



Shackleton Energy Lunar-Sourced Propellant Depot Architecture

PTMSS / SRR 2012

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Cleared for Public Release

Shackleton Energy Company

“Fueling the Space Frontier”



By 2020

Open the World's First Low Earth Orbit and Moon-based
Propellant Depots To Enable Untold New Business
Opportunities in Space



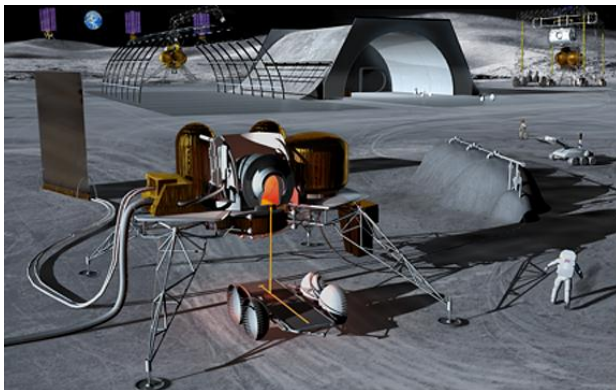
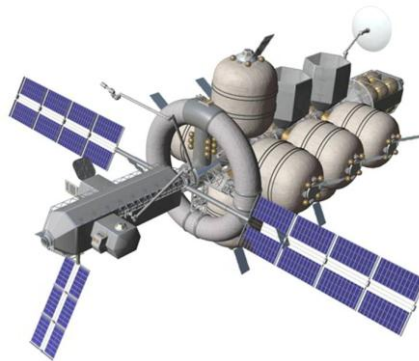
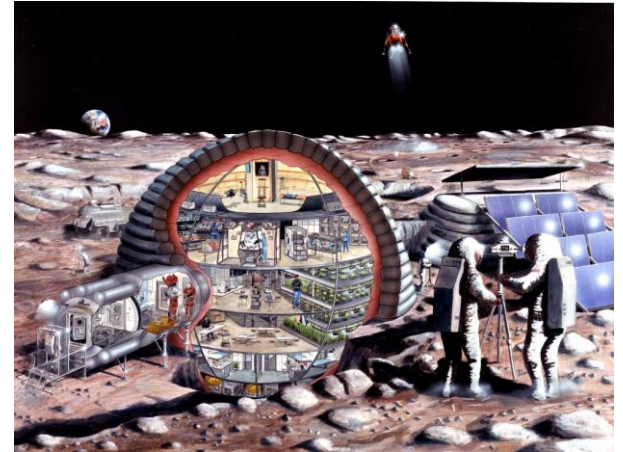
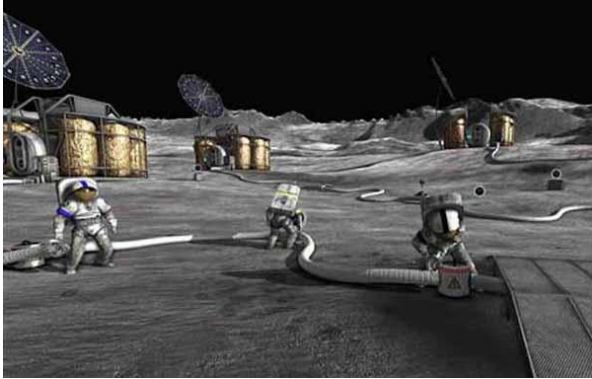
Using Lunar Ice-derived Rocket Propellants to Power Commerce



- SEC will enable
 - Opening the New Space Frontier
 - Creating the Cis-Lunar Transportation System
 - Installing industrial-scale infrastructure for customer build outs and improved operations
 - Facilitating massive expansion of opportunities off Earth
 - Science
 - Security
 - Commerce
 - Multi human space programs
 - Settlements (species preservation)



