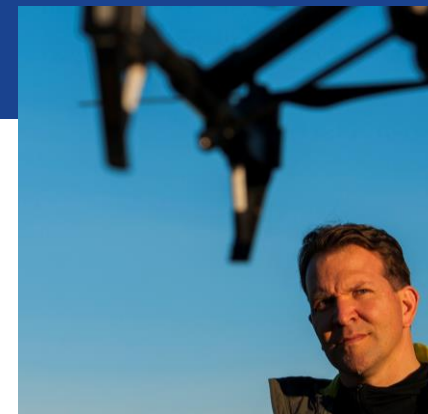


Session 1: Mineral extraction

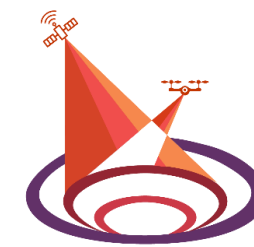
m4mining



Steven Micklethwaite
Sustainable Minerals Institute,
University of Queensland, Australia



Project name



M4MINING

Real-time rock, mineral and environmental mapping via UAV allowing seamless 3D visualization and decision making.

Develop – Monitor – Demo - Trial

Project duration

1 January 2023 – 31 December 2025

Budget

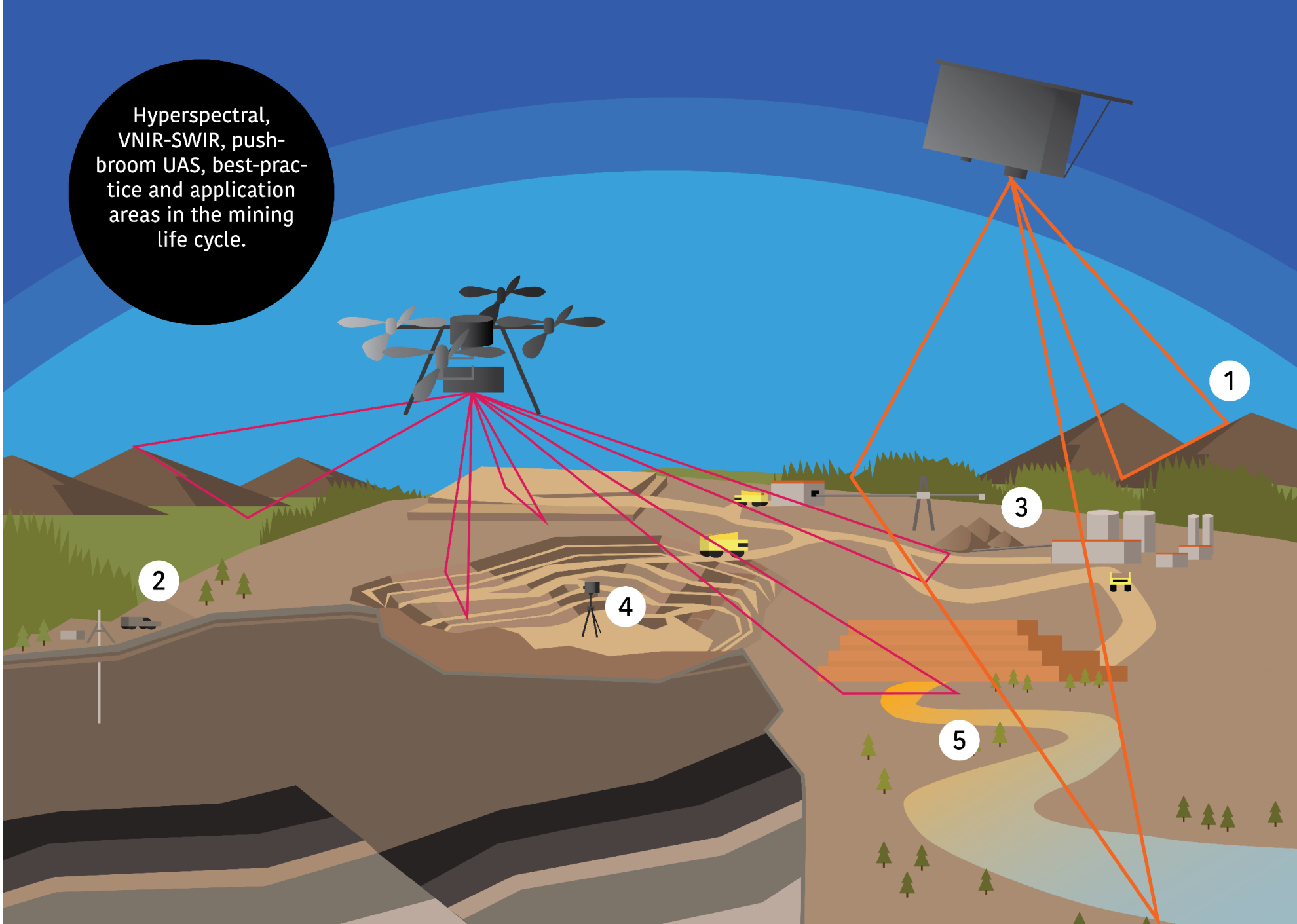
€ 4 696 629 (€ 4 499 512 EU contribution)

TRL level - 6

Major industrial/research partners



Hyperspectral, VNIR-SWIR, push-broom UAS, best-practice and application areas in the mining life cycle.



Value Proposition

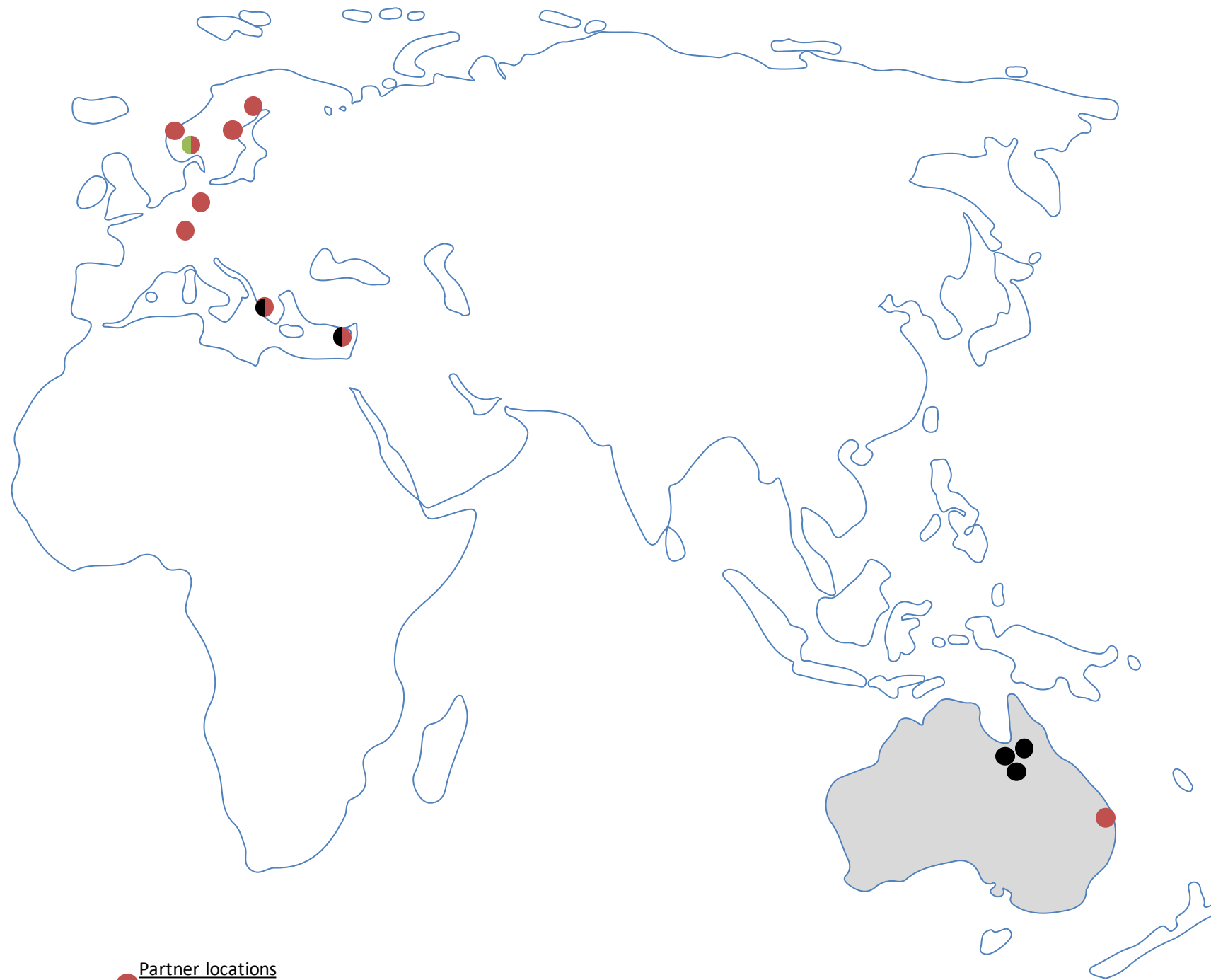
- Interoperable equipment
- High spatial resolution for optimisation of operations
- High temporal resolution for rapid decision making

Application

- Geology mapping
 - Exploration vectoring (mineralogy)
 - Open pit mapping
 - Geotech monitoring
 - Early-stage geomet data
 - Ore/waste tracking
 - Stockpile mineral chem
- ROM monitoring (soft sensor optimisation)
 - Tailings monitoring
 - AMD identification
 - Sediment control & erosion
 - Water chemistry
 - Rehabilitation & weed control

IMAGING SPECTROSCOPY FOR THE MINING LIFE CYCLE: A GUIDE FOR DRONE APPLICATIONS

Exploration	Operational mining	Closure and Rehabilitation
<p>1 12 studies including imaging spectroscopy for exploration</p> <p>2 18 studies from the realm of hyperspectral drill core scanning</p>	<p>3 6 studies utilizing hyperspectral imaging, including first studies of geometallurgy applications</p> <p>4 26 studies detailing ground-based hyperspectral scanning</p>	<p>5 59 studies in post-mining environments, including hyperspectral imaging for AMD monitoring, rehabilitation and geotechnical applications</p>



