



Real-Time Mineral X-Ray Analysis for Efficient and Sustainable Mining

X-Mine project: Real-Time Mineral X-Ray Analysis for Efficient and Sustainable Mining

ETP SMR Webinar Series

18th of November 2020

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VTT Technical Research Center of Finland

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Sveriges geologiska undersökning
Geological Survey of Sweden



X-MINE

45
MONTHS

12 M€
BUDGET

15
PARTNERS

9 COUNTRIES

Large-scale demonstration of new sensing methods

Smart exploration

- Pilot: 3D modeling of ore deposits

Selective drilling

- Pilot: Fast & accurate tomographic drill core analysis

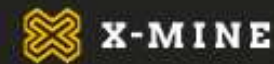
Optimal extraction

- Pilot: Sensor-based mineral sorting system



This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No [730270]

<http://www.xmine.eu/>

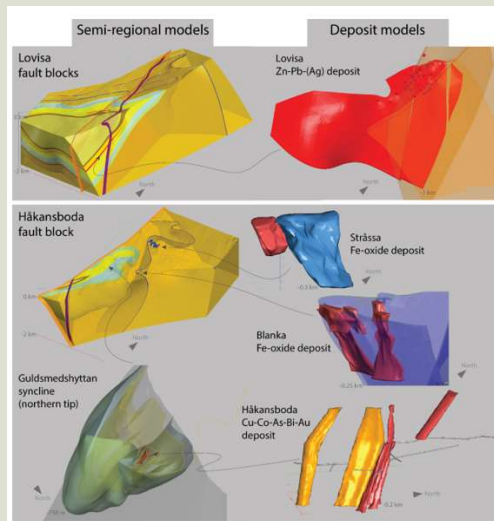


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X-Mine development & pilots

3D geomodelling



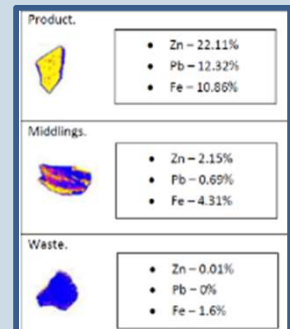
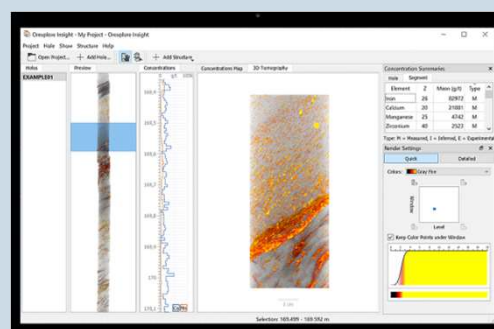
Sensor development



Prototypes



Pilots

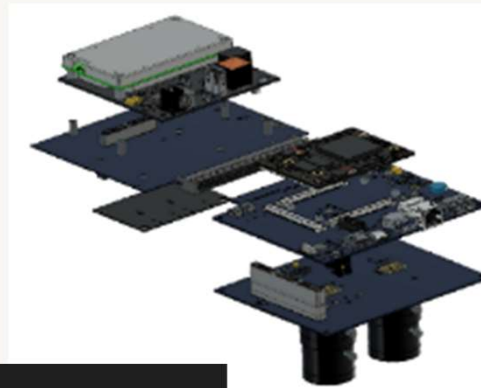


Key area 1: Improve and combine various online sensing technologies

CdTe camera prototypes
1x5, 1x10, 1x15, 1x20



3D scanner prototypes



XRF spectrometer
prototypes



Key area 1: Innovations

CdTe camera prototypes
1x5, 1x10, 1x15, 1x20



High-speed
multienergy X-
ray sensors



3D scanner prototypes



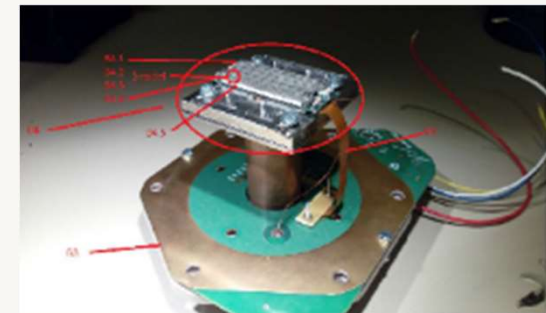
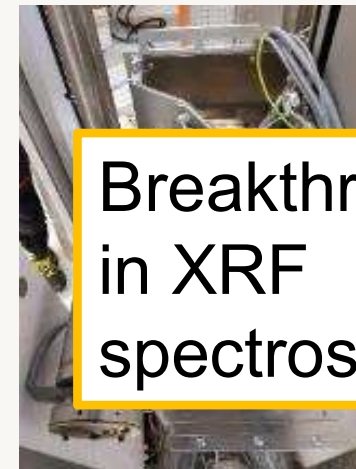
High-speed
3D scanning
with object
tracking



