Callisto: A Study of Environmental Conditions and Human Viability

BASIC INFO

Discovered: **January 7, 1610**
Radius: **2,410.3 km**
Discoverers: Galileo Galilei, Simon Marius
Gravity: **1.236 m/s²**
Orbital period: **17 days**
Apparent magnitude: 5.65 (opposition)
Eccentricity: 0.0074
Diameter: **4820 km** (3000 miles)
Average Temperature: **-136°C**

TERRAIN

- Equal parts of rock and ice
- Brighter parts of the surface is water ice, darker patches is rocky material
- Icy surface
- Covered by craters of various shapes and sizes
    - Most heavily cratered object in the solar system (NASA)

PROS & CONS

Feature	Advantages	Disadvantages/Risks
40% water	**Life Support:** Water is essential for human survival, providing drinking water, enabling agriculture, and supporting sanitation. **Hydrogen and Oxygen Production:** Water can be electrolyzed into hydrogen and oxygen, which are critical for breathing and potentially for rocket fuel. **Temperature Regulation:** Water can be used to help regulate temperature within habitats and provide thermal mass. **Presence of Living Things:** Presence of possible microbes such as Halophiles.	**Extraction and Purification:** Extracting water from ice or subsurface sources in the harsh environment may be challenging and energy-intensive. **Contamination Risks:** Water must be purified and tested to ensure it is safe for human consumption. **By products:** Due to the low temperatures the waters would have small traces of ammonia to keep the water in liquid form.

	These microbes are able to evolve special cell walls to prevent superoxides from fully flushing out its membrane.	
Low radiation	**Health and Safety:** Lower radiation levels reduce the risk of radiation-related health issues, such as cancer, and can support longer-term human habitation. **Less Protective Infrastructure:** Reduced need for heavy radiation shielding lowers construction and operational costs for habitats and equipment. **Crop growth:** Increased agricultural growth within the environment.	**Potential for Higher Radiation Exposure During Solar Events**: While radiation levels are generally low, solar flares and other cosmic events could increase radiation exposure temporarily.
Low gravity (1.236 m/s²)	**Mobility and Operations**: Lower gravity makes it easier to move and handle equipment, potentially improving efficiency in tasks such as construction and exploration. **Reduced Structural Load**: Structures can be designed with less material due to the lower gravitational forces, potentially lowering construction costs.	**Health Effects**: Prolonged exposure to low gravity can lead to muscle atrophy, bone density loss, and other health issues. Long-term countermeasures and medical solutions would be necessary. **Biological Processes**: Human biology is adapted to Earth's gravity, and low gravity can affect various physiological processes, including fluid distribution and cardiovascular health.
No geological activity (tectonic plates, volcanoes)	**Stable Environment**: The absence of tectonic activity and volcanic eruptions provides a more stable and predictable environment for constructing habitats and infrastructure. **Low Risk of Natural Disasters**: Fewer geological hazards reduce the risk of disasters that could impact human safety and infrastructure.	**Limited Scientific Research Opportunities**: Lack of geological activity means fewer opportunities to study dynamic geological processes and the moon's interior.
Uneven, cratered surface	**Exploration Potential**: Diverse terrain could offer interesting geological and scientific research opportunities.	**Mobility Challenges**: Rough, uneven terrain complicates the movement of rovers and other exploration equipment, increasing operational difficulties and costs.

		Construction Difficulties: Building structures on an uneven surface requires advanced engineering solutions and could lead to higher costs and logistical challenges.
Temperature of -136°C	**Stable Environment for Equipment**: The cold can help preserve certain materials and reduce the risk of biological contamination.	**Harsh Conditions**: Extreme cold requires specialized insulation and heating systems to protect human habitats and equipment. Energy needs for heating are significantly higher. **Material Limitations**: Many materials become brittle or fail at such low temperatures, necessitating the use of advanced, temperature-resistant materials.

MARKETPLACE

- Market expansion is fueling global investment
- Moon exploration is expected to achieve a 5% 10 year compound annual growth rate.
    - Reaching an estimated $17 billion by 2032
    - Supporting human spaceflight missions
    - Necessitating substantial investments in transportation and orbital infrastructure.
- Global government investment rose to $26 billion during 2023
- The cumulated revenues over 2020-2040 across different segments are forecasted at around $8.5 billion and $11.9 billion.
    - Overall lunar data market possesses the potential to provide businesses additional areas of revenue.
- The environmental market accounts for $8.3 billion with 595 of this being generated by SRU data and 41% from the non-SRU market.

