GEOLOGICAL SURVEY OF NORWAY
- NGU -

GREENPEG®

The H2020 GREENPEG project
at
EU Raw Materials Week 2023
Horizon Technology Success Stories

DISCOVER **PEGMATITES** **IN EUROPE**

November 13th 2023 – Claudia Haase – Geological Survey of Norway (NGU)

Funded by the Horizon 2020 Framework Programme of the European Union GA 869274

GREENPEG - New Exploration Tools for European Pegmatite Green-Tech Resources

THE TARGET

Critical Raw Materials (Li, Si, REE, Be, Ta) for the green energy shift enriched in **pegmatite type deposits**.

Pegmatites are small (<5 million m^3) but occur in large numbers and clusters in Europe, allowing exploitation with little investment, like in quarries.
But they are hard to discover if buried.

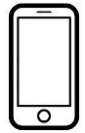
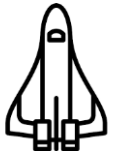
THE OBJECTIVES – Exploration 'made in Europe'

GREENPEG is developing an innovative **toolset** at Technical Readiness Level 7 for the exploration of buried Li-Cs-Ta and Nb-Y-F pegmatites, including:

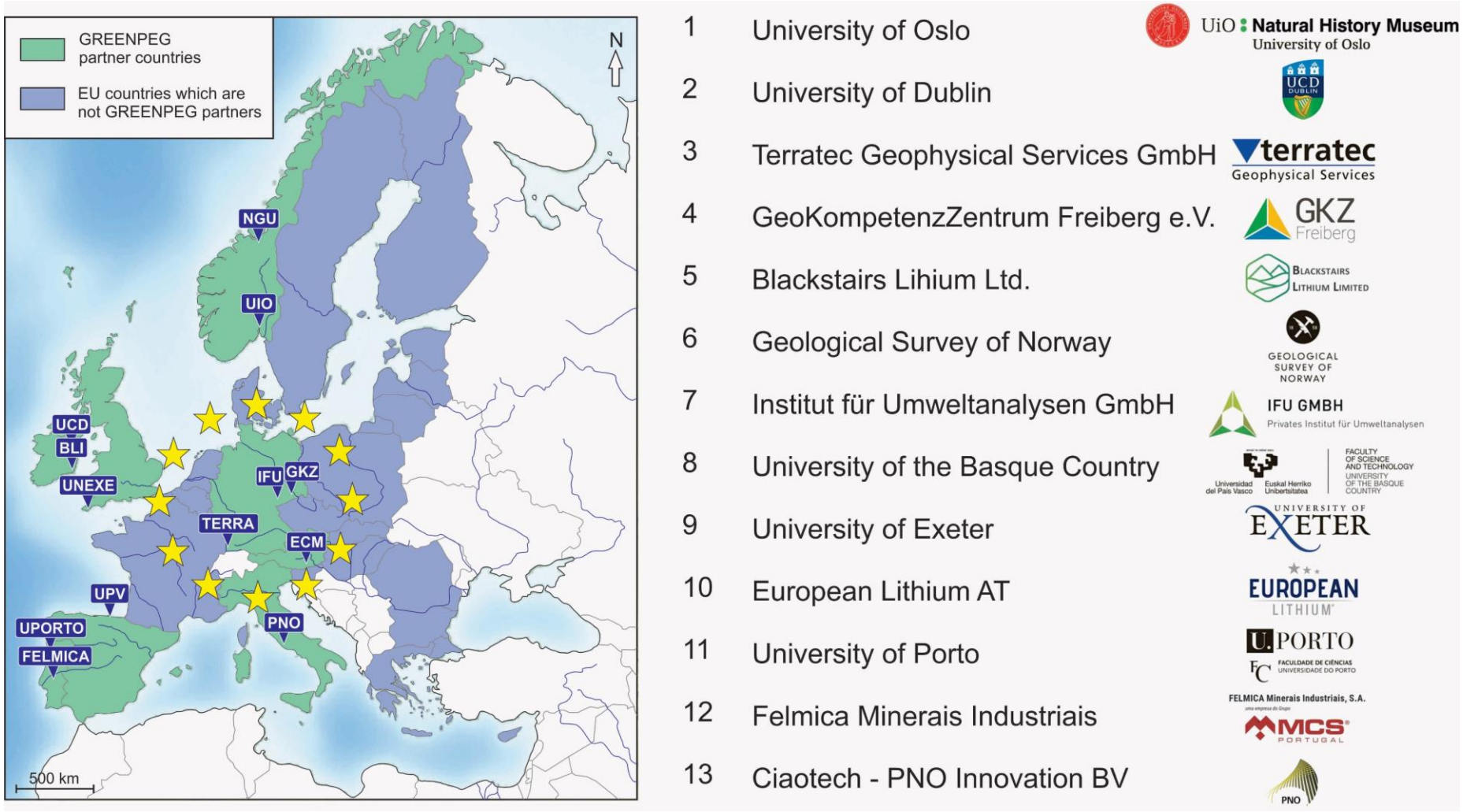
- Three **new geophysical instrumental exploration techniques and devices** (piezoelectric seismograph, helicopter-complementary nose boom magnetometer, drone-borne hyperspectral imaging system), embedded in the toolset
- two **new exploration datasets and workflows** for prospect scale (<50 km^2) and district scale (50-500 km^2) exploration.

