# Presentations from Member companies of DSMA and NMM on Deep Sea Mining from digital seminar on March 16th 2022

Johannes Post – Managing Director of DSMA

Egil Tjåland – Secretary General of NMM

# Company introduction – Seatools

- Core activity: design and build of subsea equipment
- Typical projects:
  - Entire subsea vehicles / machines
  - Subsea equipment infrastructure
- Relevant track record DSM:
  - GSR nodule collector
  - Allseas nodule collector

# Areas of interest for cooperation

- Development and realization of deep-sea mining related subsea equipment
- Exploration:
  - Drilling/coring equipment
- Exploitation:
  - Overburden removal equipment (e.g. subsea grabs)
  - Nodule collectors
  - Drilling / cutting machines
  - Riser instrumentation / hydraulics / electronics
- Typical way of cooperation:
  - Partner develops and brings in core technology / concept
  - Seatools realizes concept

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# One of Europe's largest independent research organisations

SALES

NOK 3.4

billion

EMPLOYEES

2000

PROJECTS

6800

CLIENTS

3400

GLOBALLY

**NOK 470 million**

PUBLICATIONS

**5100**

NATIONALITIES

**75**

CLIENT SATISFACTION

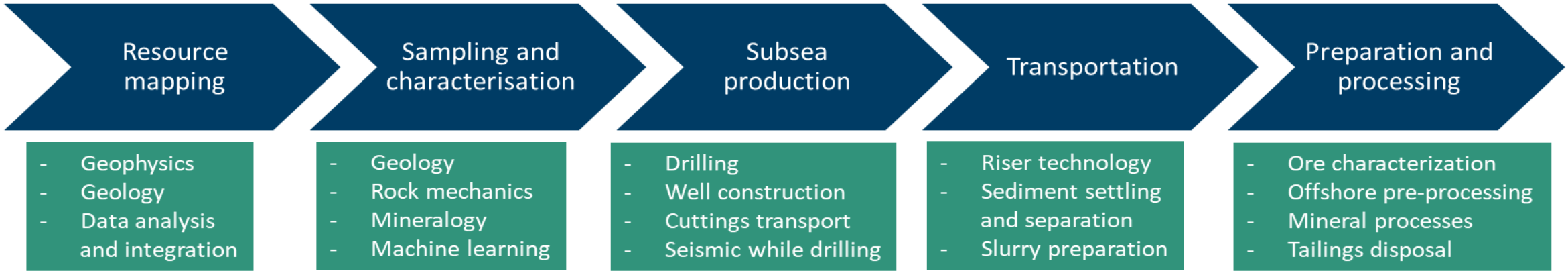
**4.6 out of 5**

Technology for a better society

# Vision: Technology for a better society

Expertise from ocean space to outer space

# Areas of interest for collaboration



# GCE NODE

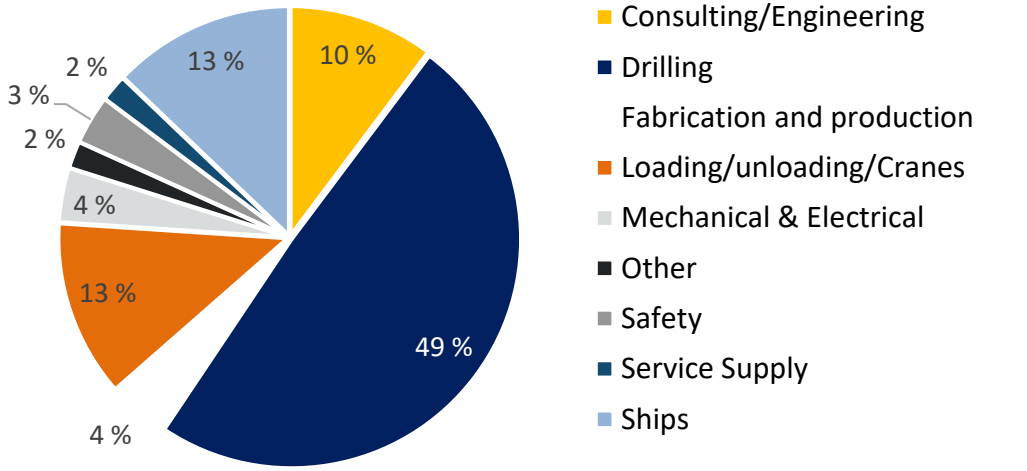
An Industry-Driven Cluster for Ocean Technologies

**DSMA – NMM Seminar on developing scientific and industrial partnerships for seabed mining**

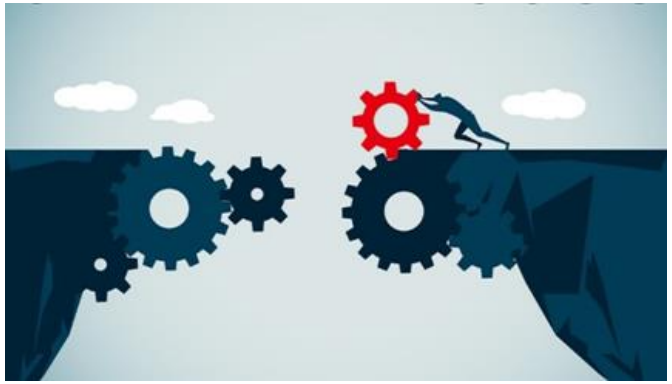
March 16. 2022

Christian B. von der Ohe
RD&I Manager, GCE NODE

# + 110 Cluster Participants




- **Increased competitiveness in existing markets**
- **Expand technology and competence to new markets**



# Seabed Mining



## Cross-over Technologies:

- Drilling and Excavation
- Offshore Vessels
- Cranes
- Heave Compensation Systems
- Material Lifting and Handling systems
- Anchor Handling systems
- Vision, Camera systems
- ROV & AUV
- Subsea Autonomy

## GCE NODE provide:

- Arenas for Extended Network
- Market Information / Inspiration
- Exposure to New Opportunities and Partners
- Expertise & Help with Soft Funding
- Facilitate R&D Consortia / Collaboration
- New Knowledge / Technology Transfer
- Business Development / Innovation projects
- Assisting in Marketing Work (Trade Fairs, Seminars, B2B)

GCE Ocean Technology

GOLD Cluster Management Excellence
PROVEN FOR CLUSTER EXCELLENCE

# Marine minerals

## - NMM – DSMA meeting 16 March 2022

Jon Oddvar Hellevang · · · · · R&D MANAGER, GCE OCEAN TECHNOLOGY

www.gceocean.no

# Facilitating Innovation

- Secured about 2 billion NOK in external funded RDI projects
- Business Development Programmes
- Cources and training

- Established in 2006
- Marine minerals key part of strategy since 2014

Hosting Underwater Mining Conference – UMC 2018

[Eco-Safe Ridge Mining Project](#) (2021-2024)

Assess the possibility of environmentally responsible deep-sea mining in Norway

Project partnes:

~ 50 annual events, courses and joint projects

Tina Bru, Norwegian Minister of petroleum and energy at Marine Minerals – One Day Seminar 2021

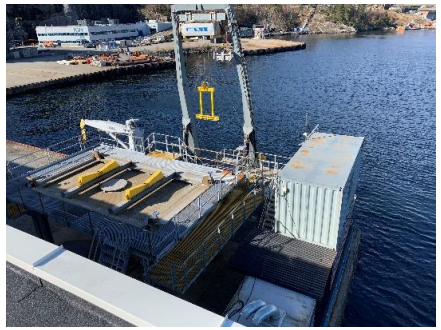
# Upcoming activities/events

- Establish basis for joint national test infrastructure for marine minerals:
  Answer our survey

- UTC Marine Minerals - 14 June 2022
  Presenters: Ministry of Petroleum and Energy, UNGC, Rystad Energy, NOROG etc.

- List of all events: https://www.gceocean.no/events/

- Contact: Jon Hellevang, R&D Manager GCE Ocean Technology
  jon.hellevang@gceocean.no / +47 988 488 28



OCEAN INNOVATION | NORWEGIAN CATAPULT CENTRE

# DeepOcean DSMA - NMM

# Technology-driven, independent solution provider in the ocean space

## World-leading experts and capabilities

Can-do attitude, ability to leverage optimal equipment, 1000+ skilled employees across the globe

## Proven smart and sustainable solutions

Solving complex ocean challenges using leading and fit-for-purpose technology

## Technology-driven ‘remote first’ model

Digitally enabled, cost-efficient, remote / unmanned and low carbon operations

## Trusted independent solution provider

Delivering the right solutions, with flexible access to right vessels and world-class equipment

## Asset light operating model

Owning specialized assets, including ROVs and extensive toolpool, while working in partnerships with ship owners to meet the vessel demand

# Our strategy and focus

## The leading ocean service provider

## Globally recognized, locally differentiated

| | | | | |
|---|---|---|---|---|
| **Markets** | Offshore renewables | Oil & gas | Ocean minerals | Ocean solutions |
| **Competence** | Project management | Engineering | Technology | |
| **Services** | Survey | Project management, engineering and installation | Maintenance | Recycling |

mhwirth

Baker Hughes

# What we do

HMH delivers a global full-service offshore and onshore drilling equipment offering that provides our customers with a broad portfolio of products and services that are designed to be safer and more efficient.

| O&G Drilling | Digital Technology | Mining | RC Drilling | Services |
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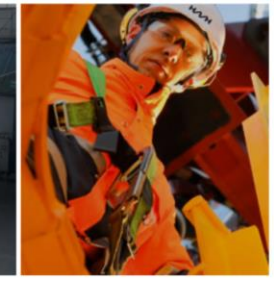
| | | | |  |



# Expanding the Frontier

Recognizing and exploring opportunities in adjoining industries

Understand and learn → Recognize opportunities → Explore → Demonstrate → Win and Scale

| Offshore Wind | Deep Sea Mining | Digitalization | Other |
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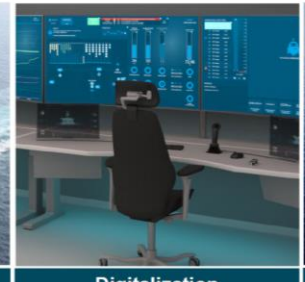
| | |  | |



# Race for the first license round in Norway has begun

*Scientific surveys for marine minerals since late 1990s with numerous promising discoveries have resulted in establishing the seabed minerals act*

*Awaiting the results on the ongoing impact study of marine minerals productions on the NCS, private companies and partner organizations are preparing for the first licensing round*

Source: Rystad Energy, NPD

## Several companies are positioning for license awards in Norway…

| Company | Country | Resource type | Location | Target production | Ownership |
|---|---|---|---|---|---|
| LOKE MARINE MINERALS | | SMS/Crusts | NCS & internationally | 2030 | • Technip FMC<br>• Wilhelmsen<br>• NorSea Group |
| GREEN MINERALS | | SMS/Crusts | NCS | 2026 (pilot) | Listed entity (OSE) |
| Adepth minerals | | SMS/Crusts | NCS | 2029 | • DeepOcean<br>• Management |
| NORDIC MINING | | SMS | NCS | N/A | Listed entity (OSE) |
| Others | | N/A | N/A | N/A | |

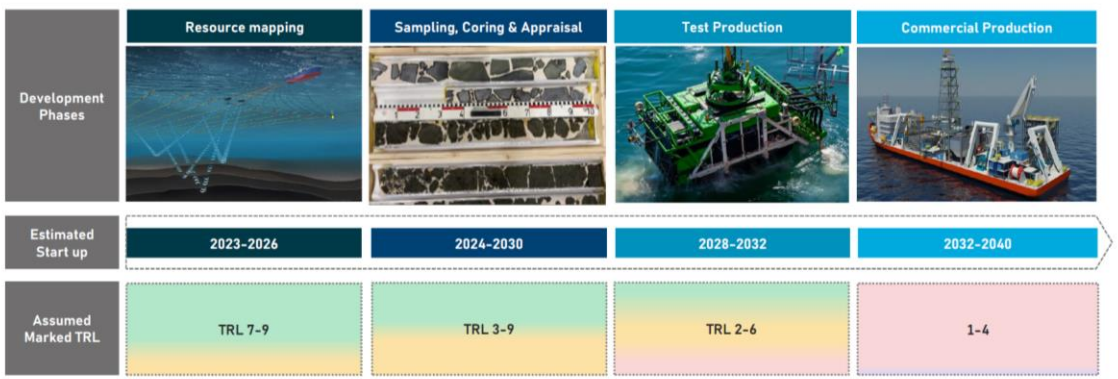


## …and there is also a lot of interest globally

| Company | Country | Resource type | Location | Target production | Ownership |
|---|---|---|---|---|---|
| the metals company | | Nodules | CCZ (Pacific Ocean) | 2024 (Pilot) 2030 | Listed entity (NYSE) |
| GSR | | Nodules | CCZ (Pacific Ocean) | N/A | DEME group |
| JOGMEC | | Crusts/ Nodules | Japan EEZ & CCZ | N/A | Japanese Government |
| OCEAN MINERALS | | Nodules | Cook Islands EEZ | N/A | Management |
| LOCKHEED MARTIN | | Nodules | CCZ (Pacific Ocean) | N/A | Listed entity |
| Ocean Mineral Singapore | | Nodules | CCZ (Pacific Ocean | N/A | • Keppel<br>• UK Seabed Resources |
| DSMF | | SMS | Calm Seas (Papa Guinea) | N/A | USM |