Infrastructure Required



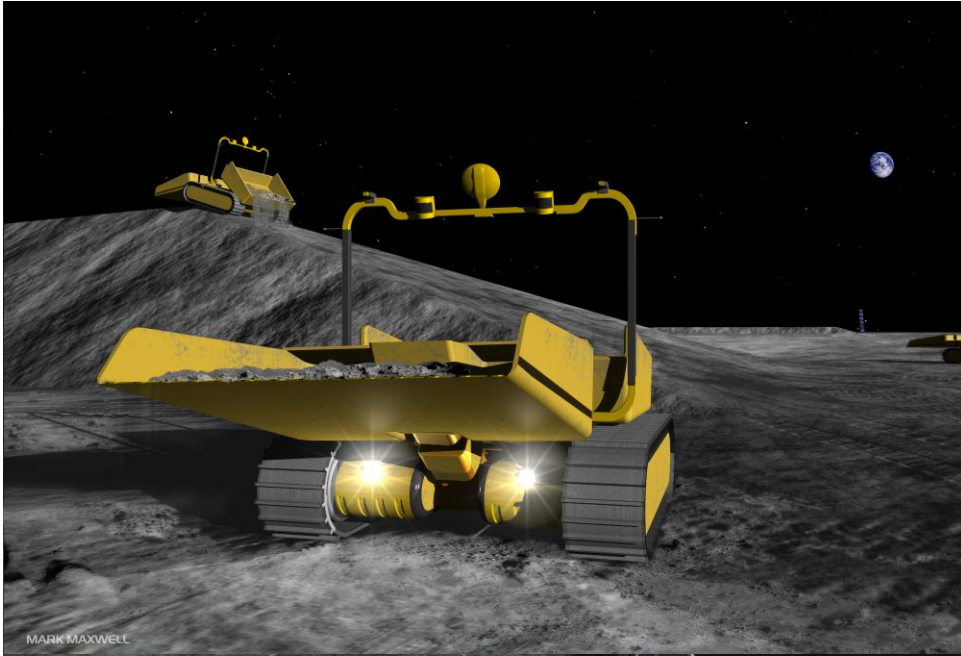


Total Capability





Total Capability





Enabling Platform

- Profitable in-space business
- Realistic milestone-based CAPEX
- Delivery timescales in years not decades
- Rapid revenue generation and positive ROI
- Interconnected expanding market place
- Multiple customer service opportunities
- Highly reliable, scalable, reconfigurable, modular infrastructure
- Human operations in space—absolutely essential
 - Real-time mission optimization and problem solving
 - Quickest route to market