FEEDING THE ENERGY TRANSITION

Pegmatite bound commodities are essential for battery, solar panel, semiconductor, fibre optic, ceramic (etc.) production

GREENPEG target commodity	Natural host (mineral) in pegmatites	Major application
Lithium (Li)	Spodumene - **Li**$Al(SiO_3)_2$	
Silicon metal (Si)	Quartz - **Si**O_2	
Rare earth elements (REE)	Allanite - (**Ce**,Ca,Y)$_2$(Al,Fe)$_3$(SiO_4)$_3$(OH)	
Tantalum (Ta)	Tantalite - FeMn**Ta**$_2O_6$	
Beryllium (Be)	Beryl - **Be**$_3Al_2Si_6O_{18}$	
Feldspar ($KAlSi_3O_8$)	Potassium feldspar - **$KAlSi_3O_8$**	

GREENPEG PARTNERS



1	University of Oslo	UiO : Natural History Museum University of Oslo
2	University of Dublin	UCD DUBLIN
3	Terratec Geophysical Services GmbH	terratec Geophysical Services
4	GeoKompetenzZentrum Freiberg e.V.	GKZ Freiberg
5	Blackstairs Lihium Ltd.	Blackstairs Lithium Limited
6	Geological Survey of Norway	Geological Survey of Norway
7	Institut für Umweltanalysen GmbH	IFU GMBH Privates Institut für Umweltanalysen
8	University of the Basque Country	Universidad del País Vasco / Euskal Herriko Unibertsitatea — Faculty of Science and Technology, University of the Basque Country
9	University of Exeter	University of Exeter
10	European Lithium AT	European Lithium
11	University of Porto	U.Porto — Faculdade de Ciências Universidade do Porto
12	Felmica Minerais Industriais	Felmica Minerais Industriais, S.A. — MCS Portugal
13	Ciaotech - PNO Innovation BV	PNO

Coordination by:
Natural History Museum of the University of Oslo

Involvement:

- 3 exploration services / mining operators,
- 1 geological survey,
- 3 consulting companies,
- 5 academic institutions

from 8 European countries.

GREENPEG®

terratec
Geophysical Services

NOSE BOOM

First EASA-certified heliborne nose boom system for the European market!

