

Advancing Muography for Mining Applications in the Horizon Europe Projects AGEMERA and Mine.io

Poster presented at MUOGRAPHERS 2026, 1-5 June 2026, Budapest

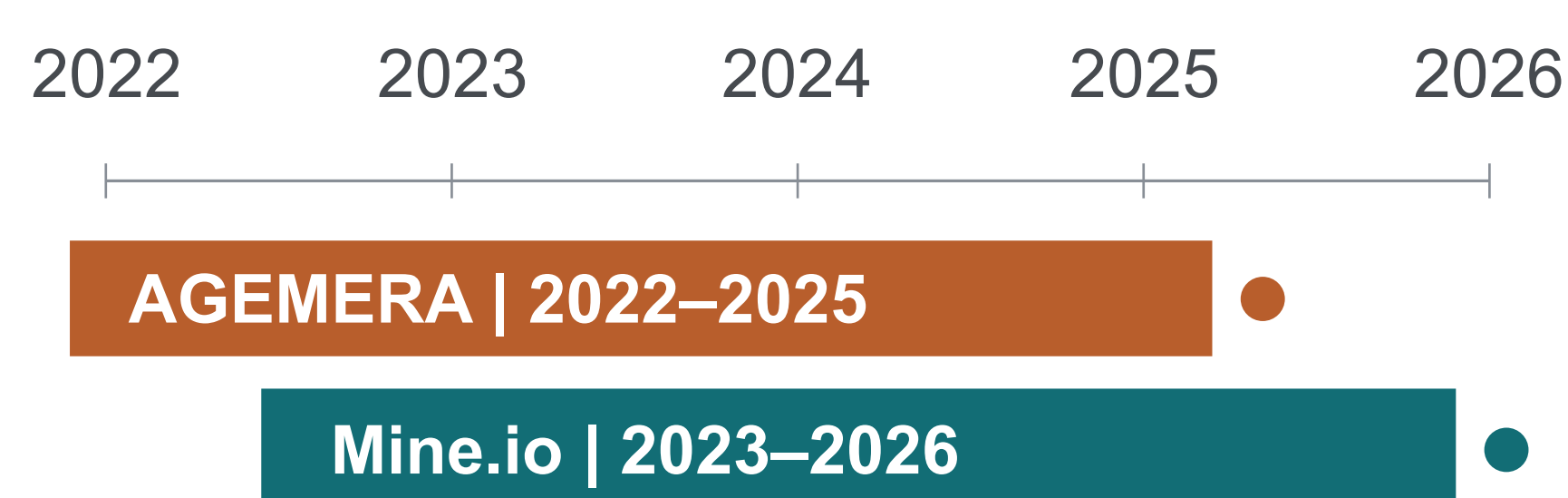
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Why muography for mining?

