Determination of uncertainties in DSM economic models for polymetallic nodules project

Peter Balaz

INTEROCEANMETAL

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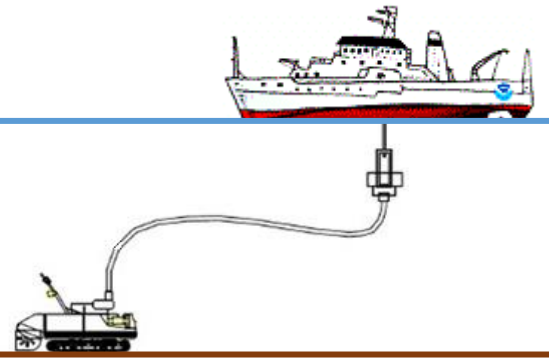
MINISTRY OF THE ENVIRONMENT

IOM

INTERNATIONAL SEABED AUTHORITY

DSM economic models

- WEF-RESOLVE-ISA workshops (Chennai, Goa, San Diego, London, Singapore)
- Contractor's models (BGR, GSR)
- MIT model (ISA meeting)
- Articles and proceedings (UMC, ISOPE)



DSM economic model uncertainties

Resulting from:

- **Technology issues (mining, processing)**
- **Legal issues (payment regime, environmental regulations)**
- **Economy issues (demand, prices, market)**

Technology uncertainties

Pilot mining test

- **complete DSM system has never been tested so far**
- **carrying out complete mining tests will take several years**

Determination of mining efficiency will provide information on real production capacity, scope of area mined, number of mining vessels and collectors needed, etc.

Technology uncertainties

Processing

- processing of 3-5 metals requires complex and costly operations = construction of new plant (70-80% of costs)
- seeking possibilities of PNs processing in existing plants (mixing with terrestrial ores)
- use of other metals contained in PNs (REE, precious metals)

Legal uncertainties

Mining Code

Commercially acceptable regulations, including payment regime, are crucial for future DSM business.

- **Fees (administration, environmental)**
- **Royalties**

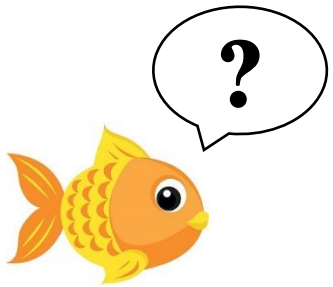
Technical issues connected with weighting of mined ore on sea.

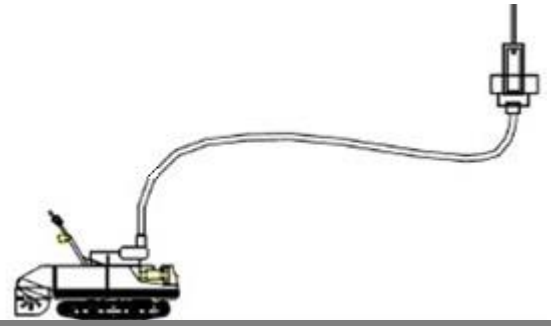
Definition of wet/dry polymetallic nodules?

Legal uncertainties

Environmental regulations

- environmental rules, EIA/EIS procedures, setting of pollution limits, monitoring requirements
- experiences of environmental regulations in EEZs for deep sea oil/gas extraction (?)





Economy uncertainties

Demand

- Forecasts based on increasing population, urbanization, industrialization
- recycling, substitutions
- low carbon technologies – demand for specific metals (not only electric vehicles)

Economy uncertainties

Demand

The growing role of minerals and metals for low carbon future (World Bank Group, cooperation with ICMM, IEA, 2017)

- commodities demand up to 2050
- focus on renewable technology demands to meet different climate scenarios (Paris Agreement, 2015)
- political decisions influence

Source: World Bank Group, 2017

	Wind	Solar photovoltaic	Concentrating solar power	Carbon capture and storage	Nuclear power	Light-emitting diodes	Electric vehicles	Energy storage	Electric motors
Aluminum	X	X	X	X		X		X	X
Chromium	X			X	X	X			
Cobalt				X	X		X	X	
Copper	X	X		X	X	X	X		X
Indium		X			X	X	X		
Iron (cast)	X		X			X		X	
Iron (magnet)	X								X
Lead	X	X			X	X			
Lithium							X	X	
Manganese	X			X			X	X	
Molybdenum	X	X		X	X	X			
Neodymium (proxy for rare earths)	X						X		
Nickel	X	X		X	X	X	X	X	
Silver		X	X		X	X	X		
Steel (Engineering)	X								
Zinc		X				X			

