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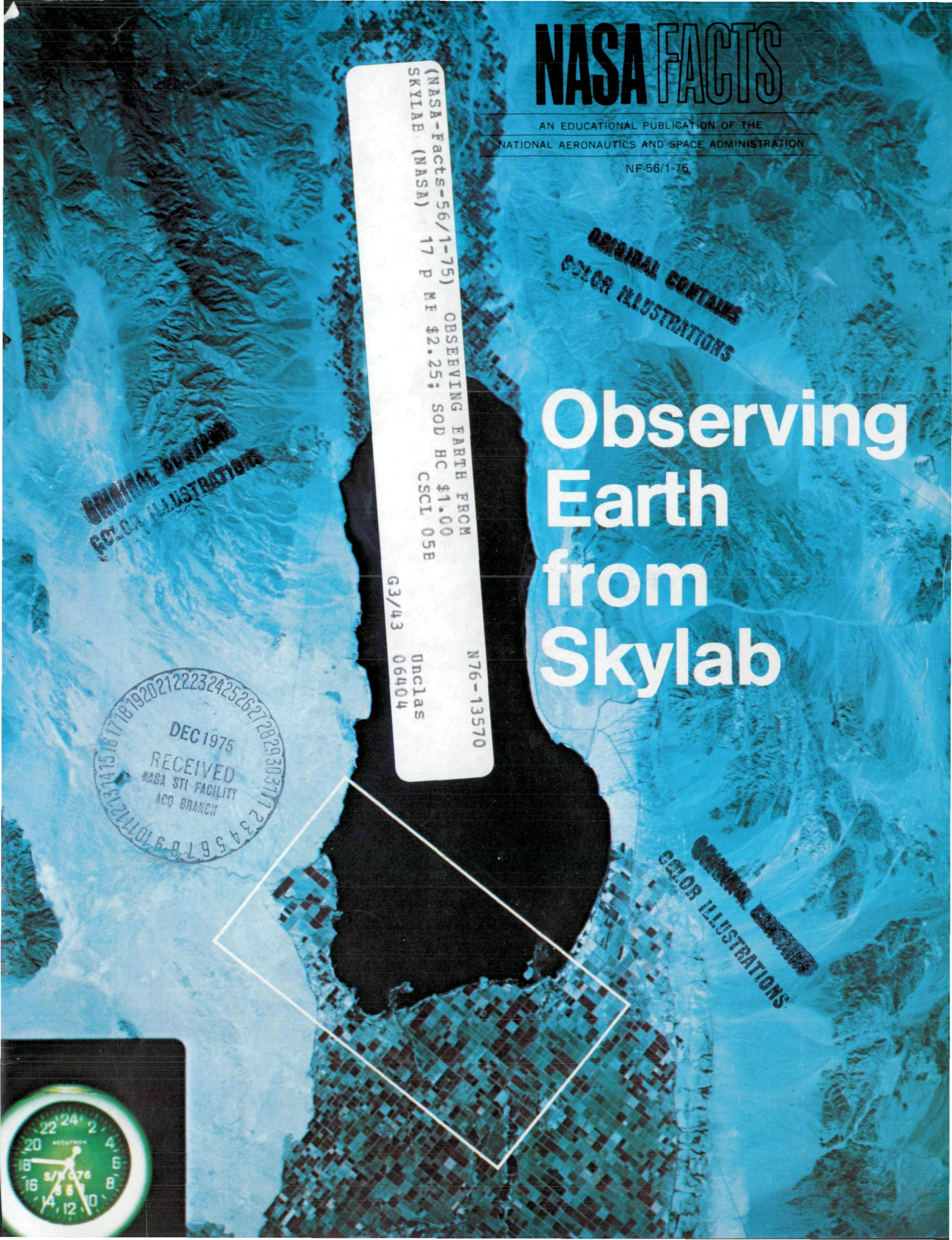


Observing Earth from Skylab

The photograph on the cover was obtained from Skylab, the nation's first space station. It shows the Salton Sea in southern California and was taken from an altitude of about 430 kilometers using the earth terrain camera provided by Actron Industries in Monrovia, California.