XRF spectrometer
prototypes



Breakthrough
in XRF
spectroscopy



Key area 2: Integrate the multi-sensor solution in an online analysis platform

Sensor testing platform



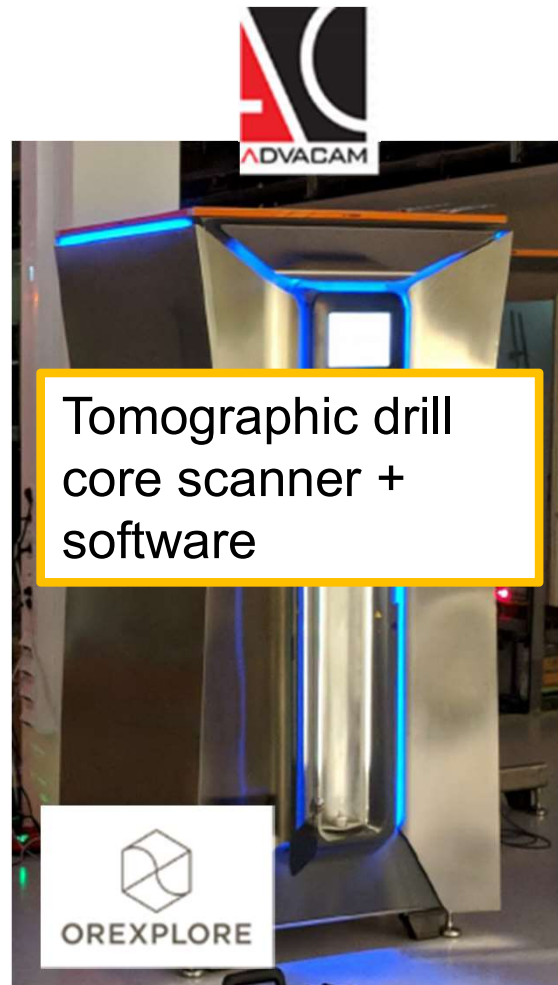
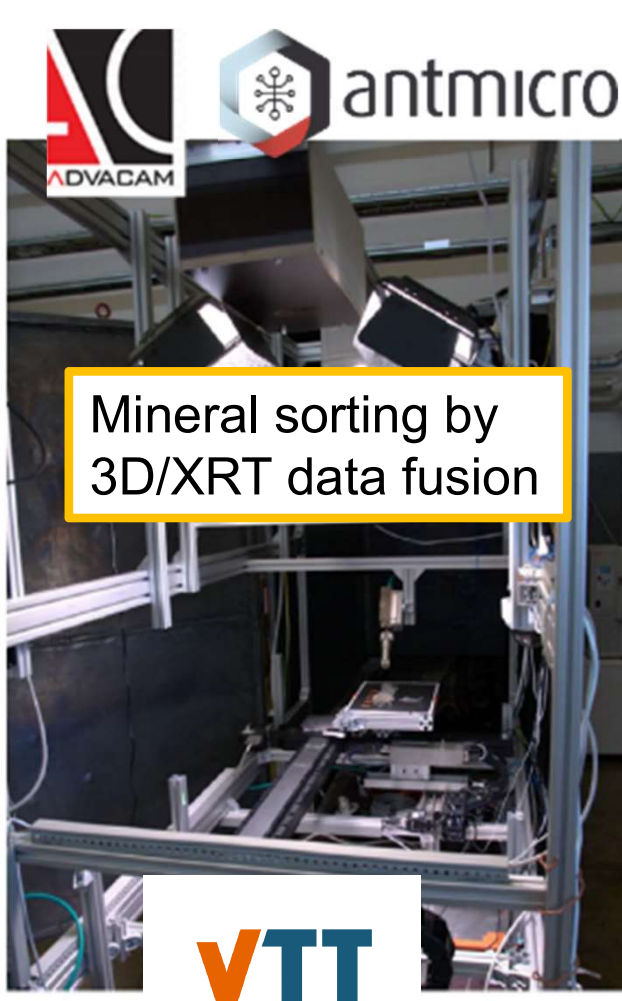
Drill core analyzer



Containerized sorting prototype



Key area 2: Innovations

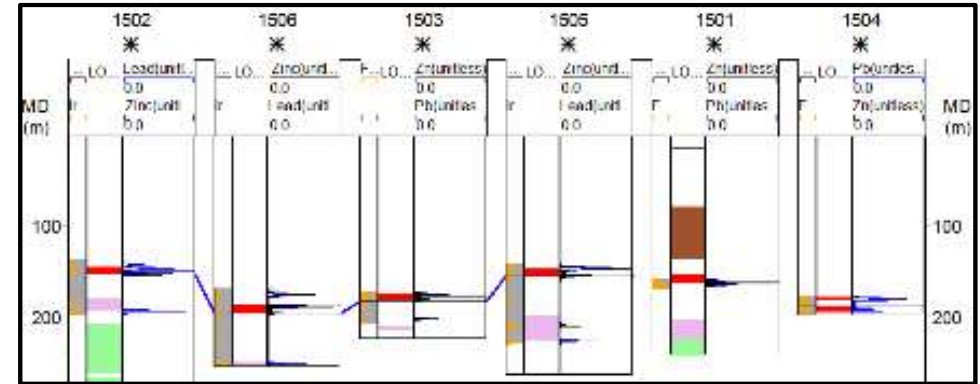


Key area 3: Demonstrate the solution in real mining operations, drill core scanner & 3D modelling

