXMIN - UNEXUP

(2016 – 2019)

Development and testing of a multi-robotic platform for spatial and geoscientific survey of underwater environments

Core objective: Develop a prototype for underwater exploration; raise scientific interest

(2020 – 2022)

Commercialization of the robotic technology, while further improving its software, hardware and capabilities

Core objective: Upgrade the robotic technology; commercialize it as an exploration service

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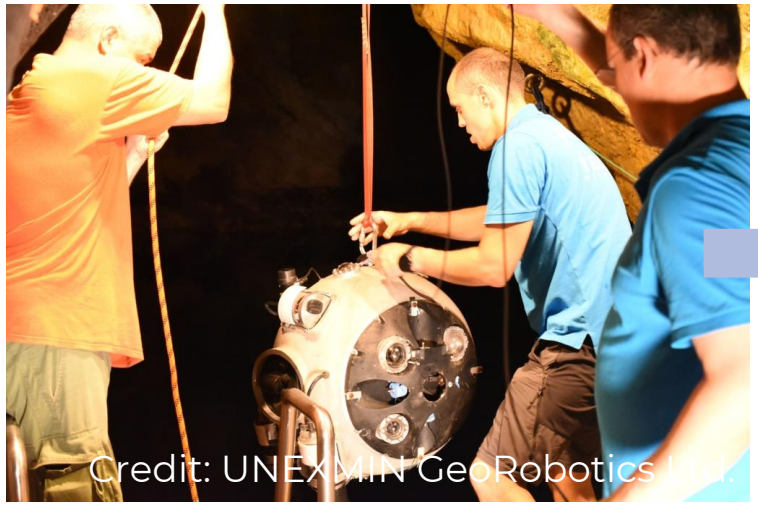
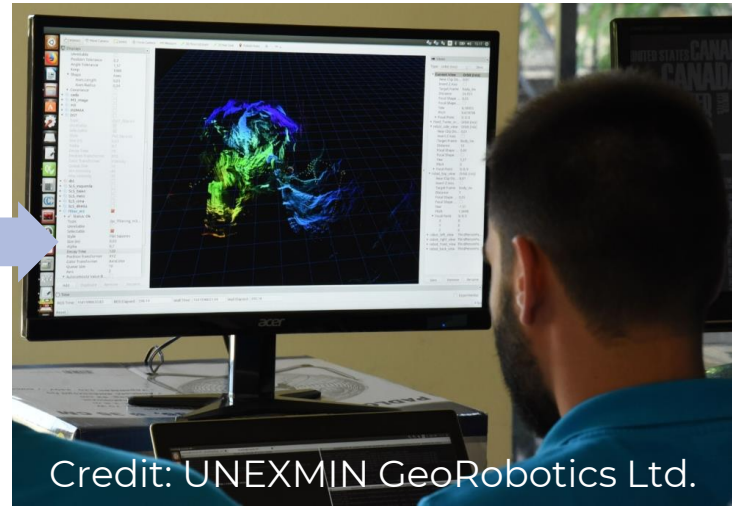
UNEXMIN outcomes

The UX-1 robotic platform is able to gather high-quality and high-resolution geological, mineralogical and topological data from currently inacessible mine sites without human risks or environmental impacts.





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Field Trials during the UNEXMIN project

1) **Kaatiala Mine, Finland (June 2018)** - Pegmatite mine, open-pit and small underground part

2) **Idrija Mine, Slovenia (September 2018)** - Mercury mine, UNESCO World Heritage site

3) **Urgeiriça Mine, Portugal (March/April 2019)** - Uranium mine in granite pegmatite

4) **Ecton Mine, UK (May 2019)** - Cu–Zn-Pb mine flooded in 1858 and never previously resurveyed