## Technology for mapping and sampling is already in use, but mining production system are very immature

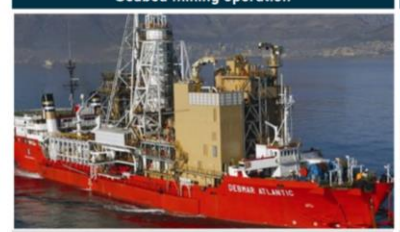



TRL 1 = Concept/idea TRL6 = Prototype tested TRL 9 = Field Proven



## Our capabilities and references for Marine Minerals

**Seabed mining operation**



Systems for Exploration and Production
- Large Diameter Seafloor Drilling
- Riser system
- Vertical Transport System
- Heave Compensated Hoisting Systems
- Tubular Handling
- Lifting Equipment
- Control systems
- System integration

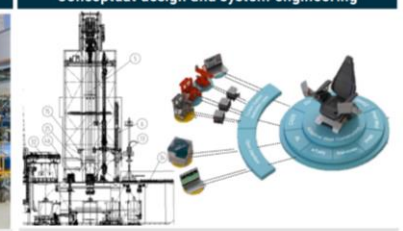
MHWirth is involved in several projects for extraction of diamonds and methane hydrate from the seabed

**Mining and metallurgical technology**

Shaft drilling for mining
- Market leader in reverse circulation drilling (RCD)
- Pile diameter from 600 mm to 8,000 mm
- Drilling depths of up to 500 m

Piston Pumps for
- Pipeline transportation
- Mining (processing) industry
- Power industry
- > 650 pumps delivered in total
- Pressure up to 30 MPa
- Capacity up to 1,400 m³/h

**Conceptual design and system engineering**



Conceptual design of deck layouts and functionality
- Drill ships (several clients)
- Mining Vessels (conceptual design ongoing)
- Coring vessel (China Geological Survey)

System engineering including
- Process design
- Detailed arrangements/layout
- 3D drawings
- Animations of functionality
- Full control system integration
- Operator environment

WHEN TRUST MATTERS

# DSMA – NMM Online Seminar on developing scientific and industrial partnerships for seabed mining

Presentation of DNV

16 March 2022

# Introduction of DNV

- DNV is an international accredited registrar and classification society headquartered in Høvik, Norway. In DNV 2013 merged with Germanischer Lloyd.
- DNV has 12,000 employees and 350 offices operating in more than 100 countries.
- DNV is the world's largest classification society, providing services for 13,000 vessels and mobile offshore units and also provides other maritime services and services within renewable energy, oil & gas, electrification, food & beverage and healthcare.
- DNV works actively with deep sea minerals, examples:
  - Recommended practice “Managing environmental aspects and impacts of seabed mining”
  - Several guidelines and reports for the International Seabed Authority
  - Technology report on seabed minerals for the Norwegian Petroleum Directorate as part of the opening process and the impact assessment for the Norwegian Continental Shelf (with NTNU + external experts)
  - The EU JPI Oceans – MiningImpact2 programme – Threshold levels for deep sea mining activities
  - Legacy Rules for classification and construction of underwater working machines

# Areas of interest for cooperation with other companies/institutions

- Certification of equipment for deep sea minerals operations
- Research within deep sea minerals operations, especially environmental impacts
- Testing new technology for deep sea minerals operations
- Developing guidelines for deep sea minerals operations

# Contact person:

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**www.dnv.com**

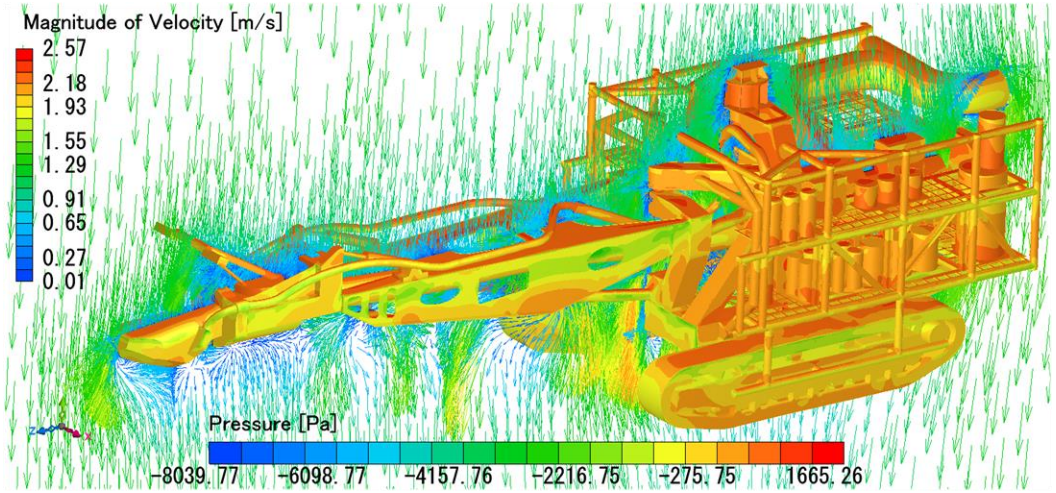
# Introducing AXTech

Engineered Lifting and Handling Solutions

- Specialists in tailor-made **heavy lifting and material handling equipment** for marine and offshore environments.
- All relevant **engineering and calculation** resources **in-house**.

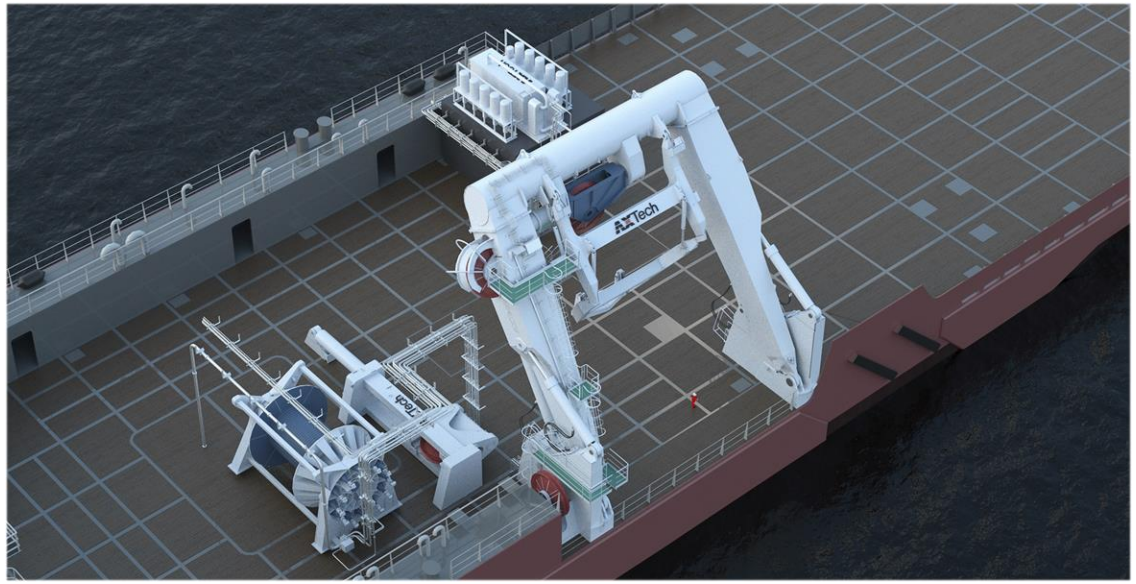
- Industry **pioneers** in providing solutions for **subsea minerals recovery** with several delivered projects (also for commercial scale):
  - Complete LARS for subsea machinery
  - Slurry riser handling and deployment systems

# AXTech offering and cooperation possibilities




- **FEED Studies** for lifting and material handling equipment
- Multi-body **physics simulations and dynamic analysis** of subsea lifting operations (including Computational Fluid Dynamics and vessel response)

- **Engineering and delivery** of:
  - Winches, umbilical systems, heave compensation, A-frames and lifting towers, riser systems, power systems (hydraulic and electric), control systems and SCADA, deck skidding systems, etc.
- **Installation** and commissioning, operation assistance, **training** and service




Engineered Lifting and Handling Solutions

# Bauer and Harren&Partner: what we stand for

- Before anybody starts mining in the deep-sea, he needs data from the ore body
- To get this data, we started a cooperation  between Bauer and Harren & Partner
- Usage of Bauer ´s cutter technology together with H&P´s offshore experience
- Offering **S**eabed **M**ineral **S**ervices for the exploration of SMS deposits
  - Small scale core drilling with MeBo
  - Bulk sampling with the “Vertical Approach”
- Results to be used for scaling the Vertical Approach to the demands of mining

# Bauer and Harren&Partner: what we look for

- Potential suppliers for finalizing and improving our technology

- Data from potential resources deposits
  - Depth
  - Bathymetry
  - …
- Potential partners for further development

- Potential clients for the execution of exploration/sampling projects

# NUI AS

NUI is based in Laksevåg, Bergen in Norway on a harbor site. For more than 40 years, we have built up unique competence, experience and facilities within underwater technology. We work closely with international expertise within a wide range of specialist areas applicable to the varied challenges within underwater operations.

## UNIQUE LOCATION

**Services includes:**

Hyperbaric reception center
Hyperbaric operations
**Hyperbaric pressure testing**
Pressure testing
Diving equipment testing
**Advisory services**
Laboratory services
**Seabed sampling services**
Hyperbaric oxygen therapy
Courses and training
+++


+47 55 94 28 00

post@nui.no

www.nui.no

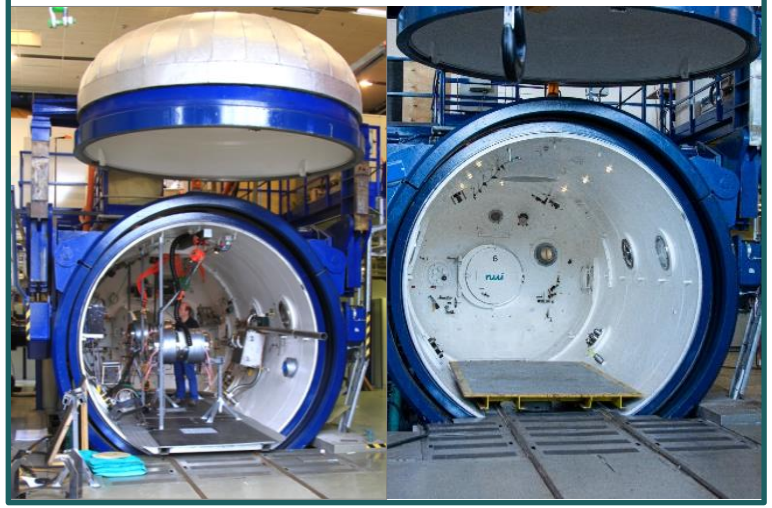
# Hyperbaric testing facilities

## Deep water testing

Two state of the art test chambers, with capacity to simulate depths down to 7 000 and 10 000 meters. Both chambers of signifcant size and capabilitites for cooling

