ASTEROID (101955) 1999 RQ36: OPTIMUM TARGET FOR AN ASTEROID SAMPLE RETURN MISSION

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Introduction: Asteroids are direct remnants of the original building blocks of the terrestrial planets. Carbonaceous asteroids are an important source of volatiles and organic matter to the Earth. Sample return from a carbonaceous asteroid has been identified by the Space Studies Board of the US National Research Council as high priority [1]. OSIRIS-REx is a sample return mission currently in Phase A in the NASA New Frontiers program. The OSIRIS-REx science team has identified asteroid (101955) 1999 RQ36 as the optimum target for a sample return mission.

Characteristics: 1999 RQ36 has a semi-major axis of 1.126 AU [2]. Lightcurve observations give a rotational period of ~4.3 hours. It is a B-class asteroid characterized by a linear, featureless spectrum with bluish to neutral slope [3]. B-class asteroids in the main-belt are known to be some of the most volatile-rich small bodies in the inner Solar System [4]. Near-infrared spectroscopic data suggest a very low albedo that is consistent with a carbonaceous surface. The best spectral analogs for 1999 RQ36 are the CM, CR, or CI chondrites, though none are a perfect match.

1999 RQ36 was observed with the Arecibo and Goldstone Planetary Radar Systems in 1999 and 2005. [5]. Delay-Doppler imaging provides shape information at a spatial resolution of 7.5 m/pixel. The data reveal an ~575-m diameter asteroid undergoing retrograde rotation. The radar polarization ratio suggests a smooth surface of fine-grained material. These data provide high confidence in the presence of regolith on the surface of RQ36.

Assuming a plausible density of 1.4 g/cm^3 we find a subdued slope distribution for this asteroid at the spatial resolution of the shape model, with maximum slopes of 33°, near zero slopes in the equatorial region and an average slope of 13°. This range is consistent with a regolith-covered body with a relaxed surface.

1999 RQ36 was observed with the Spitzer Space Telescope in May 2007 [6]. The Spitzer data yield a thermal inertia of 600 J $m^{-2}s^{-1/2}K^{-1}$, suggesting that the regolith is comprised of fine gravel (4-8 mm). These data also strongly support the concept that there is abundant regolith on the surface available for sampling.

1999 RQ36 is a potential Earth impactor. The probability of an impact in the late 22nd century is 10^{-3} [7]. The primary source of uncertainty is the dynamical model of its orbital evolution. The main non-gravitational orbit perturbation is due to the Yarkovsky effect, which results from anisotropic thermal re-emission of incident solar energy [8]. A mission provides for an increase in position knowledge, leading to a better understanding of the threat.

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