5) **Molnár János cave, Hungary (June/July 2019)** – Underwater cave system

https://unexup.eu/unexmin-pilot-tests/

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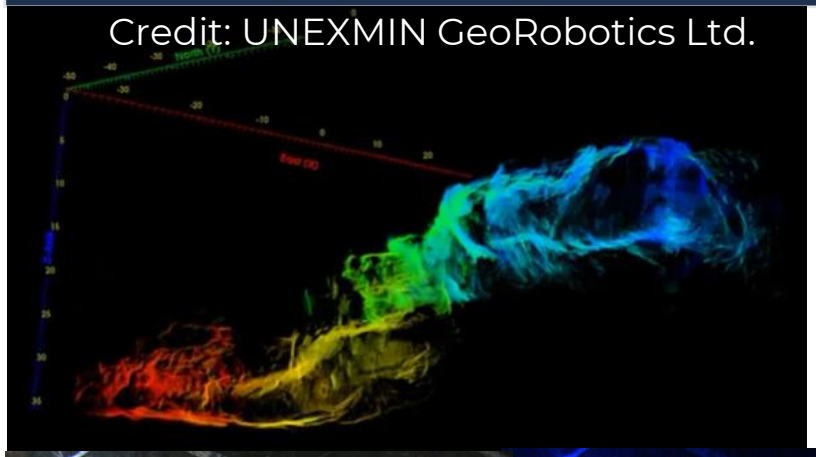
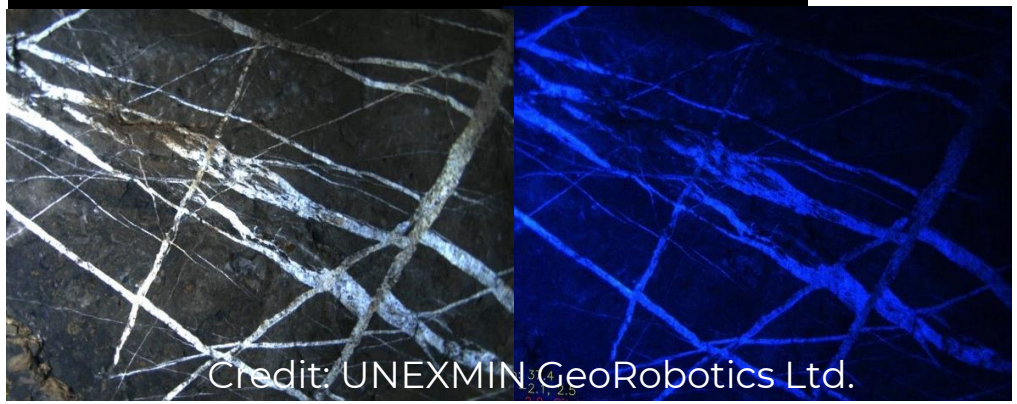
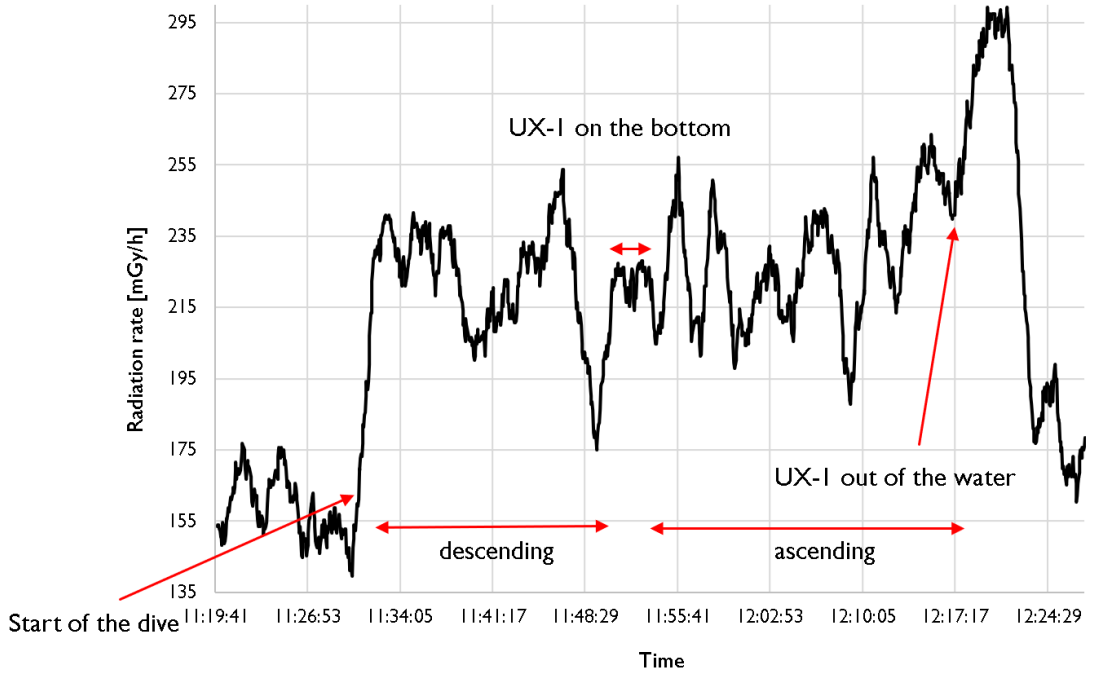
Practical outcomes