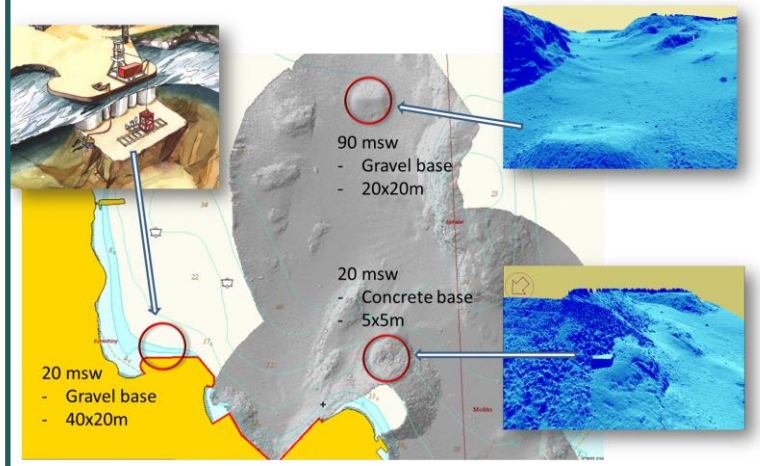
## Large scale testing

A unique 50m$^3$ test chamber by volume. Simulates depth down to 650 meters depth. Equipped with rails to ease equipment mobilisation and capacity for heating and cooling. Also suitable for gas testing. NUI also facilities an indoor pool (7x5x3.5m)



## Subsea test areas

A selection of flat subsea test earas. Two off located at 20 meteres depth and one located at 90 meters depth. All locations in proximity to NUIs quay



# GEOSCIENCE TECHNOLOGY LEADERSHIP

16. March 2022

cgg.com

# CGG - Our perimeter

## OUR STRENGTHS

### Remarkable data & technology

Unique Earth data library, imaging, geoscience & digital technologies

### Outstanding people & performance

Ingenuity, diversity and expertise driving innovation and exceeding expectations

### Resolute ESG commitments

Enabling our clients to be more efficient, effective, responsible and sustainable

## THREE CORE BUSINESSES

### Geoscience

Established leader in subsurface imaging, geology and geoscience services

### Multi-client

The industry's most technically advanced seismic data and geologic studies in the world's key locations

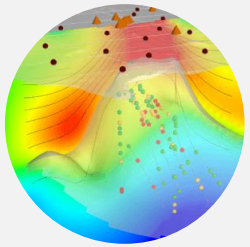
### Equipment

Established leader in marine, land, ocean floor and downhole seismic equipment and gauges

# CGG - Our Geoscience ecosystem

**Subsurface Imaging**
Unmatched expertise, advanced geoscience & digital algorithms and excellent service in every image

**Geology & Engineering**
Leading geological and reservoir services and consultancy for natural resource development



**Multiphysics**
Expert analysis and interpretation of multi-domain geophysical data for natural resources and environmental applications

**Energy Transition**
Applying our geoscience and digital expertise to Geothermal, CCUS, Critical Mineral and Environmental analysis & monitoring

**Earth Observation**
Intelligence from imagery for Energy, Mining, Engineering, Environment and Defense

**Digital Sciences**
Bespoke HPC & Cloud services, data transformation, machine learning and AI

**GeoTraining**
Bringing together the full breadth of CGG's capabilities to provide comprehensive learning path programs

# About TechnipFMC

Company presentation

NMM-DSMA Seminar

16th March 2022

# Who we are

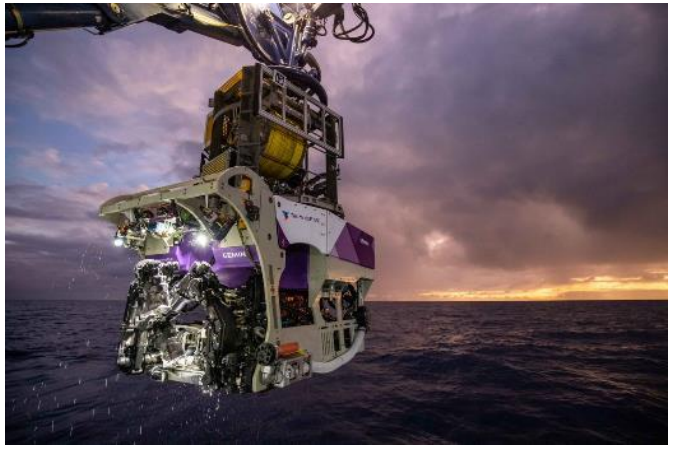
We are a **leading technology provider** to the **traditional and new energies industry**; delivering **fully integrated projects, products, and services**. With our proprietary technologies and comprehensive solutions, we are transforming our clients' project economics, helping them unlock new possibilities to develop energy resources while reducing carbon intensity and supporting their energy transition ambitions.

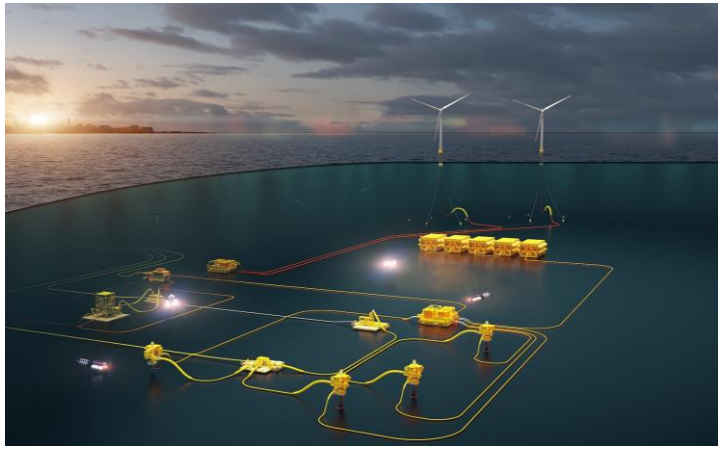
Organized in two business segments – Subsea and Surface – we will continue to **advance the industry with our pioneering integrated ecosystems**, **technology leadership** and **digital innovation**.

**20,000~**
Employees

**40**
Countries

**$6.4bn**
Total company revenue (2021)





# TechnipFMC experience in Marine Mining

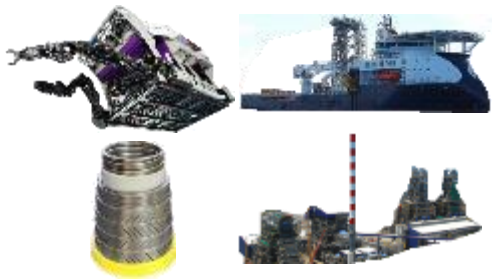
## A unique and complimentary combination of know how

TOP **20** ACTIVE COMPANIES IN LAST 20 YEARS

**10+** years of R&D

**11** Patents

…plus additional IP harvesting opportunities



## Memberships

Cluster Maritime Français

DSMA DeepSea Mining Alliance

NORWEGIAN FORUM FOR MARINE MINERALS

EUROPEAN RAW MATERIALS ALLIANCE ERMA

## R&D

- One of top 20 active companies in last 20 years
- 11 patents granted (2007-14)
- >10 conference presentations
- Includes mining tools, rock characterization, hyperbaric crushing, pumping systems, flexible riser design, flow modelling and field architecture

## Projects

- Neptune Project (2008)
- Wallis and Futuna exploration cruises with IFREMER (2010-12)
- Nautilus Project (2010-13)
- Fonasurf (2015-17)
- TIOS Coring Campaign for NPD (2020)
- Loke Marine Minerals (2021-ongoing)

FONASURF

Concept for a Subsea Mining Pilot System to extract minerals from Seafloor Massive Sulphide deposits
*World Innovation Challenge Phase 2*

Project Partners: TechnipFMC, BAUER, comex, NAVAL GROUP

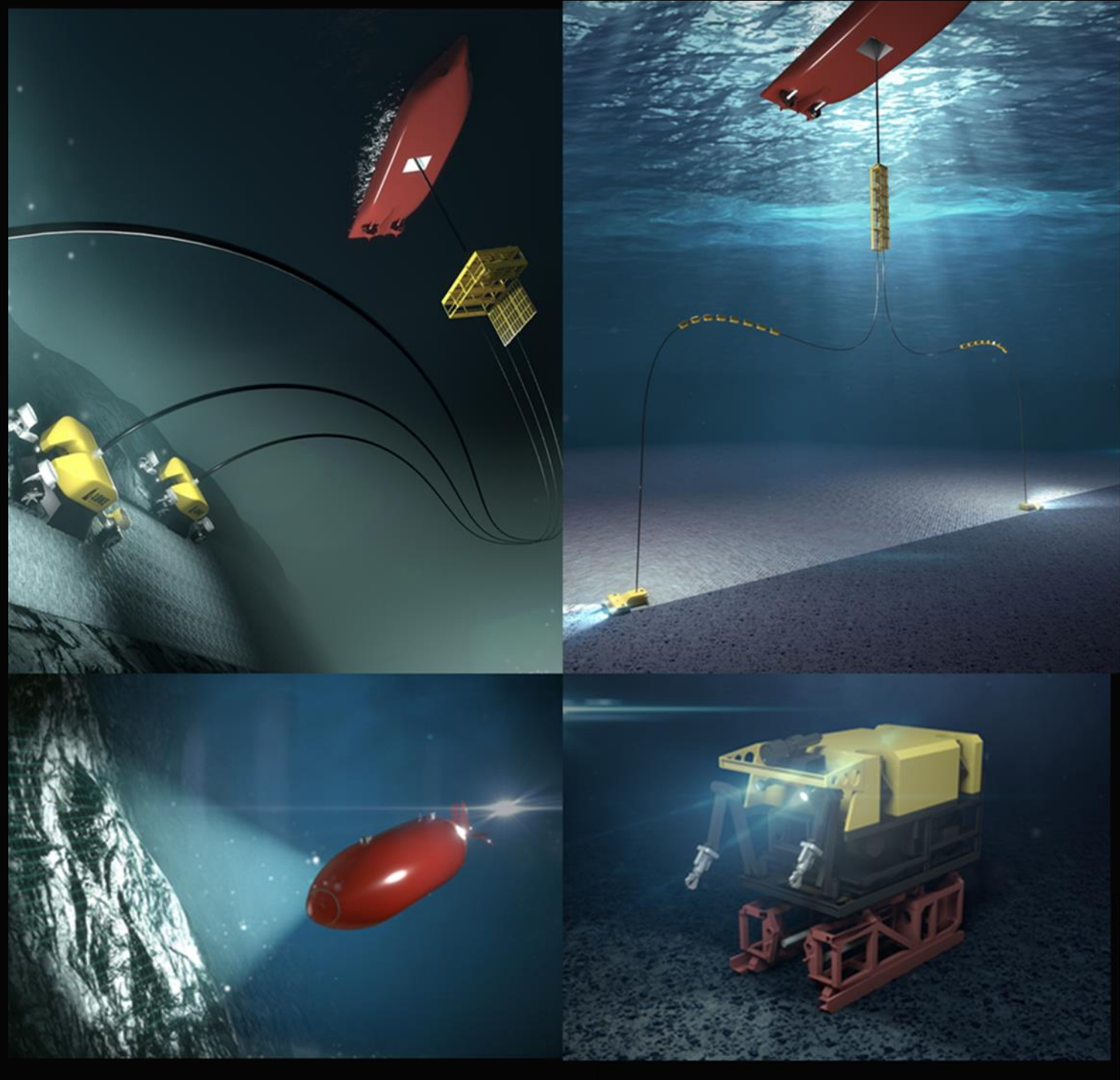
Sponsored by: bpifrance

# loke

Loke and partners are developing differentiating and environmentally focused technology built on more than 50 years of experience from world class subsea oil and gas sector

- AUV/ROV based exploration technology
- Plume free seabed mining technology
- Autonomous real-time environmental monitoring

Sustainability through technology



# Building strategic partnerships along the minerals value chain

**Phase 1 – exploration and technology development**

**Phase 2 – production, operation & logistics**

**Phase 3 – midstream & downstream mineral off-take**

| Exploration | Offshore production system | Shipping | Onshore base and logistics | Onshore processing facility | Energy transition Metals |
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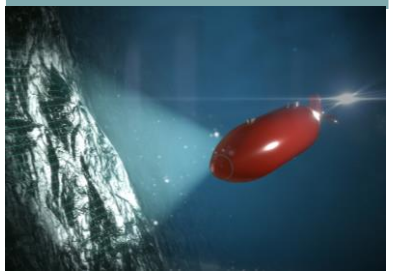
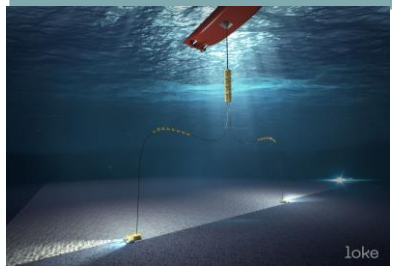
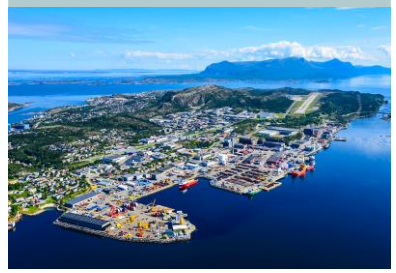
|  |  | |  | | |
| • Environmental baseline studies<br>• Remote/autonomous operations<br>• Survey AUV/ROV<br>• Resource/core sampling | • Production vessel<br>• Vertical transportation system<br>• Mineral collectors | • Shipment of ore minerals from production vessel to onshore base<br>• Decarbonised operation and transportation | • Onshore base/terminal for mineral unloading | • Refining of critical minerals.<br>• Nickel, Cobalt, Copper, Manganese and REE | • Energy storage and battery producers<br>• Energy grid infrastructure<br>• Solar and offshore wind component industry |

AMC consultants · TechnipFMC · REACH SUBSEA · massterly · Wilhelmsen · NorSeaGroup · KONGSBERG · atdepth

Still looking for new partnerships

# HYDROMOD Service GmbH

## Member of the DeepSea Mining Alliance - DSMA

- Management and conduction of hydro-physical, geophysical and environmental surveys,
- Environmental Impact Studies (EIS),
- Met-Ocean Studies,
- Hydrodynamic modelling of sediment and pollution transport,
- Consulting in deep-sea minerals exploration and mining.