Partner locations

Test-sites

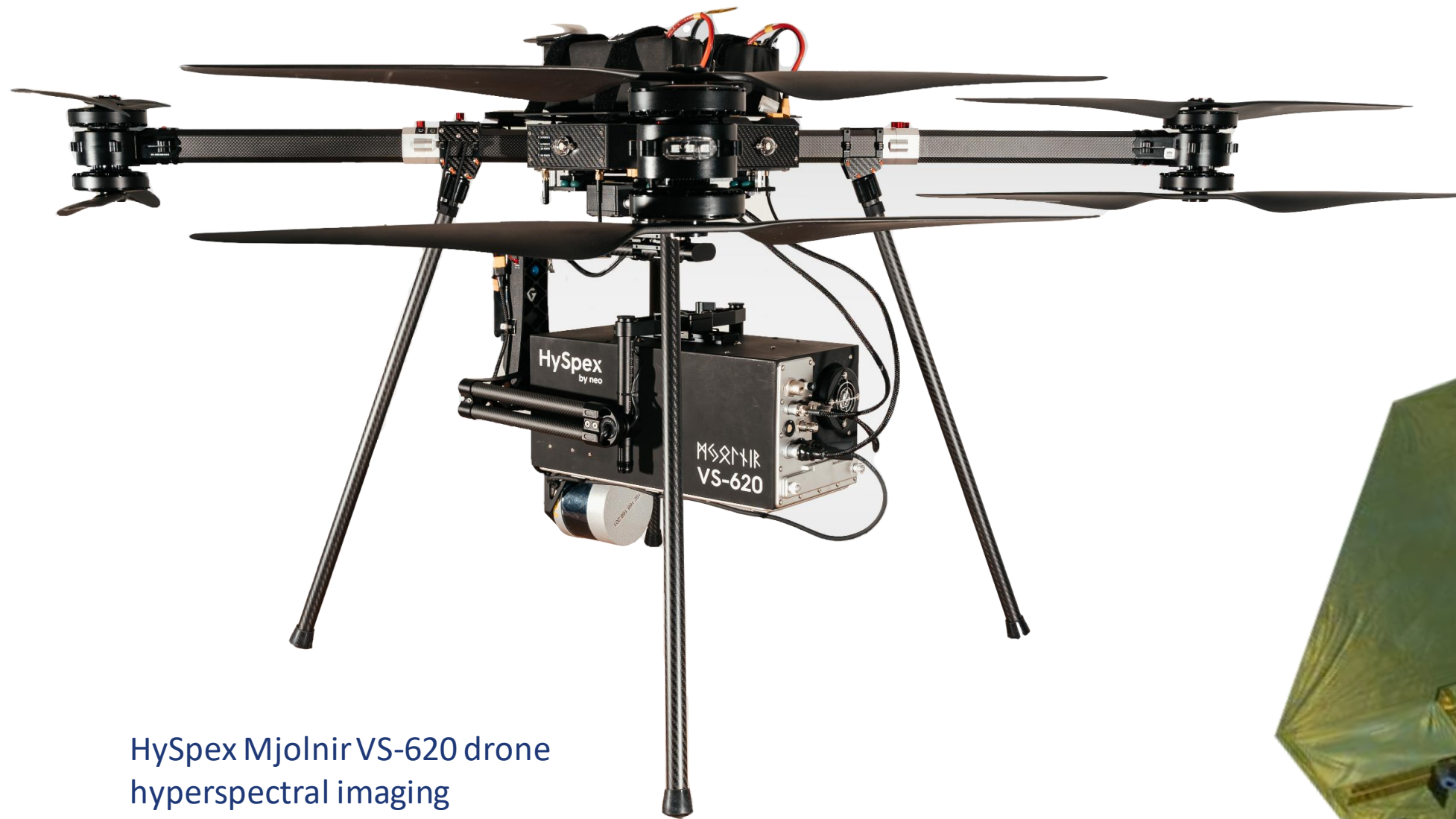
Demo

Australia – Active Cu-tailings and legacy Au- and U-REE- tailings and (mineral mapping, rehab, enviro)

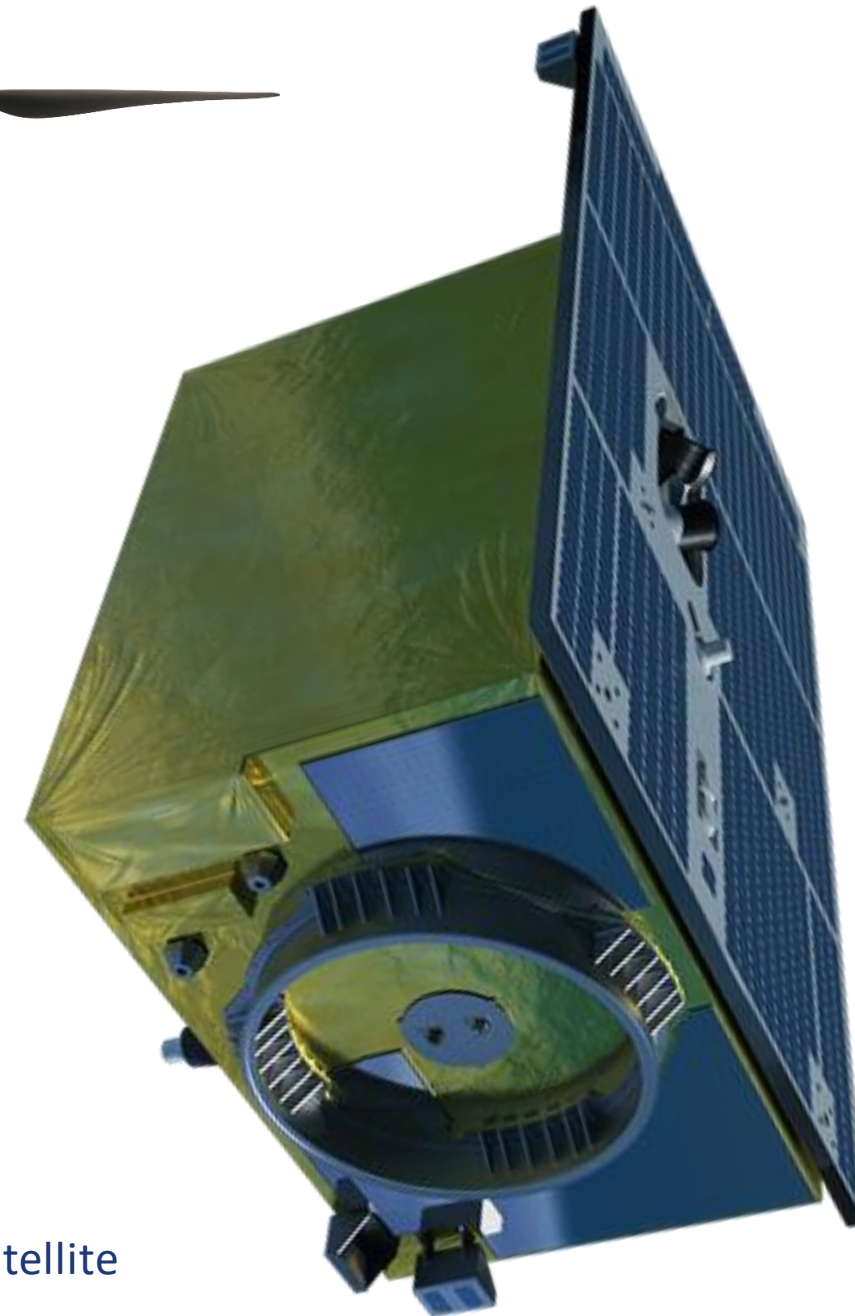
Greece – Active carbonate-hosted bauxite mine

Republic of Cypress – Pyrite mine tailings (rehab, AMD)