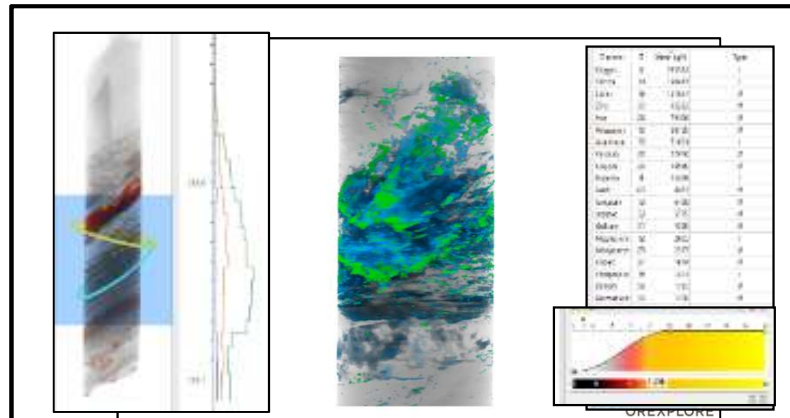
Drill core scanning



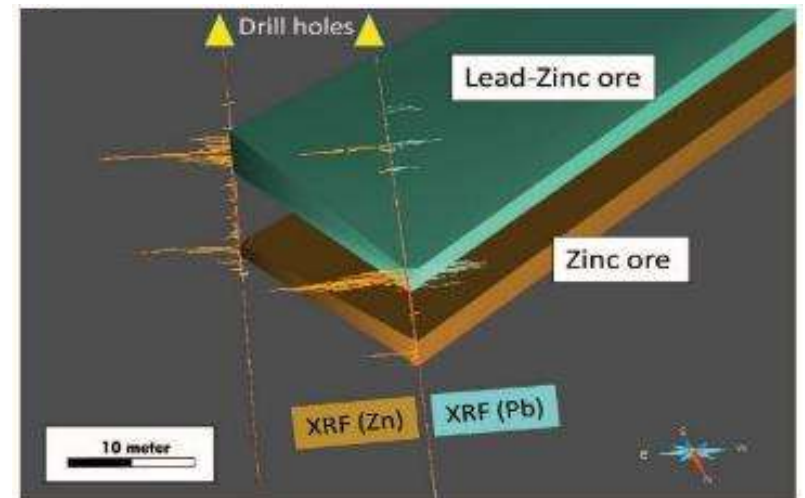
Well correlation



Drill core analysis



Integration of data into 3D models

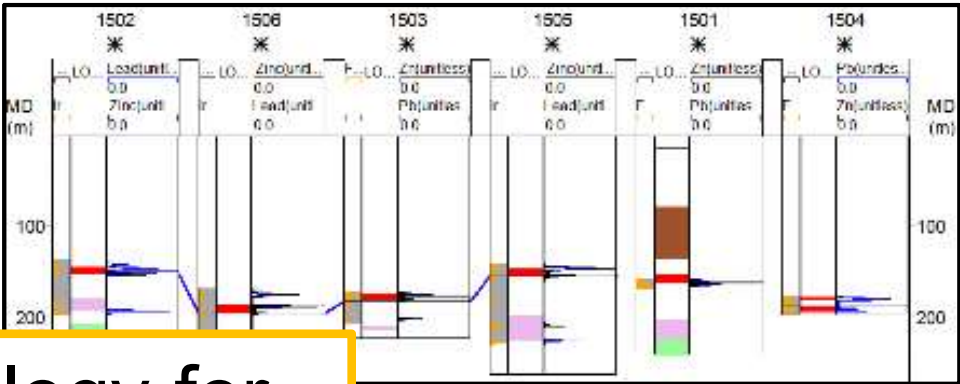


Key area 3: Innovations

Drill core scanning

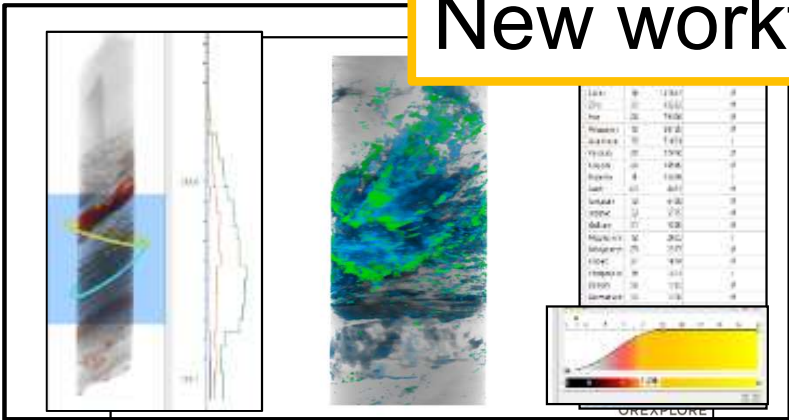


Well correlation

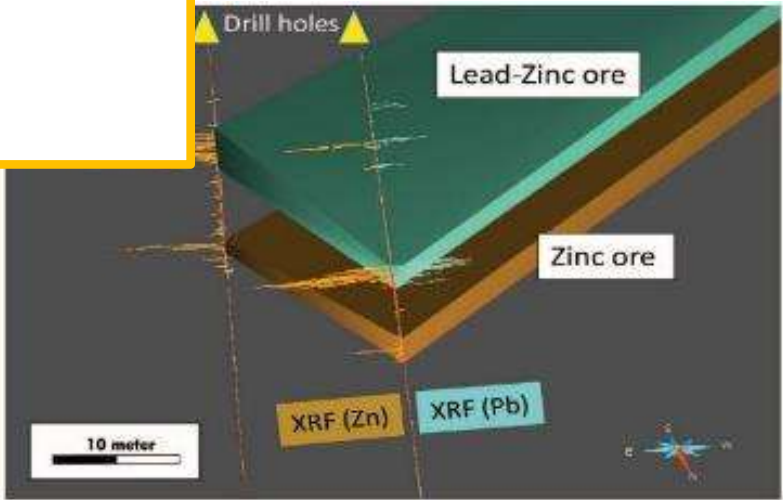