Observing Earth from Skylab

History of Exploration

Throughout history, man has explored the earth because he wanted to reach his neighbors, because some of the known routes were too dangerous or too costly, and because he wanted to see what was there.

Columbus' first voyage west across the Atlantic had the objective of finding a simple sea route to the Far East and thus avoid the difficult and expensive route via the Middle East.

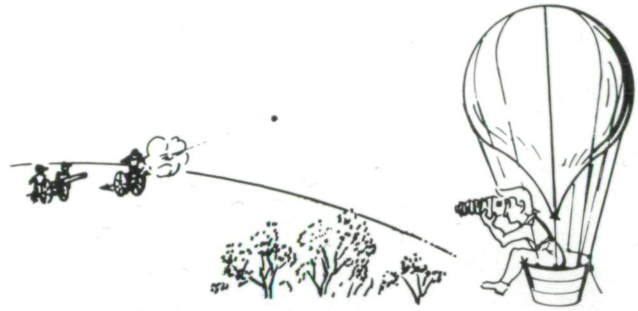
The development of technology has always set the pace for exploration. There is no doubt that exploration of the world really began to accelerate when seafaring communities began to use the oceans as traffic routes.

Development of Techniques

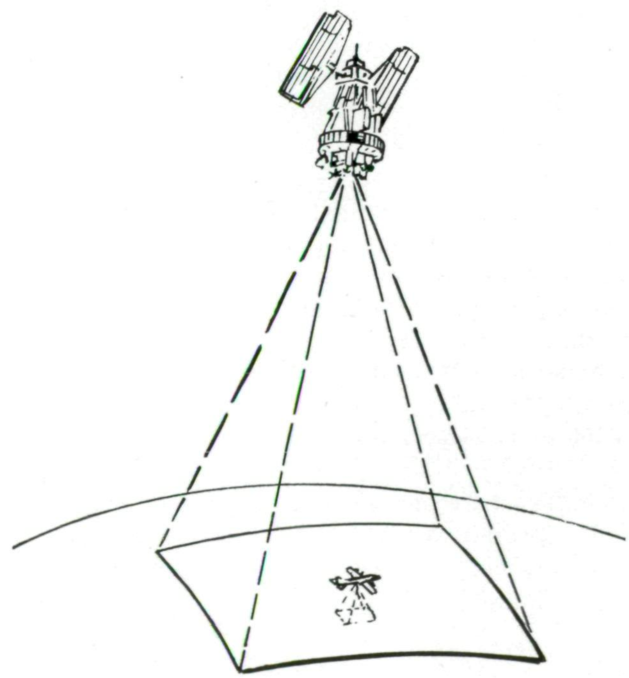
In recent years man's activities have included survey and research of remote areas. In the more populated areas the study of the earth's surface involves mapping terrain and analyzing and plotting resources, weather, and environment.

Early explorers used words and sketches to describe their discoveries. With the invention of the camera, a scene could be portrayed more quickly and accurately.

When manned flight in balloons and later in aircraft became possible the camera was carried aloft to provide a much wider area photograph. For example, military photographic reconaissance from balloons was used in the 19th century in the Civil War.



The arrival of the Space Age with its orbiting satellites and spacecraft at altitudes of 150 kilometers and higher has completely revolutionized earth surveying methods. Because it is so far from earth, a satellite can sweep an area so vast that no high-flying photo-reconnaissance plane can match it. It would take a plane 20 *years* to photograph the same area that the Earth Resources Technology Satellite (ERTS) can scan in only 18 *days* if the weather is satisfactory.