Norway – Rapid prototyping and quarry testing

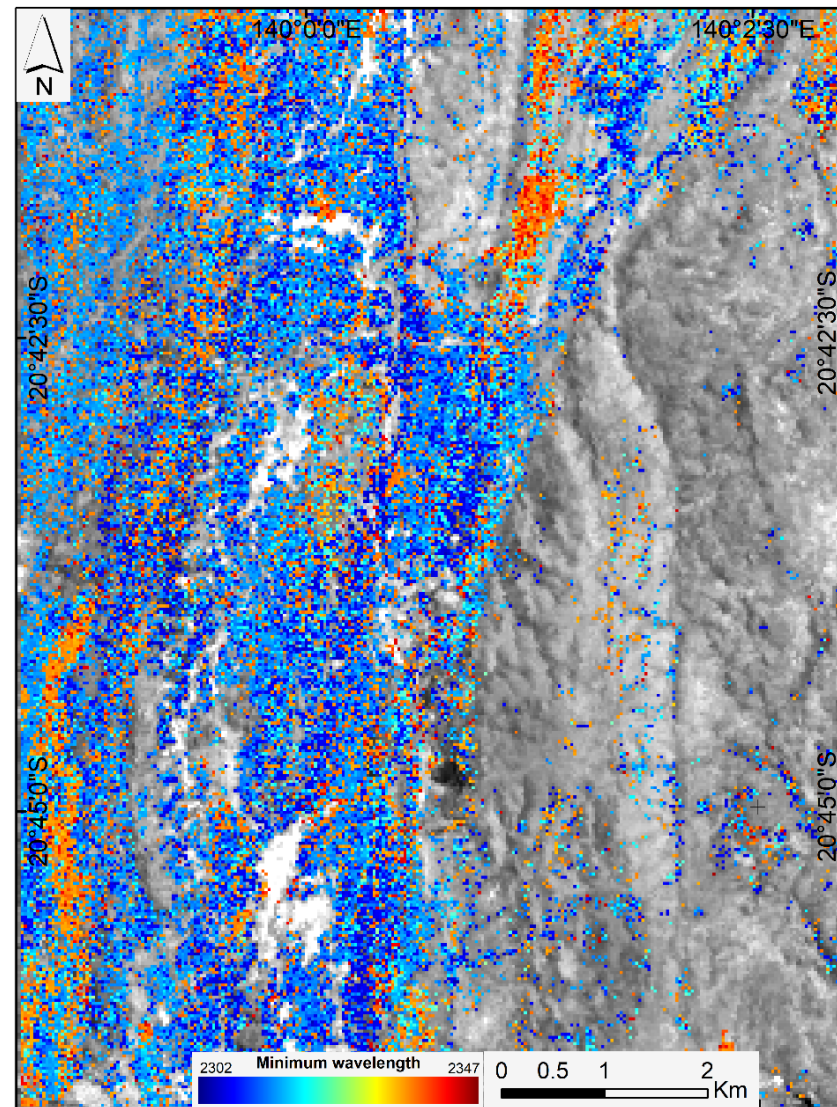


HySpex Mjolnir VS-620 drone
hyperspectral imaging



EnMAP satellite

**Demo: Mary Kathleen, Australia – REE-U
Satellite**



Variations in the minimum wavelength of Mg-OH feature

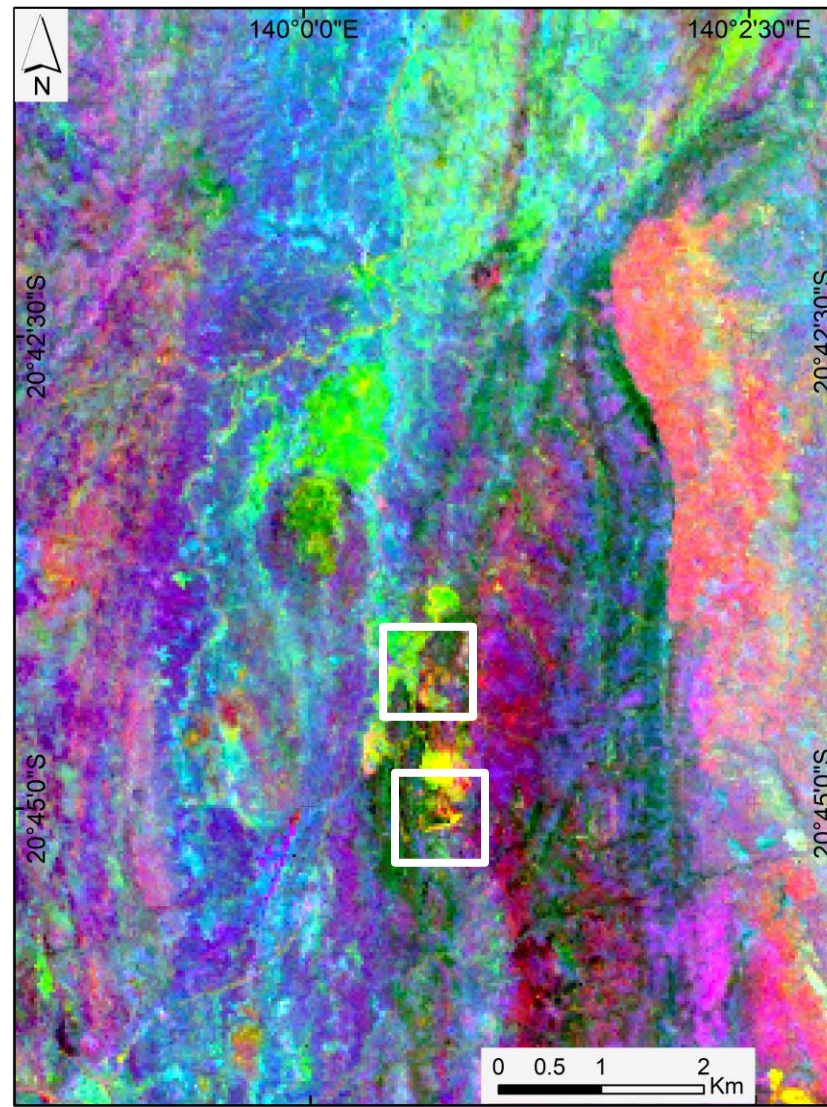
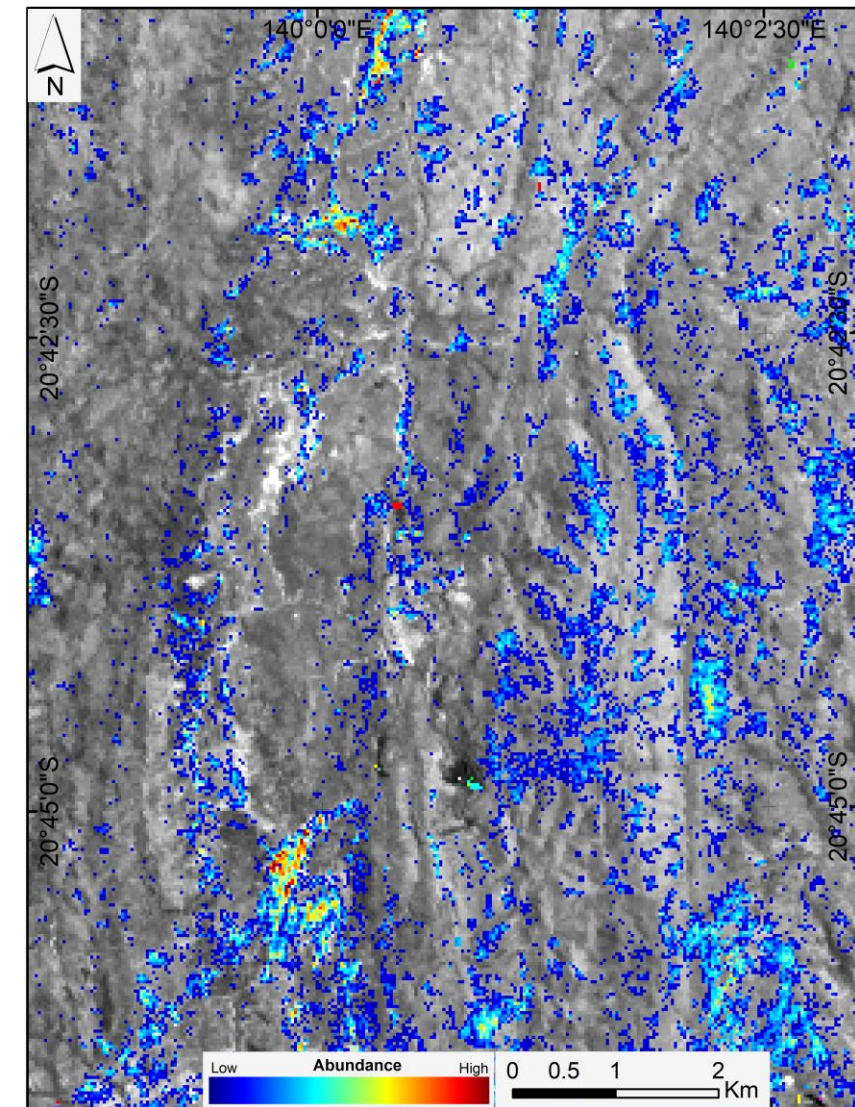
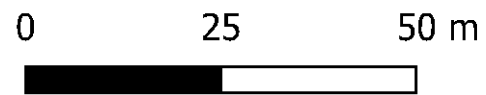
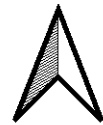
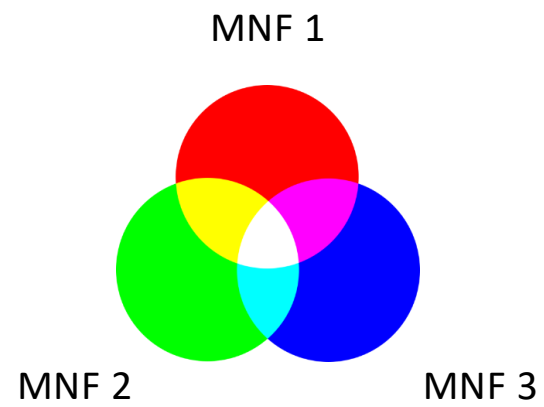
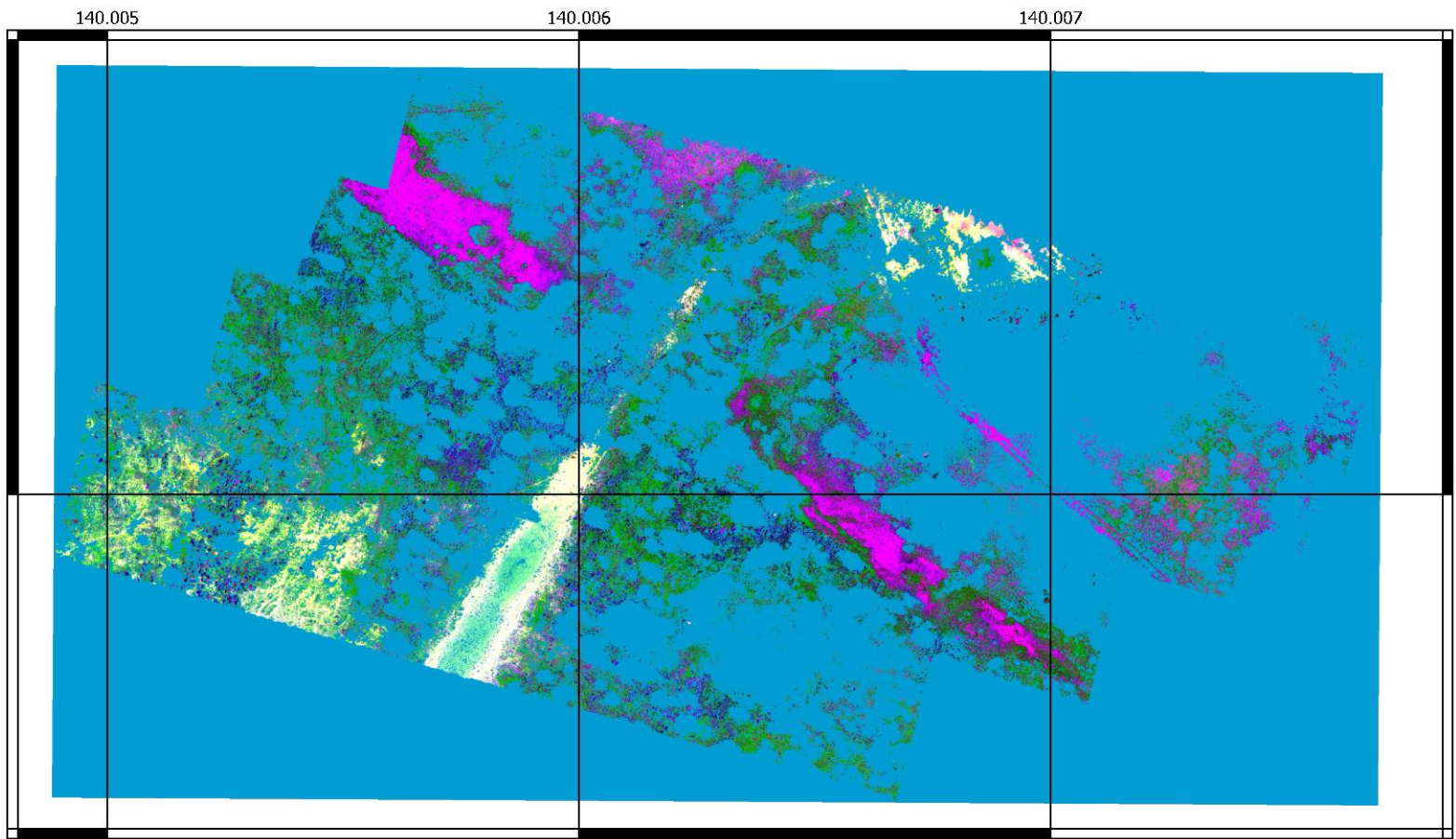


Image enhancement using Minimum Noise Fraction (MNF) transform



Hematite abundance map: spectral unmixing

Minimum noise fraction



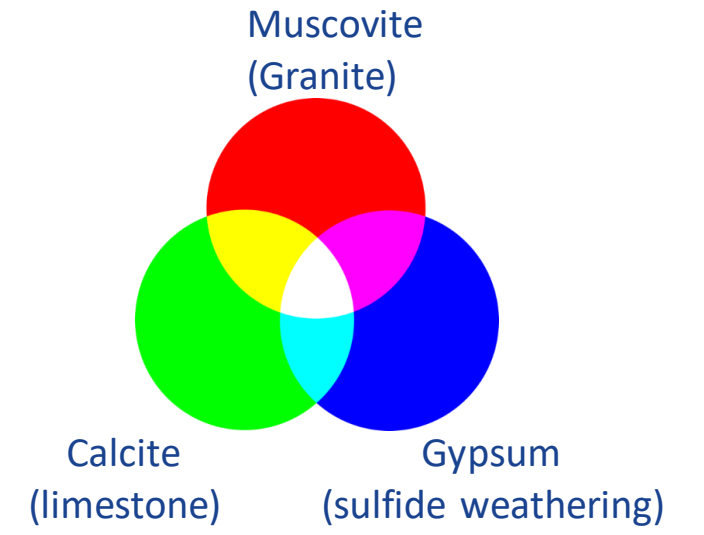
- Band 01: MNF Band 1
- Band 02: MNF Band 2
- Band 03: MNF Band 3