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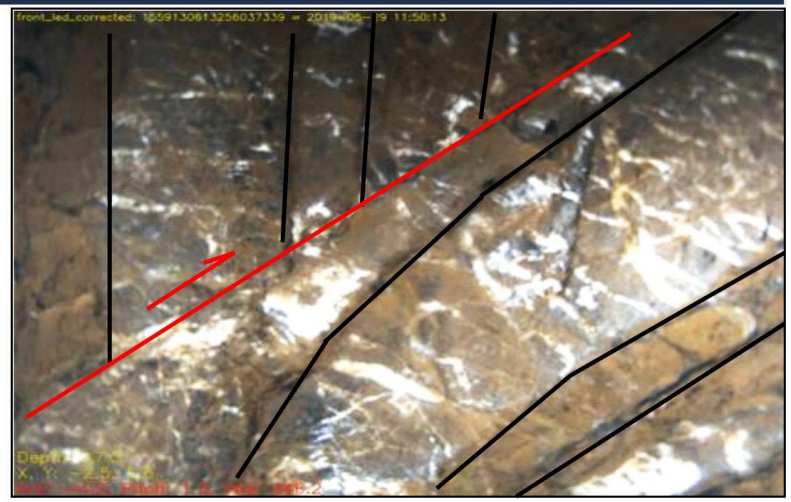
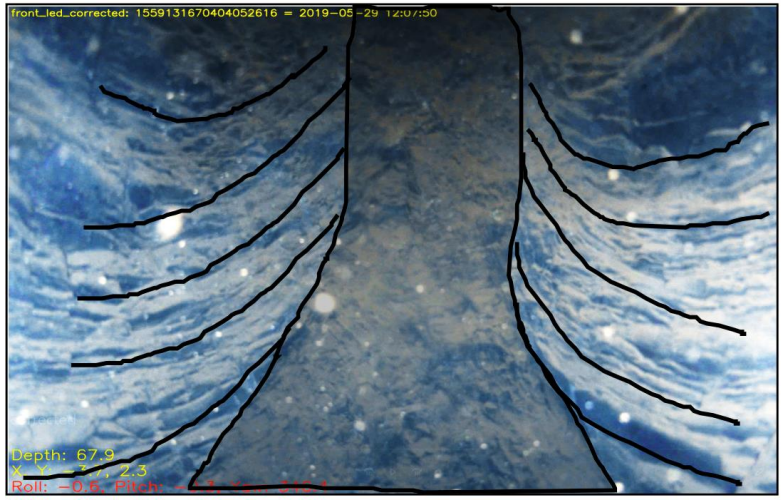
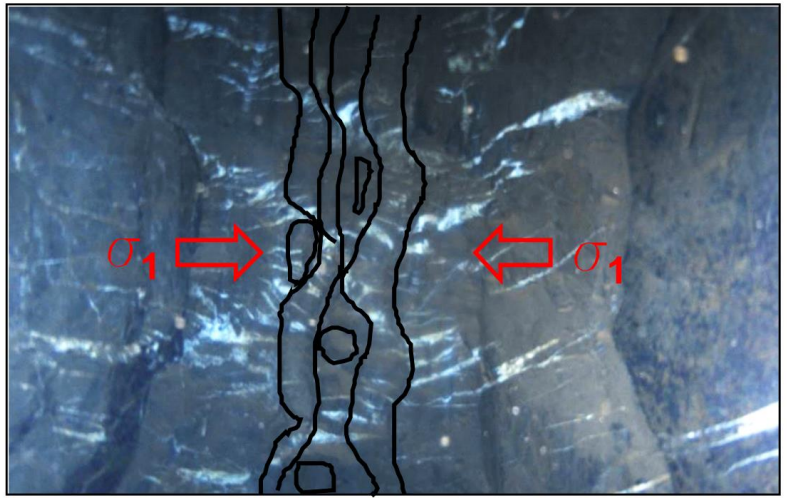
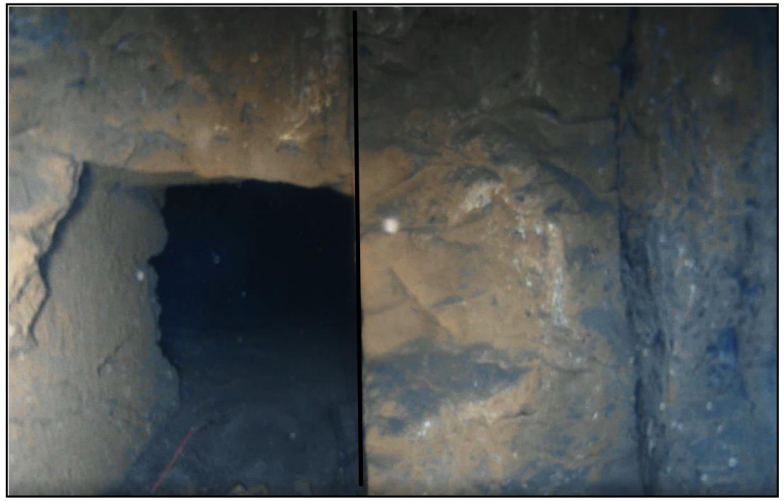
Practical outcomes