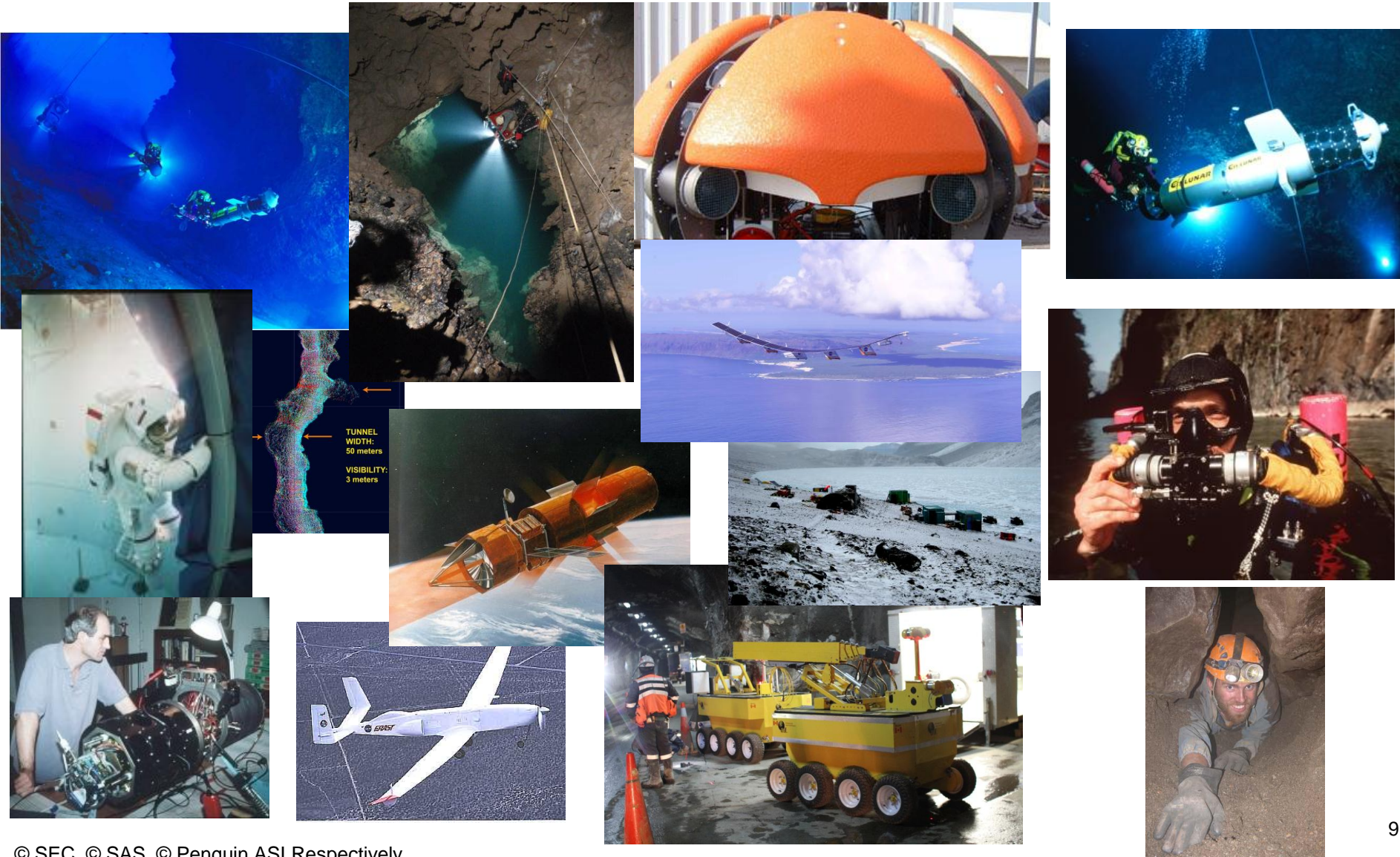


Shackleton Energy Company

- Comprehensive business model with multiple profit centers
- Early revenue generation (within 12 months of program start)
- First propellant delivery 2018 (launched from Earth)
- Subsequent in-space business streams
- Customer service to nations and companies
- World-class team
- Privately financed
- 20 years of planning anchored by Clementine, Prospector, Chandryaan and LRO discoveries



Team Experience





Team Experience

- Aerospace missions
 - Launch vehicles; satellites; high altitude, long endurance aircraft; mission operations
- Extreme endurance manned/unmanned missions
 - Underwater, underground, land, air and space
- Autonomous, intelligent robotic vehicles and systems
- Ultra-long endurance life support systems
- Extreme remote mining and operations (Chile)
- World-class expeditionary leadership and teams
- Essential NASA-funded exploration technologies developed for Europa missions
- *International participation*