Aiming for cooperation in the context of deep-sea exploration, deep-sea mining and corresponding environmental monitoring!

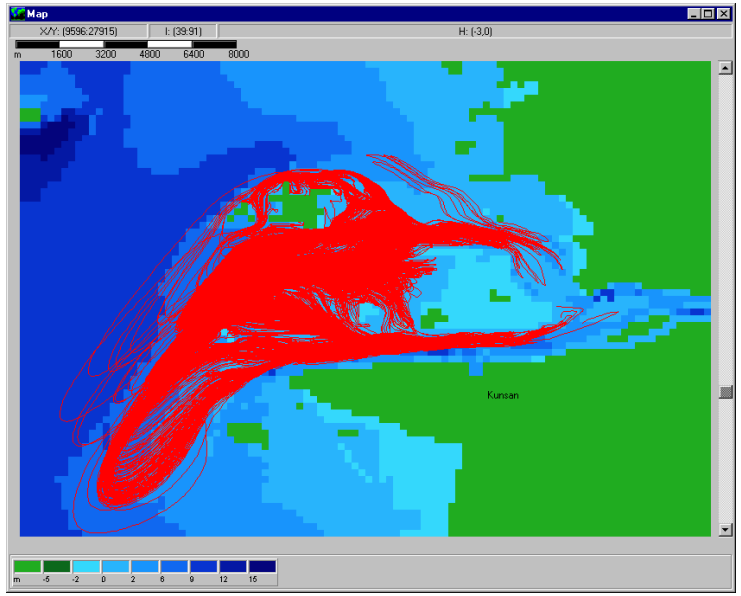
OSAT

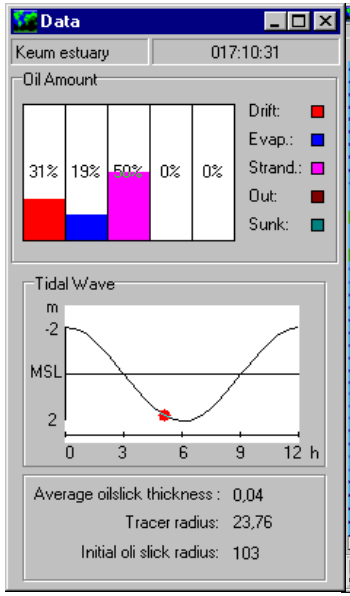
HYDROMOD Service GmbH

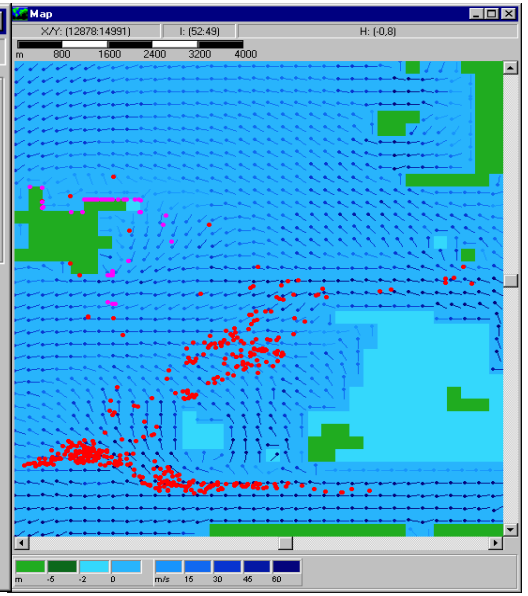
HYDROMOD®

# Example of Model Results:

## Forecasting of the tidal transport and the corresponding spreading of oil after a ship-accident in an Korean estuary.




**johannes.post@hydromod-service.de**

OSAT

HYDROMOD Service GmbH

HYDROMOD®

IHC Mining

# Royal IHC

## Introduction Royal IHC and IHC Mining
## Deep Sea Mining Capabilities

## Introduction Royal IHC – Company profile

Anchored in a rich Dutch maritime history, Royal IHC is a leading supplier of maritime technology and expert craftsmanship.

With the right people and skills on board, and driven by innovation, we provide a competitive edge to our worldwide customers in the dredging, offshore, mining and defence industries. However, Royal IHC is much more than equipment, vessels and services. We deliver reliable, integrated solutions that improve operational efficiency and allow for a more sustainable performance.

All over the world, our people are deeply committed to technological innovation, supported by our long-standing experience in our core markets. Our experts work in close collaboration with multiple stakeholders to meet the specific needs of each customer.

As we navigate new waters in an ever-changing world, our aim remains unchanged: to discover the smartest and safest way forward for both our customers and our people.

Together, we create the maritime future.

IHC Mining

## Introduction Royal IHC > Four main brands

IHC Dredging

IHC Offshore Energy

IHC Mining

IHC Defence



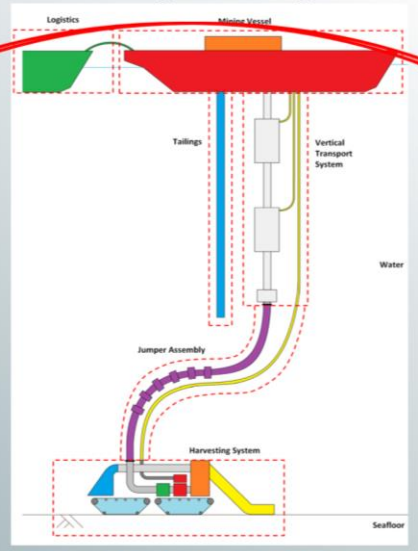
## Introduction IHC Mining > Unique wet mining know-how

- Serving the mining market with unique know-how in wet mining and mineral separation solutions
- Long-term commitment to develop Marine and Deep Sea Mining technology through research and business development
- Powered by a global team of dedicated and experienced industry professionals
- Leading to sustainable equipment and services throughout the entire mining life cycle

IHC Mining

## 2. Introduction IHC Mining – Integrated approach

- RULES AND REGULATIONS: fair and just balance for all stakeholders
- SOCIAL CONTEXT: Benefit of Humankind, Responsible use of Oceans and Resources
- ENVIRONMENT: Benthic impact, Plumes, Noise, Recovery



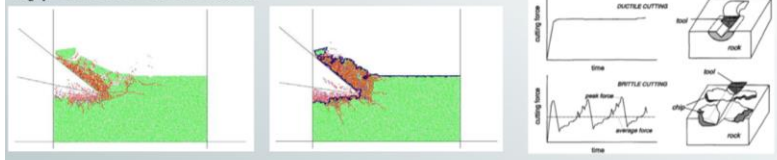

- MINING VESSEL: platform for LARS, operations, processing and logistics
- VERTICAL TRANSPORT SYSTEM: Dynamics, Safe operations, Slurry flow and control
- EXTRACTION SYSTEM: High efficient with minimized impact and plumes
- PROVEN RESERVES: Geology, Seafloor conditions, Environmental baseline, Mining/Production requirements

IHC Mining

5

## IHC Mining - Deep Sea Mining Capabilities

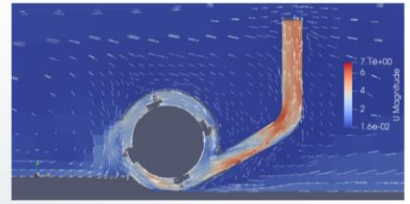
Hyperbaric excavation



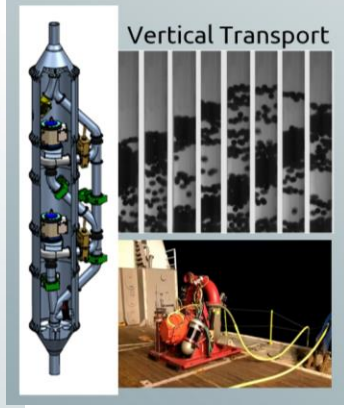
P = atmospheric, v = 0.5 m/s
Breakout and brittle behavior

P = 180 bar, v = 0.5 m/s
No Breakout and ductile behavior

Pickup and Slurrification



Vertical Transport



Hardware: from systems to integrated Mining Vessels

## 4a. Projects and Experience – Blue Projects

| | | | | | | |
|---|---|---|---|---|---|---|
| blue harvesting | • Development and testing of a Hydraulic Nodule Collector while minimising its environmental impact | Start date: 1 April 2019<br>End date: 31 March 2022<br>Duration: 36 months<br>EIT Funding: 3.7 MEUR<br>9 Partners from 5 different countries | Industry | Research Institutes | Service Supplier | RawMaterials |
| blue nodules | • Breakthrough solutions for the sustainable harvesting and processing of Deep Sea Polymetallic Nodules | Start date: 1 February 2016<br>End date: 31 July 2020<br>Duration: 48 months<br>EC Funding: 8 MEUR<br>14 Partners from 9 different countries | Industry | Research Institutes | Service Supplier | The Blue Nodules project has received funding from the European Union's Horizon 2020 Programme for research, technology development and demonstration under grant agreement no. 688975 |
| blue mining | • Breakthrough solutions for sustainable Deep Sea Mining | Start date: 1 Feb 2014<br>End date: 31 Jan 2018<br>Duration: 48 Months<br>EC Funding: 10 MEUR<br>19 Partners from 6 different countries in Europe | Industry | Research Institutes | Service Supplier | This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 604500 |

IHC Mining

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## Profile

**Andreas Kaede, German Attorney-At-Law (Rechtsanwalt)**

**Mid 1980s**: legal training; first Law-of-the-Sea („LOS") contacts

**1987-2015**: corporate lawyer (automotive industry) with focus on intellectual property („IP") contracts; never lost interest in LOS topic

**2016:** retirement; establishment of private law firm in co-operation with Haver&Mailänder Partnerschaft mbB, Stuttgart

**Hence**: participation in SOS (WOC), UMC (IMMS) and DSM Summit congresses with presentations on various aspects of technology transfer in LOS regulatory environment; stakeholder submissions to the ISA Exploitation Rules drafting process

