**LASER RETURN SIGNATURE OF ANALOGS TO OSIRIS-REx TARGET ASTEROID (101955) 1999 RQ$_{36}$.** A. Shaw[1], M. G. Daly[1], E. A. Cloutis[2], K. T. Tait[3], M. R. M. Izawa[2], O. S. Barnouin[4] [1]York University, Toronto, Canada, [2]University of Winnipeg, [3]Royal Ontario Museum, [4]Johns Hopkins University Applied Physics Laboratory. **Correspondence:** ashaw@yorku.ca, dalym@yorku.ca

**Introduction:** The OSIRIS-REx New Frontiers Mission target asteroid, (101955) 1999 RQ$_{36}$ (hereafter RQ$_{36}$; Fig. 1), has been well observed via ground-based methods, yet there is much that is still unknown about this roughly 500-meter diameter object. In particular, the composition responsible for its very low (3 - 4%) albedo and spectral signature has yet to be determined. Several spectra have been taken of the object, and they appear to have different slopes [1], this could indicate compositional inhomogeneity of RQ$_{36}$ (barring any systematic error). At least one of the spectra has been found to be a reasonable match to several CM chondrites as well as to the CI chondrite Ivuna after artifical thermal metamorphism at 700 ºC [2].

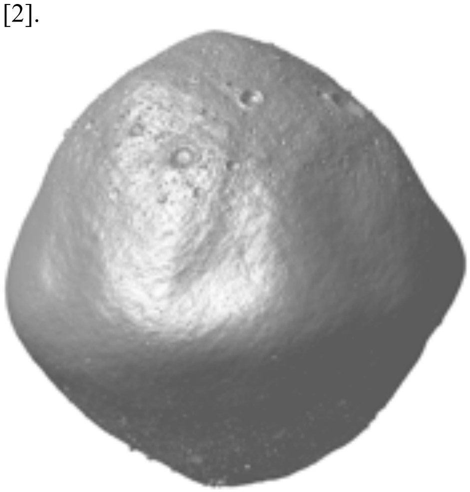

**Figure 1.** RQ$_{36}$ shape model [3]. Some artificial features, such as small craters, have been introduced to simulate an asteroid surface. Courtesy of R. Gaskell, M. Ilnicki.

To better constrain the composition of RQ$_{36}$, additional information on the possible constituents of and analogs for the asteroid would be useful. To this end, we are setting up experiments to investigate the laser return signature of terrestrial and meteorite analogs to RQ$_{36}$ and their individual constituents. The primary focus will be on returns from a 1064 nm laser, similar to the one that is planned to fly aboard the OSIRIS-REx asteroid sample return mission. The objective is to understand the nature of the laser returns given possible compositional, grain size and slope distributions on the surface of RQ$_{36}$. Such an understanding should permit the characterization of the surface regolith of RQ$_{36}$, especially the surface grains sizes, which would significantly aid efforts to identify suitable sites for sampling by the OSIRIS-REx mission.

**Approach:** Returns from a 1064 nm laser will be used to determine reflectance of RQ$_{36}$ analogs and their constituents. Particular attention will be paid to how laser return power changes with sample grain size, and with composition. Grain size is known to affect the spectral albedo and continuum slopes of surface materials. The samples will also be processed under various conditions to simulate space weathering, thermal metamorphism, and aqueous alteration.

Our approach involves three main categories of experiments. 1. For each compositional type, reflectance measurements of a set of samples, each of a different grain size, will be taken. 2. A similar set of measurements will be taken, this time varying incidence angle at zero phase. The results will be important for calibrating OLA data, including separating the contributions of range, surface roughness, and surface composition. 3. Phase function (angular scattering distribution) measurements will be conducted for the same set of samples. This will be particularly useful for comparison with OSIRIS-REx Visible and IR Spectrometer (OVIRS) and OSIRIS-REx Camera Suite (OCAMS) data taken at varying illumination and viewing geometries. The phase function is primarily related to small-scale surface roughness and therefore particle size. Once the above experiments are completed, we will introduce the variable of macro-scale surface roughness into the experiments.

The anticipated database generated will be used in the interpretation not only of the OSIRIS-REx Laser Altimeter (OLA) data, but also of color imaging and spectral data returned by OVIRS and OCAMS..

