

**Material from the "WHAT Are You Looking At?" Discovery Station  
[Supporting NASM's *Looking at Earth* Gallery]**

## **The "Big Eight" Elements of Image Interpretation**

Eight fundamental parameters are used in the interpretation of remote sensing images: size, shape, tone, texture, site, association, shadow, and pattern. In some cases, a single such element is alone sufficient for successful identification; in others, the use of several different elements will be required.

"Size" and "shape" are pretty much self-explanatory; "tone" is the brightness of a black-and-white image or the color in a color image; "texture" is distinctive variation of tone across a single object; for some objects, their location ("site") is a valuable datum in interpretation, as might also be any "association" with nearby, readily-identifiable objects; "shadow" can at times reveal diagnostic details otherwise invisible in a vertical image; and "pattern" is a distinctive array of objects. Examples follow, using public-domain images acquired by the IKONOS satellite (with the exception of the R-G-B image, from the U. S. Geological Survey).

### **Size and Shape: The Pentagon**



The **shape** of this particular building is a certain give-away, particularly once its **size** is understood (by comparison with the recognizable parking lots and nearby highway).

How would one estimate the number of people working here?

### **Size, Shape, Pattern, Shadow: The Pyramids**



Roads in this image are readily identifiable, which helps the observer get a sense of size. But the key elements here are shape and shadow. These are the famous Pyramids near Alexandria, Egypt. But what else can you determine from this image?

Note the pattern of rectangular objects to the right of the lower pyramid. What might they be?

What about the medium gray-toned set of elongated features in the lower-left corner?

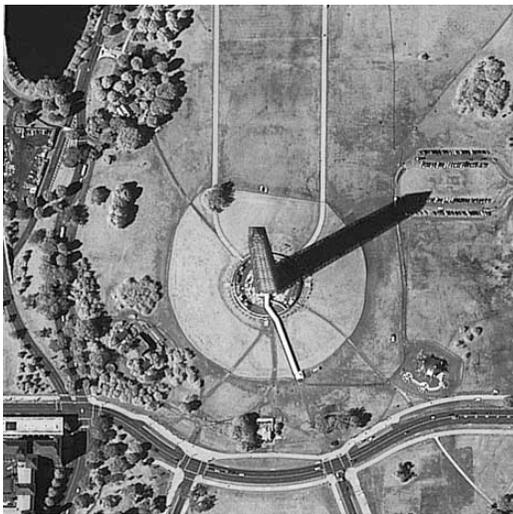
(Hint: if the image were wider, you would see 18 of these elongate features. Who'd have thought, in the shadow of the Pyramids..... !

## Association: Hoover Dam



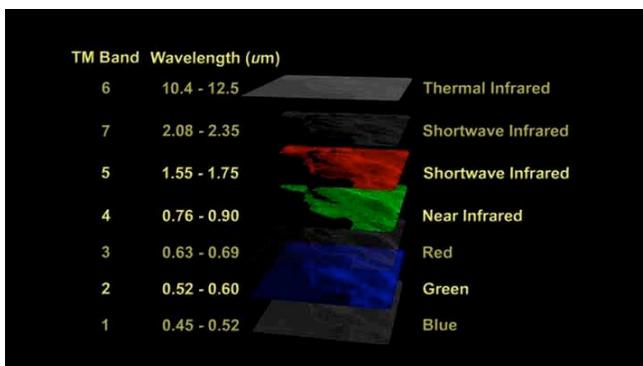
Sometimes objects that are difficult to identify on their own can be understood from their **association** with objects that are more easily identified. For example, the distinctive curved shape of the object in this image, the apparent difference in height of the dark surfaces on either side of it, and other details all suggest that it is a dam. In that context, the open lattice structure along the bottom of the images is much more likely to be recognized as a transformer yard electrical station than it would be if it were not seen in **association** with a nearby source of hydroelectric power.

## Shadow: The Washington Monument



Here **shadow** reveals **shape**. Both **shape** and **site** can be used to readily reveal its identity; in this case the Monument also resembles a sundial. If one knows the altitude of the Sun when the image was acquired, then it is simple trigonometry to calculate the height of the monument. (North is to the right in this picture, making this a mid-morning view, and it was taken when renovation scaffolding was in place.) Since the height of the Washington Monument is well known, it the problem can be worked in reverse to calculate the date and time at which the image was acquired.

## "False Color" Infrared & R-G-B



**Tone** in a black-and-white image is another word for shade of gray. In a color image, **tone** refers to color. Ask your participant if they have ever looked at a color TV image with a magnifying glass, or if they have ever looked closely at an old projection TV image and projector. The color image is made up of a

combination of three separate images: red, green, and blue. Our brain fuses the three into one image we interpret as having full color.