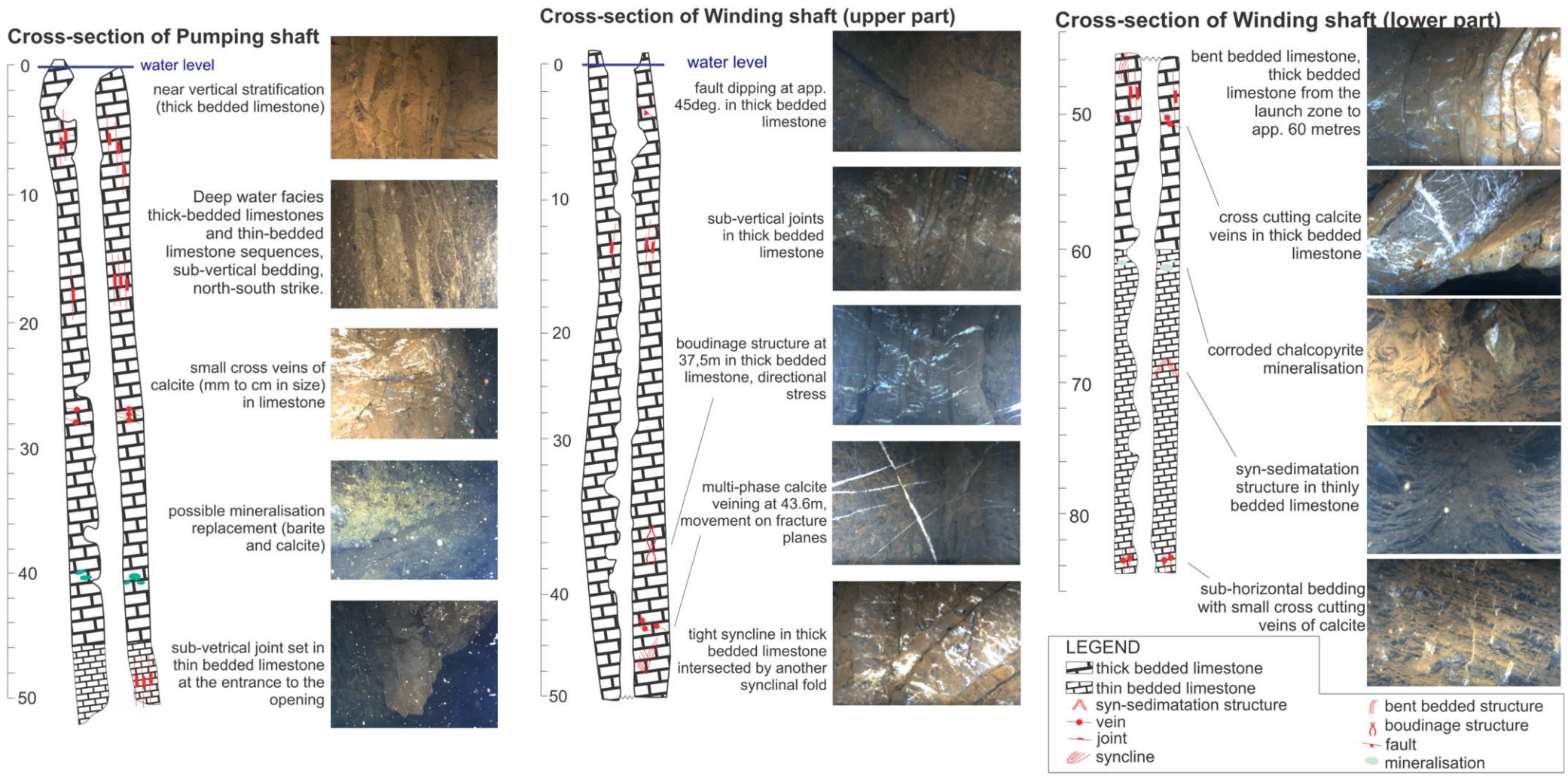






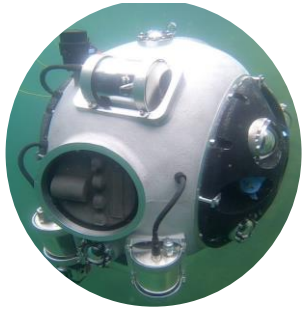


Practical outcomes



UX-1 (2018) vs. UX-1Neo (2020)

UX-1 (2018)



- ✓ Monolithic
- ✓ 112 Kg
- ✓ Limited lateral motion, no pitch stabilization
- ✓ 5 DOF (2 with limitations: pitch and lateral)
- ✓ 5 Cams
- ✓ 4 SLS
- ✓ SLS Short baselines limits the sensor range
- ✓ Internal batteries – charged inside of the robot
- ✓ 500m rated
- ✓ 1450 Wh
- ✓ 5h operation

UX-1Neo (2020)

- ✓ Modular
- ✓ <90 Kg
- ✓ 6 DOF
- ✓ 6 Cams
- ✓ 6 SLS
- ✓ Swappable batteries
- ✓ Vertical scanning sonar
- ✓ Fibre optic connector
- ✓ 10 Gb fibre optical umbilical
- ✓ Over 500m depth
- ✓ 2600 Wh
- ✓ >8h operation (estimated)

