

SPACE RESOURCES ROUND TABLE | 2025



OPTIMIZING LUNAR RESOURCE EXTRACTION

CUT-OFF GRADES FOR RESERVE ESTIMATION

Carlos D Espejel | Founder & CEO



SPACERS

WHO WE ARE

CONSULTANCY AND TECHNOLOGY COMPANY



Based in **Luxembourg**
Founded in **2024**



Specialized in **mining value chain optimization**, reserves evaluation.

Technology integration, and **Intelligence** across both the terrestrial and space **resources industries**.

Dual Sector

Space



Consulting

- ISRU Value Chain Optimization
- Resources and Reserves Evaluation
- Systems Engineering
- Legal Services (International Space Law)

Technology

- Terrestrial and Space technology for the
- ISRU and SRU industry

**SPACE
RESOURCES
INDUSTRY**

**TERRESTRIAL
MINING
INDUSTRY**

Terrestrial



Consulting

- Strategic Mine Planning (e.g., NPV, IRR, etc.)
- Value Chain Optimization
- Resources and Reserves Evaluation
- PFS & FS

Technology

- Observation Satellites for the mining industry
- Intelligence, data acquisition, and data products

Current Customers

Activities in the US, Australia, Peru, Chile, Mexico and Luxembourg

GLENCORE

Glencore
Multi-metal



**BHP, Glencore, Teck
Resources, Mitsubishi**
Multi-metal



MMG
Multi-metal



Southern Copper
Multi-metal





From Resources to Reserves

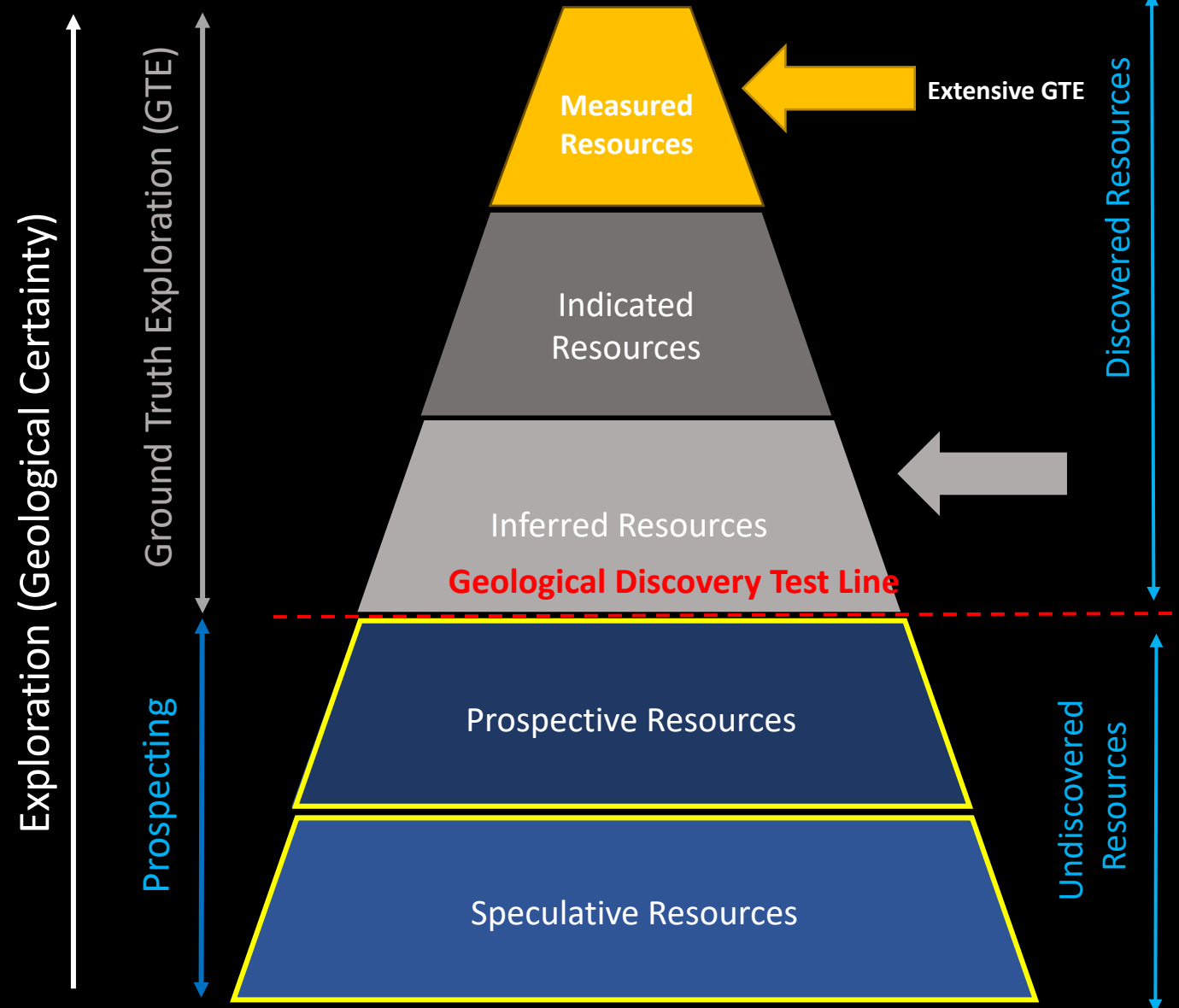
- What qualifies as a "reserve on the Moon"?