New methodology for
drill core analysis & 3D
modelling
New workflows

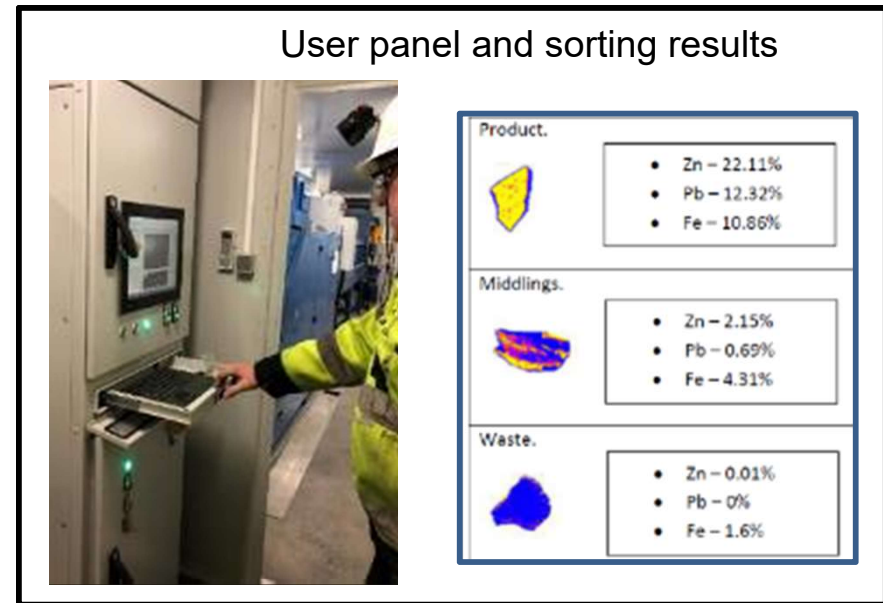
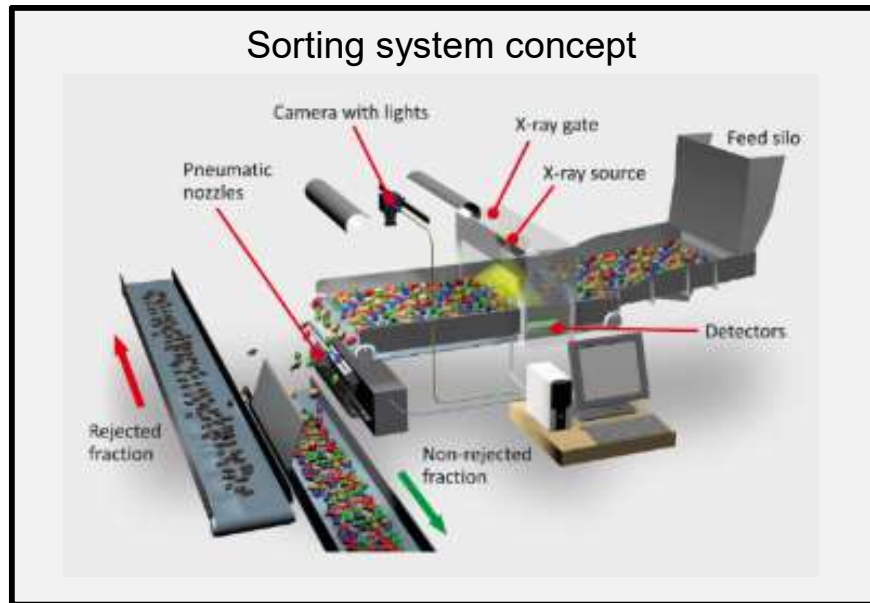
Drill core analysis



Integration
of data into
3D models



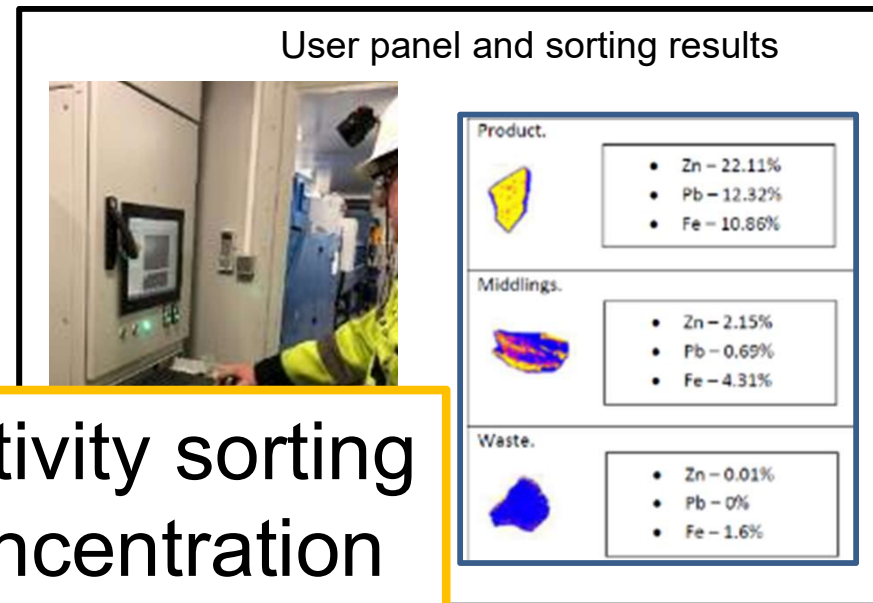
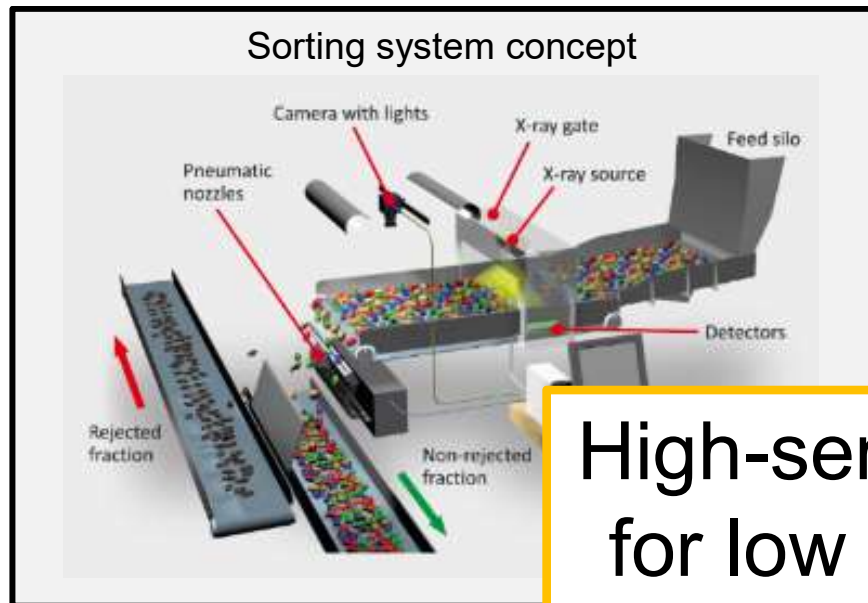
Key area 3: Demonstrate the solution in real mining operations, mineral sorting