**E.2019**: acquired membership in DSMA

ANDREAS KAEDE
ATTORNEY AT LAW

IN CO-OPERATION WITH
HAVER & MAILÄNDER RECHTSANWÄLTE PARTNERSCHAFT MBB

LAMMSTRASSE 6
D-70839 GERLINGEN

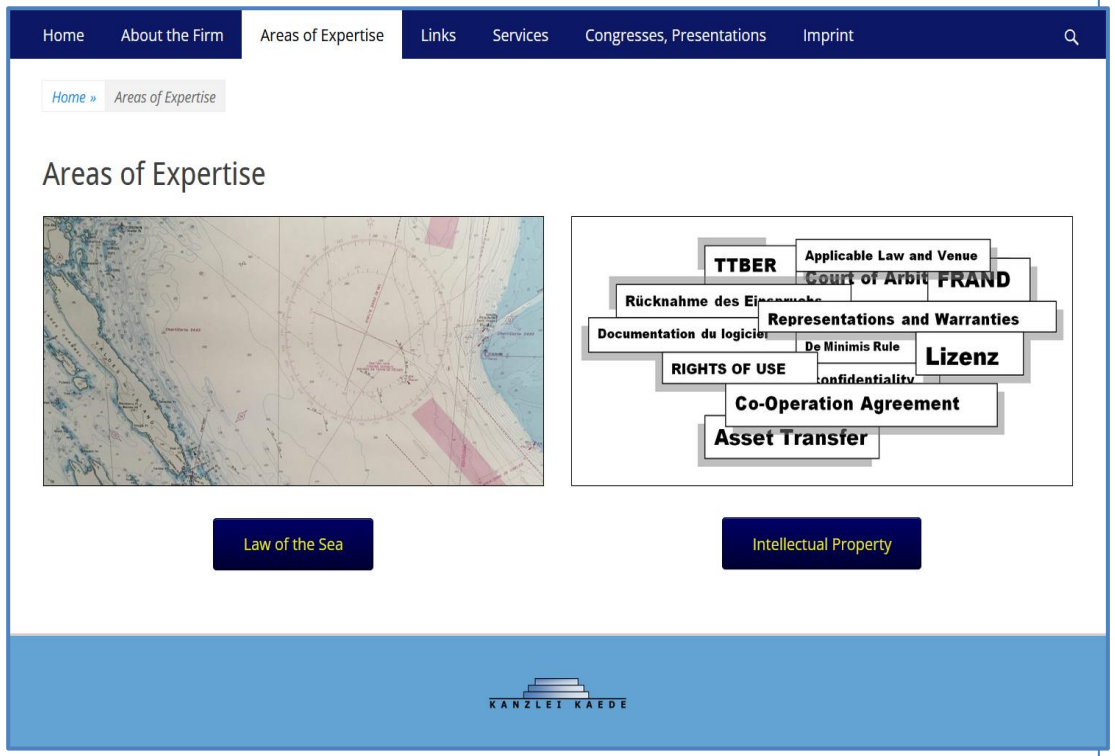
TEL. +49 (0)7156 433 100
CELL +49 (0)173 928 70 20
MAIL ANDREAS.KAEDE@T-ONLINE.DE

## Areas of Interest for Co-operation

**Andreas Kaede, German Attorney-At-Law (Rechtsanwalt)**

- Consultation regarding/drafting and negotiation of
  - Contracts between companies and the Authority on exploitation rights in the Area
  - Contracts between members of an exploitation consortium
- Interpretation of provisions of the (draft) ISA Exploitation Rules and the ISA Exploration Rules
- Advice on legal protection as well as transfer (be it by licensing, sale or disclosure) of DSM technology

**You are also invited to visit the website of „Kanzlei Kaede" at [www.kanzlei-kaede.de](http://www.kanzlei-kaede.de)**



# EvoLogics – About us

- Berlin-based **high-tech company**
- Founded in **2000**
- Focus on maritime and underwater **robotics, communication, positioning** and **sensor systems**
- Currently:
  - 52 team members
  - 10 mEUR turnover
  - customers in 64 countries

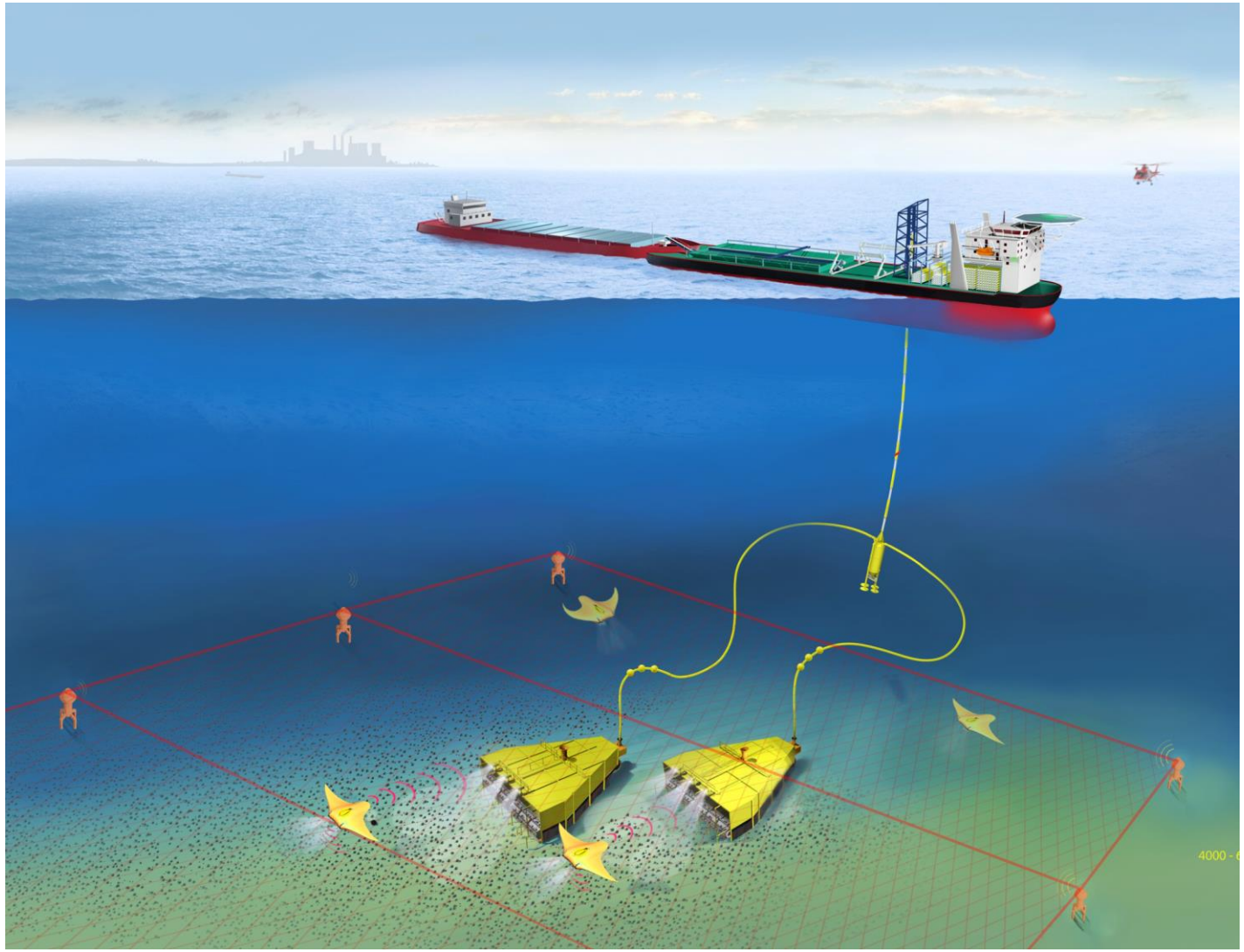
- Learn more at www.evologics.de

Contact:

Dr. Rudolf Bannasch
info@evologics.de

Source: EvoLogics

# EvoLogics - Services for DeepSea Mining



**Product solutions**

- Advanced modem technology and comprehensive network solutions for reliable acoustic underwater communication and positioning
- Sensor integration for environmental monitoring and collaborative data acquisition

**In preparation**

- Resident AUV swarm application with AI for time- and cost-efficient high-resolution on-site survey, technical inspections and ecological impact control

# Fugro Marine Site Characterisation

**Acquisition, Processing and Interpretation of Seabed Data required for seabed mining**

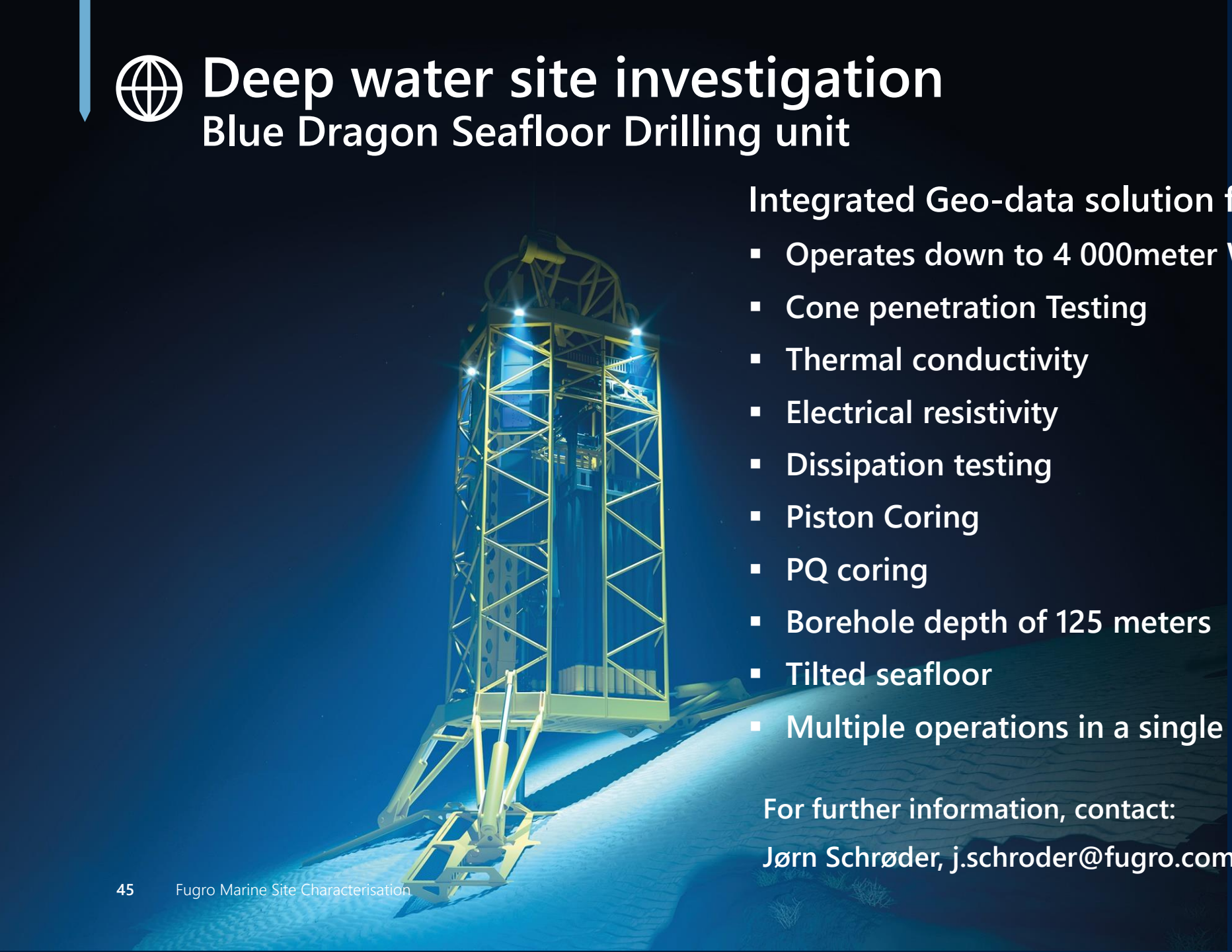
Fugro are 10 000 employees and operate 26 vessels, 119 ROVs, 5 AUVs, 40 laboratories and 16 R &D centres. We provide all geophysical, geotechnical and environmental services required for seabed Mining

- UHR/UUHR seismic
- Sub Bottom Profiler
- Bathymetric data, MBE, SSS
- High Resolution Imagery
- Magnetometer
- Geotechnical Properties

- Seafloor sampling
- Metocean
- Marine Environmental Services
  - Taxonomy
  - Consultancy
  - Environmental Surveys
  - Laboratory testing

Fugro conducted its first Marine Mineral survey in 2018

# Deep water site investigation
## Blue Dragon Seafloor Drilling unit



**Integrated Geo-data solution for remote seabed drilling:**

- Operates down to 4 000meter WD
- Cone penetration Testing
- Thermal conductivity
- Electrical resistivity
- Dissipation testing
- Piston Coring
- PQ coring
- Borehole depth of 125 meters
- Tilted seafloor
- Multiple operations in a single dive

For further information, contact:

Jørn Schrøder, j.schroder@fugro.com, 95846854

# Movable HYDROPOWER Plants

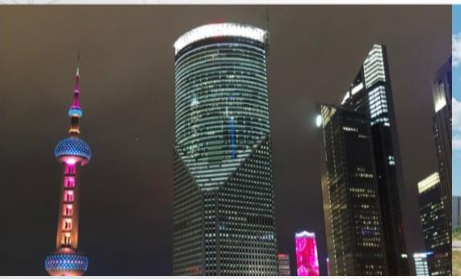
**Prof. Dr. Martin Sobczyk - CEO**

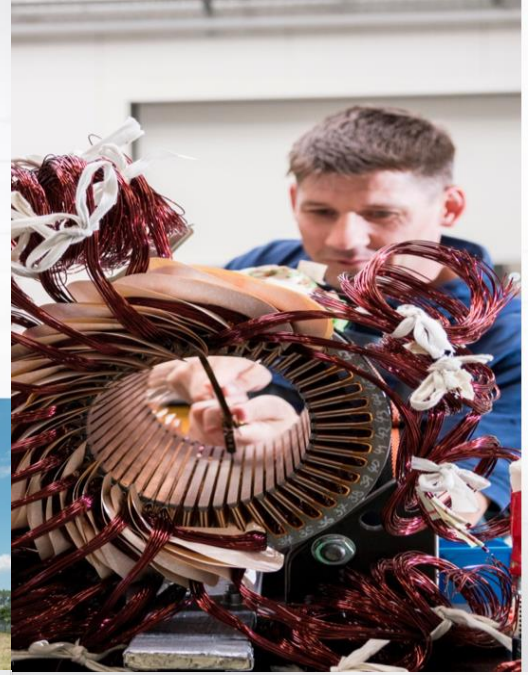
Krebs & Aulich

Sonderbare Elektromaschinen

# THE COMPANY

- founded 1997
- 95 employees
- more than 200 international customers
- 12 mio.€ turnover/ p.a.
- Inhouse engineering/ design dept regarding custom made requests
- CNC manufacturing/ Assembly
- 2 Teststands for development and projects
- Shanghai office: Chinese organisation suppluying AfterSales service and local sales
- Detroit office: Consulting, Sales, Distribution, AfterSales
- K&A is a ISO9001:2015 TÜV-certified company since August 2017





... MORE THAN 20 YEARS EXPERIENCE

## TESTBENCH DYNANOMETERS

More than 1.000 installations worldwide. Krebs & Aulich test bench dynos in operation at the R&D centres of the OEMs and well known testing service providers.
Applications for Powertrain, comustion engines, E-mobility.

## R&D AUTOMOTIVE/ BATCH PRODUCTION

In the area of traction drives Krebs & Aulich is suppluying R&D services for single components like stator, rotor or housings.
Also complete drive systems can be developed, manufatured and tested.
Whether airospace, machine tooling or heavyduty applications. Krebs & Aulich solutions does fit into the environment were others won't be sufficient.

## HYDROPOWER/PROJECTS

Since 2007 Krebs & Aulich delivers PM-generators from 50 up to 3.000kW.
In comparison to induction technology 30% more efficiency can be realized.

# Movable HPP

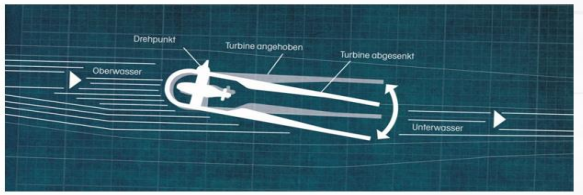
- Improvement of flood runoff without additional structures
- **ecological continuity** for fish and small organisms
- no silting up in the congestion and re-discharge area
- **lowest noise emissions**
- very **high overall efficiency** over the entire operating range
- higher power generation even during floods
- **robust, durable and low-maintenance technology**
- harmonious integration into the landscape
- short construction times and low construction costs
- higher annual yield with lower manufacturing costs

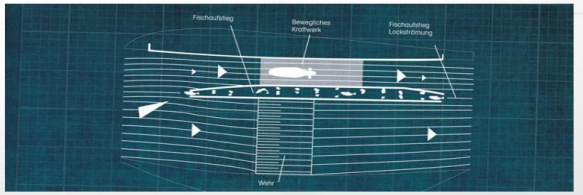
Quelle: Die bewegliche Wasserkraftanlage – HSI Hydro Engineering GmbH

# Movable HPP

The movable hydropower plant is characterized by the swiveling steel housing and the built-in efficient technology:

- compact unit with double-regulated Kaplan tubular turbine and permanently magnetically excited synchronous generator
- operation without converter - highest efficiencies in the partial load range
- peak efficiencies above 90 % possible




Quelle: Die bewegliche Wasserkraftanlage – HSI Hydro Engineering GmbH

Fraunhofer IKTS

**Enabler for subsea systems**

# Advanced ceramics and condition monitoring


**Contact**

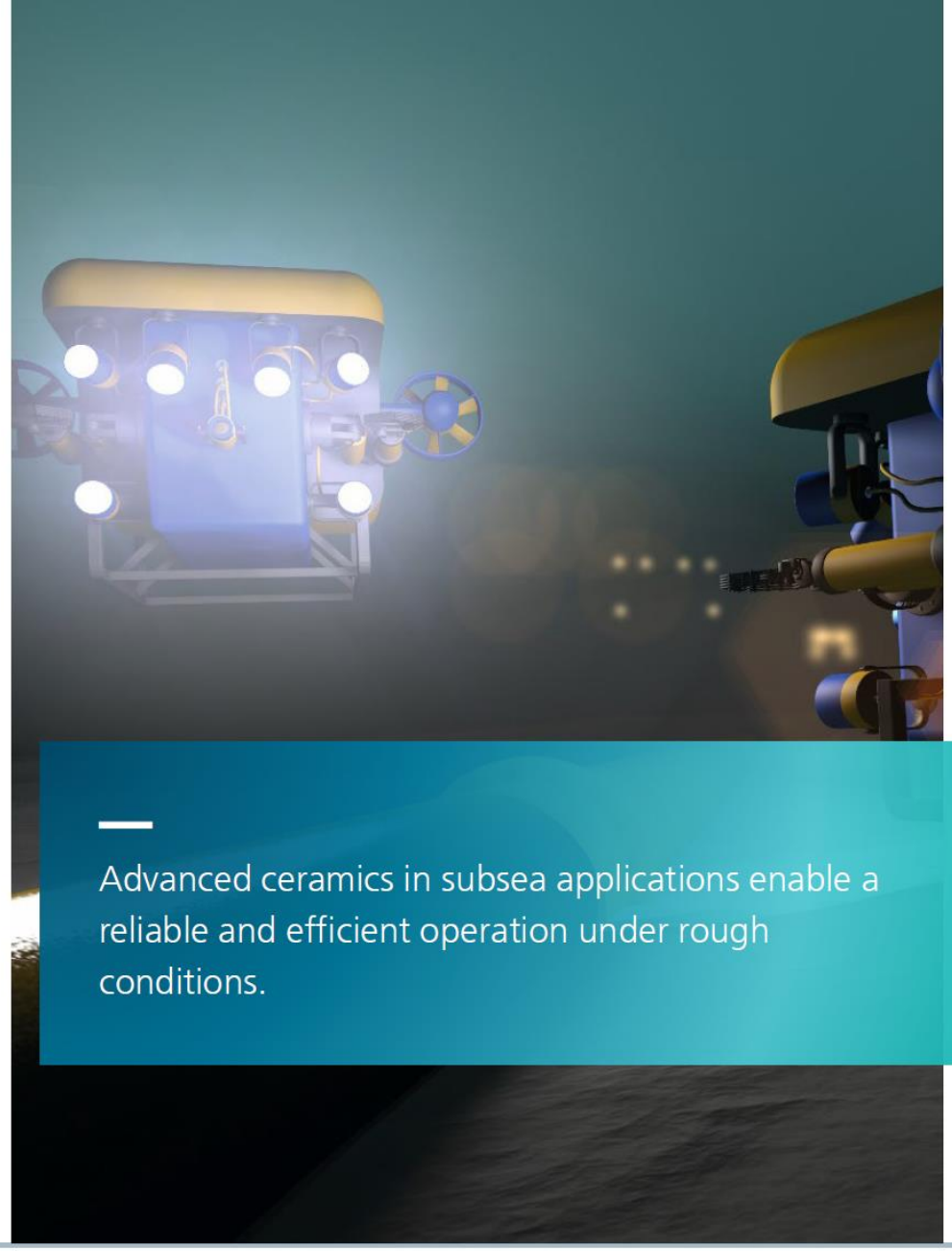
Dr.-Ing. Michael Zins
+49 351 2553-7522
michael.zins@fraunhofer.de
www.ikts.fraunhofer.de

# Advanced ceramics and condition monitoring as enabler for subsea systems

## Gaining the competitive edge through advanced ceramics

Due to their extremely high compressive strength in combination with corrosion and wear resistance, ceramic materials are perfectly suited to be used in maritime applications:

- Wear and corrosion-resistant components (e.g. for pumps, linings)
- Pressure-resistant transparent ceramics (e.g. protective covers for cameras, sensors)
- Robust electronics and sensor systems (hermetically sealed, shock-resistant encapsulation, high-temperature and corrosion resistant)
- Compact membrane systems (resistant to organics, good desalination behavior and thermal stability)
- Measuring and monitoring systems for structural health monitoring and process control (e.g. pipelines, tanks, offshore structures)



Advanced ceramics in subsea applications enable a reliable and efficient operation under rough conditions.


© Fraunhofer IKTS

# Advanced ceramics and condition monitoring as enabler for subsea systems

## Wear protection

Ceramics, tungsten carbides and cermets are able to minimize wear and thus significantly increase the service life of such systems – sometimes by a factor of 100 – as compared to conventional material solutions.

## Process water treatment

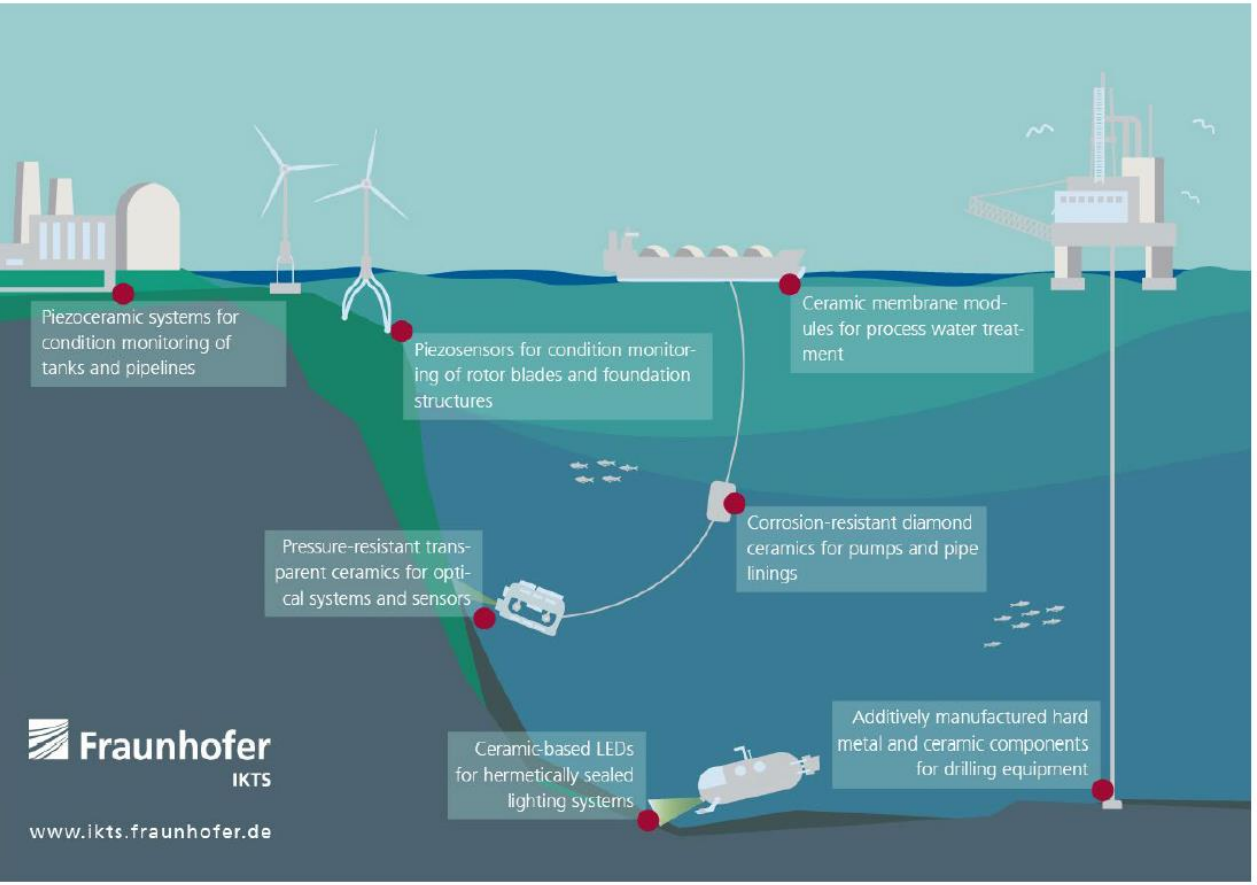
Membrane separation is combined with electrochemical and oxidative processes for the treatment of mining waters or process waters. Ceramic components are the key to continuously extending the existing limits.