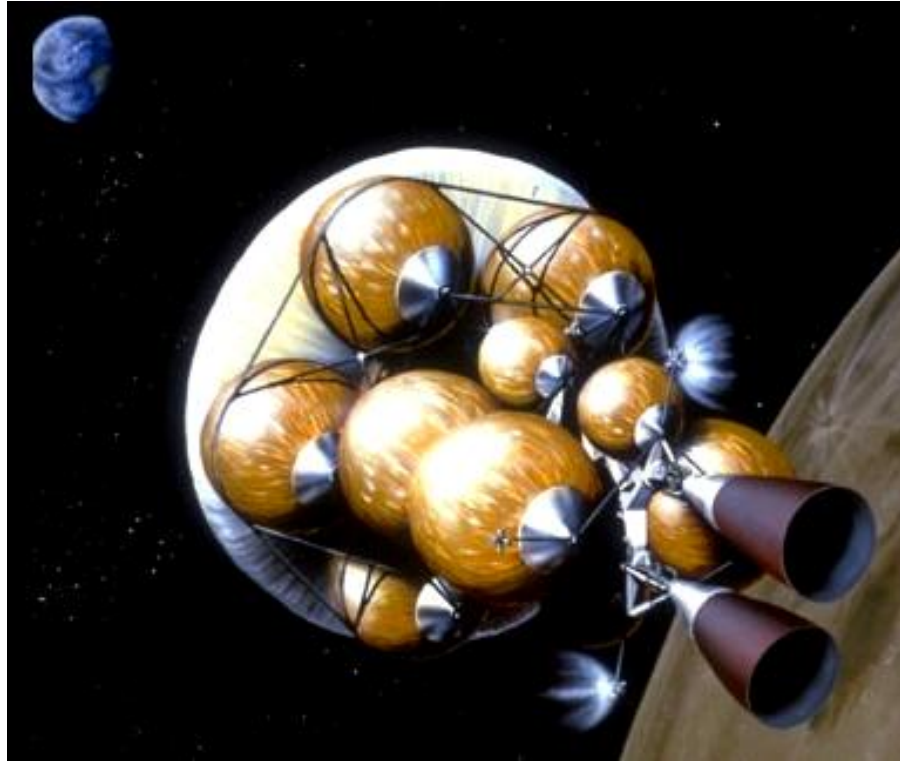


Multi-phase Program

- Robotic prospecting and mapping missions
- Human-tended operations
 - In orbit infrastructure
 - Lunar mining and processing operations
 - Full lunar geo-physical prospecting after 2020
- Customer propellant transfer and sale
 - Just in time delivery
 - Favorable terms for advance bulk-buy purchases
- Spin-off services and facilities



Cis-Lunar Transportation



An inflatable tug based on the Moon will deliver water to Earth orbit.

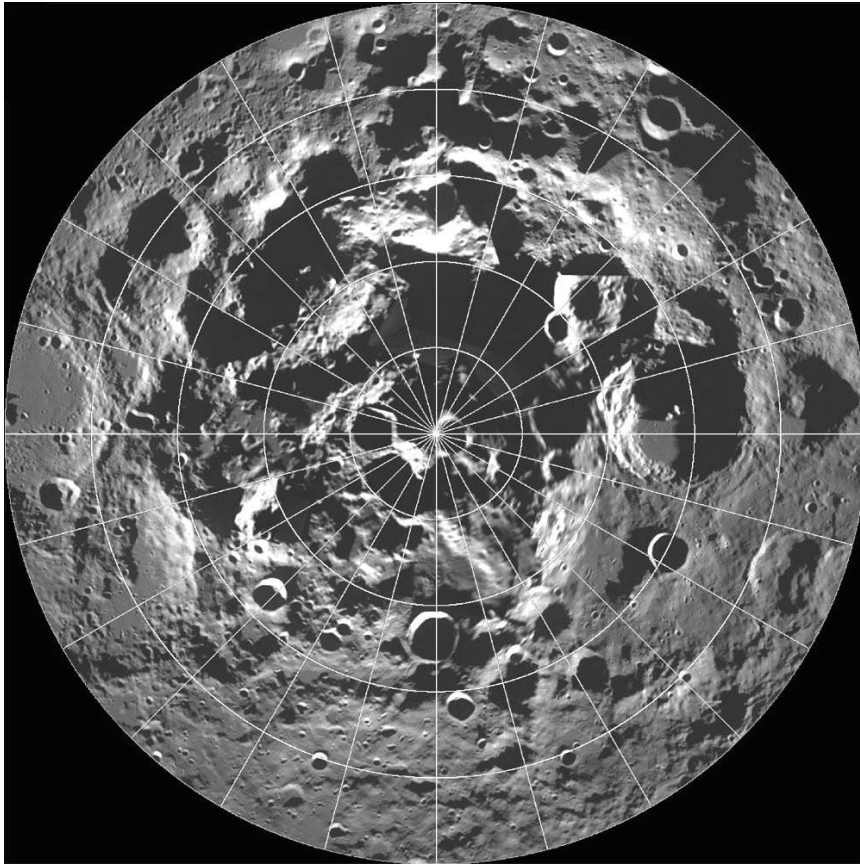


Inflatable “Ore” barges will store water and propellants in orbit.