**Setup:** To accomplish some of the goals above, a gonioreflectometer is being designed. This instrument allows reflectance measurements at various illumination and viewing geometries. The preliminary design is shown in Fig. 2. The reflectometer will have an arch and an arm, either of which can accommodate a source or detector. The arm will rotate in azimuth and elevation, allowing data acquisition over the whole hemisphere.

**Priority Samples:** Previous studies have looked at CM chondrites and found spectral features indicative of serpentines [2, 4]. Therefore, we will be conducting reflectance measurements on several serpentinite samples (Fig. 3) as well as relatively pure mineral samples of serpentines and chlorites. For the mineral samples, it is beneficial to focus on dark, iron-rich serpentines and chlorites, such as the thuringite (ferroan chamosite, approximate formula: $(Fe^{2+},Fe^{3+},Mg,Al)_6(Si,Al)_4O_{10}(O,OH)_8$) shown in Fig. 4. Promising samples will likely later be mixed with fractions of nanophase magnetite, a constituent which is present in small quantities in CM chondrites and which can lower albedo and result in a bluer spectral slope [4] and therefore may also be present on $RQ_{36}$. Once the analysis of terrestrial analogs is complete, we will also analyze meteorite analogs, focusing on CI and CM chondrites.

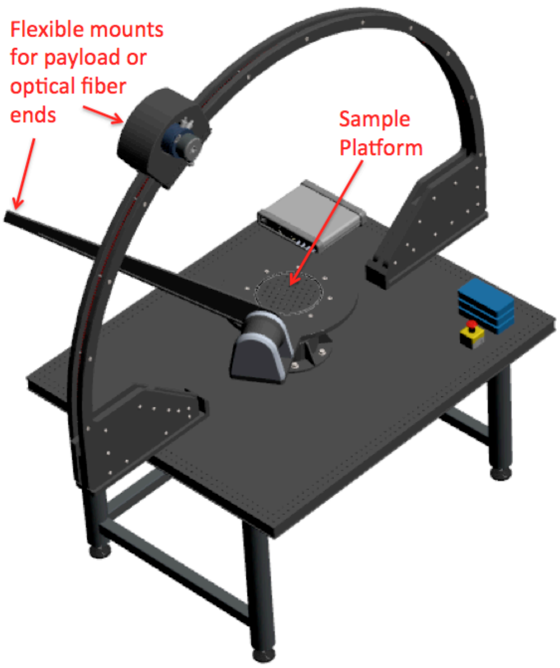


**Figure 2.** Preliminary design of gonioreflectometer, courtesy of Basic Robotics.

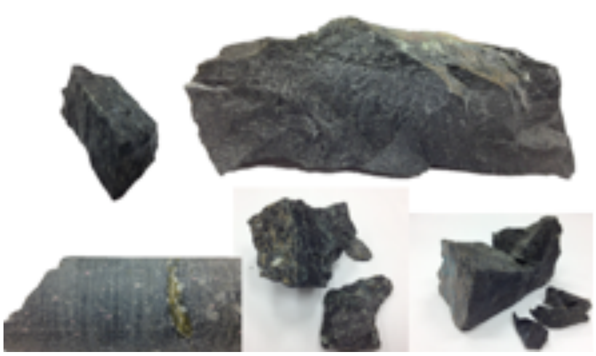

**Figure 3.** Serpentinite samples provided by the Royal Ontario Museum (ROM catalog numbers M56438, M56439, M56440, M56441, M45040).

**Figure 4.** Thuringite, ROM catalog # M6394.

**Summary:** The composition and textural properties of $RQ_{36}$ are still unknown, and it is important to create a database of reflectance measurements of terrestrial and meteorite analogs that can then be used for comparison to ground-based data as well as data that will be collected by OSIRIS-REx. We have outlined our approach to this problem.

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**References:**

[1] Binzel, personal communication. [2] Clark et al. (2011) *Icarus, 216*, 462-475. [3] Nolan, M. C. et al. (2012) *LPS XLIII,* Abstract #6345. [4] Cloutis et al. (2011) *Icarus, 216*, 309-346.