## Condition monitoring

Robust sensor systems designed for harsh operating conditions realize non-destructive defect detection, real-time monitoring and associated condition-based maintenance or plant optimization.


© Fraunhofer IKTS

# Advanced ceramics and condition monitoring as enabler for subsea systems




## Research partner from the idea to the product

It is our drive to develop complete system solutions and services, but also to solve specific challenges within the processes of our partners from industry and science. Our expertise in the characterization and analysis of materials, components and systems along their life cycle provides us with a unique data pool to carry out new developments more efficiently and faster.

### Services offered

- Development and characterization of subsea materials
- Design of subsea components
- Prototype production up to small-scale production
- Development and implantation of monitoring systems and processes
- Testing of subsea systems
- Feasibility studies
- Consulting


© Fraunhofer IKTS

# ADEPTH MINERALS

## TAKING A LEADING ROLE AS NORWEGIAN DEEP SEA MINERAL EXPLORATION COMPANY

- A competent, data-driven and innovative exploration and production company targeting deep sea minerals on the Norwegian shelf
- Incorporated in 2020 on the shoulders of subsea, geology, data/AI knowledge
- Team with 100 + years of industrial & geology experience and strong financial track record from investments in the energy space
- 100% equity financed - fully funded until 2024 - robust shareholder structure
- Extensive collaboration with strong industrial partners/shareholders and research institutions (DeepOcean, Seabed Solutions, University of Bergen, +++)
- Research expedition Q4 2022 - testing core drilling equipment & performing research

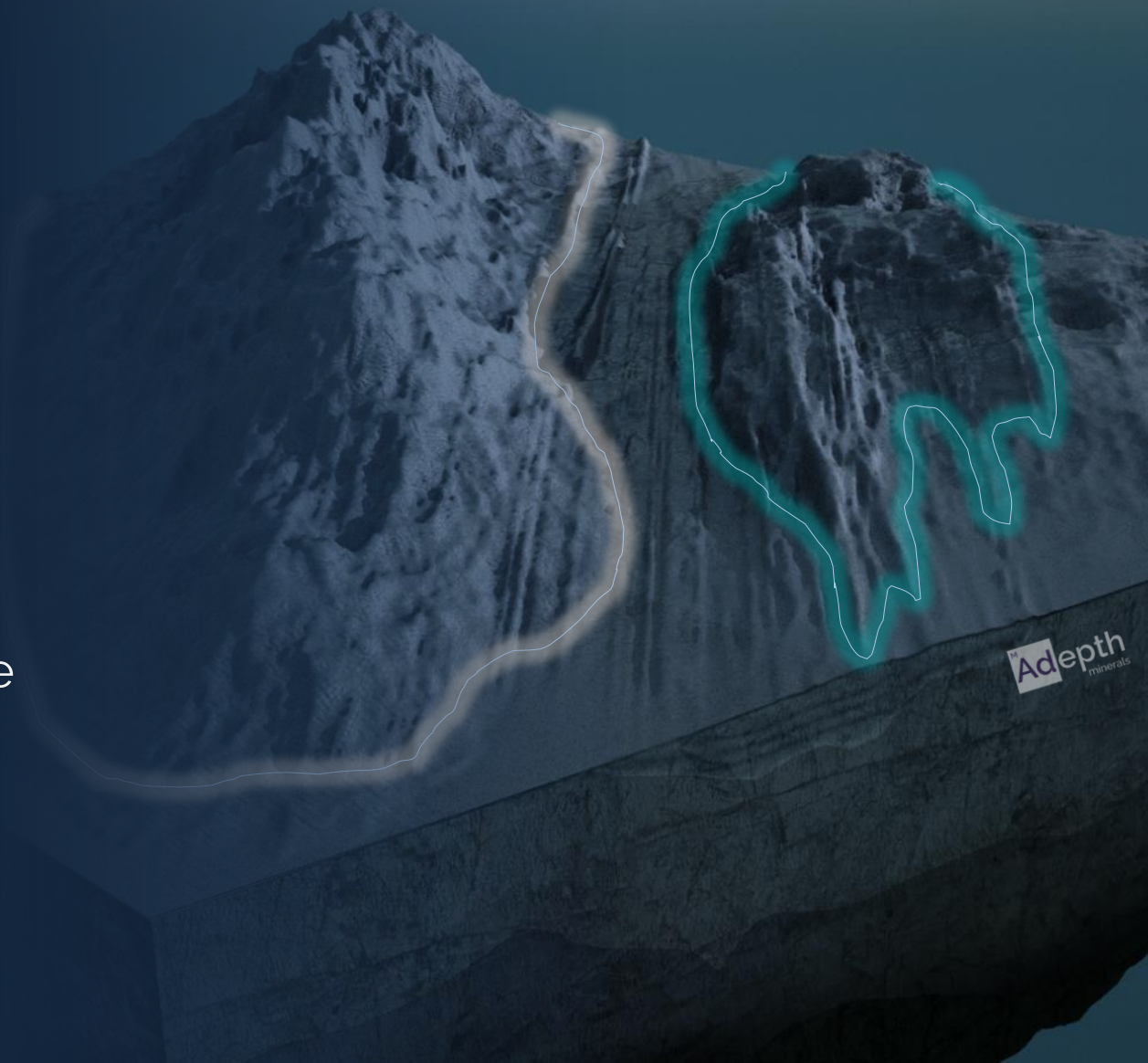
# ADEPTH MINERALS

POWERING THE TRANSITION TO A LOW CARBON FUTURE

## Sustainable exploration and extraction of deep-sea minerals

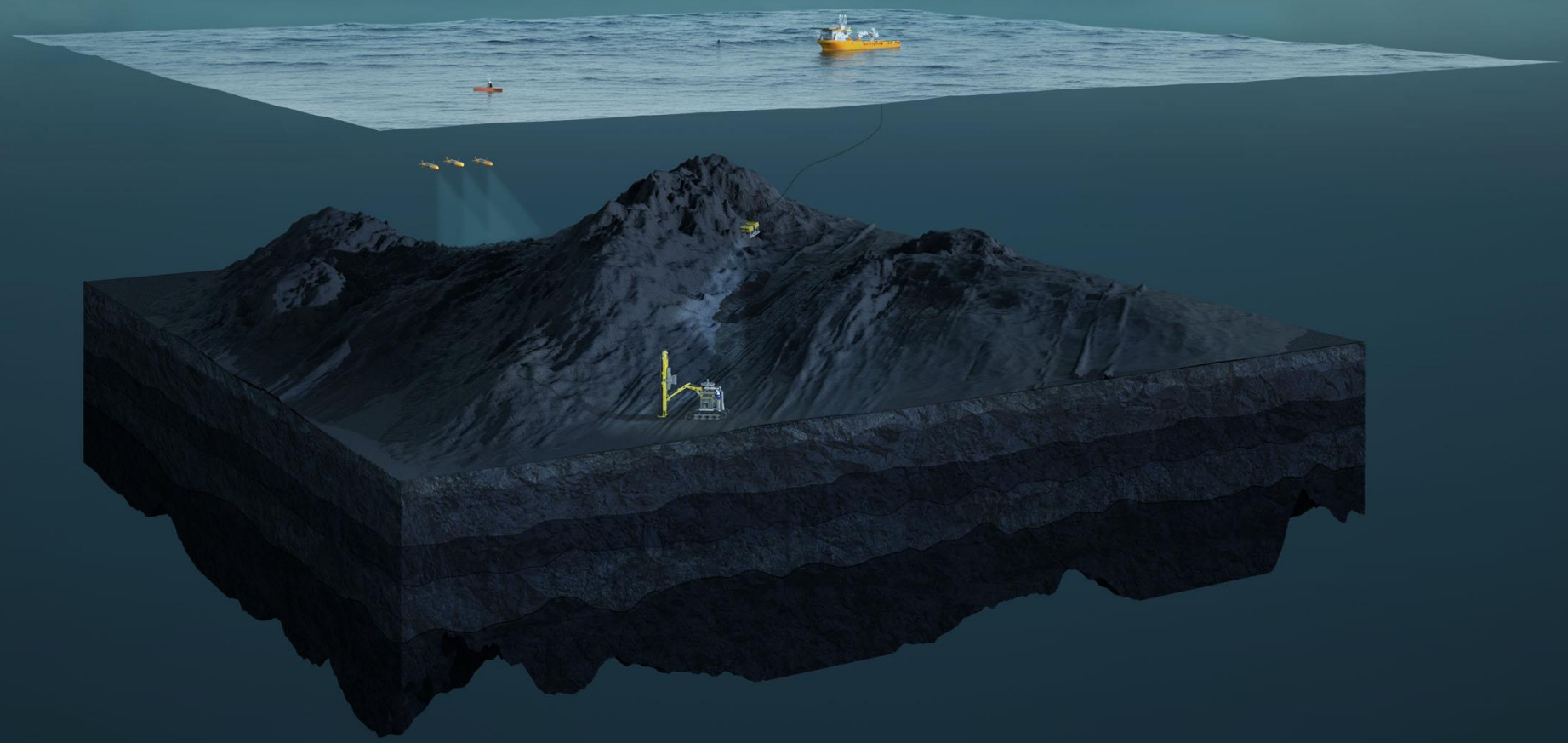
ADEPTH Minerals mission is to:

- Discover and extract commercial deep-sea minerals
- By utilizing new technology with low carbon intensity and reduced footprint
- Integrate big data and artificial intelligence for prospect analysis and risk assessment



# Areas of interest for cooperation with other companies/institutions

## The Exploration Toolbox



Not to scale

DEEPOCEAN Seabed Solutions Adepth minerals

# Bosch Rexroth

## Many Technologies. One Right Solution

WE MOVE.
YOU WIN.
Now. Next. Beyond.

Assembly Technology

Electric Drive and Control Technology

Gear Technology

Industrial Hydraulics

Linear Motion Technology

Mobile Hydraulics, Electronics and IOT

Mobile Robotics

Moulding and Casting Technology

Production Assistants (APAS)

Resistance Welding Technology

Tightening and Joining Technology

Xtreme Engineering



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rexroth
A Bosch Company

# Bosch Rexroth

## Subsea Automation Systems

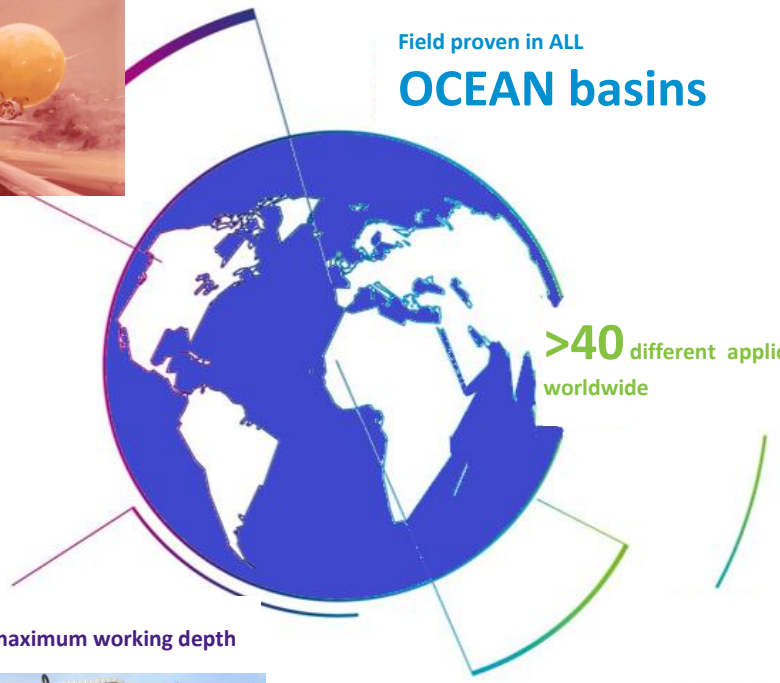
WE MOVE.
YOU WIN.
Now. Next. Beyond.