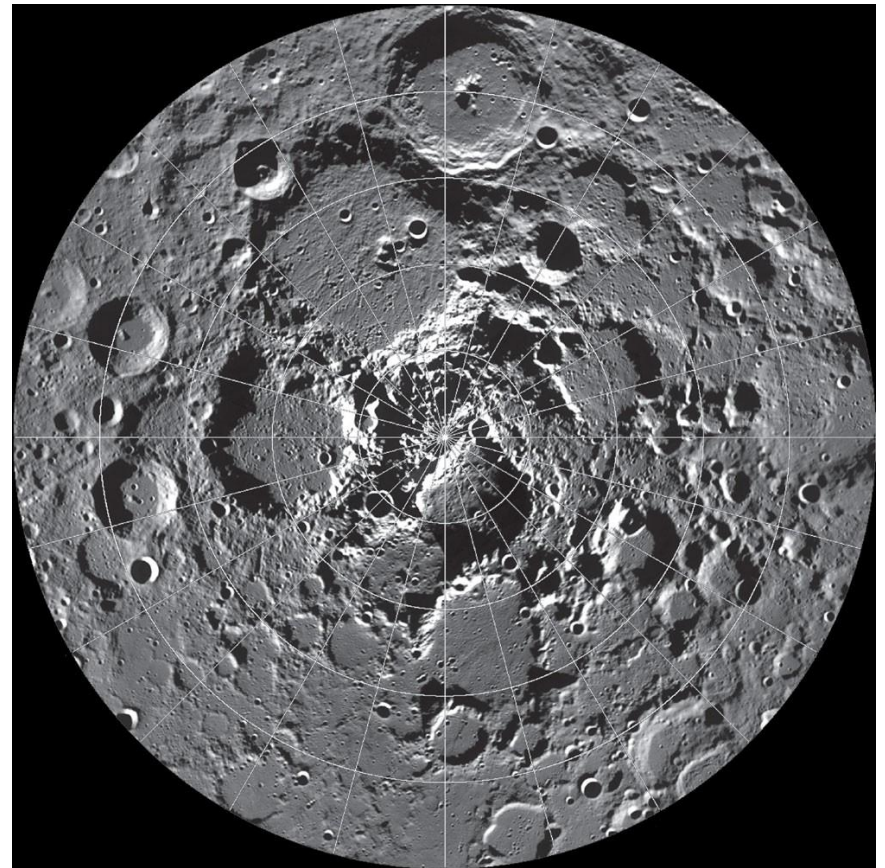


Lunar Poles with Ice

South Pole

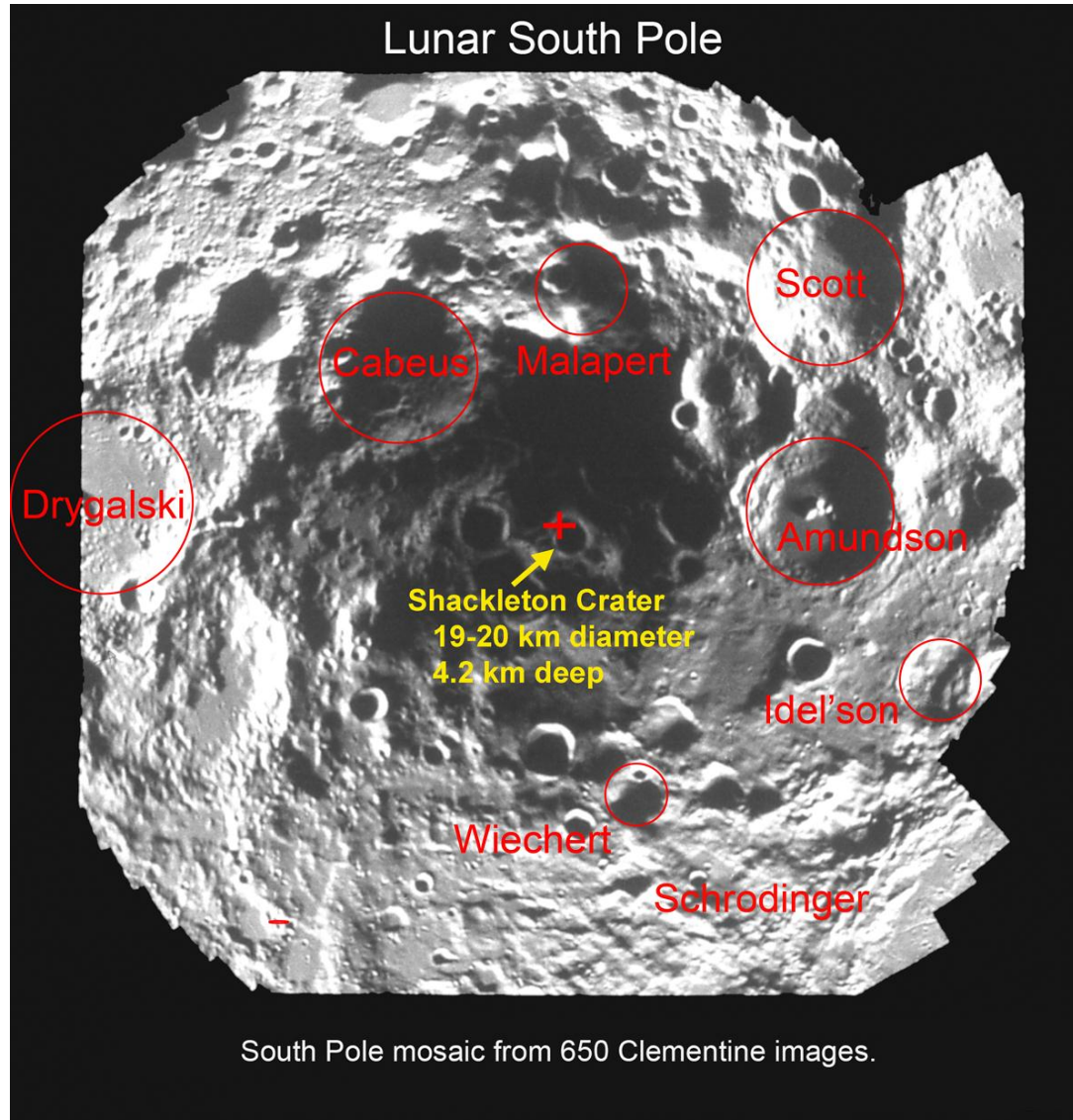


North Pole



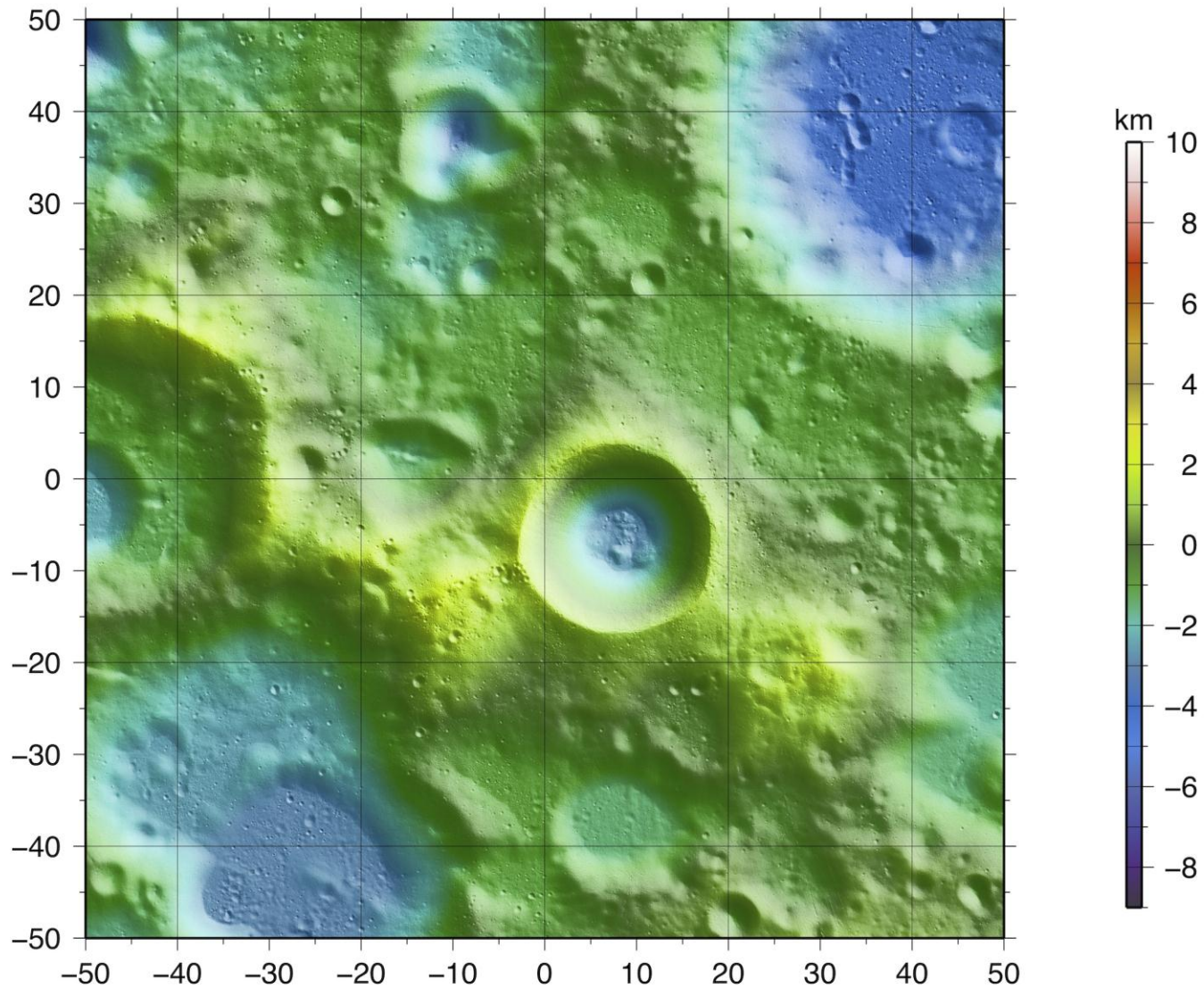


Shackleton Crater





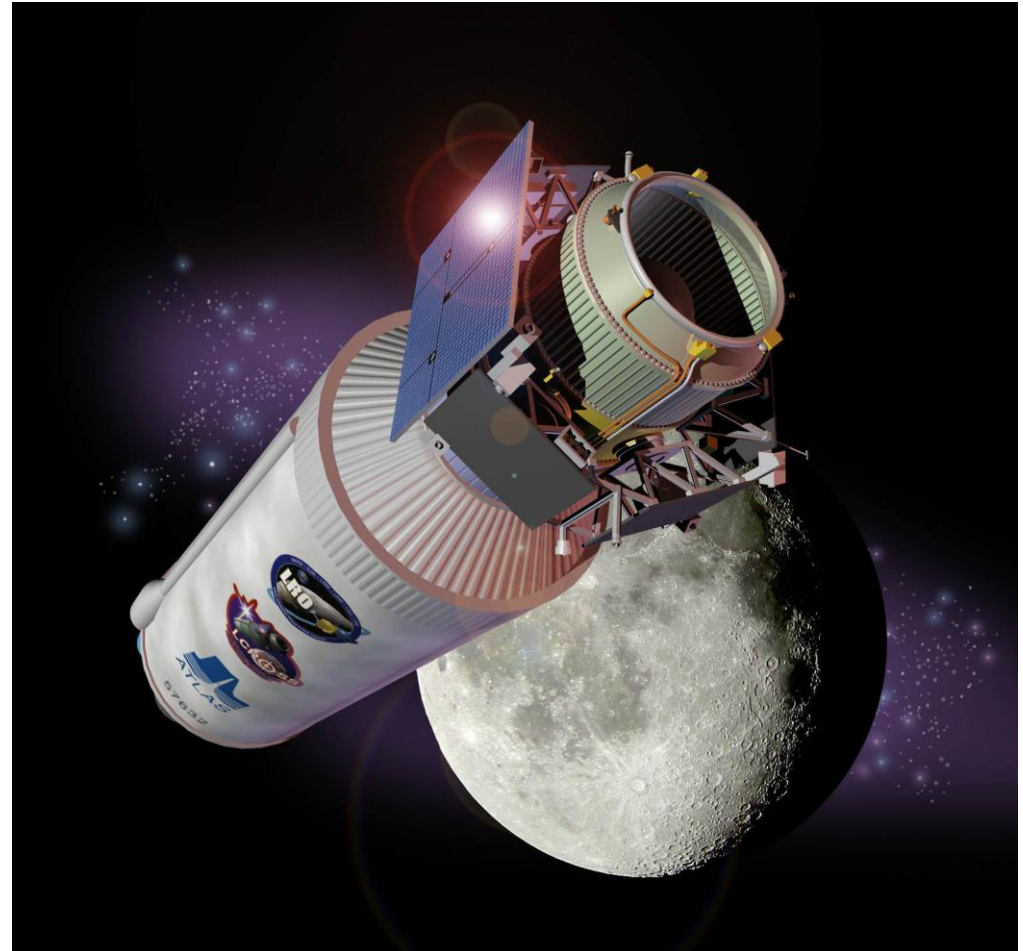
Shackleton Crater





Water Discovery

- Billions of tons of ice estimated to exist at the Lunar Poles
- Trapped in dark, cold craters
- Most hostile places in this Solar System other than the Sun
- Ready for in situ prospecting by SEC



US (NASA), Japan (JAXA), India (ISRO)



Primary Ice-Derived Products

- Water