Demo: Mary Kathleen, Australia – REE-U

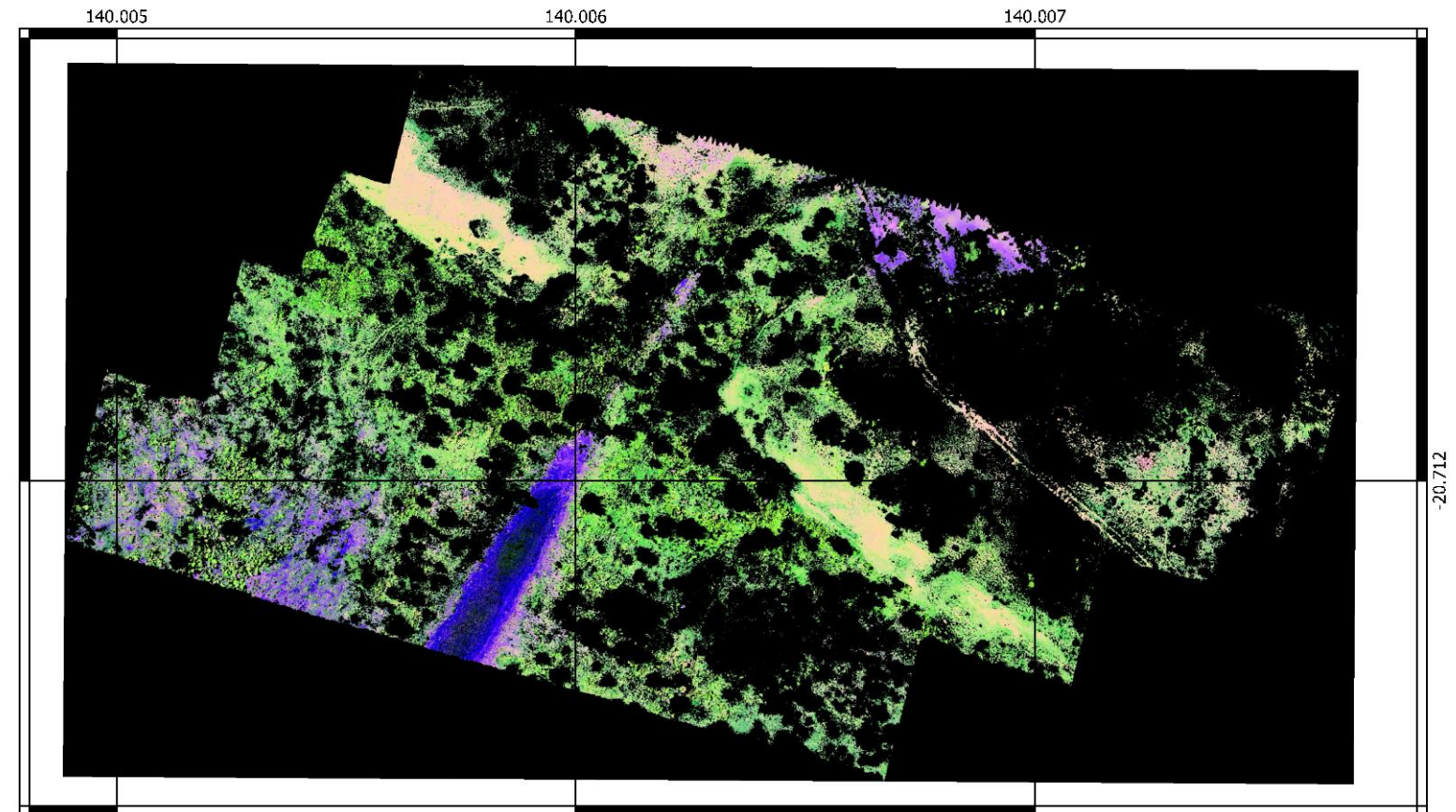
Drone (scoping near real-time visualization)

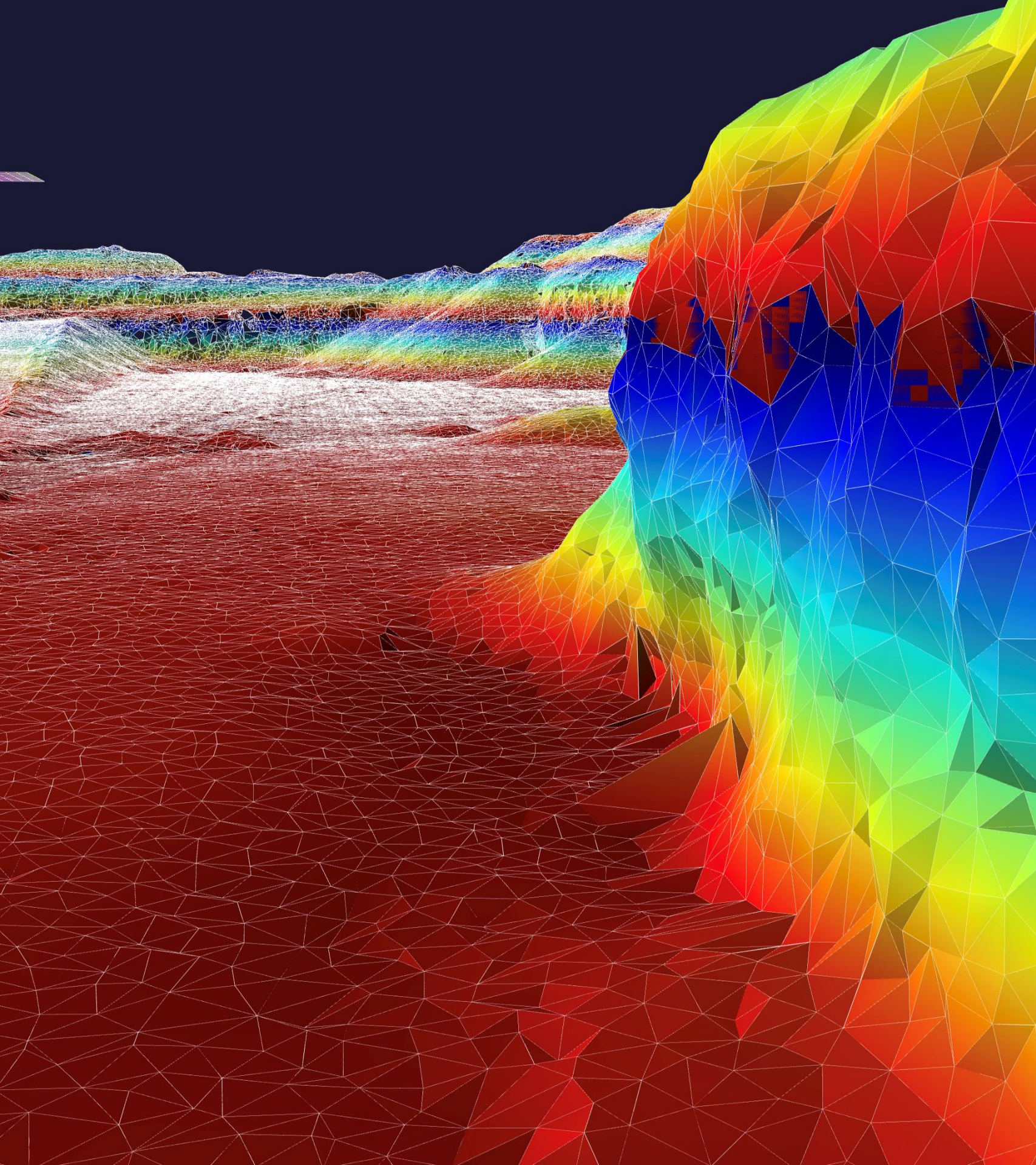
Vegetation masked

In-field data QAQC



SAM





Real-time R&D results

- 258 seconds recording from a drone
- 66 million points
- Point density of 260k per sq meter.
- Meshing took ~10 seconds
- True 3D

Conclusion: Achieved real-time calculation of 3D topography & DEMs with high precision LiDAR.

www.m4mining.eu

Talk to Steven Micklethwaite at PDAC

<https://www.linkedin.com/in/steven-micklethwaite-83145177/>

Or reach out to our project management office

pmo-m4mining@norceresearch.no

Visit our



#m4mining



Funded by
the European Union

m4mining is funded by the European Union's Horizon Europe programme under Grant Agreement ID 101091462

Nexgen SIMS



Jan Gustafsson
Project Coordinator
Epiroc

Niclas Dahlström
Outreach & Communication
LTU Business

NEXGEN SIMS

Next Generation Carbon Neutral Pilots
for Sustainable Intelligent Mining Systems

Project duration

1 May 2021 – 30 April 2024

Budget

€16 000 000 EU contribution

TRL level

5-7



Our vision: Sustainable and Efficient Mine Production

Competitive technology advantage leading to unlocking substantial reserves of new or today unexploited resources within the EU



**Minimized
environmental impact**



**Operation
efficiency**

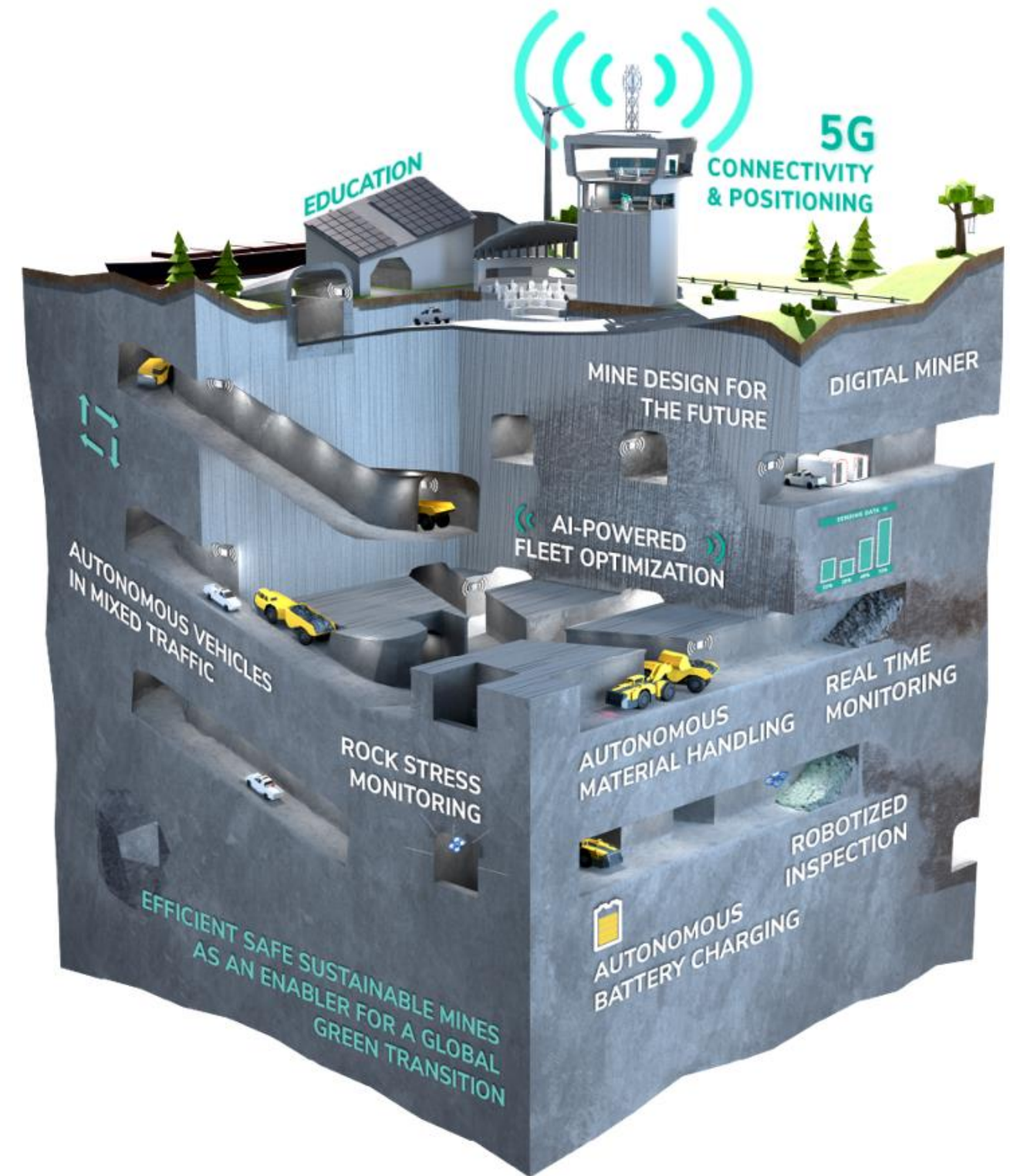


**Safety & job
creation**

A more sustainable and efficient production of raw materials, resulting in economic growth and minimized environmental impact, supporting **the next production paradigm shift** of the mining industry.