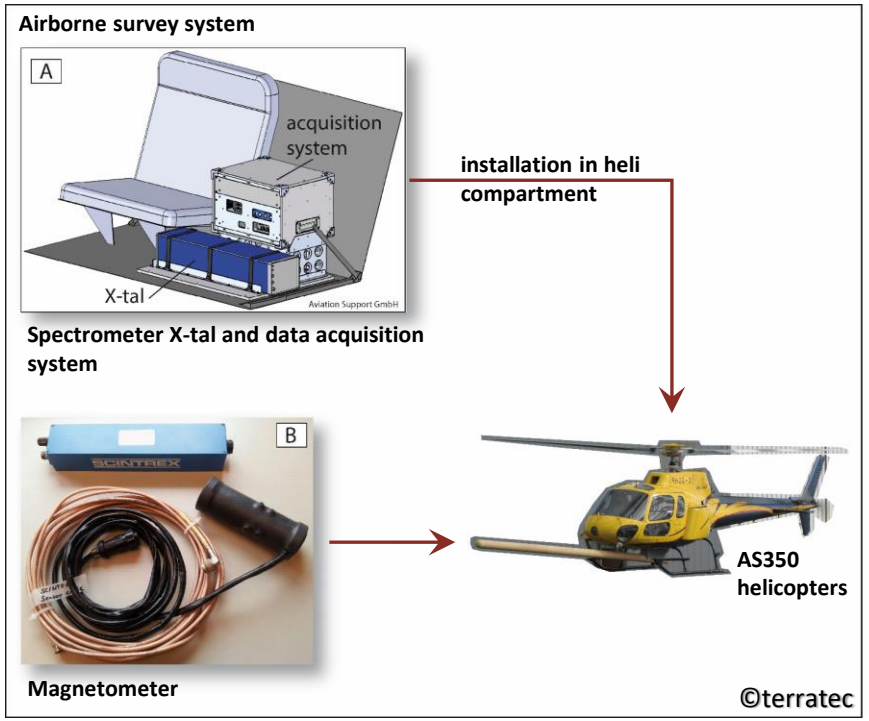
High resolution magnetic and radiometric data acquisition for lithological and structural interpretation!

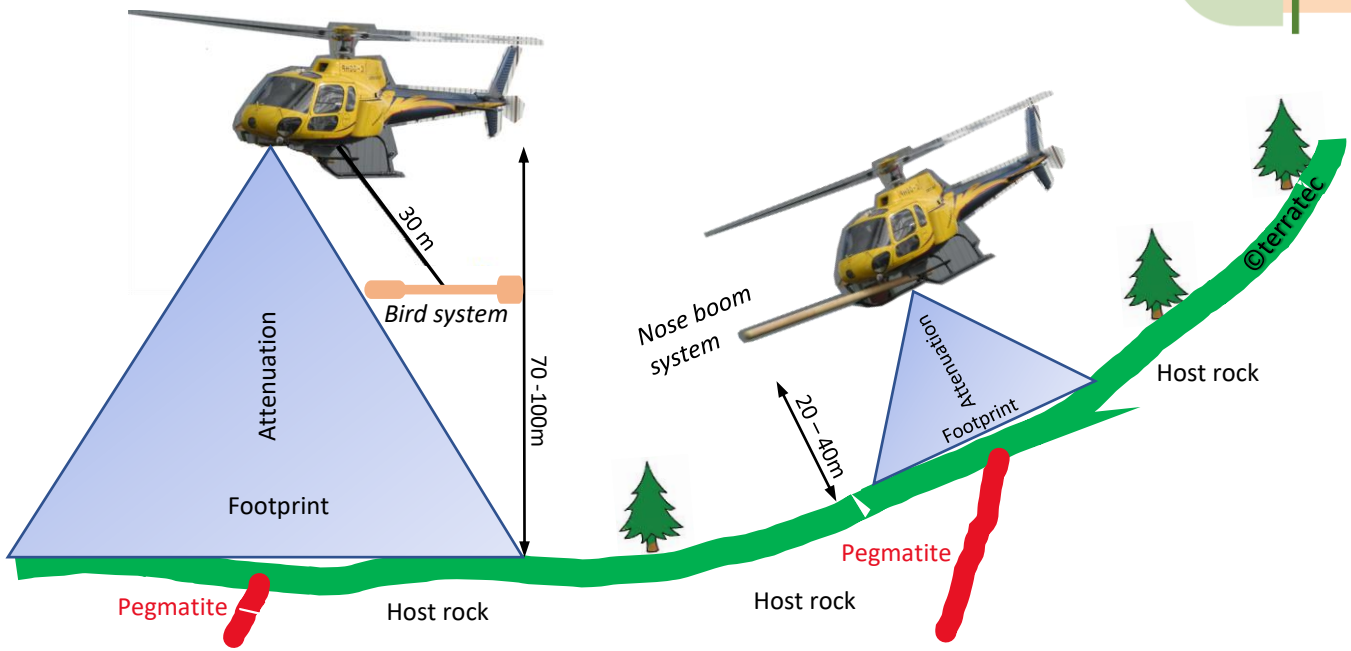
Low altitude flights even in mountainous terrain!