Containerised sorting system pilot at the Lovisagruvan mine, Sweden (left) and at the Hellas Gold mine, Greece (right)



Key area 3: Innovations



High-sensitivity sorting for low concentration ores

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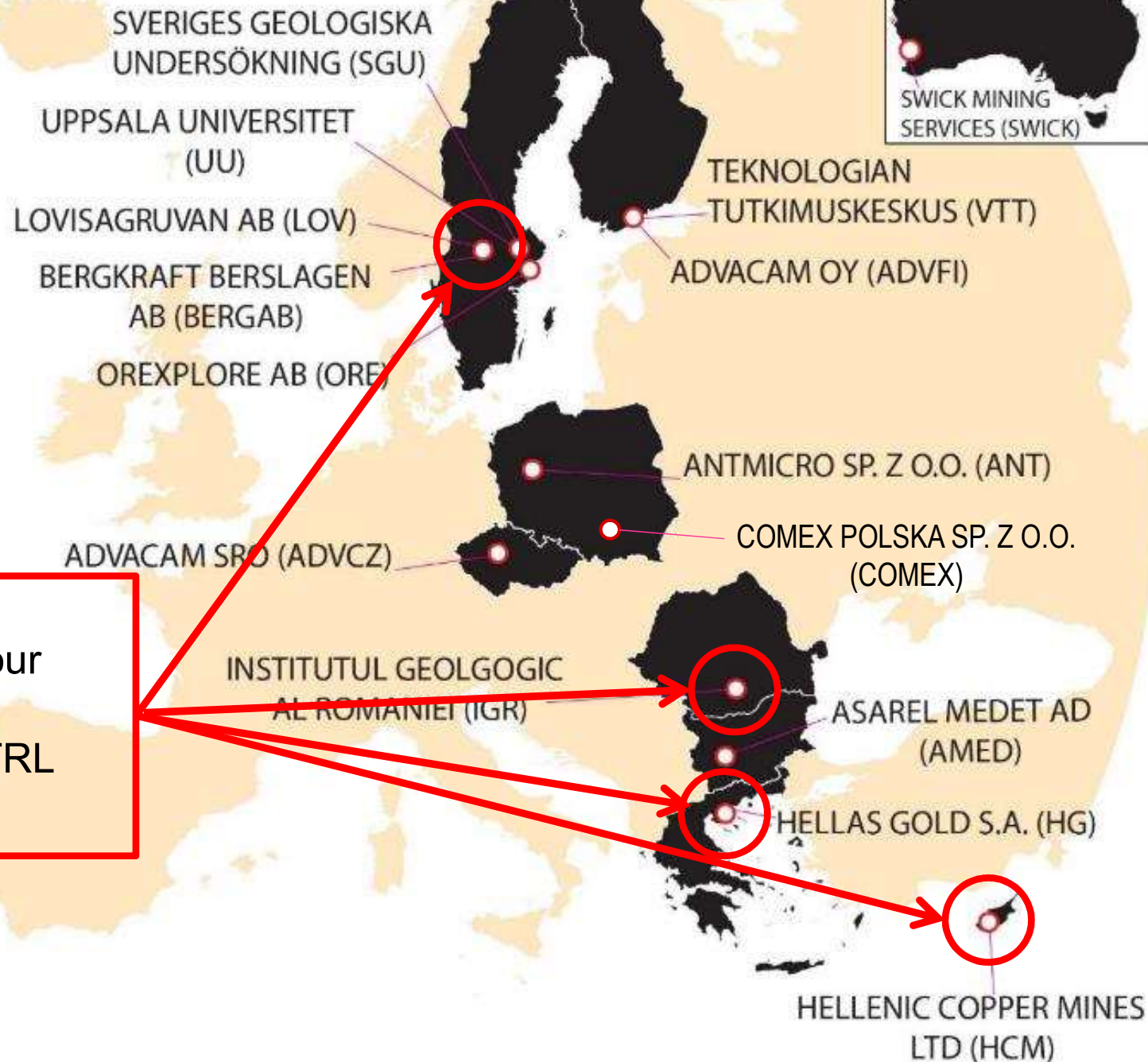
Containerised sorting system pilot at the Lovisagruvan mine, Sweden (left) and at the Hellas Gold mine, Greece (right)