LORS - GR-CS1

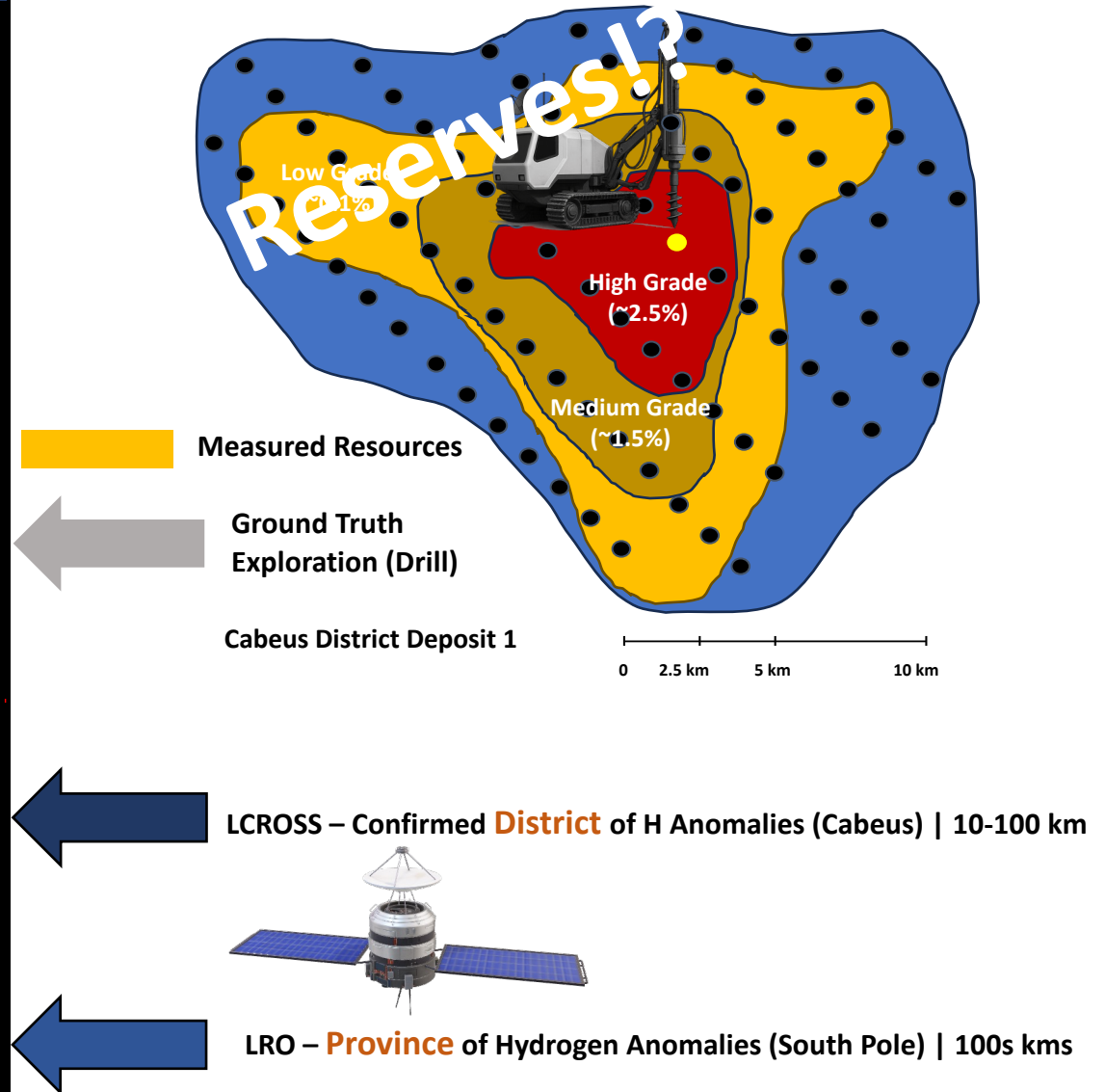
MAIN ACTIVITIES

GR-CS1 CLASSIFICATION SYSTEM

DISCOVERY
TEST



Exploration Region



LORS - Reserves

How much of this resource is a **reserve**!?

Is there any potential **Ore** in this resource?

Definitions

Reserve: It is the **Economically, technologically** and **technically** extractable portion of a **resource** (indicated or measured).

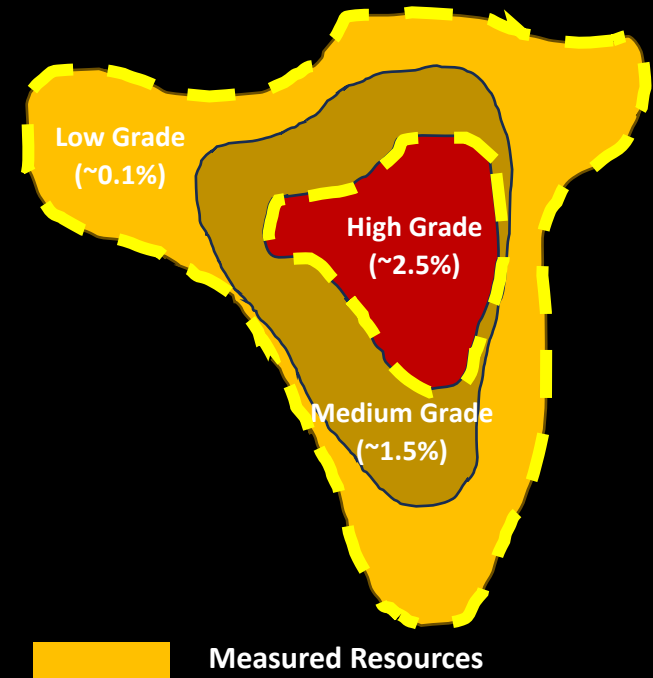