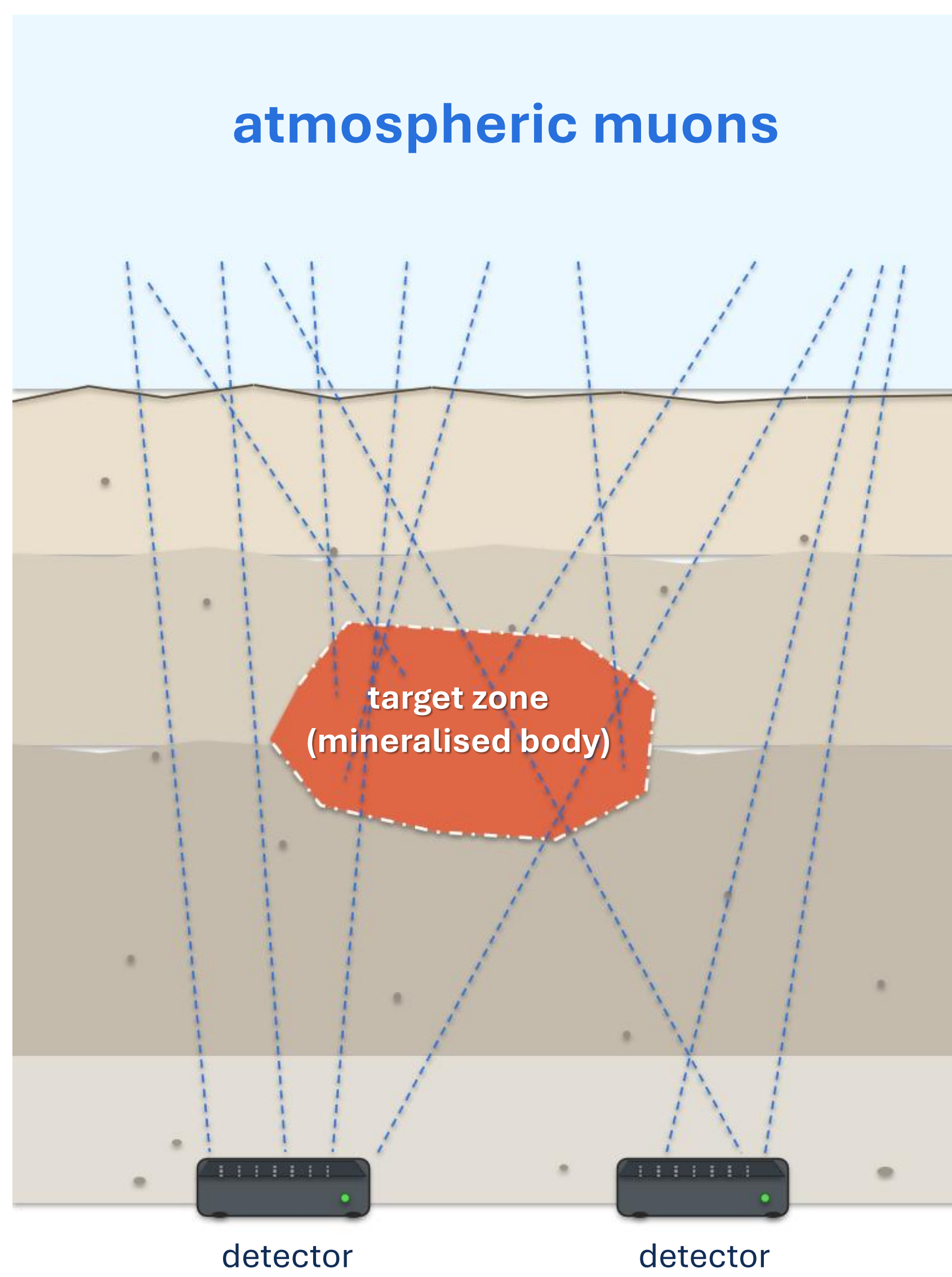
- Passive and non-invasive
- Sensitive to density contrasts
- Supports 2D radiography and 3D tomography
- Complements conventional geophysics and geological data

Project timelines



How muography works

Simplified schematic



Variations in directional muon attenuation reveal density contrasts, which are reconstructed into images.

Variations in muon attenuation between the target and the detector encode density contrasts, which are reconstructed into images.

AGEMERA: muography as one of three innovative geophysical methods

Horizon Europe GA 101058178 | 2022–2025



Muography



Passive seismic



Drone geophysics

1 Role in AGEMERA

Muography was developed as one of AGEMERA's three core innovative geophysical methods for critical raw material exploration.

2 Imaging capability

Used for density characterization of rock volumes, supporting 2D radiography and 3D tomography in mining and brownfield settings.

3 Integrated interpretation

Designed to contribute to integrated interpretations together with other geophysical and geological datasets.

4 Responsible exploration

Part of a broader workflow to improve geological understanding while reducing reliance on invasive drilling.