Remote Sensing

The growing need for natural resources and wise use of them requires continual accurate monitoring of known resources and search for new resources. There will always be the need for on-the-spot detailed analysis of the condition of geological features, rivers, forests, and crops. However, a technique is being developed to help the man on the ground by using information obtained by instruments in aircraft and spacecraft. In the future this technique will reduce the need for on-the-spot observation. The information from aircraft and spacecraft will reduce the time and effort required for ground-based surveying by directing the researcher to areas where the need is greatest. This technique is known as *remote sensing.*

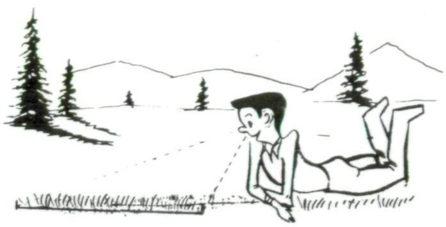
Remote sensing can be used to monitor crop production, water supplies, and weather. It has been used to survey famine or flooded areas. It can locate new natural resources. Ultimately remote sensing will be a valuable tool in man's continued life on this planet.

A milestone in earth exploration was reached on May 14, 1973, when Skylab was launched into a nearly circular orbit about 435 kilometers above the earth. Skylab carried instruments into orbit designed to observe earth, and to verify that detailed information on natural resources over wide areas of the world's surface could be obtained using remote sensors.

Four of what we call man's five senses are remote sensors. From them we get information about an object without actually touching it. We can see it, hear it if it makes a noise, smell any odor it emits, and feel the heat it radiates.

In a similar way we can get information about features on earth without actually touching them. A camera makes a picture of a scene by recording the color and brightness of the light reflected from each part of the scene. At night the same camera can make a picture of an illuminated sign by recording the color and brightness of the light emitted by the sign.

The many different features on earth have different appearances when viewed in different ways. The young blades of grass in a new lawn give the ground a faint green color when viewed from the side. The color is not nearly as noticeable when viewed from directly overhead. The area of each blade of grass seen from the top is small compared with the amount of soil seen.



Grass appears green because it reflects more light in the green part of the visible spectrum than in other parts of the spectrum.

When white light passes through a prism, the light is divided into the familiar rainbow of colors ranging from red to violet. This is the visible spectrum. Familiar objects reflect radiation in various ways in the invisible regions of the frequency spectrum, such as ultraviolet, infrared, and radio (see Figure 1). Green mature soybeans reflect radiation in the infrared wavelength at a much higher intensity than in the familiar visible green wavelength as shown in Figure 2.

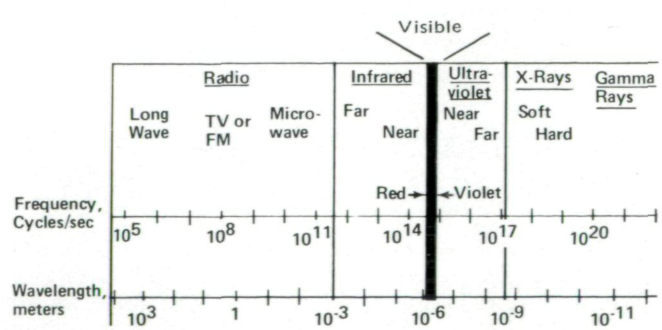


Figure 1 Spectral Chart

Spectral Signatures—When measuring the intensities of reflected radiation in a number of wavebands in the visible and invisible parts of the spectrum, certain patterns, called profiles, show up. These profiles are characteristic of the features studied. This means that a certain pattern will always show up when measuring a certain feature under identical conditions. These profiles are called *spectral signatures.*

The profiles for different materials are plotted in Figure 2. These profiles show how these features can be identified by measuring and recording reflected radiation at several wavelengths at the same time.