Focus areas

Enablers to reach the impacts



The next mine production paradigm shift

Piloting and Demonstration in European Mines

Scale-ups demonstrating technical performance and health & safety benefits
– 8 Pilot Sites

1. Kittilä Mine (Agnico Eagle Finland)
2. LTU Test Mine & VR Lab (Luleå University of Technology)
3. Kankberg and Kristineberg Mine (Boliden)
4. Kvarntorp Test Mine (Epiroc)
5. Werra Mine (K+S)
6. Rudna Mine (KGHM)
7. Lubin Mine (KGHM)

Business value for partners by integrating Go-to-Market strategies that ensure successful exploitation and commercialization of the project results







Thanks for your attention!

Follow our 3 year journey towards sustainable mining on our website and social media



Twitter

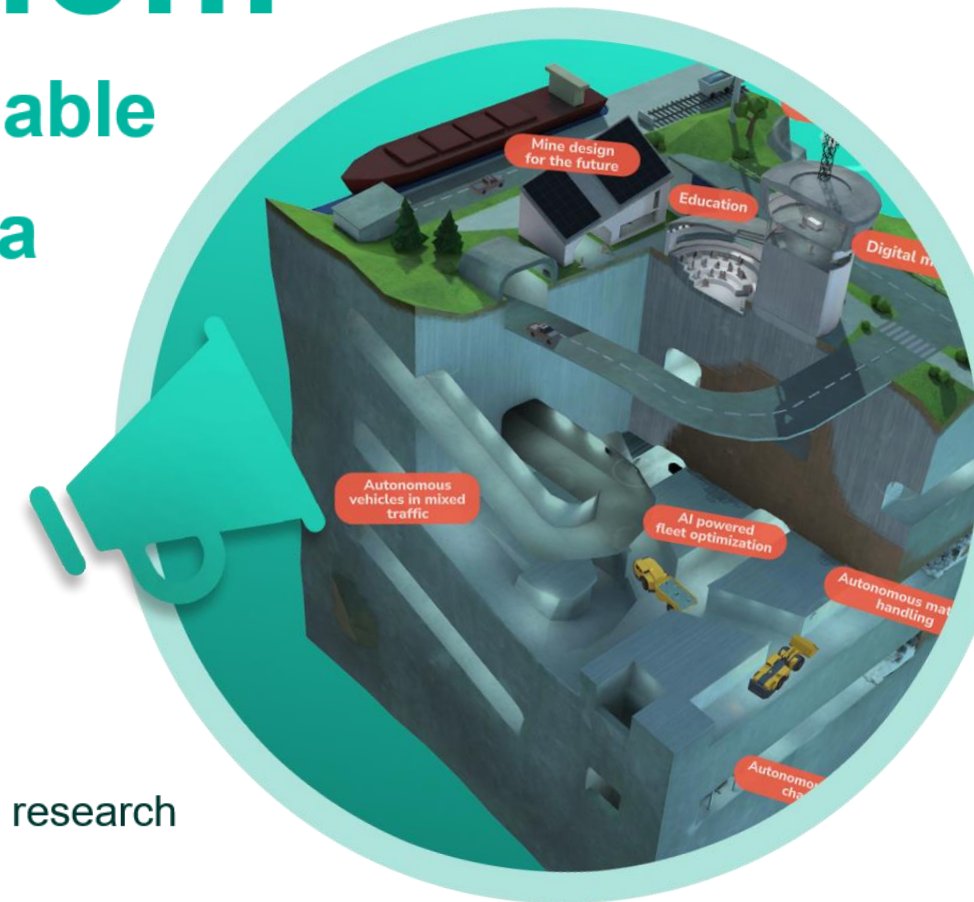


LinkedIn

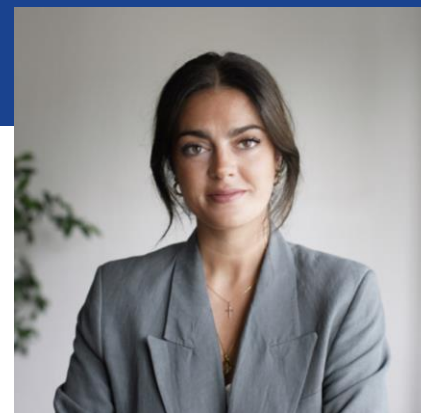
www.nexgensims.eu



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003591



ROTATE



Lorena Viladés

ANEFA

Spanish Aggregates Association, Spain

ROTATE

CIRCULAR & CRITICAL RAW MATERIALS ECOLOGICAL ESSENTIAL



Project name

ROTATE

Short description

Circular, Ecological, Essential and Critical Raw Materials

Project duration

1 September 2022 – 31 August 2026

Budget

€14 212 290 (€11 432 610 EU contribution)

TRL level

TRL 5

Technology validated in relevant environment

TRL7

System prototype demonstration in operational environment

Major industrial/research partners





Pilot sites

- Celestite mine – Granada, Spain.
- Granite quarry – Sandnes, Norway.
- Sand and gravel pit – Fontainebleau, France.
- Sand and gravel pit – Soria, Spain.
- Limestone quarry – Lisbon, Portugal.

Core R&I targets

- Extraction and processing improvement
zero emissions, materials, resources and consumption efficiency.
- Circularity, industrial symbiosis
waste valorisation.
- Environmental footprint
assessment, management and monitoring.
- Social engagement.



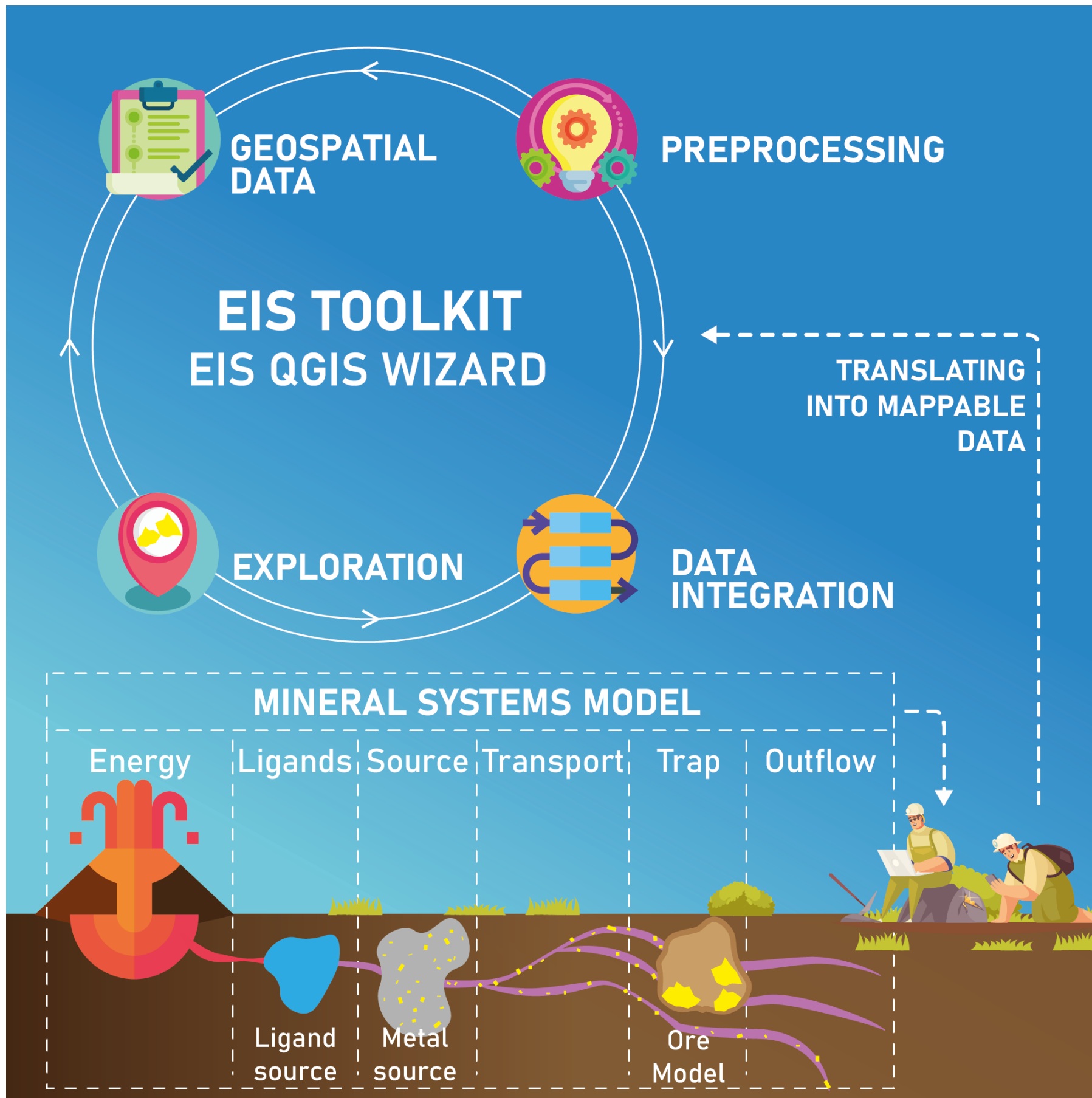
Session 2: Mineral exploration

EIS - Exploration Information System

Making mineral exploration better



Hafsa Ahmed Munia
Geological Survey Finland,
Espoo, Finland



Project name

EIS

Short description

New innovative exploration concepts and data analysis tools to enhance the probability of finding new sources of critical raw materials (CRM) for the EU's economy.