Example: Bauxite lens imaging / mining-field demonstration



Mining demonstration site: Jajce, Bosnia-Herzegovina



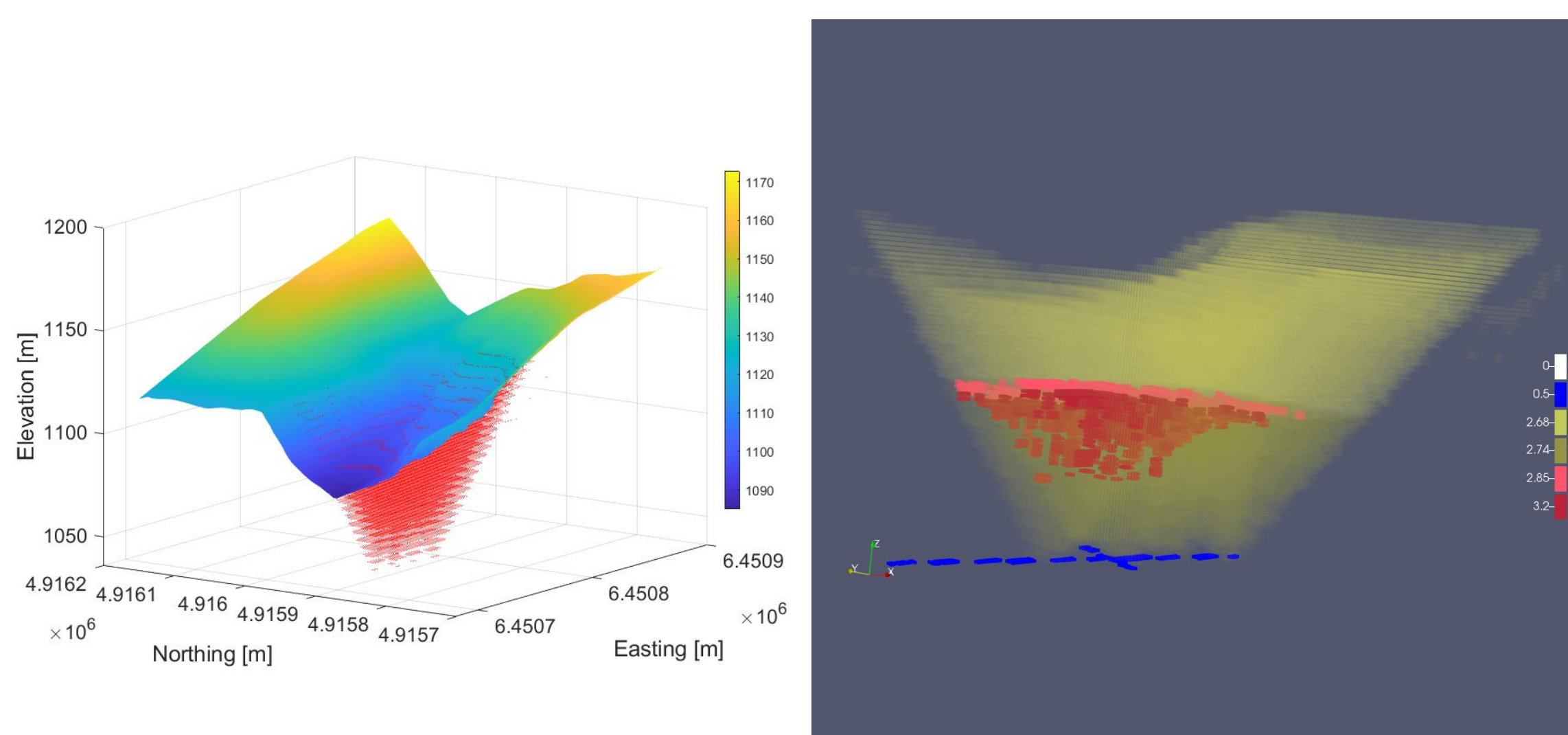
Bauxite lens (brown)



Adit entrance



Adit



High-density bauxite lens identified within lower-density host rocks.

Results support exploration targeting and geological interpretation.

Mine.io: toward integrated and underwater muography

Horizon Europe GA 101091885 | 2023–2026

1 Mining-oriented instrumentation

Mine.io advances muography through imaging and monitoring instrumentation tailored to mining applications.

2 Underwater concept

A concept combining a muon detector, waterproof casing, and autonomous robotic deployment.