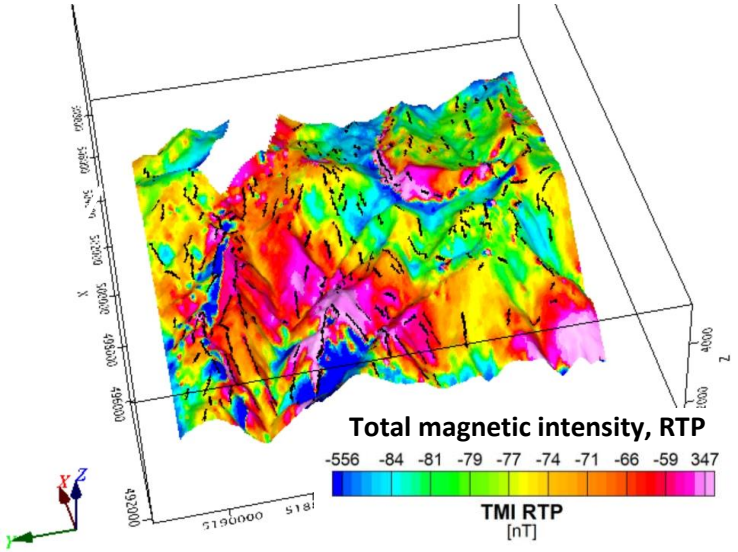
EASA: European Union Aviation Safety Agency

Fotos: terratec

NOSE BOOM - survey system: Data acquisition, magnetometer & spectrometer







- Fully EASA-certified magnetic and radiometric system with optimized magnetic compensation for helicopter effects. Ready to fly on AS350 helicopters.
- Only system capable of acquiring airborne geophysical data in difficult terrain; indispensable for Geological Surveys to comply with the national programs for exploring geological resources (CRMA).

Modern high-resolution airborne geophysics, as conducted in Canada for decades, is finally available in Europe to support mineral exploration projects.

The technology is accessible as a service.

Without the GREENPEG project market risk and investment would have been too high for terratec!

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IFU GMBH
Privates Institut für Umweltanalysen

Hyperspectral – drone based

Hyperspectral imaging system based on acousto-optical monochromator (AOM) for drone-borne applications!

