Oasis-1: Blue Origin's First Commercial Lunar Prospecting Mission. J. D. Tarnas[1], Vlada Stamenkovic[1], S. Jones[1], L. Giersch[1], A. Imbault[1], M. Burgin[1], D. Kornuta[1], and the Oasis-1 Team, [1]Blue Origin (jtarnas@blueorigin.com)

Introduction: Oasis-1 is a two-SmallSat mission designed to deliver the most detailed lunar resource maps to date, enabling new science around lunar volatiles, crustal magnetism, radiogenic heat production, and solar wind-derived species on the Moon, with a special focus on the South Pole. Deployed by Blue Origin's MK1 lander into a 10 × 50 km polar orbit with periapsis near the South Pole, the mission combines low-altitude neutron and gamma-ray spectroscopy (following a similar approach as LunaH-Map; Hardgrove et al., 2020), magnetometry, and multispectral pushbroom imaging to achieve up to nine times finer spatial resolution than current global datasets. Following a 90-day global mapping phase, a short secondary phase will acquire along-track measurements during controlled deorbit, yielding water maps at hundreds of meters per pixel over targeted permanently shadowed regions. Oasis-1 uses a tiered data strategy: commercially relevant, high-fidelity resource maps will be offered via licensing, while some non-commercially-relevant datasets can be publicly released to accelerate lunar science, modeling, and mission planning. Integrated with existing public datasets (e.g., LP, LRO, Chandrayaan-1, Kaguya, GRAIL), Oasis-1's products will advance our understanding of polar volatile reservoirs at mineable scales, the distribution of radiogenic elements, the nature of crustal magnetization, and the surface proxies for helium-3, while de-risking landing site selection and traverses for upcoming surface mobility vehicle missions, including astronauts, rovers, hoppers, and ballistically deployed instrumentation.

Mission architecture and instrumentation: Platform and orbit: Two identical low-flying SmallSats will operate in a 10 × 50 km lunar polar orbit with periapsis near the South Pole. After the 90-day primary phase, a 10-day controlled deorbit will acquire ultra-low-altitude, along-track measurements over water-rich targets identified during global mapping.

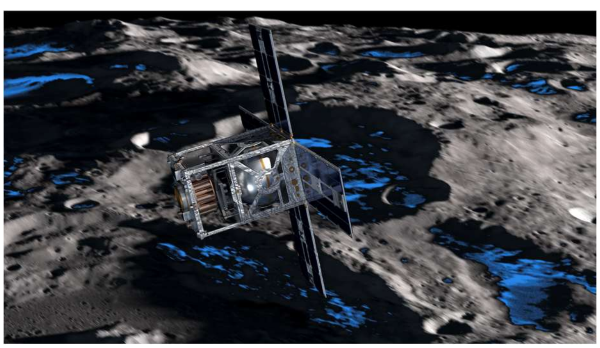

Figure 1: Artist's concept of Oasis-1 flying low over the South Pole, with Nobile Crater and Mons Mouton in the background.

Instrument suite: Each SmallSat carries three instruments: 1) hybrid gamma-ray and neutron spectrometer (GRNS) to quantify water-ice and radionuclides (and proxies for rare earth elements) to ~1 m depth; 2) magnetometer with deployable boom to map crustal magnetic anomalies (and potential proxies for metals/platinum group elements); 3) multispectral pushbroom spectrometer to measure proxies for helium-3 abundance at the surface.

Resolution and sensitivity: GRNS maps deep water and radionuclides at up to nine times better spatial resolution than current global datasets, with ~15 km/pixel resolution at the South Pole. Magnetometer maps most anomalies at 15–30 km/pixel. Multispectral pushbroom achieves <5 m/pixel for surface proxies. Deorbit-phase data will deliver water maps at hundreds of meters per pixel over targeted permanently shadowed clusters flown over prior to impact.

Neutron spectroscopy at low altitudes: Neutron spectroscopy is the only remote sensing method that can uniquely quantify water to ~1 m depth. Because neutron spectrometers are not optical instruments, and because of challenges associated with past efforts to interpret collimated neutron spectrometer data covering the Moon, flying low is the most reliable way to increase the spatial resolution of these instruments. This spatial resolution enables mineable-scale mapping of subsurface water ice.

Tiered data strategy and public-private integration: *Commercial data products:* High-fidelity maps of water ice, helium-3 proxies, radionuclides, rare earth elements, and proxies for platinum group metals will be productized and offered via controlled licensing to de-risk landing site selection, increase investor confidence, and optimize ISRU strategies.

Public data release: Some non-commercially-relevant datasets will be identified for public release, aligned with Artemis Accords commitments and international collaboration goals. European Space Resource Innovation Centre (ESRIC)-led infrastructure will support public processing pipelines and community access.