 - Products for human consumption, hygiene, aqua/agriculture, life, radiation shielding, habitat insulation, cargo
- Electrolysis
 - Gaseous oxygen and hydrogen
 - Products for life support, fuel cells (power), heating and welding
- Liquefaction
 - Liquid oxygen and hydrogen
 - Products for rocket propellants and fuel cells
- Chemical Processing
 - Highly pure hydrogen peroxide
 - Product for catalytic on-demand propulsion



Value Proposition

- Access to space is incredibly expensive
 - >\$5,000/kg LEO
 - >\$80,000/kg Lunar
 - Major barrier to business expansion off Earth
 - SpaceX and others attempting to reduce launch costs
 - However, 85-95% of all mass going beyond LEO is propellant
 - Why pay the severe gravity/atmospheric drag penalty when you don't have to?
- SEC will provide propellant services *in space* to all customers on demand in unlimited quantities
 - Significantly cheaper (\$/kg) than anything launched from Earth
- Potential \$ trillion business within 10 years of operations
- Huge business multiplier effect for those who use our propellants and services



Challenges

- Technology
 - Ultra cold (30K), space vacuum machine/human ops
 - Rovers, drillers, transporters, habitats, processors, miners, movers
 - Water separation
 - Volatiles separation, gasification, liquefaction, storage
 - Cryogenic (LOX/LH2) storage and refueling
 - Power generation and transfer (solar, laser, microwave, nuclear)
 - Reusable propulsion systems
 - Robust, reliable communications
 - Turnkey reliable, rapidly-reconfigurable transport systems
 - Smart, risk tolerant operations
- Policy/Regulations
- Capital
- Market development



Take-Away

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T-Minus and Counting





Thank You

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“Accelerating Industrialization of Space”