The Surface of Asteroid 101955 Bennu

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Introduction: Bennu is a 560-km diameter Near-Earth Object, an asteroid that has the potential of colliding with the Earth sometime in the future. The spacecraft OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer) was designed, as its name implies, to try to understand Bennu’s history, to determine its composition (while in orbit around Bennu and with a returned surface/subsurface sample), and to be able to predict its orbit and motion in order to determine the chances of it colliding with the Earth in the future. OSIRIS-REx has mapped Bennu’s surface and scientists can now compare its surface composition with meteorites—rocks that have come to Earth from other asteroids. While some things have been correctly predicted based on observations from Earth, Bennu brought many surprises to the scientists. They expected to find a smooth, cratered surface with lots of regolith (dust and small broken rocks created when larger surface rocks are broken up by meteoroid impacts) as we see on other, larger asteroids, the Moon, and Mercury. This made locating a site and collecting material to return to Earth challenging. Scientists now think that they know why there is so little regolith on Bennu—the surface rocks are like a dry sponge that collapses when hit by a meteoroid rather than breaking up and creating regolith.

Investigating the Surface of Bennu: On the next page are two images of Bennu. The first one shows the features that have been named on Bennu. The second image pinpoints the locations of the four proposed sample return sites. The area chosen was Nightingale in the upper left corner.
The image on the next page is the same as the first one above, but we have included an image of the Moon that is on the same scale. This image was taken by the HIRISE camera on the Lunar Reconnaissance Orbiter. Can you see any differences? The arrows point to the location of the Chinese Chang’e 4 lander and rover. The white bars are 100 meters long.
The image on the next page compares a HIRISE image of the Apollo 17 landing site to a higher resolution image of Bennu, near the Nightingale sample return site. Again, these are on the same scale. What are the similarities and differences between these two images? If both objects are impacted by meteoroids at the same rate, which surface is older (hint: which has more craters)? While not in this Bennu image, the largest boulder seen on Bennu (lower right in the first image on page one) is about 56 meters wide and 20 meters tall (above the surface, some of it might be buried).
Activity: You have a set of images that covers most of Bennu’s surface. If you put them in the correct order, you will create a mosaic of the surface. You may try counting craters and boulders larger than a certain diameter, say 5 meters (use the scale on the bottom left of each image to estimate 5 meters). Do some areas have more boulders than others? Do some boulders reflect more light (appear whiter)? By asking these questions and investigating the images in order to answer these questions, you are modeling scientific inquiry. You are probably asking the same questions that were being asked by the scientists when they first looked at these images!