Abstract. Asteroids are direct remnants of the building blocks of the terrestrial planets. Carbonaceous asteroids are an important source of volatiles and organic matter to the Earth. The Space Studies Board of the US National Research Council has identified sample return from a carbonaceous asteroid as high priority [1]. The Origins, Spectral Interpretation, Resource Identification, and Security–Regolith Explorer (OSIRIS-REx) mission will return the first pristine samples of carbonaceous material from the surface of a primitive asteroid. OSIRIS-REx’s target – asteroid (101955) 1999 RQ36 (see Figure) – is the most exciting, accessible volatile and organic-rich remnant from the early Solar System, as well as the most potentially hazardous asteroid known to humanity.

Characteristics: 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 RQ36 are the CM, CR, or CI chondrites, though none are a perfect match.

RQ36 was observed with the Arecibo and Goldstone Planetary Radar Systems in 1999 and 2005. [5]. Delay-Doppler imaging at a spatial resolution of 7.5 m/pixel 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/cm³ 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.
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.

**Importance:** The Earth sterilized itself during formation, melting to a depth of at least 1000 km, perhaps repeatedly [7]. Yet we are here, so organics must have either self-assembled from carbon atoms or have been delivered from space where they are abundant. No such material survives Earth entry as meteorites today without experiencing substantial contamination. Hence OSIRIS-REx will provide the first sample of material for study that might have led to life on Earth.

In addition, we use spectra obtained by telescopes and spacecraft to infer the composition of asteroids, but asteroid surfaces suffer from space weathering while meteorite analogs are freshly ground surfaces. OSIRIS-REx will return a pristine sample of RQ36 regolith surface for direct comparison of laboratory instruments, telescopic and spacecraft measurements.

One day humans will venture far from Earth and may need local resources to function effectively. OSIRIS-REx will provide a resource inventory of materials available on a carbonaceous near-Earth asteroid.

Finally, RQ36 is a potential Earth impactor. The probability of an impact in the late 22nd century is $10^{-3}$ [8]. 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 [9]. The OSIRIS-REx mission provides for an increase in position knowledge and asteroid surface properties, leading to a better understanding of the threat to Earth from 1999RQ36.