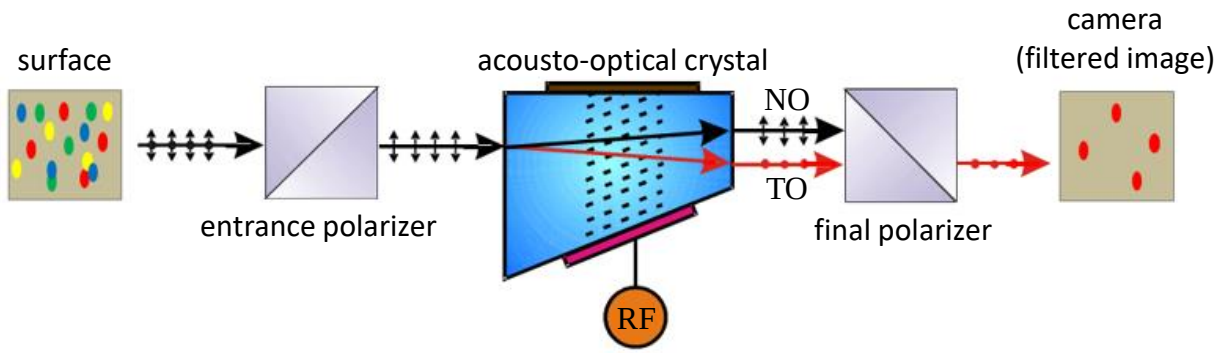
Flexible system applicable during exploration, monitoring and closure!

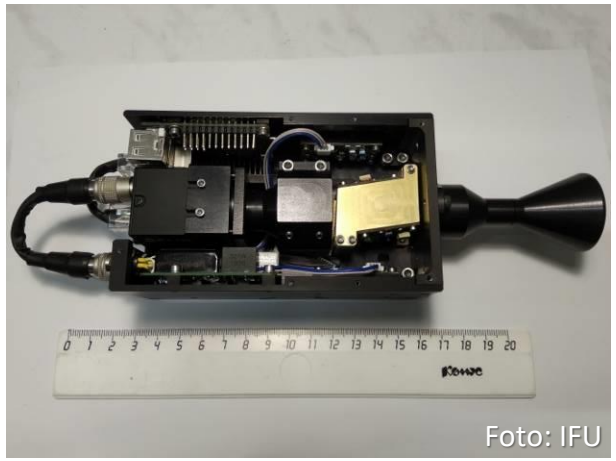
Fotos: IFU

Hyperspectral – drone based

Acousto-optical monochromator (AOM)

- Development of a drone-borne AOM to be used as hyperspectral camera (750 g, FOV = 45°, Wifi/USB)
- Acousto-optic crystal is piezoelectric and double refractive
  - Modulation of the refractive index by a high AC voltage
  - Tuneable wavelength: 450–970 nm @ 720x540 px





Drone integration

- E-410 quadrocopter (9 kg payload)
- Custom drone mount, housing and power supply
- Drone-instrument-communication
- Software development

Light-weight, low-cost, vibration-cushioned optics system providing distortion-free spectral maps.

The technology is accessible as a service and a stand-alone product.

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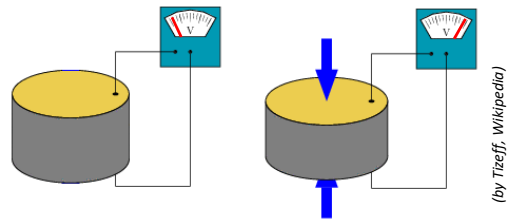
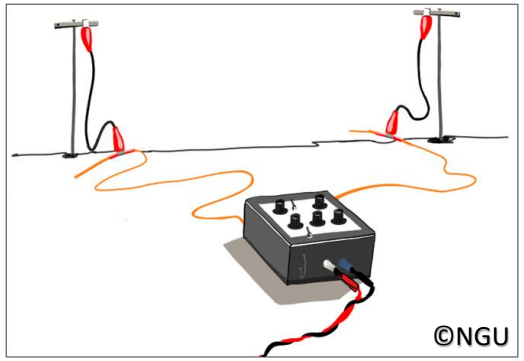