Ore:

- **Economic extractable** material scheduled for **treatment/processing**.

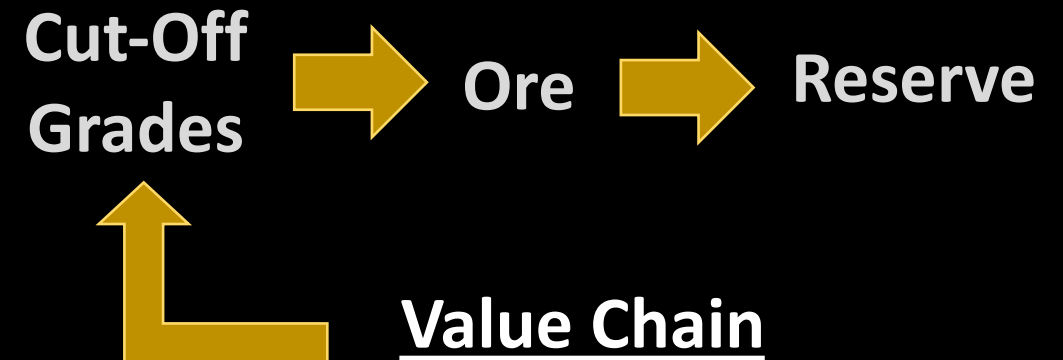
★ **Cut-Off Grade (COG):**

- **Boundary** of material within the **resource** with **mineral** above a specific **concentration**, scheduled for **treatment**.
- COG is the **Economic** definition of **Ore**.
- **Economics** involves all the mining process (**Value chain**).

(Kenneth F. Lane, 1988)



?