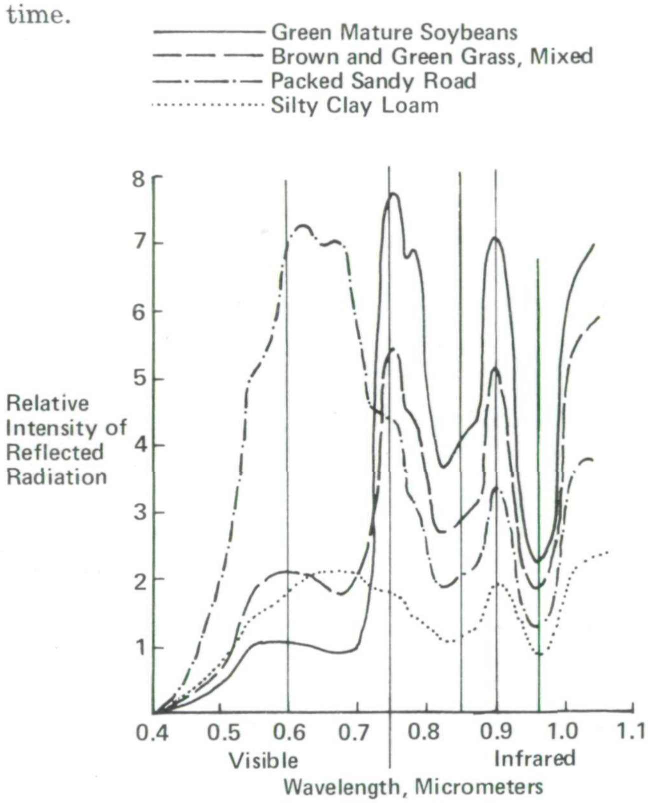


Figure 2 Spectral Signatures

To make Figure 2 easier to understand, we have written some of the reflectivity values in Table 1. The table lists the intensities of reflected radiance for soybeans at selected wavelengths. Other values have been filled in the table at random. The reader can fill in the missing numbers by picking the values off the curves in Figure 2 for each material at each wavelength indicated.

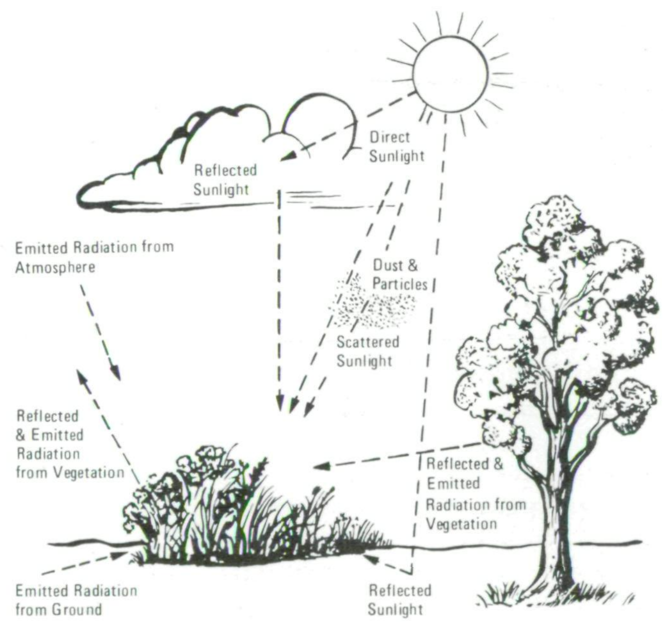
The wavelengths in this table were chosen because they show large differences in radiation intensity for the materials shown.

Table 1 Numerical Signatures

	Wavelength, micrometers				
Material	0.6	0.75	0.85	0.9	0.95
Green Mature Soybeans	1	7.8	4	7	2.2
Brown & Green Grass, Mixed			2.8		
Packed Sandy Road		4.3			
Silty Clay Loam				2.0	

The spectral signatures of earth features change depending on the quality of the light illuminating the scene. A familiar example of this is the way the color of the ocean changes from blue to green to dull gray with changing weather conditions.

Atmospheric conditions such as haze, fog, clouds or pollution, and surface conditions such as slope, shadow, wind movement of crops, and stage of growth can influence the signature of the features in a scene.



Consequently, it is important to remember that the spectral signatures obtained on one day do not necessarily apply the next day.

However, when signatures are established in one part of a picture of a scene, they can be used to analyze the rest of that picture.

The numerical example of a signature shown in Figure 2 and Table 1 can be used in a computerized analysis. A series of pictures of a scene taken at different wavelengths can be scanned by an electronic instrument that measures the brightness of each feature in the scene in each photograph. The computer, having been programmed to recognize combinations of intensity values in all of the wavelengths, lists all the features having the same combinations, or signatures.

