THE OSIRIS-REX MISSION – SAMPLE ACQUISITION STRATEGY AND EVIDENCE FOR THE NATURE OF REGOLITH ON ASTEROID (101955) 1999 RQ36.

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Introduction: NASA selected the OSIRIS-REx Asteroid Sample Return Mission as the third New Frontiers mission in May 2011 [1]. The mission name is an acronym that captures the scientific objectives: **O**rigins, **S**pectral **I**nterpretation, **R**esource **I**dentification, and **S**ecurity–**R**egolith **Ex**plorer. OSIRIS-REx will characterize near-Earth asteroid (101955) 1999 RQ36, which is both the most accessible carbonaceous asteroid [2,3] and one of the most potentially hazardous asteroids known [4]. The primary objective of the mission is to return a pristine sample from this bod, to advance our understanding of the generation, evolution, and maturation of regolith on small bodies.

Regolith on the Surface of 1999 RQ36: There are two independent lines of evidence that allow us to constrain the particle size on the surface of the asteroid: thermal IR measurements made by the Spitzer and Herschel Space Telescopes and radar polarization ratio measurements made using the Arecibo and Goldstone Planetary Radar Systems. Asteroid shape analysis using radar return data from Arecibo provides additional evidence of loose granular surface material as well as information on its likely distribution.

The Spitzer measurements were conducted during the period 4 – 9 May 2007 [5]. They consist of spectra covering 5.2 to 38 μm taken of opposite hemispheres (integration time ~1/2 a rotation period) and photometric measurements at 3.6, 4.5, 5.8, 8.0, 16, and 22 μm taken at 10 different longitudes. The Herschel measurements were conducted on Sept 9, 2011 [6]. They consist of photometric measurements at 70, 100, and 160 μm. Supporting measurements at shorter wavelengths were made during the same month using the VLT ground-based facility. These data produce a thermal inertia of ~600 J m^{-2} K^{-1} $s^{-1/2}$.

Thermal inertia data constrain the average regolith grain size. The thermal skin depth for 1999 RQ36 is estimated at 2-4 cm. The thermal inertia is substantially below the bedrock value (>2000), implying the presence of sub-cm grains within the regolith.

We used Arecibo and Goldstone radio observatories to make radar observations of 1999 RQ36 in September/October 1999 and September/October 2005 [7]. The data resulted in accurate line-of-sight velocities and distances, 7.5-m resolution images, and measurements of the radar albedo and circular polarization ratio. The polarization ratio is 0.18 at 13 cm and 0.20 at 3.5 cm wavelengths, lower than those for asteroids 25143 Itokawa (0.27), 433 Eros (0.28), and 2005 YU55 (0.45). This result suggests that the transition to a radar "rough" surface happens at a scale smaller than the shortest wavelength (3.5-cm), consistent with grain sizes in the sub-cm range.

The asteroid's shape and geomorphology provides additional evidence of the presence loose particulate regolith. We find a subdued slope distribution at the spatial resolution of the shape model (7.5 m/pixel). The average slope is estimated to be 15-24°, depending on the bulk density of the asteroid. This result suggests that there is loose material capable of migrating into geopotential lows. The global shape model of the asteroid indicates a body symmetrically disposed about the rotational axis in response to centrifugal forces, suggesting the presence of mobile particulate regolith.

OSIRIS-REx Sampling Strategy: Our Touch-and-Go Sample Acquisition Mechanism (TAGSAM) is capable of ingesting up to 2 kg of material with grain sizes from dust up to 2 cm. The bulk sample acquisition strategy is the result of over a decade of development. The team studied many different sample collection techniques including sticky pads, claw and clamshell samplers, drive tubes, augers, coring drills, scoops, rakes, and gas-stimulated sampling. Gas stimulation (bed fluidization) was chosen for OSIRIS-REx because it is capable of acquiring large amounts of material, minimizes moving parts, functions without motors during sampling, and keeps the sample pristine.

References: [1] Lauretta et al. (2012). *LPS XLIII* Abstract #2491. [2] Hergenrother et al. (2012) *LPS XLIII* Abstract #2219. [3] Clark et al. (2011) *Icarus*, 216, 462. [4] Milani et al. (2009) *Icarus*, 203, 460. [5] Emery (2010) *LPS XLI*, Abstract #2282. [6] Müller et al. (2012), *AA*, in preparation. [7] Nolan et al. (2012) *Asteroids, Comets, Meteors (ACM) 2012*