Project duration

1 May 2020 – 31 March 2025

Budget

€7,497,035.00

TRL level

5

Major industrial/research partners



Partners

17





DEVELOP INNOVATIVE
EXPLORATION TOOLS



REDUCE EXPLORATION
AND MINING FOOTPRINTS



RAISE AWARENESS
TO THE GENERAL PUBLIC

Project name

EIS

Objective 1

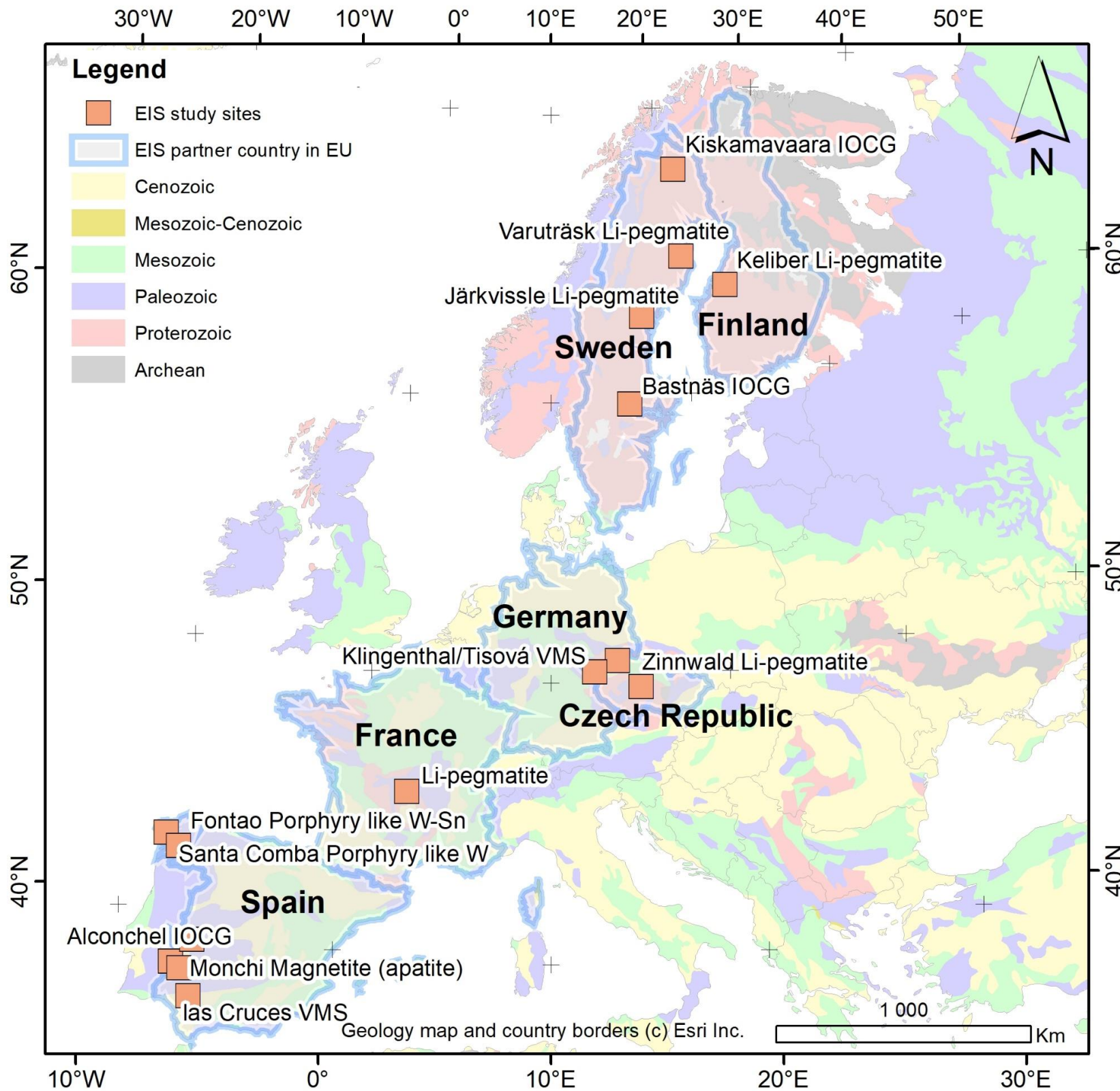
EIS will develop the “EIS Toolkit” and the “EIS QGIS Wizard”. These tools will be open-source and will provide critical information for the mining sector and geoscientists.

Objective 2

The tools developed by EIS aim to reduce the impact of exploration and mining on nature – making it more sustainable. It will reduce exploration footprints by using the existing exploration data.

Objective 2

EIS will raise awareness of the importance of critical raw materials to the EU’s transition, economy, and welfare.



Project name

EIS

Test / Demonstration Sites

Cobalt minerals potential VMS system				
Nr.	Study site	other deposits to be studied	partners	commodities
1	Tisová /Klingenthal		Golden PET, Beak, CU	Co, Cu
2	Las Cruces		CSIC, Cobre LC	Cu
Lithium-tin-tantalum-tungsten minerals potential granite/pegmatite-related system				
	Study site	other deposits to be studied	partners	commodities
3	Keliber		Keliber, GTK	Li
4	Granite-related deposits W Iberia		CSIC	Li, W, Sn, Ta
5	Zinnwald/Cinovec		Beak, DLI, LTU	Li
6		Järkvissle/Varuträsk	SGU, LTU	
7		Li-pegmatites in France	BRGM	
8		Li-pegmatite in Czech republic	CU	
Rare earths-cobalt minerals potential IOCG system				
	Study site	other deposits to be studied	partners	commodities
9	Kiskamavaara/Nunasvaara		LTU, SGU, Talga	Co, C, Cu, Au
10	Bastnäs REE		SGU	REEs
11		Burguillos-Alconchel	CSIC, LTU	Co, REE, Cu

In addition, project also has reference study sites in South Africa (Orange River pegmatite belt) and Brazil (Carajás IOCG province).

Project name

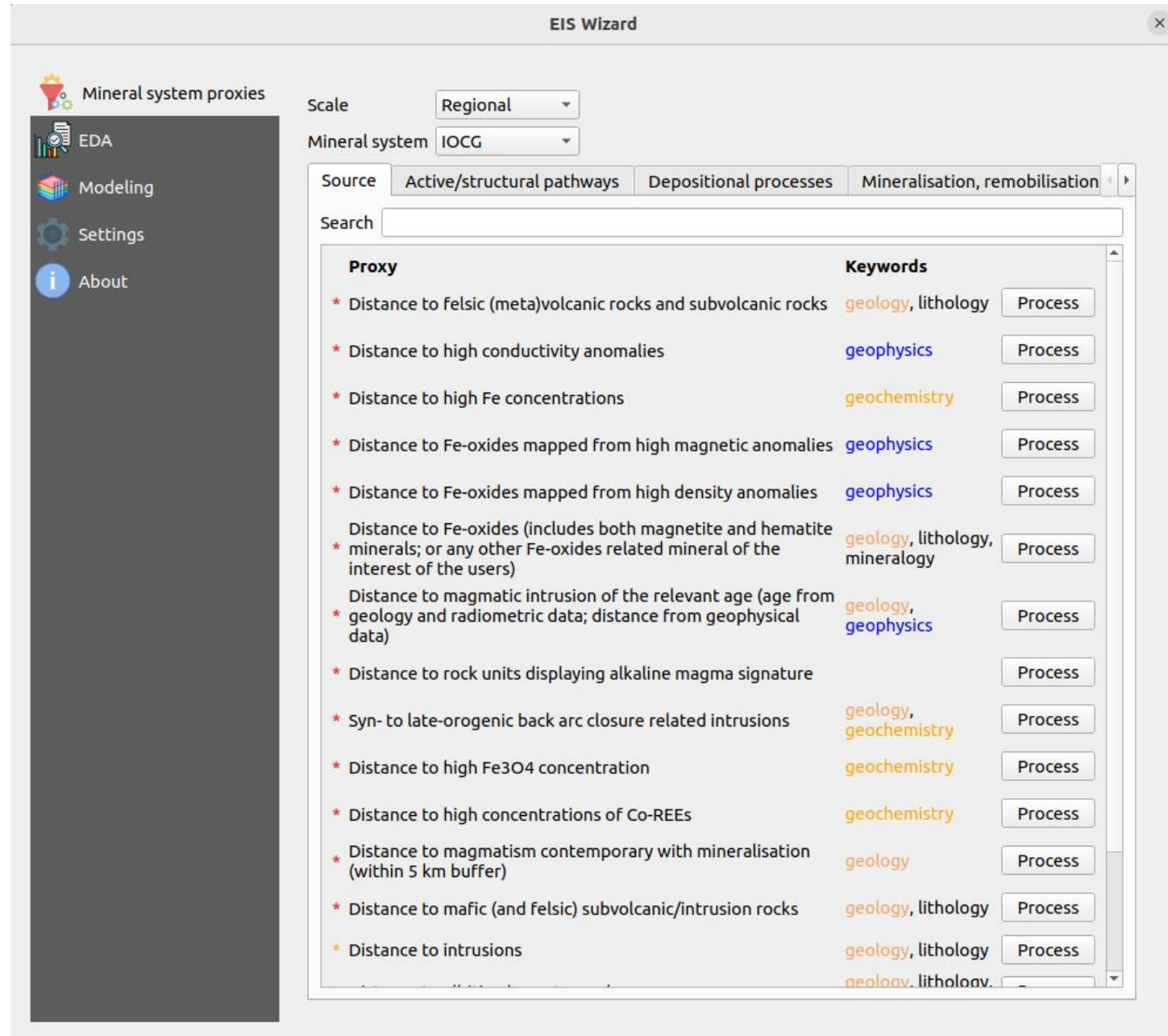
EIS

Key Results

Mineral Systems Developed

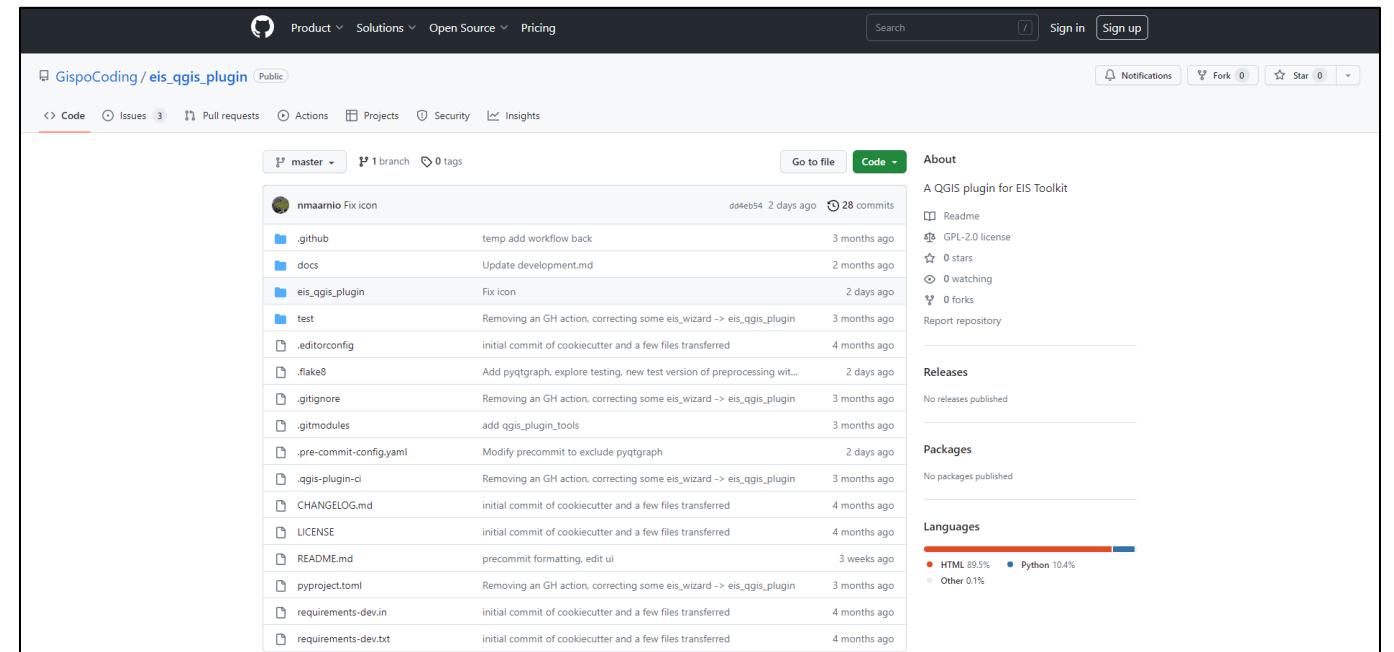
Open-Source EIS Toolkit

Open-Source EIS QGIS Plugin / Wizzard



The screenshot shows the 'EIS Wizard' application window. On the left is a sidebar with navigation options: Mineral system proxies, EDA, Modeling, Settings, and About. The main area is titled 'Mineral system proxies' and features a 'Scale' dropdown set to 'Regional' and a 'Mineral system' dropdown set to 'IOCG'. Below these are tabs for 'Source', 'Active/structural pathways', 'Depositional processes', and 'Mineralisation, remobilisation'. A search bar is present above a list of proxy items. Each item includes a description, associated keywords, and a 'Process' button.

