

## GREEN MINERALS

Enabling the green shift

#### Taking the first industrial steps into the deep sea of Norway

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## Outline

- Background
  - Copper and the energy transition
  - SMS potential in Norway
- A new industry for Norway
  - Local, low emission value chain
- Norwegian process and status
- Volume potential
  - Mined area vs exploration area
  - Land use offshore vs onshore
- Way forward





"Today, the data shows a looming mismatch between the world's strengthened climate ambitions and the availability of critical minerals that are essential to realising those ambitions." Dr Fatih Birol IEA Executive Director

Picture credit: Climate Change – The New Economy; Quote: IEA (2021), The Role of Critical Minerals in Clean Energy Transitions, IEA, Paris (Link)

# Onshore ore grade is in structural decline, the era of easy copper is over



Copper Ore grade Chile (%) 1.2 1.0 0.8 0.6 0.4 0.2 29 63,55 Cu copper<math>0,8 % 0.4 0.2 20 0,8 % 0.4 0.2 20 0,8 %

- Similar to oil, the era for easy onshore copper is over
- The average ore grade is decreasing, resulting in:
  - Higher energy cost per unit produced
  - Growing waste production

Marine minerals could provide a sustainable source for critical minerals



Visual overlay of actual copper extracted from the Palabora mine in South Africa (4,1 million tonnes). Ore grade remaining reserves: 0,7%

Source: IEA (2021), The Role of Critical Minerals in Clean Energy Transitions, IEA, Paris (link); Artwork by Dillon Marsh and photo courtesy of LCIB

#### The Mohns Ridge contains a potential world class resource



Average values from twelve valid samples of the Fåvne SMS on the Mohns Ridge off Norway



Source: Green Minerals and NPD

#### A new Industry for Norway- from exploration to batteries







Source: Upper left Adepth minerals, Exploration image: Kongsberg Maritime, Production image: Loke

#### Low emission value chain in the Nordic



- Several Battery Giga factories build/under construction in Norway and Sweden.
- Relatively short transport from Mohns Ridge to harbors in Northern Norway.
- Railway from Northern Norway to Sweden.
- Railway from Northern Norway to Southern Norway.
- Copper ore (VMS) is currently processed in Sweden.
- Several locations in Norway can be re-opened/modified to process copper ore.
- Abundant cheap and emission-free energy (hydropower) available in Northern Norway.
- Proximity to the European metal marked.



# Can SMS ore from the Mid Ocean Ridge be processed in existing plants?



Chalcopyrite

*Aim is to demonstrate that SMS ore can be processed in existing plants in the Nordics* 



....like



Joma Gruver, Røyrvik, Norway



Boliden Skellefteå, Sweden

#### Roadmap towards exploration license in '24 and production in '28





# For SMS, Norway may be the best area to kickstart the deepsea mining industry from

#### RELIABLE SUPPLY OF MINERALS CRITICAL FOR THE ENERGY TRANSITION

- Primary resource:
  - SMS in Norway
- Why Norway:
  - Stable regulatory regime
  - 50 years + with offshore O&G
  - World class offshore service industry
- Potential world class resource:
  - Copper: avg. 5% and up 14% grade
  - Cobalt: avg. 0.4% and up to 1% grade
  - Est. market value >NOK 1,000bn
- Strong economics:
  - Annual revenue of USD 550-800m
  - EBITDA margins >50%
- Favourable ESG impact:
  - Reduced waste
  - Reduced CO<sup>2</sup> emissions
  - Reduced ore use
  - Reduced risk for Megafauna wildlife

#### **Perspective on industry values: NPD data release**

Data Types Received

LOKIS CASTLE AREA

- 2,5 TB data
  - NPD, UIB, UIT
  - Multi Beam Echosounder
  - Side Scan Sonar
  - Sub Bottom Profiler
  - Syntetic Aperture Sonar
  - Self Potential
  - Magnetic
  - Water chemistry



High resolution bathymetry over the Fåvne area



Source: Green Minerals



### **Resource potential in SMS**

#### Loki's Castle area prospect map



Loki's Castle and surrounding prospects represents an active system and are only used as an example of a potential discovery area.

#### SMS production system

- Full scale production:
  - 5-8000 tonnes/day ore to surface
  - 1,5Mt ore/year
- Processing performed in Norway/Scandinavia
- Loki's Castle: 1Mt ore
- 100% exploration success in both camps in Loki area: 4,5Mt
- Minimum production period required:
  - a) Possible to deliver and process on existing plant: 5 years
  - b) Need to build processing plant: 10-15 years
- In a) **7,5 Mt** required for investment decision
- In b) 15-22,5 Mt required for investment decision

Table 4. Metal tonnage of prospects										
Variable	<i>P</i> -1	<i>P</i> -2	<i>P</i> -3	<i>P</i> -4	<i>P</i> -5	<i>P</i> -6	<i>P</i> -7	<i>P</i> -8	<i>P</i> -9	<i>P</i> -10
Area (m <sup>2</sup> ) Ore volume <sup>a</sup> (kt) Total metals <sup>b</sup> (kt)	37,527 1042.4 15.1	3618 100.5 1.46	3121 86.7 1.26	54,677 1518.8 21.9	2257 62.7 0.90	6788 188.5 2.73	13,846 384.6 5.54	5957 165.4 2.39	3490 96.9 1.41	33,743 937.3 13.5

<sup>a</sup>Ore volume calculated using the ratio 27.7  $t/m^2$ 

<sup>b</sup>Amount of metals including Cu, Zn, Au and Ag given the ore potential of prospects and the grade models provided by Mosier et al. (2009). The calculation is processed stochastically using GeoX



#### Land use, offshore SMS vs onshore (Palabora, South Africa)



4,1 mill tonnes Cu mined from the Palabora mine
Equals approximately 79 SMS deposits\*
79 SMS's equals around 3km2
Palabora Mine covers an area of 20 km2\*\*
More than 6,5 more area-effective mining offshore
In addition, waste handling is 5:1 on land vs offshore



\*Based on numbers from Juliani & Ellefsmo 2019 calculations from Lokis Castle and 5% copper ore grade

\*\*<u>https://www.mining-</u> technology.com/projects/palabora/



### **Partnership toward responsible production**



- MoU signed in August 2022 for delivery of a concept study on Harsh Environment Deep-Sea Mining System "ore from seafloor to port" for exclusive use in Norwegian waters.
- OSI becomes shareholder in Green Minerals
- Concept study through OSI-led consortium
- · Aim for closed-loop production system
- Aim for an alternative to diesel on bulk carriers/production unit

![](_page_15_Picture_7.jpeg)

### Summary: Aspirational targets – operations and financials

#### **DEVELOPMENT / PRODUCTION**

FINANCIAL TARGETS

**DE-RISKING** 

![](_page_16_Picture_4.jpeg)

- We plan for a pilot system ready to operate by 2026
- Processing to be performed in the Nordics
- Immense focus on subsea ecosystem and biodiversity
- **<u>2028 target</u>: full scale production with processing capability in one of the Nordic countries**

![](_page_16_Figure_9.jpeg)

- Revenue:
  - 1.5 Mt annual ore production
  - USD 9,000 per ton copper (Cu)
  - USD 50,000 per ton cobalt (Co)
  - ~USD 100m uplift for additional metals
- EBITDA:
  - Includes overhead, mining cost and processing cost

![](_page_16_Figure_17.jpeg)

- Political- Hurdal platform + workers
   union
- Technical team
- Partnerships
- NPD/university data
- Timeline

![](_page_16_Picture_23.jpeg)

## Thank you for your attention!

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