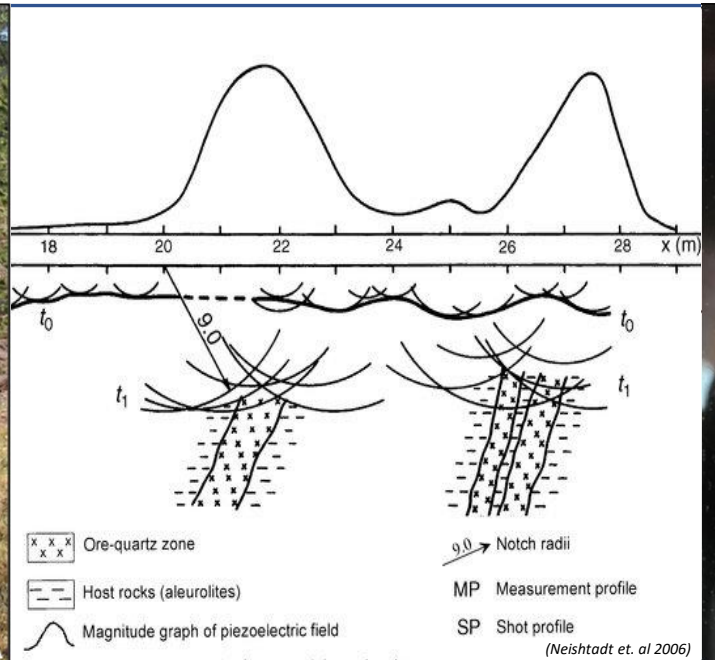


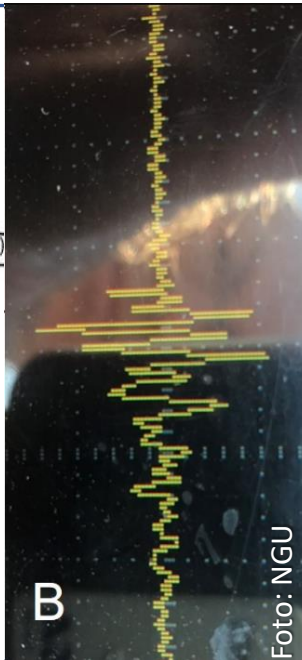
Piezoelectric seismograph

Instrument for direct detection of quartz!

Bringing piezoelectric technology in pegmatite exploration to the 21st-century!

Piezoelectric effect
Accumulation of electric charge due to mechanical pressure, and vice versa.





Piezoelectric seismograph

Piezoelectric effect - utilized in quartz exploration since 1970s

→ Now combined with:
- state-of-the-art electronic components
- advanced processing adapted to measurements of piezoelectric signals

→ Instrument is exclusively sensitive to presence of quartz.

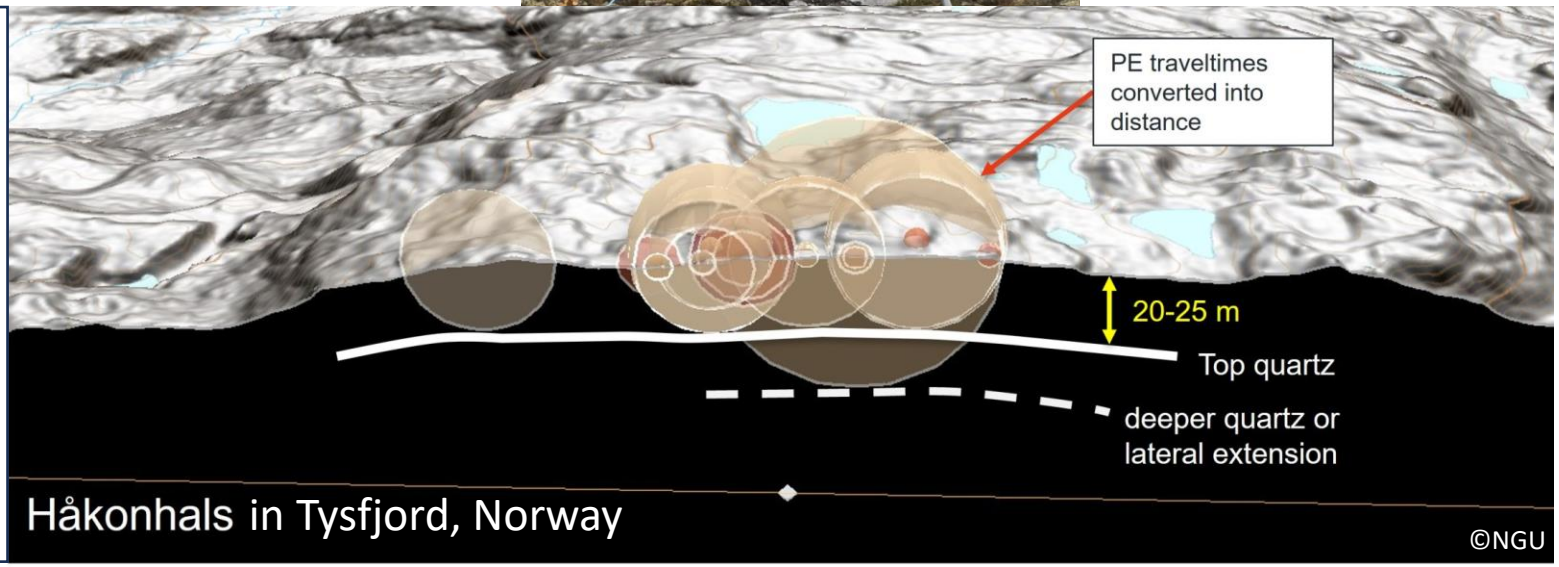
→ Stand-alone or complimentary method for brownfield and greenfield exploration.