Proxy	Keywords	Action
* Distance to felsic (meta)volcanic rocks and subvolcanic rocks	geology, lithology	Process
* Distance to high conductivity anomalies	geophysics	Process
* Distance to high Fe concentrations	geochemistry	Process
* Distance to Fe-oxides mapped from high magnetic anomalies	geophysics	Process
* Distance to Fe-oxides mapped from high density anomalies	geophysics	Process
Distance to Fe-oxides (includes both magnetite and hematite minerals; or any other Fe-oxides related mineral of the interest of the users)	geology, lithology, mineralogy	Process
* Distance to magmatic intrusion of the relevant age (age from geology and radiometric data; distance from geophysical data)	geology, geophysics	Process
* Distance to rock units displaying alkaline magma signature		Process
* Syn- to late-orogenic back arc closure related intrusions	geology, geochemistry	Process
* Distance to high Fe ₃ O ₄ concentration	geochemistry	Process
* Distance to high concentrations of Co-REEs	geochemistry	Process
* Distance to magmatism contemporary with mineralisation (within 5 km buffer)	geology	Process
* Distance to mafic (and felsic) subvolcanic/intrusion rocks	geology, lithology	Process
* Distance to intrusions	geology, lithology	Process



The screenshot shows the GitHub repository page for 'GispoCoding / eis_qgis_plugin'. The repository is public and has 28 commits. The commit history is visible, showing recent updates and file changes. The right sidebar provides information about the repository, including a README, license (GPL-2.0), and a language usage chart.

About
A QGIS plugin for EIS Toolkit

Releases
No releases published

Packages
No packages published

Languages

Language	Percentage
HTML	89.5%
Python	10.4%
Other	0.1%

GREENPEG



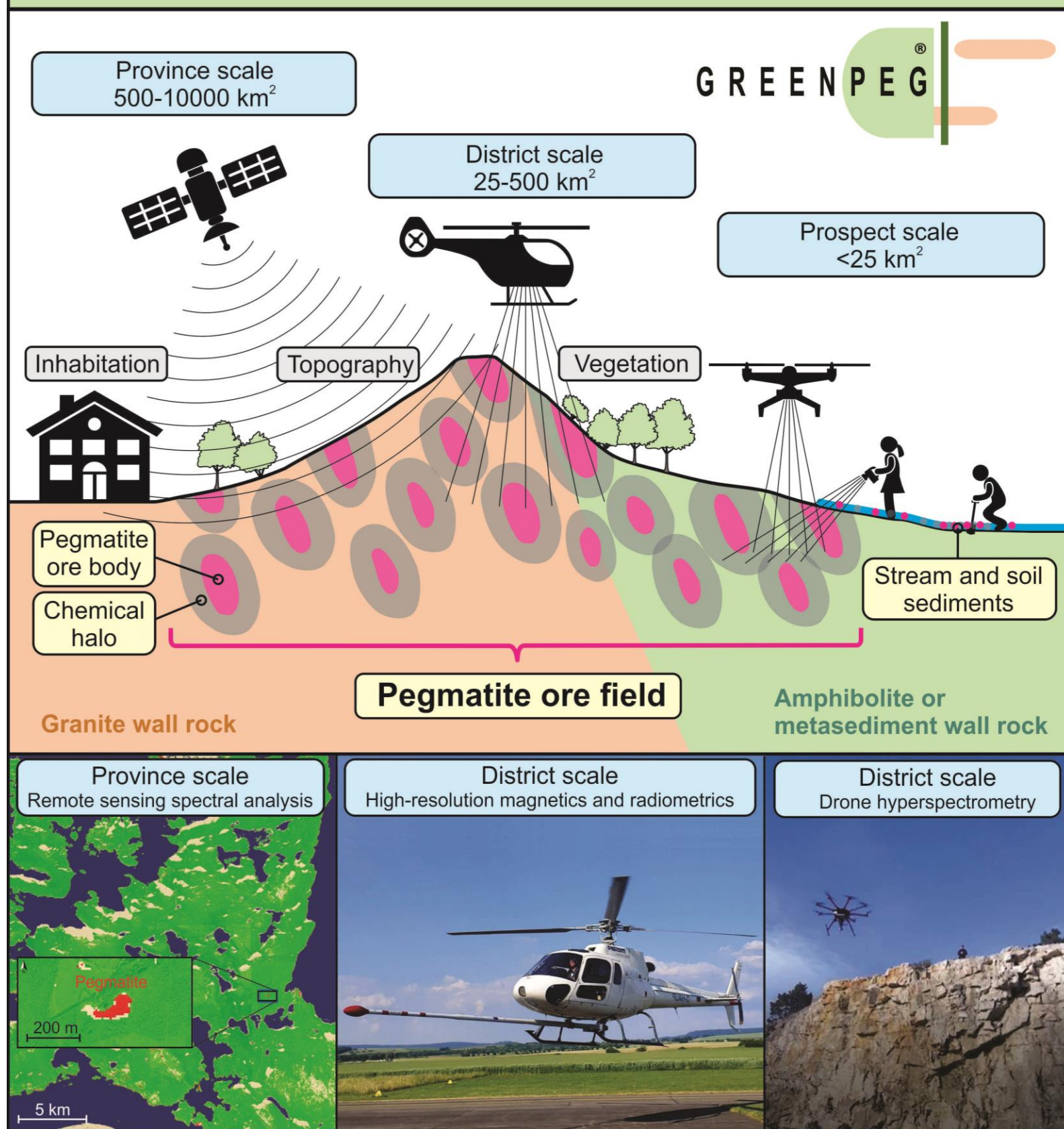
Funded by
the European Union



Axel Müller

Natural History Museum,
University of Oslo, Norway

GREENPEG - EXPLORATION TOOLSET FOR HARD-ROCK LITHIUM



Project name

GREENPEG

Short description

New Exploration Tools for European Pegmatite Green-Tech Resources

Project duration

1 May 2020 – 31 October 2024

Budget

€9 250 230 (€8 325 292 EU contribution)

TRL level

6-7

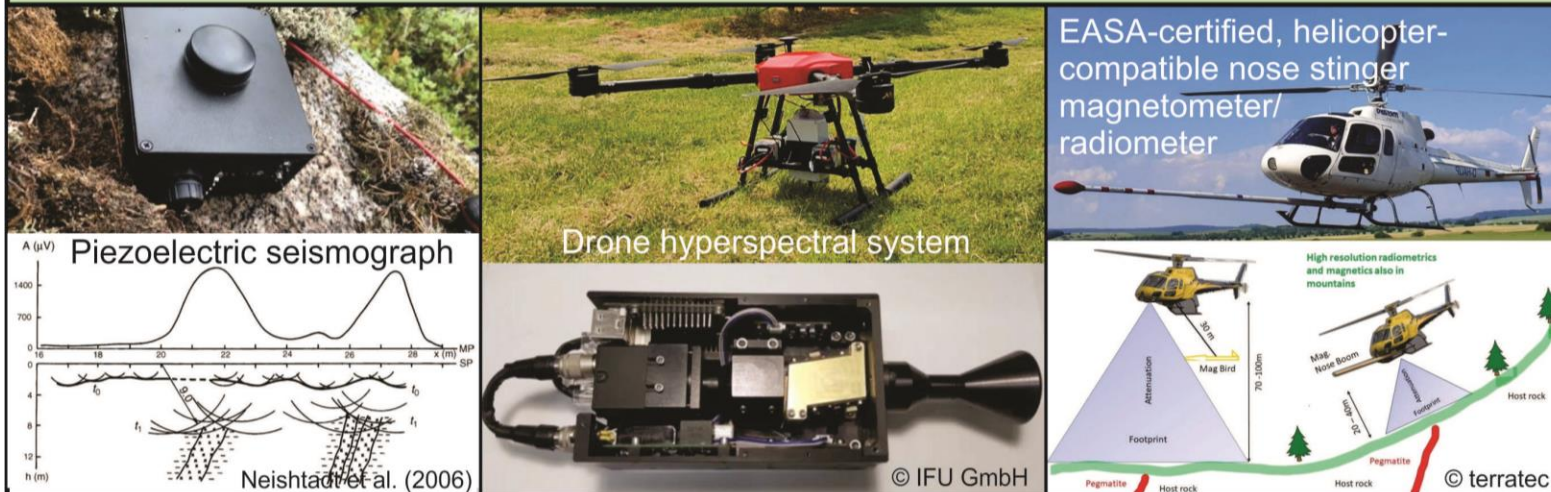
Major industrial/research partners

- European Lithium AT
- Blackstairs Lithium Ltd
- Felmica Minerai Industriais
- Terratec Geophysical Services GmbH
- Geological Survey of Norway
- University of Oslo

GREENPEG - DEMONSTRATION SITES



GREENPEG - PILOTS



GREENPEG - DATABASES

Spectral library of pegmatites and their host rocks



Petrophysical database of pegmatites and their host rocks



GREENPEG project description



Demonstration sites

- Tysfjord, Norway
- Wolfsberg, Austria
- South Leinster, Ireland

Pilots

- Piezoelectric seismograph
- EASA-certified, helicopter-compatible nose stinger magnetometer/radiometer
- Drone-borne hyperspectral imaging system (acousto-optical monochromator)

Databases

- Spectral library of pegmatites and their host rocks
- Petrophysical database of pegmatites

Core R&I targets/results

- Toolset for pegmatite exploration to enhance European exploration success and secure CRM supply chain
- Innovative exploration technology and approaches for sustainable exploration with minimal environmental and social impact
- Supported by ESG best practice methodology for societal acceptance

VECTOR



Tina Pereira

Helmholtz Institute Freiberg
for Resource Technology,
Helmholtz-Zentrum Dresden-
Rossendorf, Germany



Sarah Gordon
Satarla



Chris Stockey
Satarla

What do you consider to be the key challenges in exploration and mining projects?