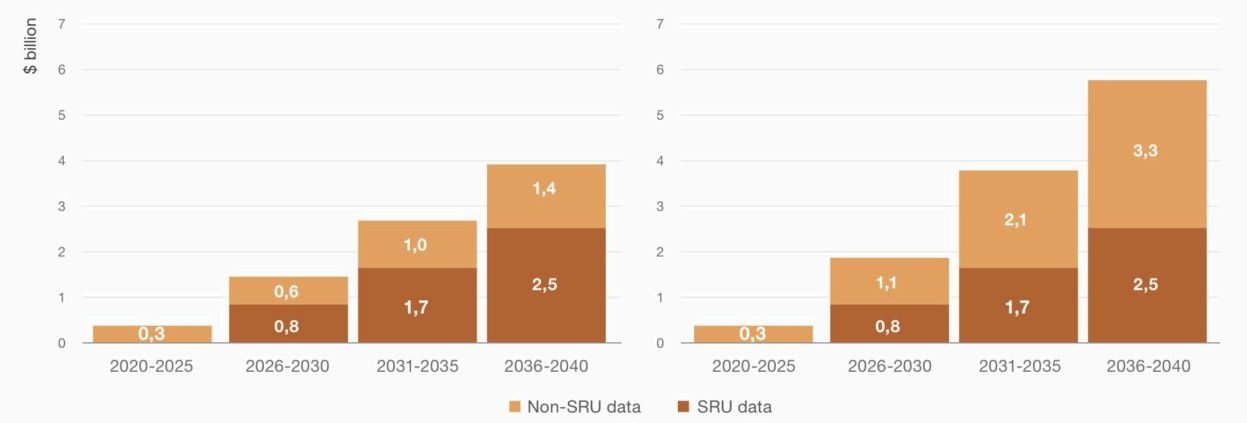

Figure 15 - Cumulated revenues for the lunar environmental data market on 2020-2040 (nominal scenario on left, optimistic scenario on right)

- *"The JUICE (Jupiter Icy Moon Explorer) mission will focus on three icy Jupiter moons, including Callisto, to get more information about its environment. JUICE is expected to arrive in 2030."*

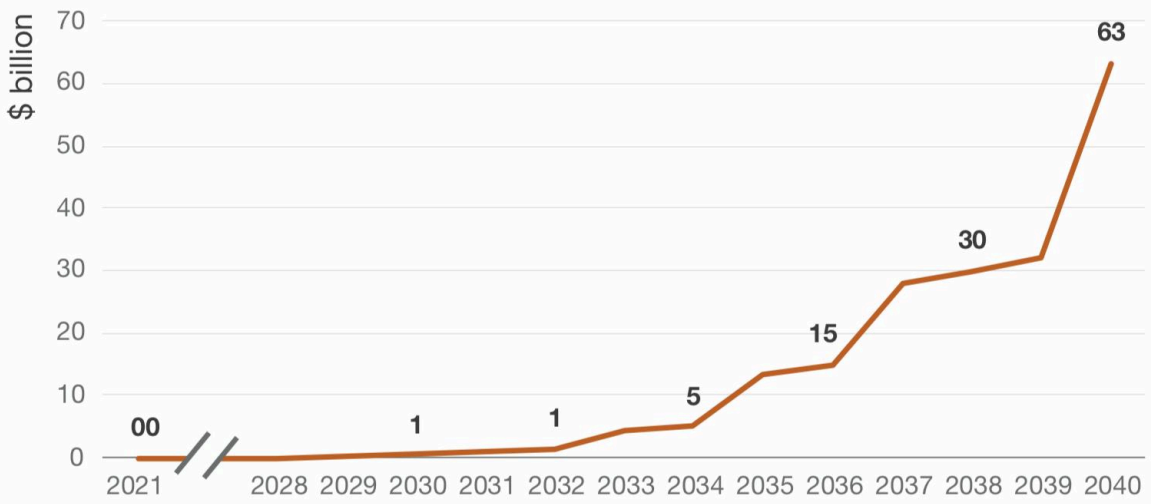

Figure 23 - Evolution of the cumulative SRU market size

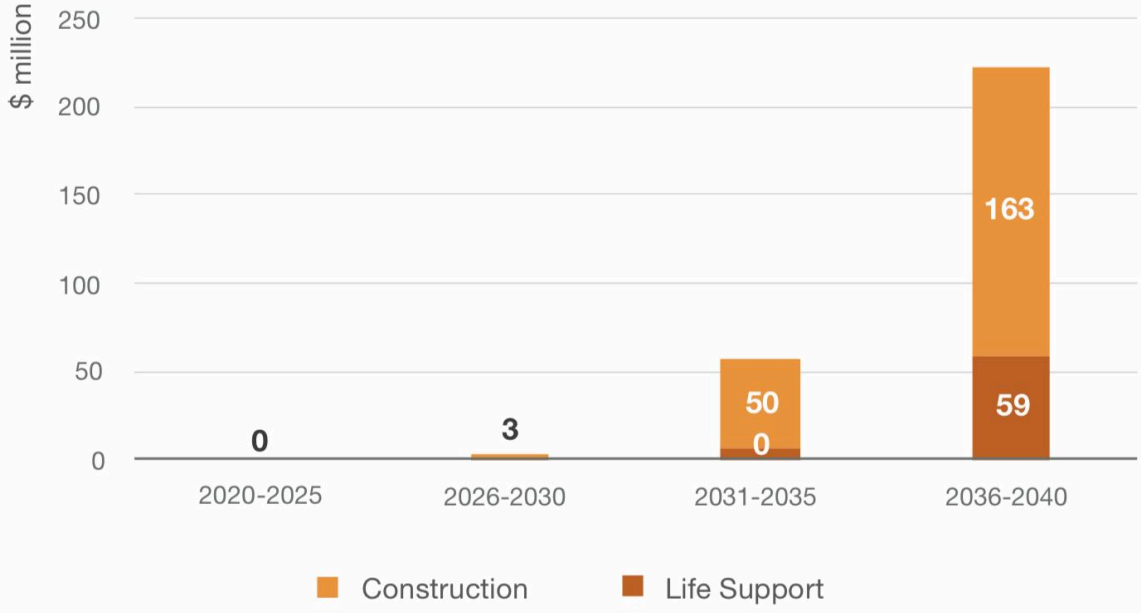

Figure 25 - SRU projections for life support and construction markets