Sustainable and cost-efficient method for exploration of quartz-hosted commodities.

The technology will be accessible as a service.

Successful detection of buried quartz deposits, confirmed by drill cores.

Quartz detection at up to 15–25 m depth embedded in amphibolite and gneiss host rock, using an 80 kg drop-weight with minimal environmental impact.

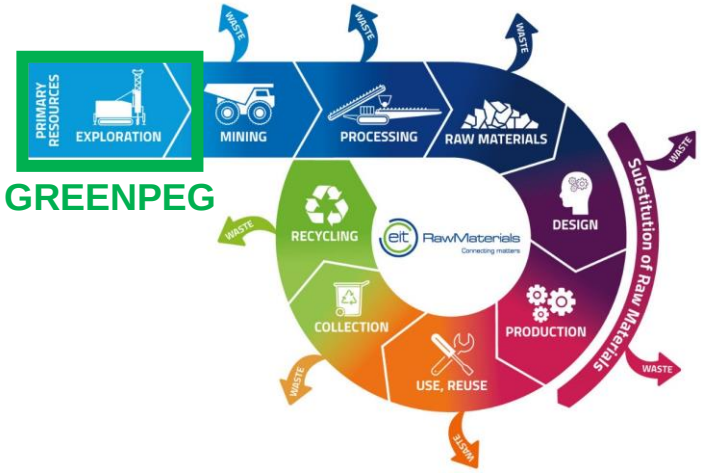


Impact on the value chain

The GREENPEG technology, exploration tools and interpretation methods will:

- Provide the mining industry and SME with the **latest know-how to "explore" European pegmatites**
- **Increase exploration success** of buried pegmatite deposits
- **Reduce the exploration costs and time** → small risk and small investment
- **Reduce environmental impacts** → increase acceptance of exploration activities in the society
- Unlock European buried mineral resources and **secure supply of Critical Raw Materials**: Li, Si, REE, Be, Ta
- Austria, Norway, Portugal, Spain already have existing downstream industry for further processing and refining, helping to **create closed value chains in these regions**

Exploration of green-tech raw materials is the first step in the value chain for a circular and CO_2-neutral economy



- Stimulate entrepreneurship and revitalise European industry: manufacturing of green technologies such as solar panels, batteries, wind turbines necessary to deliver the **EU Green Deal and the Energy Transition**
- **The technological innovations are applicable not just to pegmatite exploration but to exploration for CRM in general.**

Thank you for your attention!

www.greenpeg.eu

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