Geological pilot sites


- Irish Midlands, Ireland
- Kupferschiefer, Germany
- Jadar, Serbia (analysis of historic data only)

Core R&I targets/results

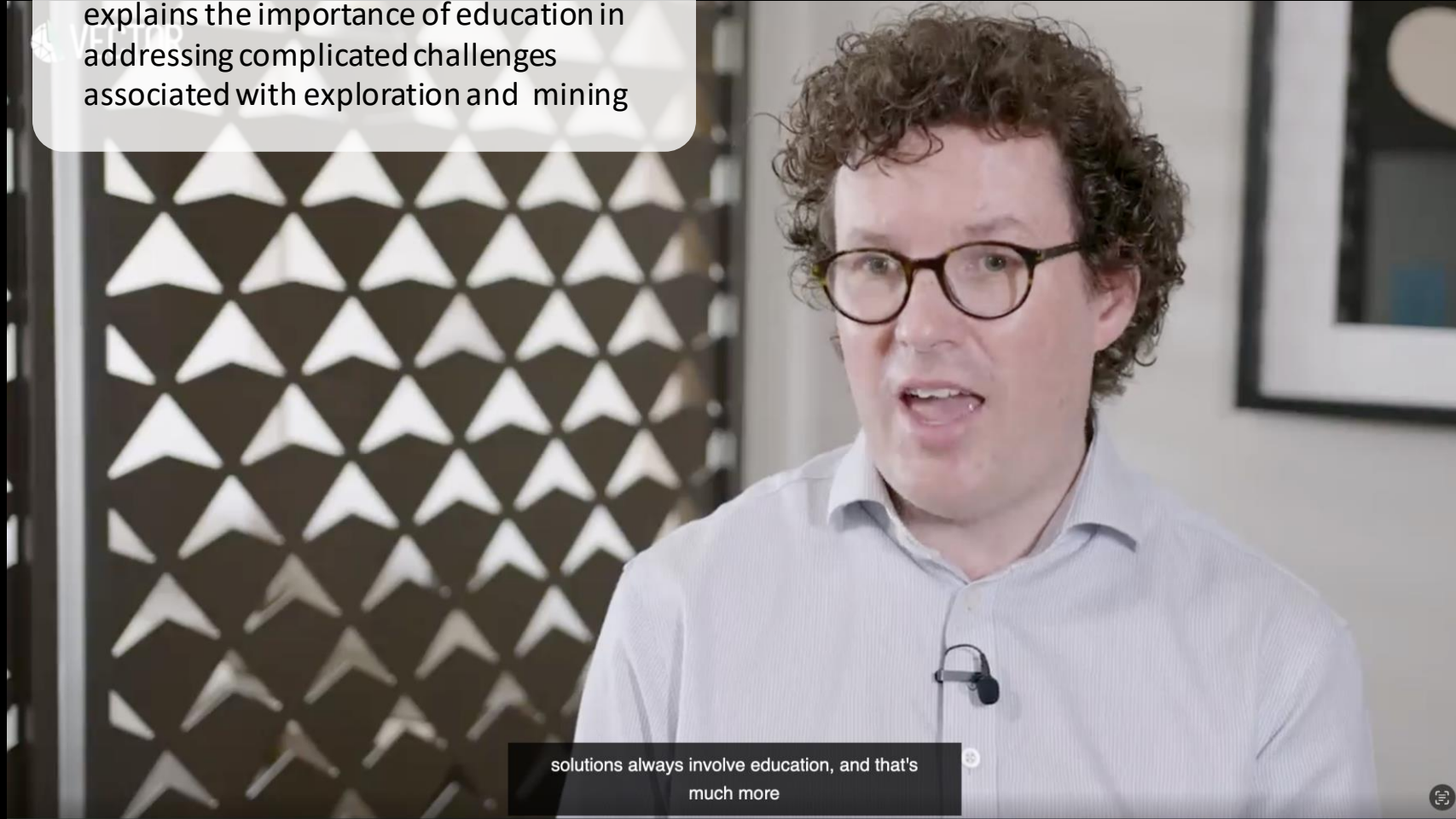
VECTOR's delivers evidence-based and accessible knowledge that integrates geoscience and social science pathways, to develop sustainable and responsible mineral exploration and mining.

Goals:

- A geological prospectivity toolkit based on a novel workflow using machine learning-based integration of less invasive geological, geochemical and geophysical measurements.
- Identification of how differences in societal values impact attitudes towards mining projects.
- An integrated toolkit that considers both geological exploration potential, social and environmental factors.

A photograph showing two workers in high-visibility yellow and orange vests inside a white container. They are working with a piece of equipment on a raised platform. The equipment has "SPECIM SPECTRAL IMAGING" and "Theia X" logos. The worker in the foreground is leaning over the equipment, while the other is standing nearby.

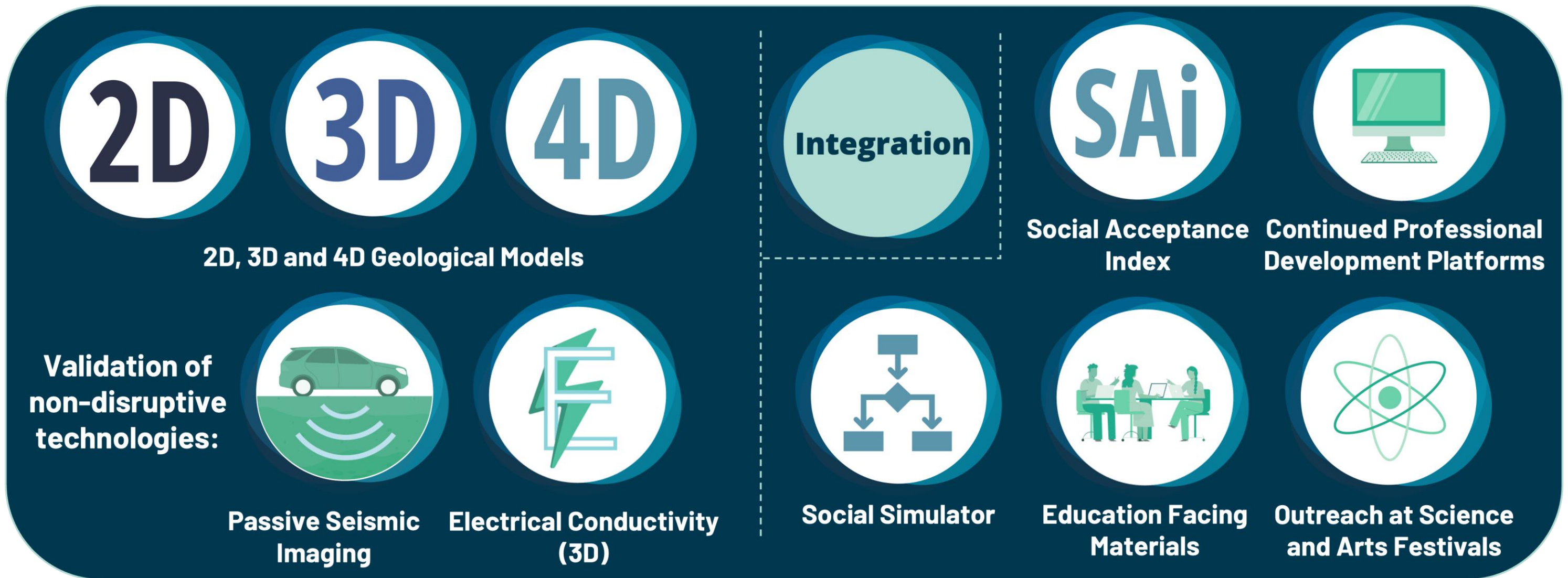
Above: VECTOR drill-core scanning campaign.

A photograph of a man with curly brown hair and glasses, wearing a light blue button-down shirt. He is speaking and looking slightly to the right. The background is a wall with a geometric pattern of white triangles on a dark background.

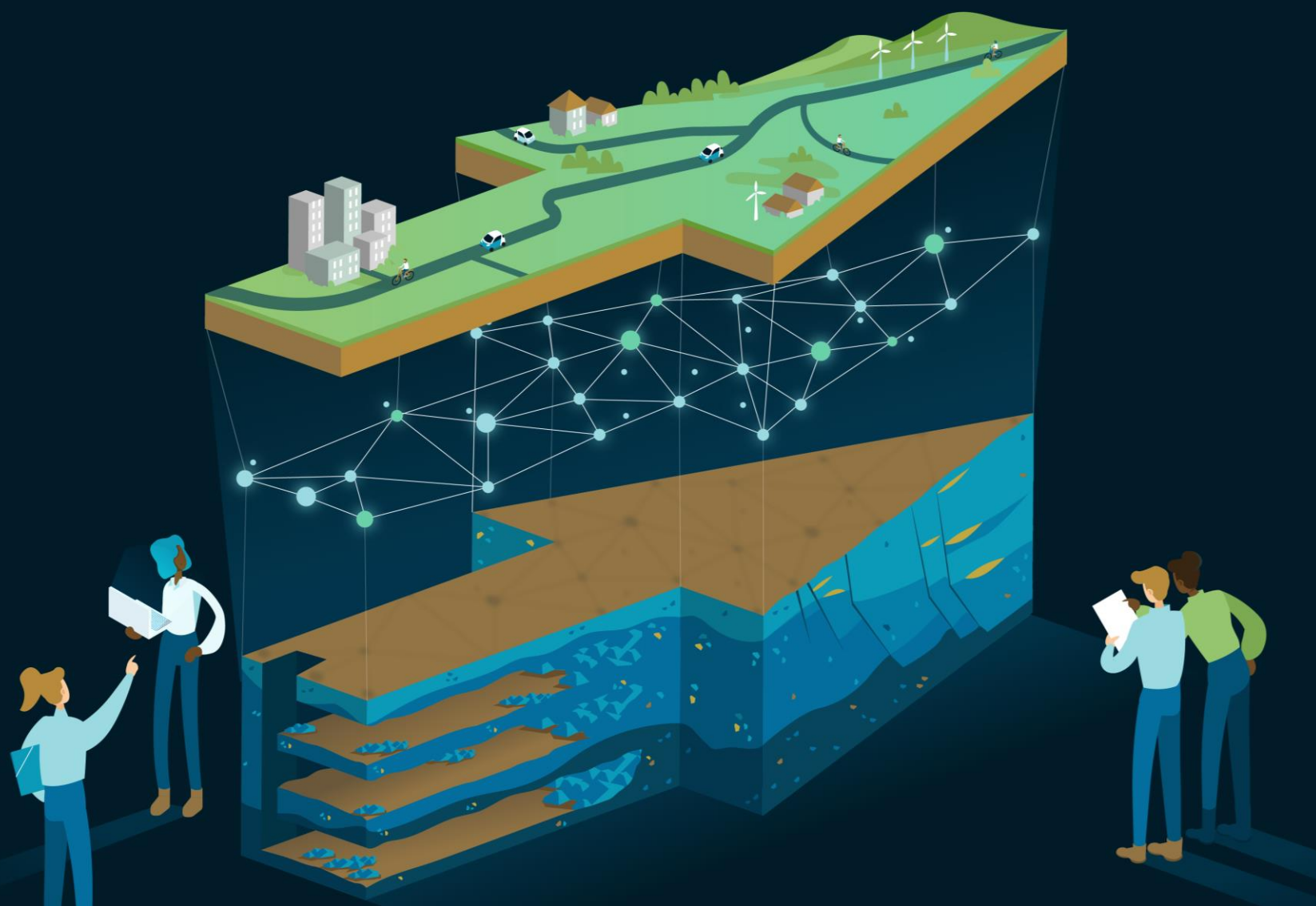
Below: VECTOR researcher Shane Bergin explains the importance of education in addressing complicated challenges associated with exploration and mining

solutions always involve education, and that's much more

Project Outputs



Vectors to Accessible Critical Raw Material Resources in Sedimentary Basins



VECTOR



Project name

VECTOR

Short description

Vectors to Accessible Critical Raw Material Resources in Sedimentary Basins

Project duration

1 June 2022 – 31 May 2025

Budget

€7,474,006 (€5,606,679 EU contribution)

TRL level

6

Major industrial/research partners