CUT-OFF GRADES (COG) ON THE MOON

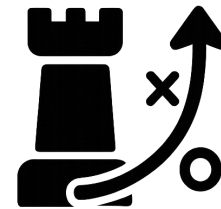
- **COG** is the boundary of material within the **resource** with **mineral above** a **specific concentration**, **scheduled** for treatment (Kenneth F. Lane, 1988).
- **Material** should only be scheduled for mining as **ore if**, and **only if**, the decision to treat it adds to the overall economic value of the operation.
- **Types of Cut-Off Grades:**



(Kenneth F. Lane, 1988).



Technical COG



Strategic COG

UNFC (United Nations Framework Classification)

COG Equations (Kenneth F. Lane, 1988)

Maximum NPV with Optimum Operating Strategy (COG)

$$V^*(T, R) = \text{Max}_w \left\{ rc(w, t) + \frac{V^*(T+t, R-r)}{(1+\delta)^t} \right\}$$

c = Cashflow created from a unit decrement of resource

w = Operating Strategy

δ = Discount Rate

V = Maximum present value at that time

T = Total Time

R = Total Resource

t = Time

r = Resource unit decrement

Limiting Economic – Cut-Off Grades

$$\text{Max}_g \{ V_m = (P - k)xy\bar{g} - xh - m - \frac{(f+F)}{M} \}$$

$$\text{Max}_g \{ V_h = (P - k)xy\bar{g} - xh - m - \frac{(f + F)x}{H} \}$$

$$\text{Max}_g \{ V_k = (P - k)xy\bar{g} - xh - m - \frac{(f+F)xy\bar{g}}{K} \}$$

Economic Cut-Off Grade Ingredients

1. Resource Knowledge

- Concentration Distributions (e.g., Cu%, H2O%)
- Material Quantities (e.g., 10 Mt @ 0.5% H2O)

2. Value Chain | Economic conditions

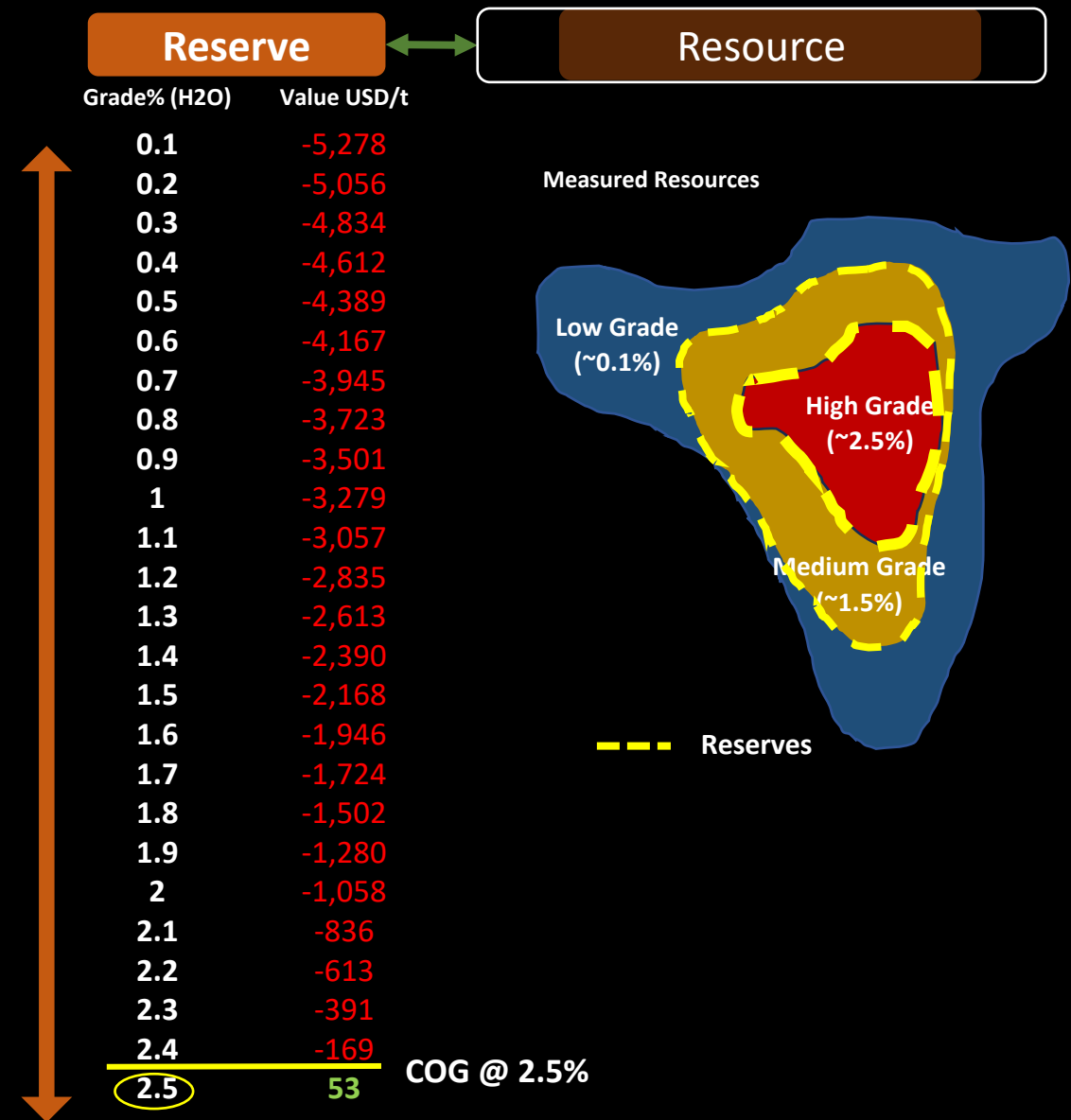
- Market Prices (e.g., Cu price, H2O price)
- Value Chain OPEX and CAPEX
- NPV Model