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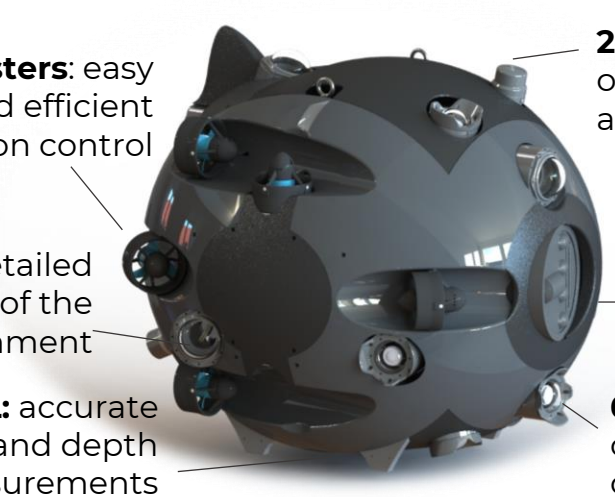
UX-1Neo

- ✓ **Ellipsoidal (700 x 620 mm)**
- ✓ **Modular design**
- ✓ **Less than 90 Kg**
- ✓ **Swappable batteries**
- ✓ **Over 500m depth**
- ✓ **2600 Wh**
- ✓ **>8h operation estimated**



- ✓ **Hyperspectral unit**
- ✓ **Water sampler unit,**
- ✓ **Water chemistry unit**
  - **Ph**
  - **O2 concentration**
  - **EC**
  - **temperature,**
  - **pressure**
- ✓ **Sub-bottom profiler**
- ✓ **Fluxgate magnetometer**

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UX-2

- To be ready in 2021, further improvement in 2022
- Greater depths ~1500 m
- Higher TRL
- Rock sampler
- Navigational and geoscientific instruments to address more challenging missions

Extending exploration capabilities

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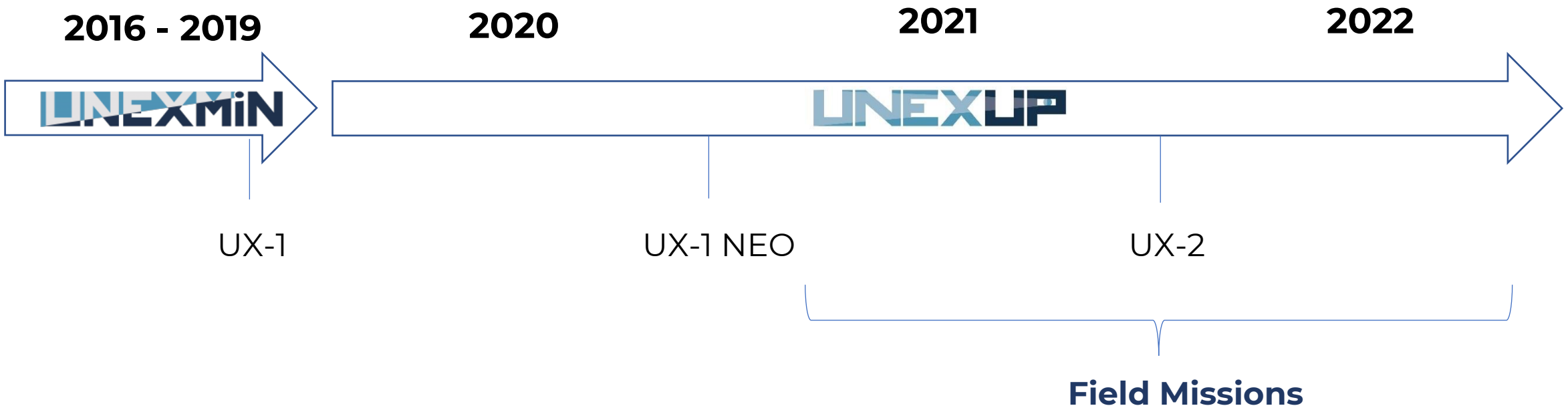
Timeline



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Field Missions

- **We are able to offer the in-depth surveys worldwide at reduced costs due to funding provided by EIT RawMaterials. Limited funding is available and only a handful of selected sites will be able to benefit from this unique opportunity**

  Selection criteria:
  - Geoscientific interest and business promotion
  - Client's financial contribution
  - Risks
  - Possibility to diversify the service, e.g. to extend the client database

https://unexup.eu/pilot-tests/

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Commercialization

UNEXMIN GeoRobotics Ltd. (UGR), founded by members of the UNEXMIN consortium, is the partner responsible for the commercialization strategy, field missions, and business plan of the UNEXUP technology.