Economy uncertainties

Prices forecast

- metal prices – simulations based on historical data and market forecasts
- oil prices – impact on the entire DSM project value chain

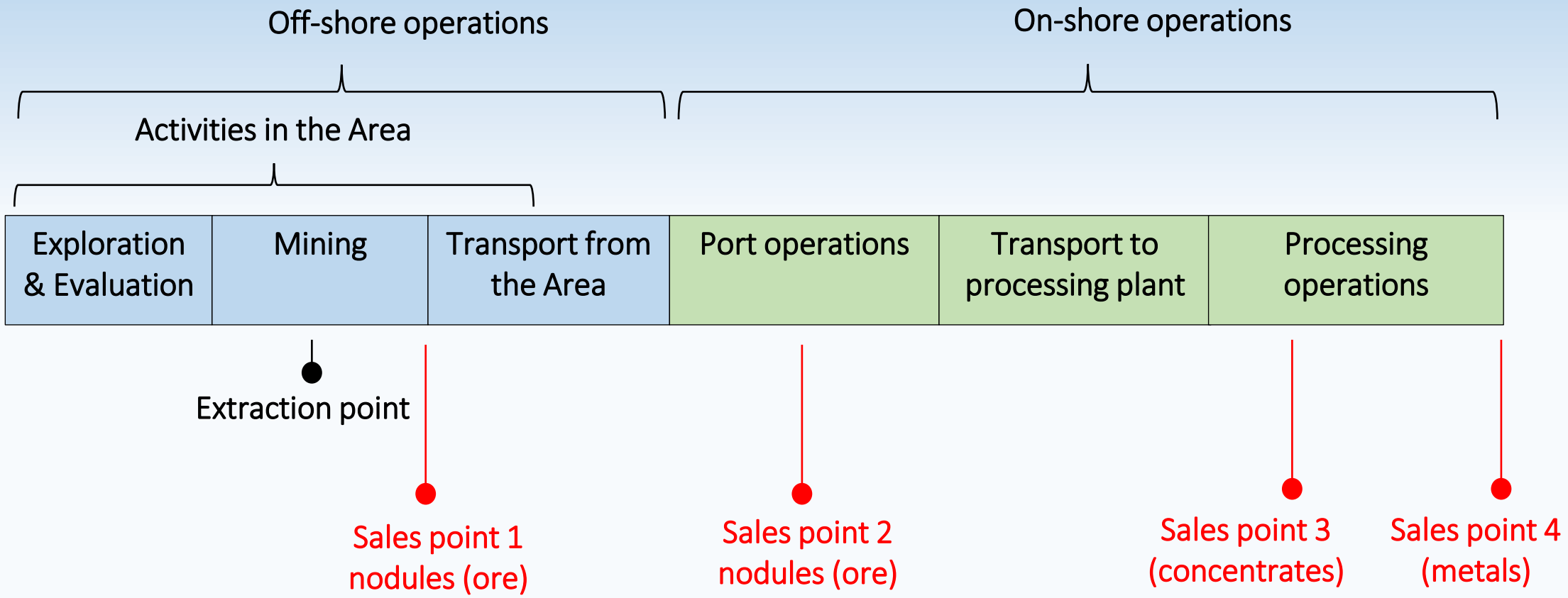
Prices (especially of metals and oil) are sensitive to political issues, market speculations = hard to predict price fluctuations.

Economy uncertainties

Market analysis

- influence of one or more PN producer's output on metal markets (increasing of stocks, prices erosion)
- competitiveness with terrestrial deposits (lowering metal grades and increasing mining depth)
- terrestrial mines protection, compensation or DSM support?

Economy uncertainties



One company covering all value chain? What final product?

Economy uncertainties

Missing data

- calculated from model by determination of limit values for commercially viable project
- theoretical results, need for practical tests for confirmation

Psychological barrier

- deep sea mining for metals represents new frontier

  “terra incognita” for investors and public
- role of communication strategy, acceptable CSR policy
- hesitation until first operation starts - breaking point

„In the not too distant future, seabed minerals would become one of the major sources of supply of the world's minerals”.

J. L. Mero - The Mineral Resources of the Sea, 1965