18/11/2020

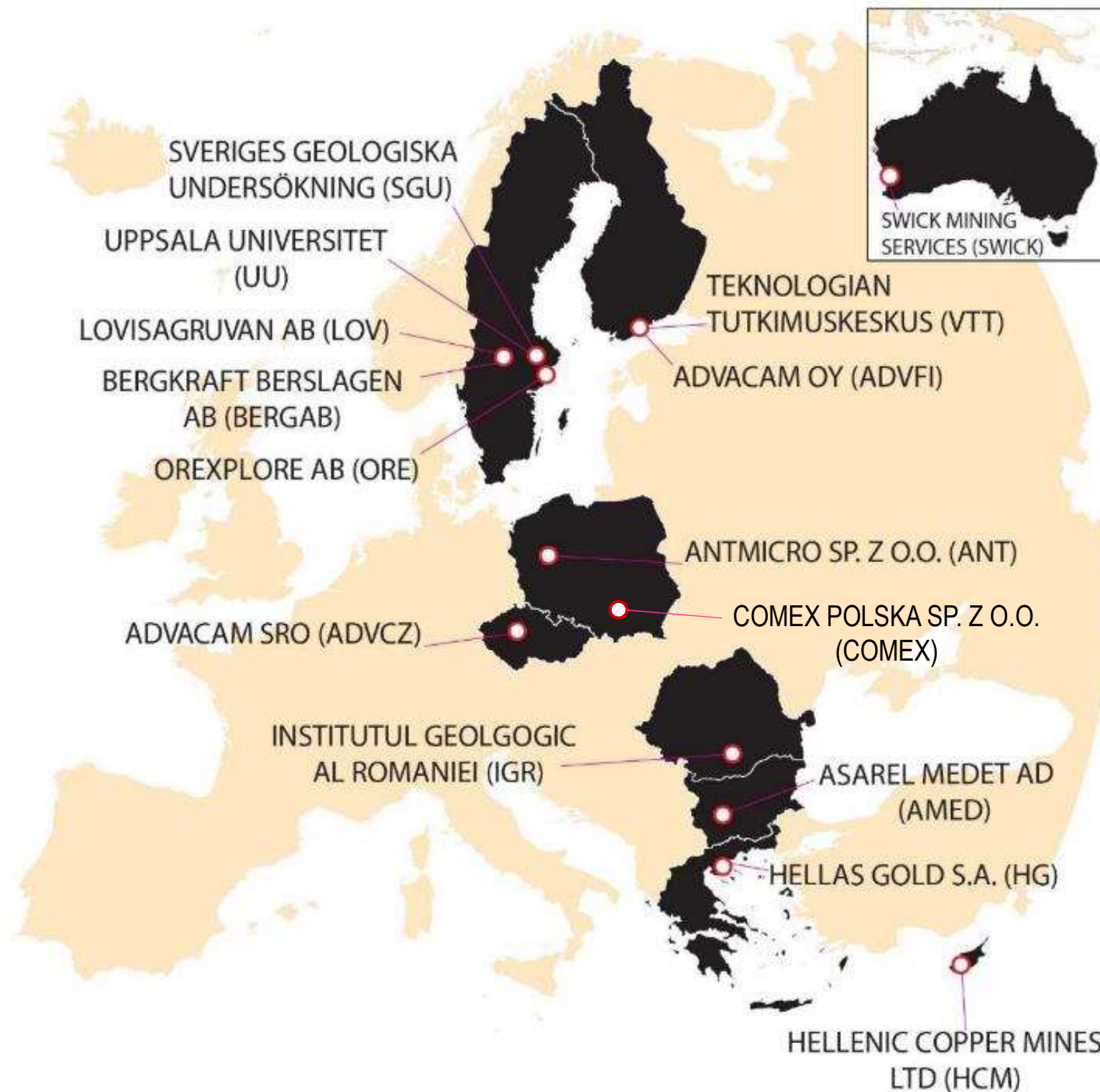
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X-Mine pilots

- Pilots at four mines
- All pilots TRL level 7 - 8



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Drill core scanning pilot completed



Mineral sorting pilot ongoing



X-MINE



TEKNOLOGIAN
TUTKIMUSKESKUS (VTT)

ADVACAM OY (ADVFI)

ANTMICRO SP. Z O.O. (ANT)

COMEX POLSKA SP. Z O.O.
(COMEX)

OLGOGIC
IEI (IGR)

ASAREL MEDET AD
(AMED)

HELLAS GOLD S.A. (HG)

HELLENIC COPPER MINES
LTD (HCM)

SVERIGES GEOLOGISKA
UNDERSÖKNING (SGU)