INTERESTED IN HAVING YOUR FLOODED SITE SURVEYED?
CONTACT UGR: info@unexmin-georobotics.com

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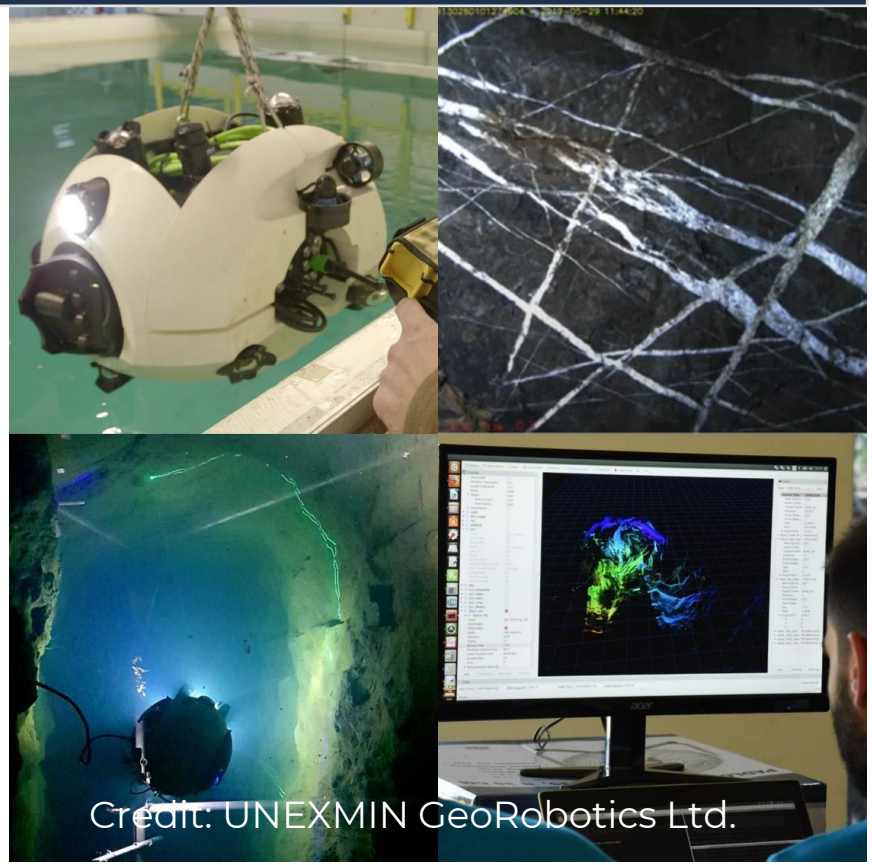
Applications of the technology

- **Mineral exploration**
  - First stages of exploration
  - Create and/or update geological models
  - Make decisions on exploitation
- **Geological studies**
  - Geological Surveys
- **Surveying of underwater structures**
  - Water reservoirs / wells
  - Cultural Heritage sites
  - Risk evaluation
  - Cave exploration



