Challenges of Underwater Mining

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Underwater Mining Business Process - Contents

**Exploration**
- Finding and Developing Underwater Resources
- Process
- Technologies employed

**Evaluation**

**Development & Acquisition**
- Regulatory and Environmental
- Feasibility Studies
  - Identifying & Selecting Technologies
- Project Implementation
- Operations

**Operations**

**Unique aspects of Underwater Mining**
Developing Underwater Resources

• Exploration - geophysics and sampling
• Land based deposits & theoretical inference
• Geological models & information
Developing Underwater Resources

Geophysics

Surface at Sea
Sub Sea
Airborne

Seismic / Acoustics
Side Scan Sonar
Chirp / Boomers
Magnetic methods
Video

Image: Courtesy Kongsberg
Developing Underwater Resources

Geophysical imaging & interpretation:

• Map sea floor topography
• Shallow sub surfaces
  • Sub bottom profiling
• Estimates of geotechnical properties
  • PSD
• Ore depth
• Target Selection
Developing Underwater Resources

Numerous Sampling methods, . . . from Uncomplicated
Developing Underwater Resources

increasing in complexity
Developing Underwater Resources

to highly sophisticated

Photo: Courtesy Benthic Geotech
Developing Underwater Resources

...and large scale
Developing Underwater Resources

Challenges: Survey & Sampling

- Costly – driven by vessel hire
- Representative samples - Need “tailored” tools
- In-Situ properties difficult to obtain
- Weather is an important factor
- Resource typically developed as mining progresses
REGULATION

- **National Legislation**: Within limits of national jurisdiction:
  - Royalties, Taxes, Legal, H&S & Environmental.
- **International Seabed Authority (ISA)** – areas beyond national jurisdiction.
- **International Marine Minerals Society**
  Code for Environmental Management of Marine Mining.
CHALLENGES

- Mining and Marine Legislation
- Increasing Environmental Awareness of Offshore Mining
  - Fishing / Revenue
  - Natural environment
- “Pressure” on regulators to be environmentally sensitive – Permitting and Licensing
- Allow sufficient time to lobby
Regulatory and Environmental

CHALLENGES cont...

- Governments looking for increased influence
  - Localisation
  - Beneficiation
  - Share / representation
  - Tax etc.
- Community
Feasibility Studies

Development & Acquisition

- Research & Development
- Regulatory & Environmental
- Feasibility Studies
- Project Implementation

Operations

- Mine Planning
- Mining Operations
- Production Management
Feasibility Studies

Typically:

Technology Identification & Selection

- Engineering Evaluation & Development
- Geotechnical & Resource Development
- System Integration
- Risk Management
- Implementation Planning
- Estimates

Financial Evaluation
Feasibility Studies

TECHNOLOGY IDENTIFICATION & SELECTION
Structured progressive iterative process

Business Requirement → System Tech → Concepts ID

Engineering Development → Final Solution

Selection → Evaluation
TECHNOLOGY IDENTIFICATION & SELECTION

Challenges:

• Owners unfamiliar with the environment – needs not well defined
• Limited geological info - expensive and time consuming
• Orebody knowledge - Variable nature of the Ore bodies
• Few off the shelf solutions – Require development
• Often reliant on R&D to develop confidence / reduce risk
• Few competitors – Limited benchmarking

Definition of Requirements
Feasibility Studies

Requirements

- Personnel
- Supply & Logistics
- Treatment Plant
- Environment
- Floating Platform
- Mining System
- Underwater Resource
Given requirements, Challenge is now:
Selecting the correct mining system

• Options available, and
• Selection Process
Feasibility Studies

Jack Ups
Feasibility Studies
Feasibility Studies

Bucket Ladder Dredge
Feasibility Studies

Cutter Suction Dredges
Feasibility Studies

CSD
B/Ladder
Jack-up
Shore

100m 80m 50m 30m 20m 15m 10m
Feasibility Studies

Grab & Backhoe Dredging
Feasibility Studies

- Clamshell Grab
- CSD
- B/Ladder
- Jack-up

Distance markers: 100m, 80m, 50m, 30m, 20m, 15m, 10m
Feasibility Studies

Drill Ships
Feasibility Studies

Drill Ship

Clamshell Grab

CSD

B/Ladder

Jack-up

100m 80m 50m 30m 20m 15m 10m
Feasibility Studies

Trailing Suction Hopper Dredgers

Wire Line Dredge
Feasibility Studies

- TSHD - Very Large
- TSHD - Large
- TSHD - Med
- Drill Ship
- Clamshell Grab
- CSD
- B/Ladder
- Jack-up
Feasibility Studies

“Crawlers” or SMT’s
Feasibility Studies

Crawler Ship
TSHD - Very Large
TSHD - Large
TSHD - Med
Drill Ship

Clamshell Grab
CSD
B/Ladder
Jack-up

100m 80m 50m 30m 20m 15m 10m
Feasibility Studies

SELECTION PROCESS

Define the System into Functional areas
• Mining Method (Tool Type)
• Tool Carrier
• Support Platform

Define functions and performance
Note capabilities & constraints
Evaluate sub-systems → eliminate
Identify plausible combinations → potential mining systems remain

Engineer, Evaluate, Rank, and Select

Often an adaptation or combination of existing technologies
Challenges (beyond the normal . . .)

• Timing - Sourcing the platform
• Space and weight
• Projects involve wide range of industries:
  • Ship repair, naval architecture, treatment plant, offshore industry & marine mining specialists
  • Maritime & Mining Legislation constraints – Statutory, Class & MH&S
• Integration takes high priority
Project Implementation

Challenges (beyond the normal . . .)

• Very few experienced build contractors – unrealistic planning, working afloat
• Work sites are extremely confined - congested work sites

• Port services
Challenges (beyond the normal . . .)

- Build anywhere – can take your project to the build facility
- Often significant foreign involvement
  - Communications
  - Logistics
  - Culture, language
  - Foreign legislation
  - Cost
- Quayside assembly
  - Modular
  - Pre-commissioning
Project Implementation

Challenges (beyond the normal . . .)

• Commissioning
  • Access to support & spares – special planning effort, and increased commissioning spares
• Weather
Mining Operations

Development & Acquisition

Research & Development

Regulatory & Environmental

Feasibility Studies

Project Implementation

Operations

Mine Planning

Mining Operations

Production Management
Mining Operations

Challenges (beyond the normal . . .)

• Personnel
  • Small pool of people prepared to work offshore – limited skills
  • Cost to employ personnel – market allowances
  • Require two teams to work opposite each other – cost
  • Living in close proximity
  • Integration of marine ethos with mining production pressures
Mining Operations

Challenges (beyond the normal . . . )

- Maintenance
  - Access to specialist support during breakdown (visas)
  - Quality of work at sea in the offshore environment
  - Limited spares holding capacity
  - Access to major spares items
  - Utilisation – Mishaps can mean significant downtime
Challenges (beyond the normal . . .)

• Operational Costs
  • Logistics cost – Shore based facilities, aviation, launch supplies
  • Dependent upon fuel for power – Variable operational cost

• Remote Operations Management - Communication, Management influence
Challenges (beyond the normal...)

- Safety at Sea – operations inherently dangerous but routine
Challenges of Underwater Mining

Thank you
References:
- Richardson K., A Perspective of Marine Mining Within De Beers

Acknowledgements:
- Benthic Geotech
- Kongsberg