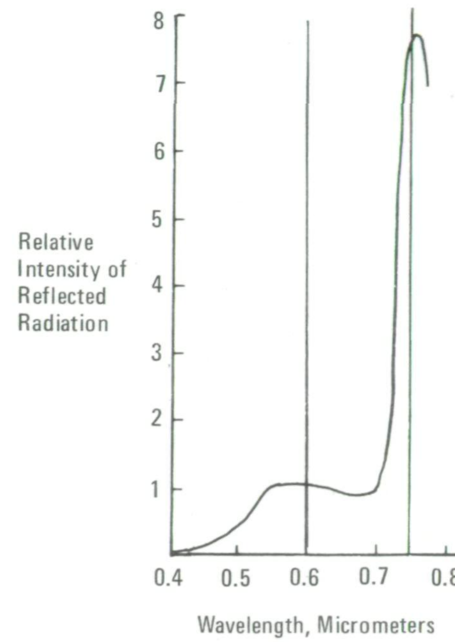
Color Enhancement—The human eye can more easily detect small changes in color than it can small changes in gray tones. This can be used to good advantage. Colors that are different from the natural colors of the scene can be applied to pictures of the scene to increase the visual contrast. This is called *color enhancement*. One enhancement method is to assign a different color to each intensity level in a picture. Then all areas of equal intensity will have the same color on a computer-developed picture of the scene.

Another method of color enhancement is to print the picture obtained in each wavelength on a transparency. A different colored light is then projected through each transparency on to a color-sensitive film.

A third method is to assign a different color to each spectral signature identified. Then all like-colored areas in the scene can be assumed to be of the same material and condition.

A fourth method is to use color infrared film. To make analysis of this type of film easier, the color sensitivities of the film are shifted so that each major waveband the film sees appears in a different color. Figure 3 repeats part of the plot of reflected radiation from soybeans shown in Figure 2. Some of the visible colors, and infrared, are shown to aid in relating color to wavelength. Regular color film shows the colors in the scene as the average human eye sees them. In color infrared film the sensitivities are shifted so that infrared emissions look red, red looks green, green looks blue, and blue does not show up at all.

These types of spectral analyses are especially advantageous for surveying difficult terrains. Even areas heavily covered with forests can be investigated for mineral resources. It seems incredible that a spacecraft speeding through space hundreds of kilometers above the earth can accurately detect mineral deposits concealed by heavy tree cover.



Reflected Wavebands	Blue	Green	Yellow	Orange	Red	Infrared
Colors Apparent in Regular Color Film and Average Eye	Blue	Green	Yellow	Orange	Red	—
Colors Apparent in Infrared Color Film	—	Blue			Green	Red

Figure 3 Infrared Color Representation

However, research has shown that trees growing in metal-rich soil absorb the metallic elements in that soil. The leaves of those trees reflect sunlight differently from the leaves of the same type of tree that grows nearby in metal-poor soil. In an actual test, using information from aircraft, trees growing in soil rich in copper and molybdenum reflected twice as much yellow, but only half as much blue light, as trees growing in ordinary soil. Thus, scientists can tell what chemical elements are contained in the soil of a forest by analyzing the reflection of leaves on the trees.

Photographic information from Skylab has been used, in conjunction with data obtained from other sources, to relate soil color to mineral deposits, and the confirmation of mineral deposits has been claimed.

Applications

A number of earth resources investigations are possible by using remotely sensed information. For example:

Mapmaking—Information can be used in photo mapping to bring maps up to date, and to improve the accuracy and content of maps and surveys.

Geology/Geodesy—Geologists can obtain information on the origin of terrain features, fault location, earthquake hazards, volcanic activity, mineral locations, soil erosion, etc. Measurement of the shape of the earth and of the distribution of the major concentrations of its material are made possible by sensors in orbit around the earth.

Water Resources—Scientists can use information in this category to map the distribution of snow fields, investigate soil moisture distribution in the plains area, measure ice concentrations near the poles, determine the quality of ground water and the areas that contain high salt content, and monitor flood control techniques.

