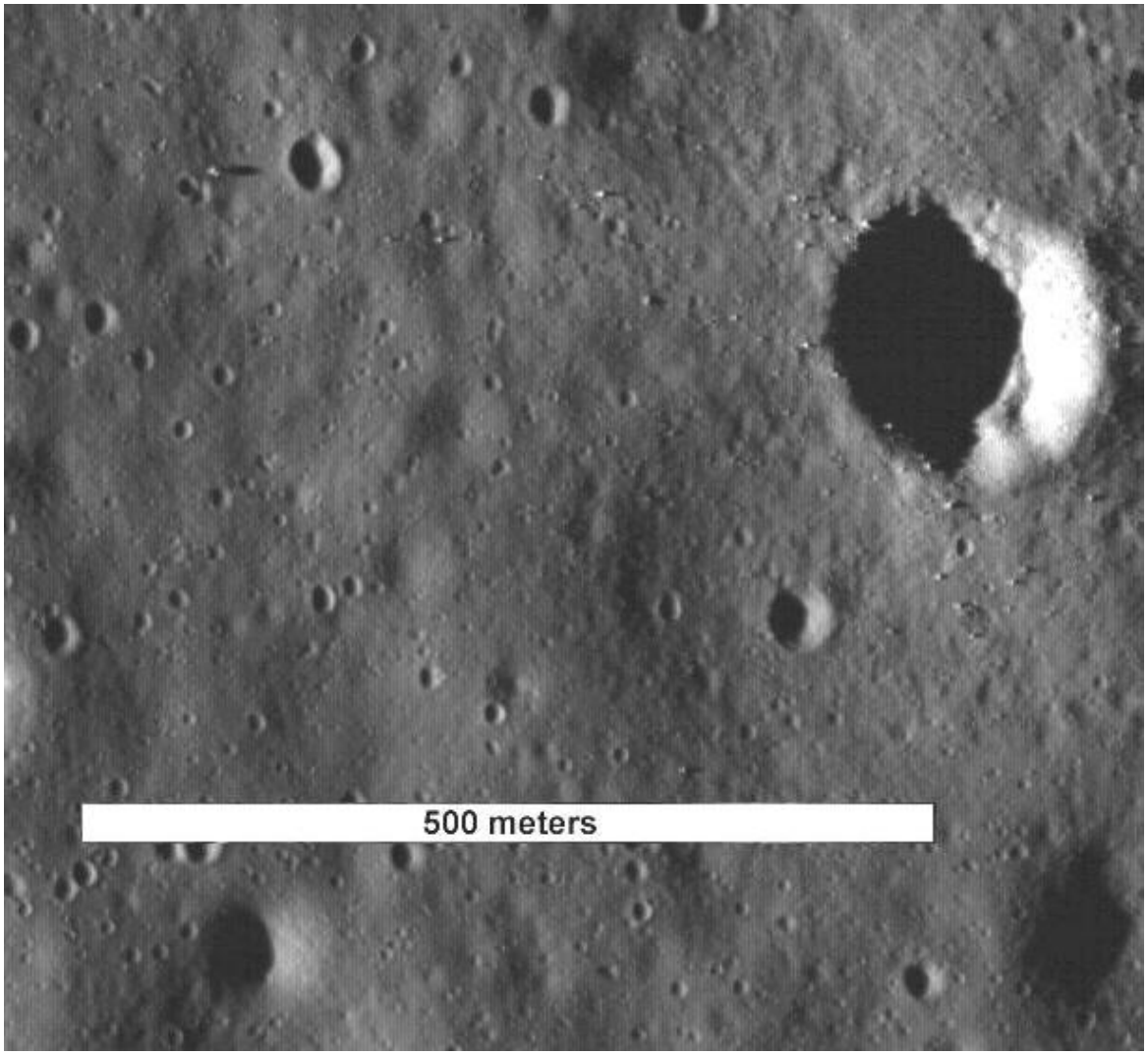

The LRO satellite recently imaged the surface of the moon at a resolution of 1.4 meters/pixel. The above image shows the region near the Apollo-11 landing area. The Lunar Module (LM) and its shadow are shown to the left of the large crater in the upper right corner. Sunlight comes from the left, and so craters will have their shadow zones on the left-hand side of their depressions. Objects above the surface, like the Apollo LM, will be bright on the left side, and have their right-side in shadow.

Problem 1 - From the information given, and using a millimeter ruler: A) determine the scale of the image (meters per millimeter); and B)the length of the Apollo LM shadow.

Problem 2 - Find as many boulders as you can, and determine their approximate size using the height of the LM (3.5 meters) and the length of the LM shadow to establish their sizes. Do you think there are smaller boulders that the ones you can easily spot?

Problem 1 - From the information given, and using a millimeter ruler: A) determine the scale of the image (meters per millimeter); and B) the length of the Apollo LM shadow.

Answer: Measure the length of the white bar on the image, which corresponds to a physical length of 500 meters on the lunar surface. Students should get answers near 111 millimeters. A) so the scale of the image is 4.5 meters/millimeter. The length of the LM shadow is 6 mm, so its physical length is 6 x 4.5 = 27 meters.

Problem 2 - Find as many boulders as you can, and determine their approximate size using the height of the LM (3.5 meters) and the length of the LM shadow to establish their sizes. Do you think there are smaller boulders that the ones you can easily spot?
Answer: The image below shows some examples. The LM is 3.5 meters tall and casts a 27-meter shadow, so by using similar triangles and proportions, that means that a 1-meter boulder will cast a shadow that is 1/3.5 x (27 meters) = 7.7 meters long. At the image scale of 4.5 meters/mm, that corresponds to a length on the image that is just under 2-mm long. Students may create tables for actual, numbered, boulders in the image and determine more accurate boulder sizes. Students should realize that, although they cannot directly see boulders smaller than about 1-pixel (1.4 meters) they can easily see the shadows of boulders much smaller than this. For example, a shadow that is 1 millimeter long is from an unobservable boulder about 0.5 meters across!