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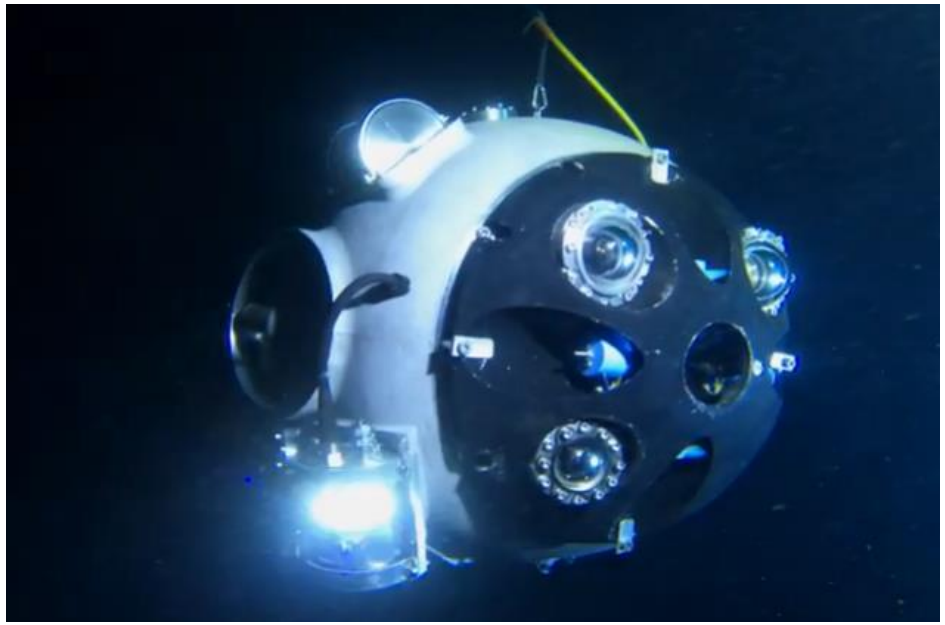
Gallery

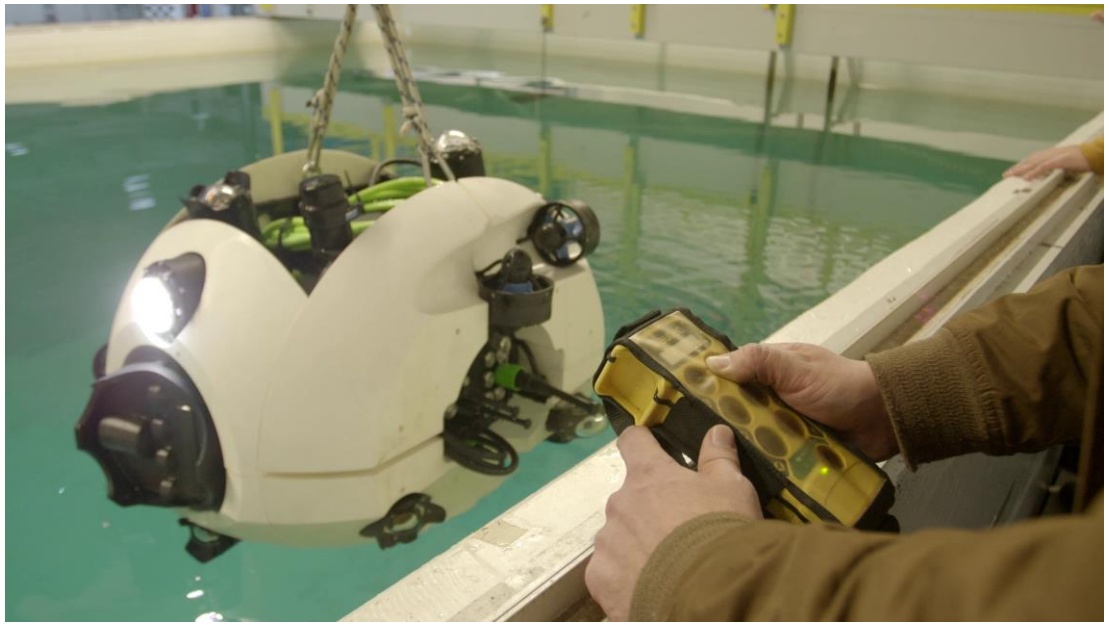
The UNEXMIN documentary film (2016-2019)

https://www.youtube.com/watch?v=OPMQvKE_z5I



Introducing UNEXUP (2020-2022)

https://www.youtube.com/watch?v=DewbI3iEko4



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THANK YOU!

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