3. Value Chain | Constraints

- Extraction Capacities
- Processing Capacities
- ❑ Processing Yields
- Market Constraint



Example | Economic COG



During Exploration

What is the Minimum concentration (COG) in a deposit? for:

- H2O
- He3
- REE
- Etc.



Types of Cut Off Grades (COG)

1. Economic COG

- **What:** Defines the economic boundary of a resource. **Economic Reserve.**
- **When:** During planning and operation of a commercial SRU mine.
- **Key Factors:** Value Chain OPEX, CAPEX, Product Price (market driven).

2. Technical COG

- **What:** Defines the technical boundary of a resource. **Technically Extractable Resources (GTX Resources, LORS).**
- **When:** For non-commercial mines (e.g., operating a grand science base).
- **Key Factors:** Minimum recovery (yield), plant capacity (tpa), production requirements (tpa), energy requirements.

3. Strategic COG

- **What:** Defines the strategic boundary of a resource. **Strategically Extractable Resources (GSX Resources, New proposition).**
- **When:** Priorities are: National / Political interest, as long-term positioning.
- **Key Factors:** Propellant supply security, critical minerals, strategic zones, etc.

End User | COG



Economic COG Example

COG: Resource \geq **0.8%** H₂O for material to be **profitable**.



Technical COG Example

COG: Resource \geq **0.5%** H₂O for plant to **operate** and meet **annual production targets**.



Strategic COG Example

COG: Resource \geq **0.3%** H₂O to **operate strategic infrastructure**.