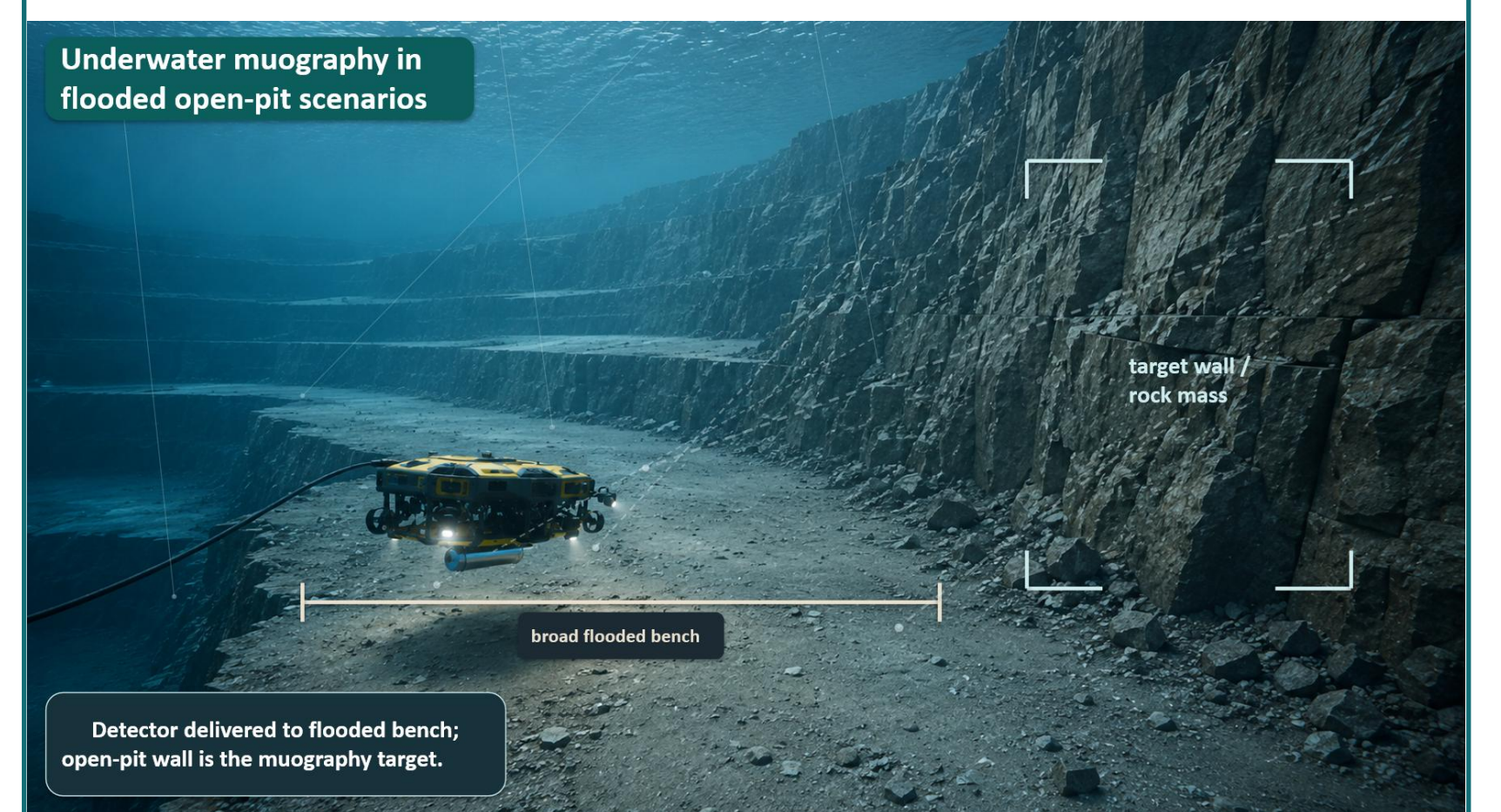
3 Validation in Portugal

Validated in flooded open-pit conditions in Portugal as a step toward applications in water-filled mine environments.

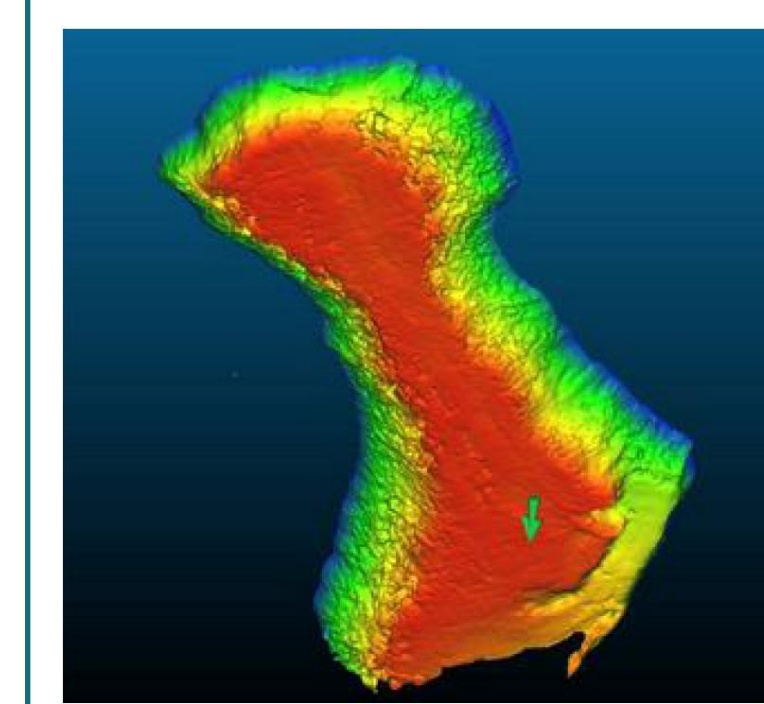
4 Digital integration

Positions muography within a broader digital exploration workflow linked with robotics, positioning, and integrated data environments.

Underwater muography



Flooded open-pit muography



Location of the underwater muography survey at the flooded Malaposta open pit, Portugal

Acknowledgement: In collaboration with INESC TEC and HUN-REN Wigner Research Centre for Physics.



Towards standardisation in muography

- No formal field-wide standards yet
- Mine.io has contributed an initial discussion
- Candidate concepts: density distribution, muon flux, metre water equivalent, standard rock
- Discussion continues within the wider community



Take-home message

AGEMERA and Mine.io show how muography is progressing from promising field-demonstration technology toward scalable, application-oriented solutions for mineral exploration and mining.



Funded by the European Union



doi: 10.3030/101058178



doi: 10.3030/101091885

Selected focus: mining muography, integrated workflows, and underwater deployment concepts

Find out more: www.agemera.eu | www.mineio-horizon.eu