Oceanography—Data can be used to learn more about ocean currents, potential fish abundance, sea surface conditions, sea and lake ice, water color and circulations, and plankton population in upwelling areas. Scientists can use this information to find freshwater plant and animal organisms, analyze bay and coastal environments, and determine coastal water circulation. They can also analyze sediment, water depth, water pollution, and monitoring techniques.

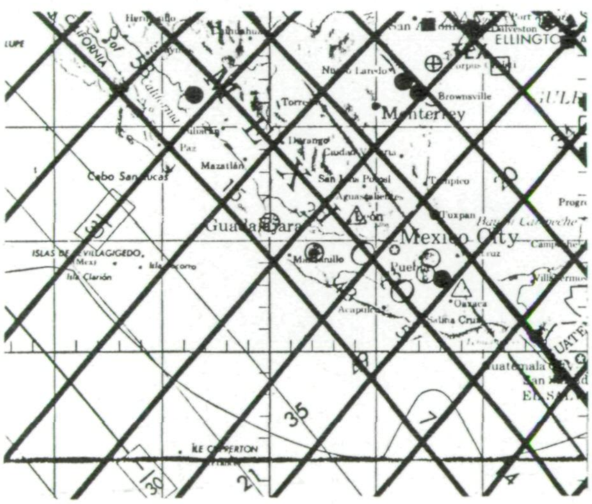
Meteorology—Information can be used to investigate various meteorological events, including cloud features and moisture content, and the effect of terrain on atmospheric disturbances. Solar and terrestrial radiation, particle concentrations, and cloud statistics and characteristics can be measured.

Geography/Ecology—Information obtained in this category can be valuable in land use mapping, crop identification, identifying disease and insect infestation in crops and forests, acreage measurements, urban studies, land classification, and in determining the effects of strip mining and effluent patterns. This information can also be useful in recreation site analysis, water resource development and management, transportation planning, and assessment of fire and erosion damage.

Skylab Earth Resources Passes

Skylab traveled around the earth 3900 times between its launch on May 14, 1973, and the return to earth of its last crew on February 8, 1974. In portions of 110 of these revolutions the Skylab earth survey instruments were directed at earth to obtain data for earth resource investigations. Skylab's orbit permitted the spacecraft to pass overhead along a series of tracks between 50°N and 50°S latitudes. The map on the adjoining pages traces the ground tracks over which data were obtained. Specific investigations were conducted over numerous sites in various parts of the world using data from Skylab in conjunction with data obtained from the surface or near the surface.

Figure 4 below is an enlargement of an area of Figure 5. It shows the passes over Mexico and illustrates the number of areas that were the subjects of investigations in this relatively small area of Skylab coverage.