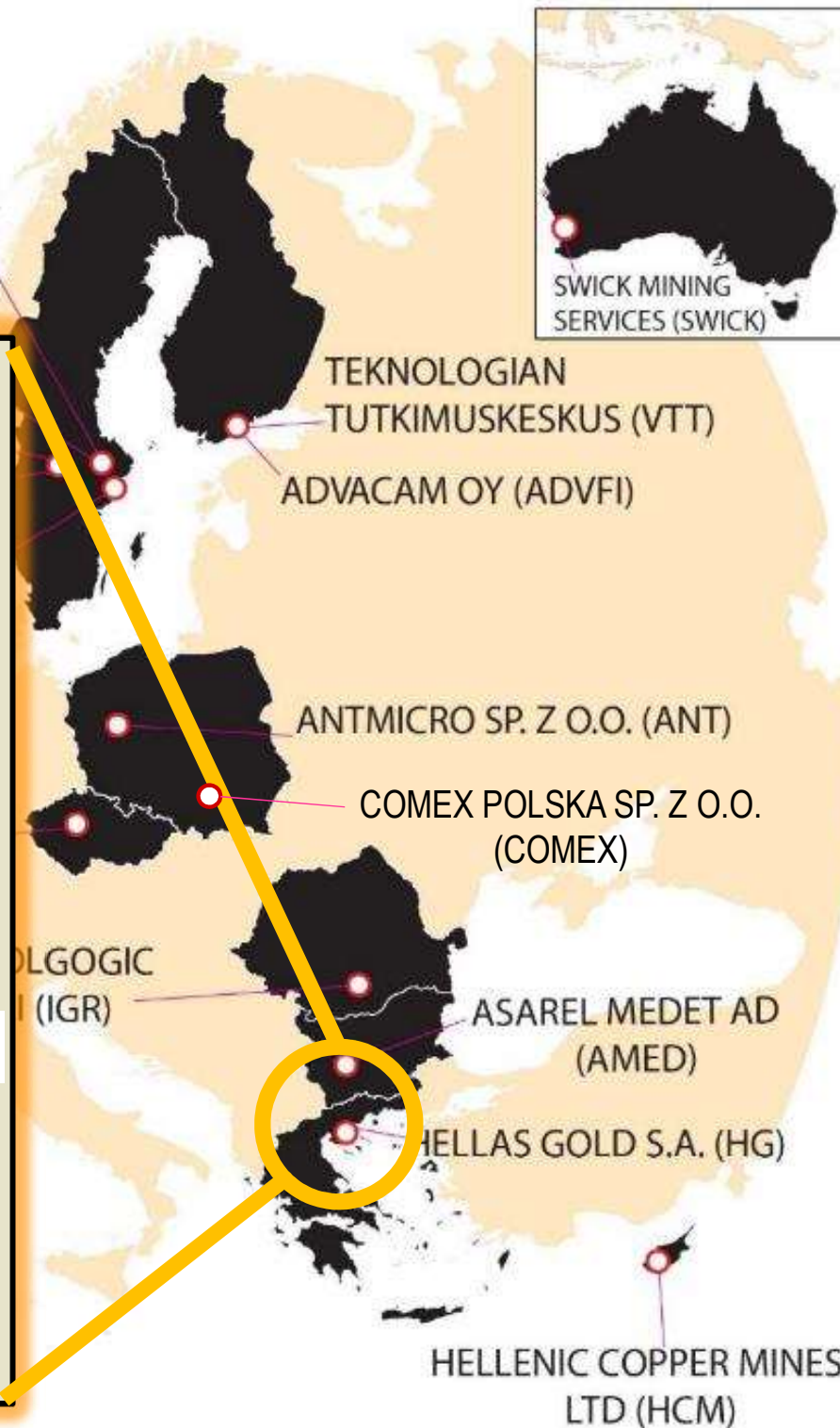
UPPSALA UNIVERSITET



Drill core scanning pilot completed



Mineral sorting pilot ongoing





Assarel
Medet

Drill core scanning pilot ongoing



Mineral sorting pilot, planning phase





Hellenic Copper Mines Ltd

Drill core scanning pilot ongoing



SVERIGES GEOLOGISKA
UNDERSÖKNINGEN

UPPSALA UNIVERSITET
(UU)

LOVISAGRUVAN AB (LOV)

BERGKRAFT BERSLAGEN
AB (BERGAB)

OREXPLORE AB (O)

ADVACAM SRO (ADV)

INSTITUTUL DE GEOLOGIE
AL ROMANIEI (IGR)

BLACK MINING
SERVICES (SWICK)

S (VTT)

(FI)

D. (ANT)

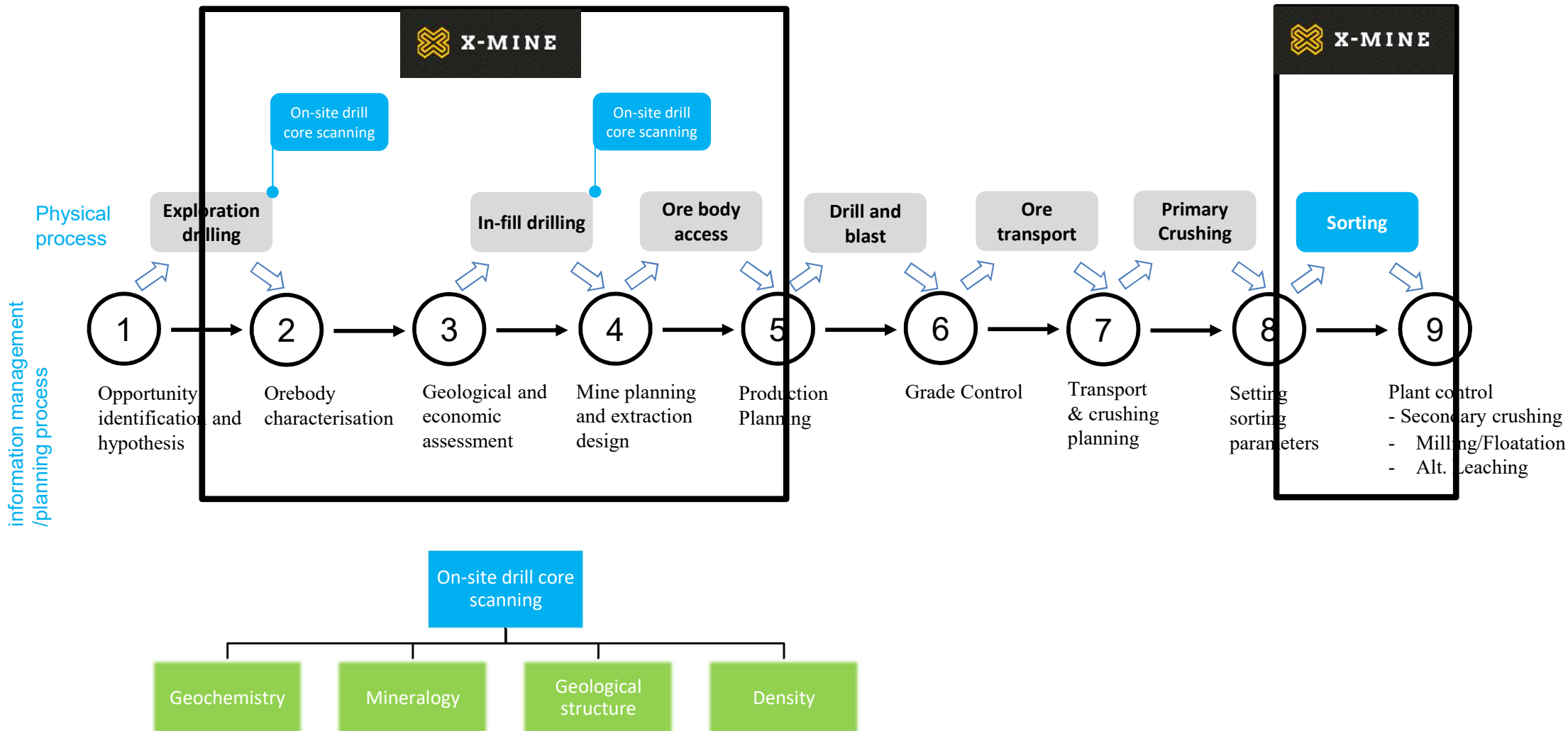
SP. Z O.O.
(K)

ASAREL MEDET AD
(AMED)

HELLAS GOLD S.A. (HG)

HELLENIC COPPER MINES
LTD (HCM)