Value Chain and COG Optimization Terrestrial | Space RS

OPERATIONS



OPTIMUM EXTRACTION CAPACITIES



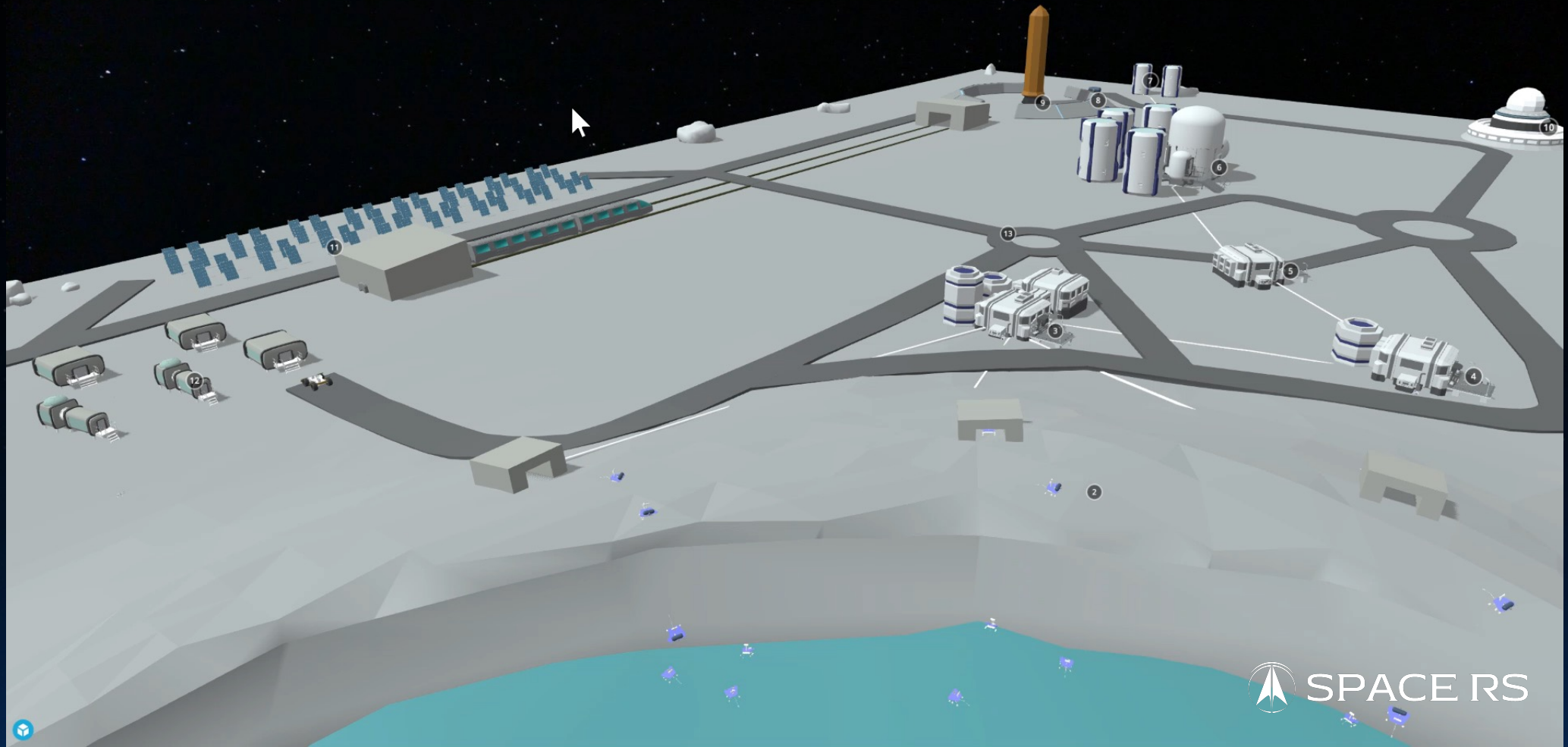
EXPANSIONS



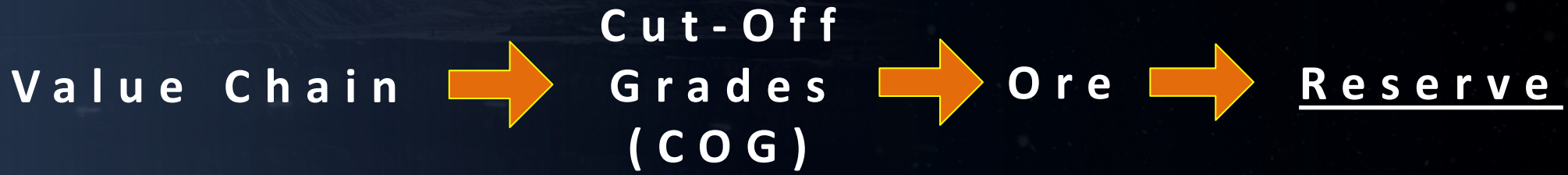
OPTIMUM PROCESSING CAPACITIES



Value Chain and COG Optimization Space | Space RS



Conclusions



Economic COG



Technical COG



Strategic COG

COG Essential For:

- Estimating and Maximizing viable **Reserves**
- Estimating **optimal capacity design**, tech specs (**Value Chain**)
- Maximizes project **Net Present Value (NPV)**

Space RS – Collaboration:

- Tech Developers: Define **optimal capacities** and **yields** (Value Chain)
- Investors: **Evaluate** the potential Lunar **reserves**
- Governments and Mining Companies: To **strategically** and **economically** plan a viable **Lunar operations**.

**For Space Miners and Governments:
“What is your Cut-Off Grade?”**

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