Lunar science enabled by integrated datasets: Prospecting for polar volatile reservoirs at scales relevant for mining (<15 km/pixel) enables distinguishing of water content in individual PSRs. These data can then be combined with geologic maps, data from past lunar missions, and illumination/thermal models to quantify the relationship between volatile concentration and surface age, geomorphology, crustal density, thermal history, composition, etc. This will enable evaluation of hypotheses for lunar volatile delivery, transport, storage,

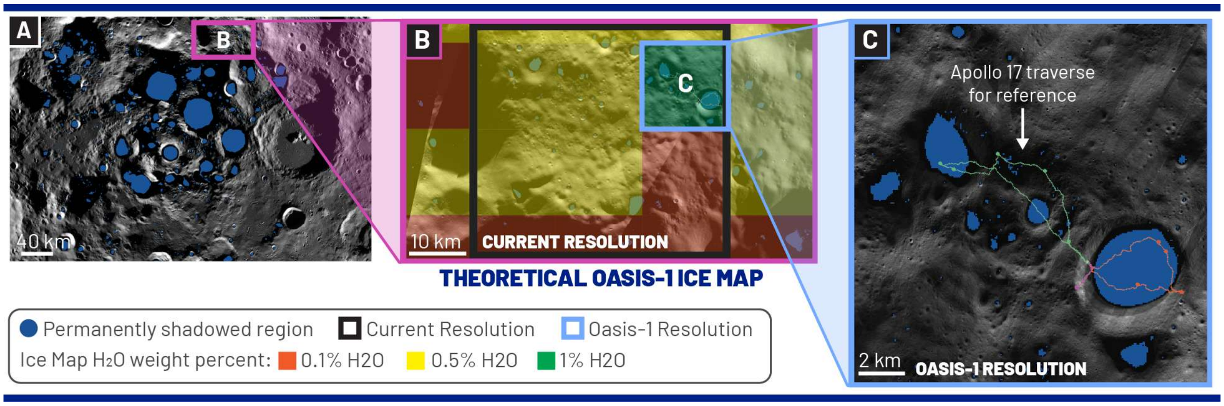

Figure 2: Oasis-1 orbital data enable selection of sites for ground truthing by mobile surface vehicles (rovers and hoppers) in Oasis-2. By selecting the most resource-rich sites for Oasis-2, the Oasis Campaign will collect enough information to determine whether these resources are actual reserves that can be profitably harvested and sold. As shown in (c), one Oasis-1 water map pixel (shown as a square for simplicity) can be explored by the traverse path of Apollo 17, demonstrating that complete exploration of permanently shadowed regions is possible with current surface mobility systems.

and loss. It will also permit selection of the best landing sites for maximizing scientific output from in-situ lunar volatile investigation.

K, Th, and U will be mapped at ~15 km/pixel near the South Pole and up to ~30 km/pixel at the equator. These maps will enable refinement of radiogenic heat budgets at regional scales. These maps can be compared with GRAIL-derived crustal thickness and gravity anomalies to investigate hypotheses regarding the relationship between crustal differentiation, basin ejecta distributions, and radionuclide distribution.

Improved maps of crustal magnetic anomalies at ~15–30 km/pixel in polar regions, will test hypotheses for magnetization mechanisms (e.g., impact-generated magnetization). These maps can be compared to surface optical maturity estimates from Oasis-1 and past missions to explore shielding effects on solar wind implantation and potential modulation of helium-3 proxies. Higher spatial resolution magnetic anomaly maps will enable identification of the best landing sites for testing hypotheses regarding the origins of lunar magnetic anomalies, including the possible associations with metal-enriched zones.

Less than 5 m/pixel maps of spectral proxies relevant to helium-3 abundance (e.g., regolith maturity, ilmenite/TiO2-related spectral indicators), can be compared with M3 spectra, Diviner rock abundance, and magnetometer data to investigate spatial controls on solar wind implantation and retention. These maps will also show the best locations on the Moon to begin harvesting and productizing helium-3.

One ~15 km/pixel water map tile can be explored by an Apollo-scale traverse (Figure 2), supporting complete coverage of selected PSR clusters with current mobility systems. This enables hypothesis-driven sampling campaigns to distinguish ice deposit facies and to quantify variability at excavation-relevant depths.

The Oasis Campaign consists of three distinct phases:
Phase 1 – Orbital Reconnaissance: From low lunar orbit, use remote sensing to identify the best locations on the lunar surface for harvesting water-ice, platinum group elements, helium-3, and rare earth elements.
Phase 2 – Surface Resource Validation: Use instrumented mobility systems on the surface of the Moon at surveyed locations to ground-truth orbital data and determine optimal resource harvesting methods.
Phase 3 – Extraction Operations: Build extraction plants for candidate resources and transform them into usable products, including propellants, cryocoolers, fusion reactor feedstock, electrodes, fuel cells, and batteries.

Oasis-1 marks the first step in this campaign, which will deliver lunar science data in unprecedented volumes via prospecting. This will enable planetary science discoveries the same way oil and mining prospecting enables Earth science discoveries.

Conclusion: Oasis-1 will deliver a step-change in lunar resource and planetary science mapping, producing the first water, helium-3, radionuclide, rare earth element, and magnetic anomaly maps at resolutions and depths directly relevant to both science and resource utilization. By integrating private, high-fidelity products with publicly released datasets and fusing them with the rich archive of lunar mission data, Oasis-1 will unlock rigorous tests of hypotheses for volatile transport and stability, refine models of crustal magnetization and radiogenic heat production, and provide astronaut- and rover-ready targets for maximum-impact exploration of permanently shadowed regions. The mission's low-altitude ConOps and instrument suite will generate maps to create a durable foundation for both scientific lunar research and the emerging cislunar economy.

References: [1] Hardgrove, C. et al. (2020), *IEEE* 35, 3.