Mining process and demonstrator application



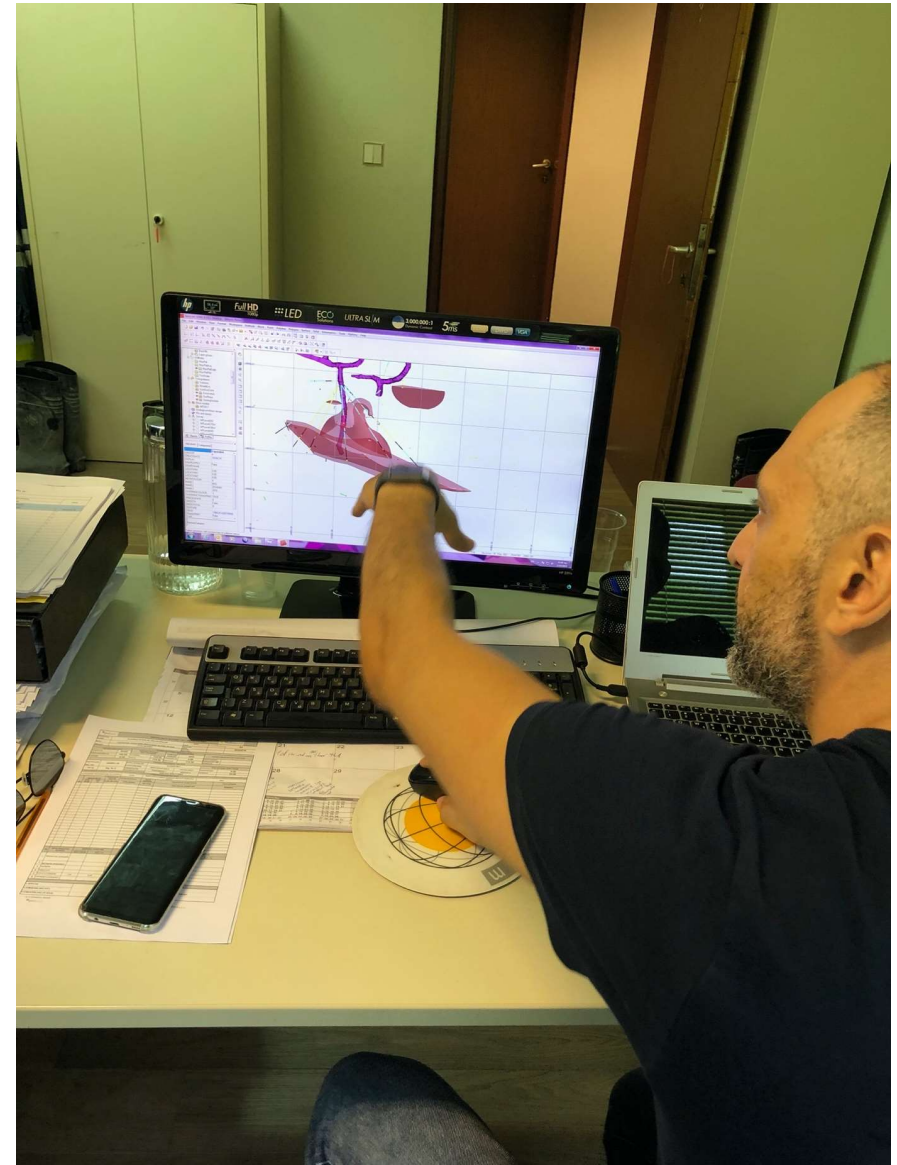
X-Mine project key performance indicators

Key Performance Indicator	Target (starting point)
Integration of 3D ore modelling models	Completed (N/A)
X-ray transmission sensor feature resolution	0.1 (0.5) mm
Minimum limit of detection	0.05% (0.1%)
Limit of detection average over element range (tonnes/hour constant)	0.01% (0.1%)
Throughput (tonnes/hour) for 10 mm particles (limit of detection kept constant)	Multiplied by 50
Excitation energy measurement range	0-120keV (0-50keV)
Increased ore recovery	+30%
Decreased waste rock	-7%
Increased mill feed grade in conventional mining operation	+25%
Transportation cost savings from mine to mill	20%
Energy consumption savings	10-30%
CO ₂ emission savings	10-30%

We are starting to reach these goals!

Use case example: Improved Block Modelling

- Use immediate drill core scanner data to improve geological 3D model
 - Geostructural data
 - Geochemistry
 - Density
 - Geotechnical data
- Leads to:
 - More efficient extraction
 - Less waste rock
 - Less use of explosives



Use case: Ore sorting

- Lovisagruvan mine, Sweden
 - Zinc-lead mine
 - Crushed ore is transported to Poland for enrichment
- Results
 - 25 - 27 % reduction of waste rock
 - Improved quality of the end product
 - Reduces the need of transportation costs about 5MSEK per annum
 - Reduced CO₂ emissions
 - Potential for converting old waste rock piles to ore



Conclusions

Sensor development



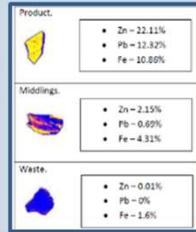
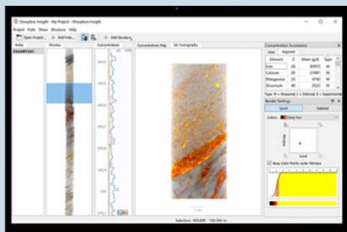
- ✓ New sensor products for a variety of markets
- ✓ New measurement methods

Prototypes



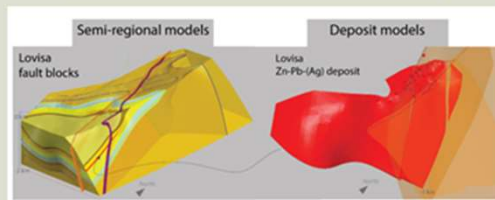
- ✓ New products
- ✓ New business models

Pilots



- ✓ New analysis & modelling methods
- ✓ New workflows
- ✓ New service-based business models
- ✓ Environmental, health & safety impacts

3D geomodelling



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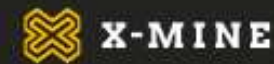
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Thank you for your attention!



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