Subsea experience since

**1970**

Field proven in ALL

**OCEAN basins**



**>40** different applications worldwide

**4000** m maximum working depth

components validated for up

**6000** m water depth

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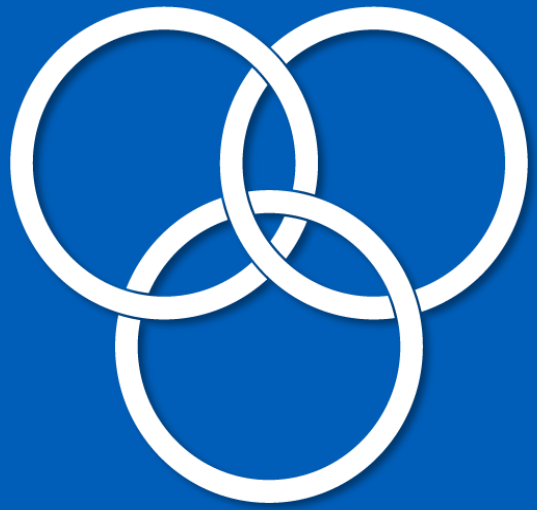
rexroth
A Bosch Company

# PGS | Who We Are | A leading marine geophysical company

Employees:
**~900**

Countries:
**14**

Active Vessels:
**6**



**Integrated Marine Geophysical Company**

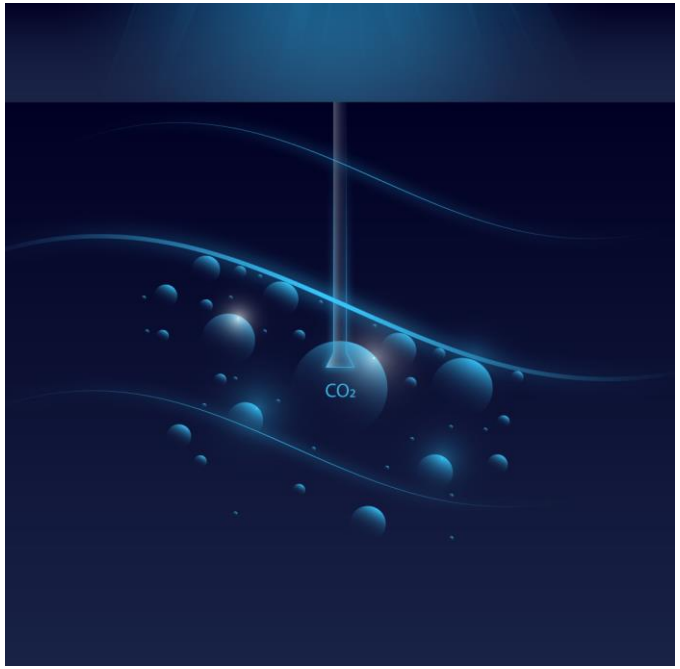
Revenues:
**$590.0m**

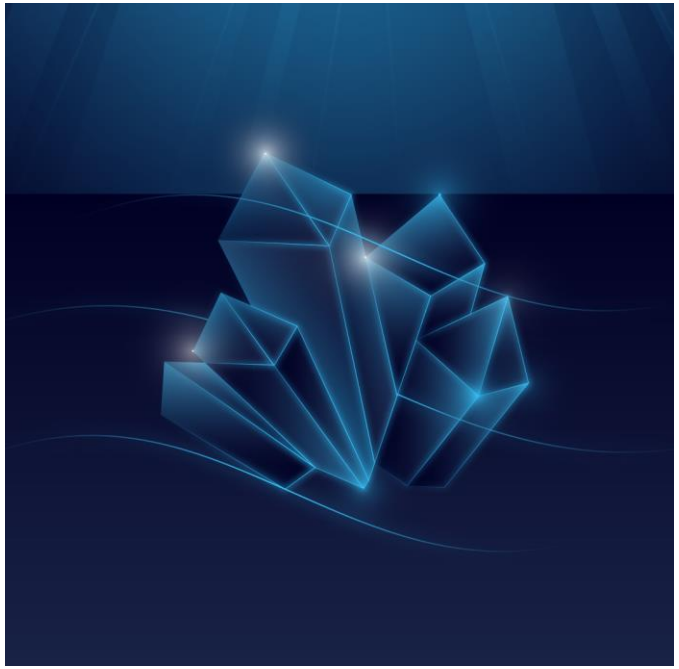
EBITDA:
**$320.2m**

Market Cap:
**$~100m**

Revenues and profits are in USD and are based on the annual result for 2021. Market capitalization is as of early February 2022.

# PGS | New Energy Focus Areas





Geophysical data acquisition,  processing and analysis

Global MultiClient Data Library with derivative G&G products

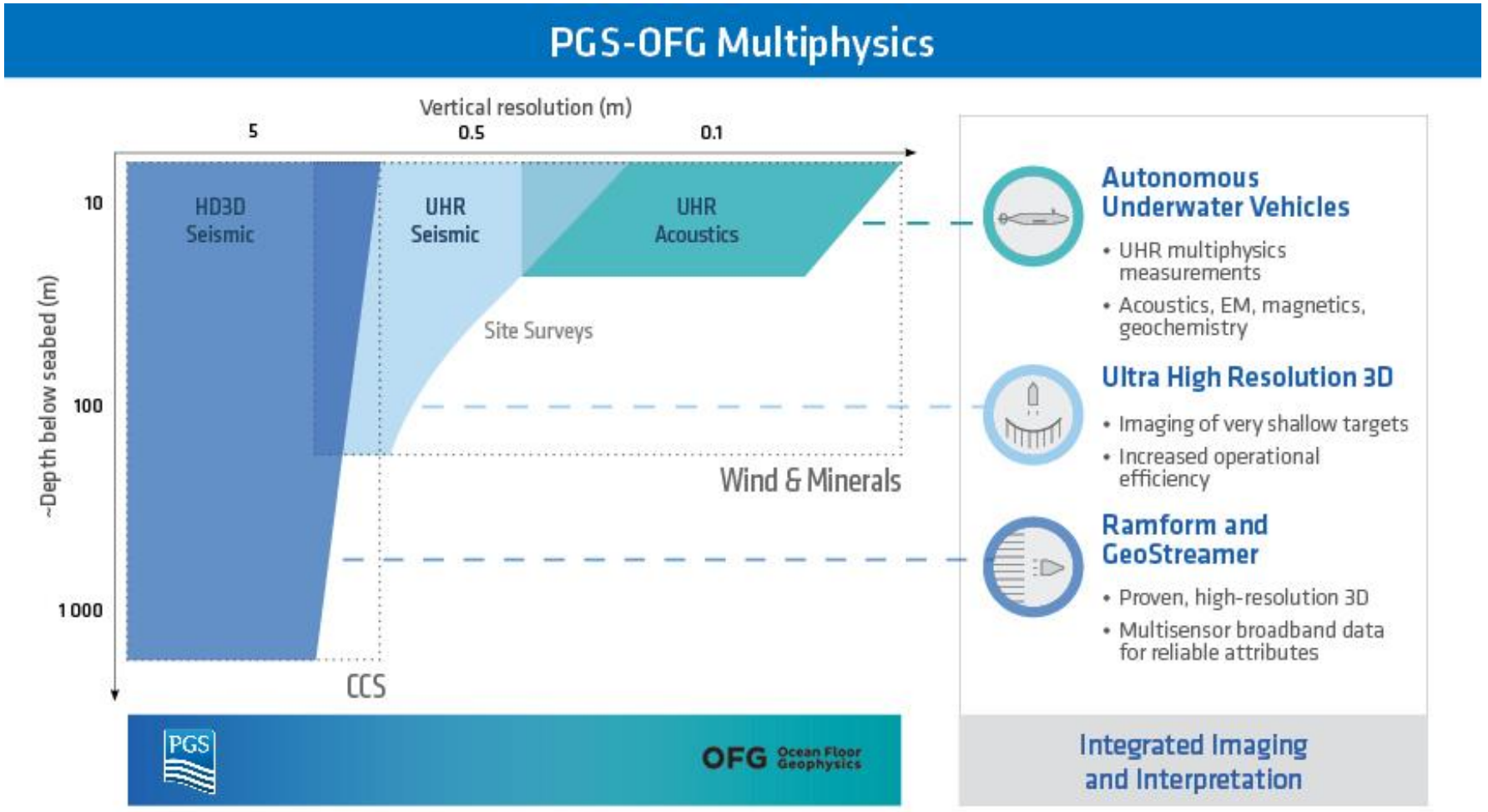
Operations advisory, support and partnership

# PGS Technology Portfolio
## See recent news here

PGS > Investors > IR News & Announcements > PGS Strengthens its New Energy Portfolio

**PGS Strengthens its New Energy Portfolio**

March 9, 2022



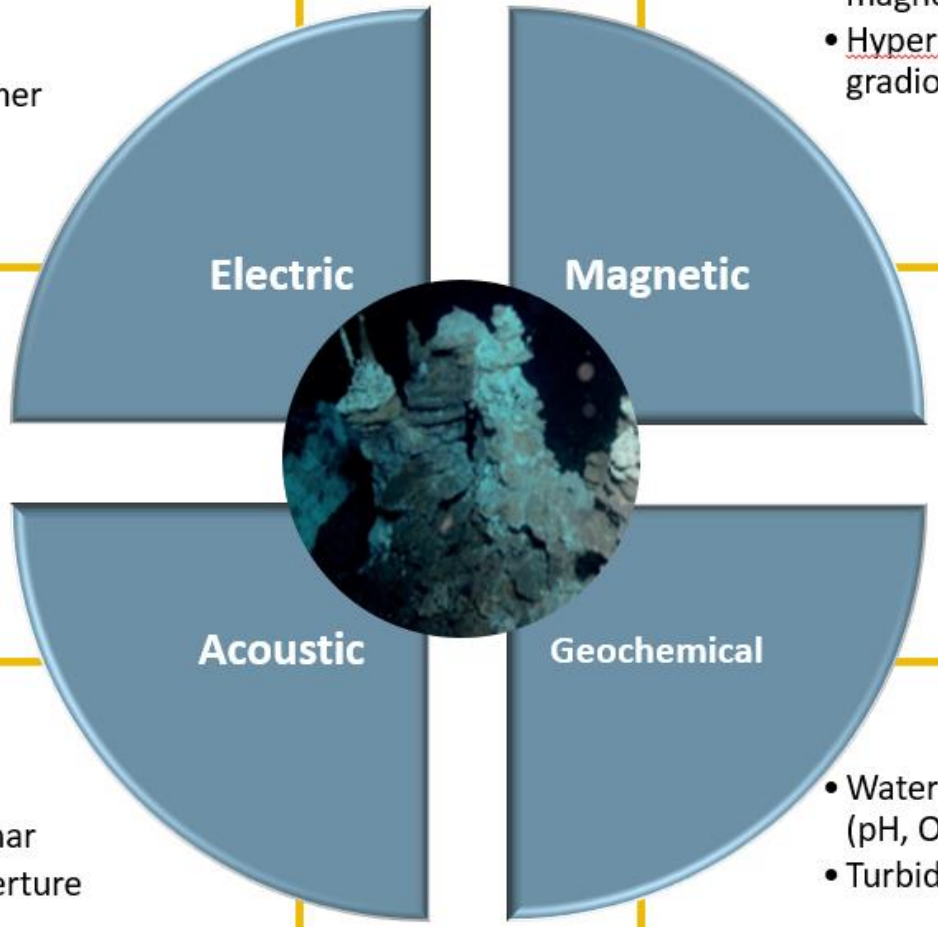

- PGS' portfolio covers the full range of depth, scales and physical parameters typically involved in the remote monitoring of the sub-surface
- Multi-physics sensors can also be deployed from a surface vessel as required

# Technology

OFG Ocean Floor Geophysics

- Self potential
- AUV – CSEM
- ROV-CSEM
- Towed streamer CSEM

- Self compensating magnetometer
- Hypermag (vector gradiometer)




- MBES
- Side Scan Sonar
- Synthetic Aperture Sonar
- Sub-bottom profiler

- Water chemistry (pH, ORP)
- Turbidity

**Sensor systems deployed from AUV, ROV, USV and surface vessels.**

© Ocean Floor Geophysics 2022

# PGS Areas of Interest for collaboration

- Resource mapping and the development of physical data driven exploration methods covering a range of scales and geophysical parameters
- Collaboration, partnership & participation in industry consortia
- Funding opportunities
- Alternative business models
- Industrialization of environmental data collection