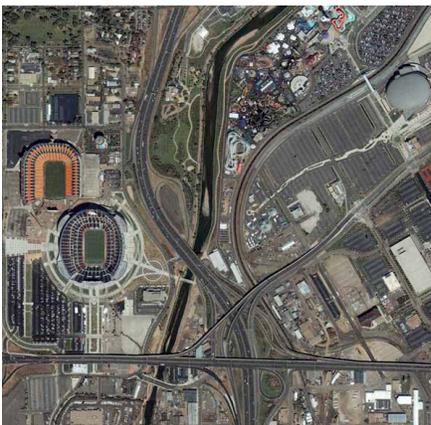
Humans can only see a narrow range of the entire electromagnetic spectrum. We can build devices that can detect EM radiation we cannot see with our eyes. Shown here are the seven bands detected by the Thematic Mapper instrument flown on late-model Landsat satellites (for more on Landsat and the TM instrument, see the NASM "Looking at Earth" gallery website).

Notice that, in the example shown, wavelengths of light other than red, green, and blue can be assigned to a red, green, blue projection system and be visualized just like true red, green, and blue images in a color TV. The resulting color image does not correspond to "reality," so we call it a "false-color" image. In this case, middle infrared is assigned to the red image, near infrared to the green, and green to the blue.

Why would we go to the trouble of reassigning the detected EM radiation to visible colors? The answer is simple, it helps us interpret things! For example, objects containing chlorophyll appear green because they absorb blue and red light and reflect the green. However, chlorophyll is also very reflective in the mid- and near-infrared. So images using the band assignments as shown would have vegetation appearing red, not green! There are many examples of this in the Looking at Earth gallery.

Green paint looks green because it absorbs red and blue light and reflects green, just as chlorophyll does in the visible part of the spectrum. However, most green paint does not reflect as much near-infrared light as does chlorophyll. Using the same red-green-blue assignment as shown here, green paint would appear blue, not the red of healthy vegetation. Anyone trying to disguise something as vegetation by painting it green would be revealed by using a false-color image of this type. Photographic film that chemically shifts the colors as shown here was originally developed to detect camouflage during World War II.

### Your Turn!



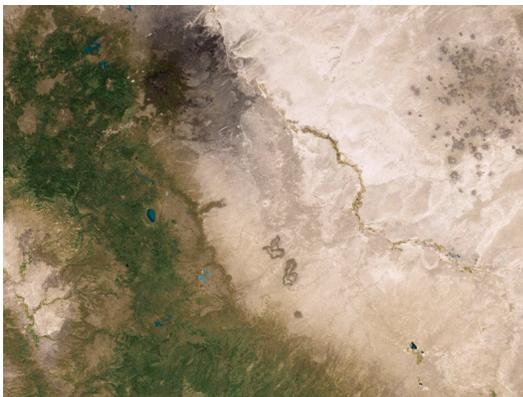
What might the two objects along the left side of this image be? Why are there two of them? **Size** and **shape** will be useful interpretation elements for this image (acquired ~2004). What is the rounded gray object to the upper right? What are the colorful, oddly-**shaped** objects in the upper center? Any ideas as to where this might be? How do you know?

## What are these?



Interpreting this image may be a bit difficult at first. Start by identifying the ocean (lower left corner) and the beach with breaking waves. What about the elongated dark features, and the straight light-colored lines and related objects? Clue: North is to the right and the scene is in North America.

## Whitish Circular Feature



Note the small, white circular feature in the center of this image, just above the two irregular dark *shapes*. Let's apply the elements, one-by-one, to try to figure out what it could be. **Size** clue: The sinuous object in the lighter terrain to the left of the image center is a river, making our mystery spot about a mile across. **Site** clue: The collection of dark splotches in the upper-right corner of the image is called the "Hopi Buttes," a group of eroded volcanoes. What location does "Hopi" suggest?

## Davenport, Iowa



This image obviously shows a river, bridge, and city. What is going on here and how do you know?

Guiding questions: Which way is the river flowing and how do you know? What is the rounded structure just to the right of the curved portion of the bridge at the top of the image? Does it look like you would expect? Is that a clue?

## Answers

1. The two objects on the left are athletic stadiums, old Mile High Stadium (then in the process of being demolished), and the new INVESCO Field at Mile High. The round, gray building is some sort of indoor arena, based on its size and associated parking lot (it is the Pepsi Center). The colorful, oddly-shaped buildings? Elitch Gardens amusement park. Individual rides, including an old "woodie"-style roller coaster, are readily visible in the original image.

2. The white circular areas are launching pads at Cape Canaveral. The given location and orientation to north put the objects on the North American Atlantic coast, and the distinctive **size, shape, shadows,** and **association** with other objects are all "in play" for a successful interpretation. The dark lanes are open water (the launch area is very marshy).

3. The tiny white circle is the famed Meteor Crater in Arizona. Compare this image with any of the Moon. Meteor Crater is the freshest "larger" impact crater on Earth (erosion tends to erase impact craters relatively quickly on Earth), but it would be totally lost in a field of much larger craters if it were on the Moon.

4. The river in Davenport is flooded. The bridge abutments create visible turbulence downstream, so the water flow direction is from right to left. The **shape** and **size** of the rounded object suggest that it is a sports stadium; the **tone** of its immediate surroundings shows that it has been partially flooded. Sharp eyes may see lines of sandbags laid in a futile attempt to protect the whitish buildings in the upper mid-left of the image.