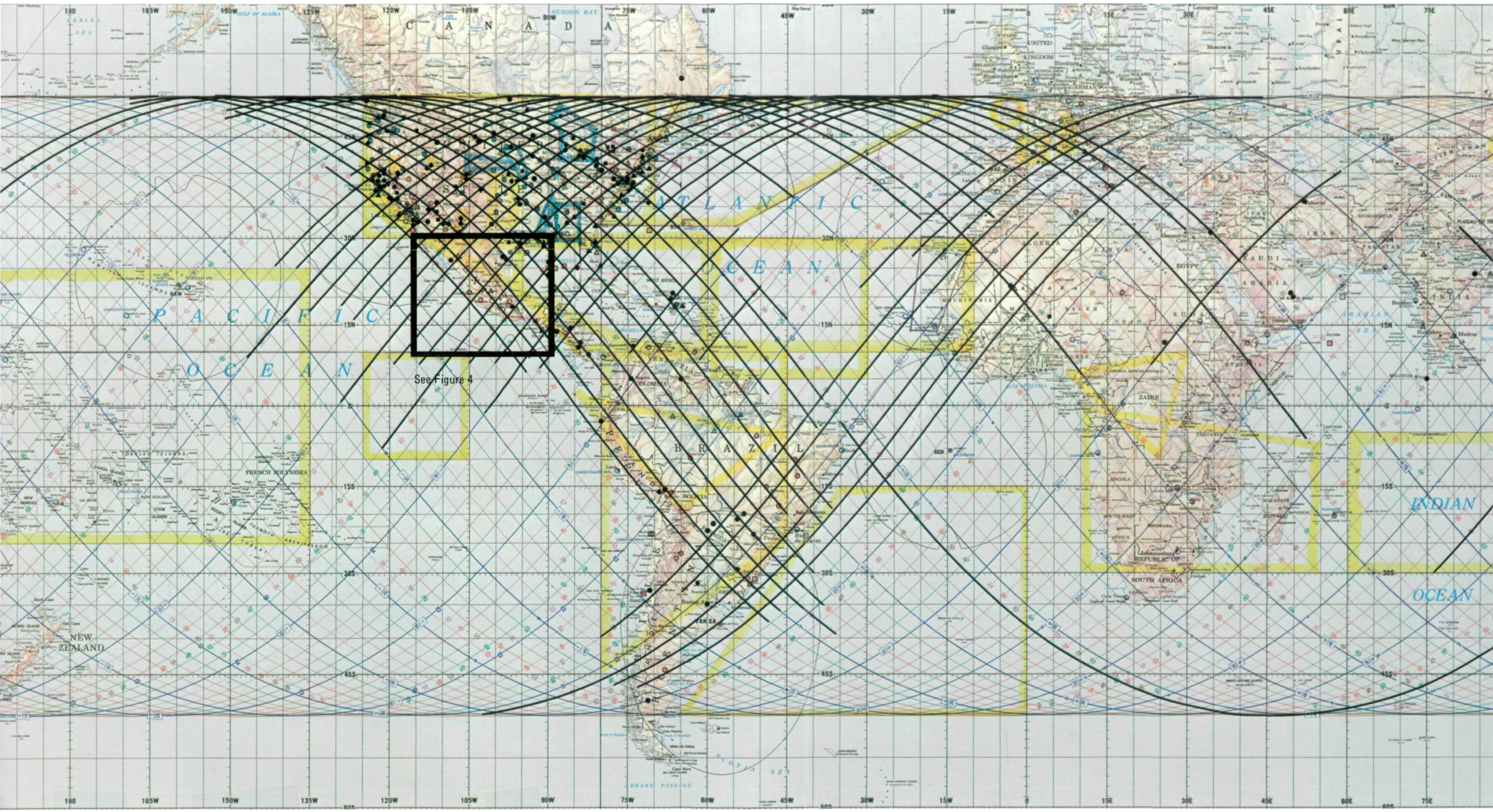
Legend:

- ● Geography □ Oceanography
- ○ Geology △ Ecology

Figure 4 Skylab Passes Over Mexico

The dark lines on the map in Figure 5 indicate those parts of the earth's surface that were surveyed by Skylab earth resource sensors. The points included on the map show the locations where specific investigations were conducted using data obtained by the Skylab crews, from aircraft, and on the surface at these locations.

Figure 5 Skylab Earth Resources Passes (heavy black lines).



FOLDOUT FRAME 2

FOLDOUT FRAME 3

Foldout page for complete map of Skylab Earth Resources observation passes.

Sensor Description

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An objective of the Skylab program was to show how feasible it is to study earth resources from spacecraft in orbit around earth using cameras, infrared sensors, and microwave sensors. Six sensors were used: two were cameras using photographic film, three recorded information on magnetic tape, and one used magnetic tape and photographic film. The rolls of film and tape were brought back to Earth by the astronauts. Basic features of these sensors are described in the following paragraphs.

Multispectral Photographic Camera—This instrument consisted of six cameras with matched lenses all designed to photograph the same area on the ground. Figure 6a shows how much ground each camera could photograph in a single exposure. The center of the area was at the nadir, that is a point on earth directly below the spacecraft. Each of the six cameras took photographs in a different wavelength of radiation reflected from surface features.

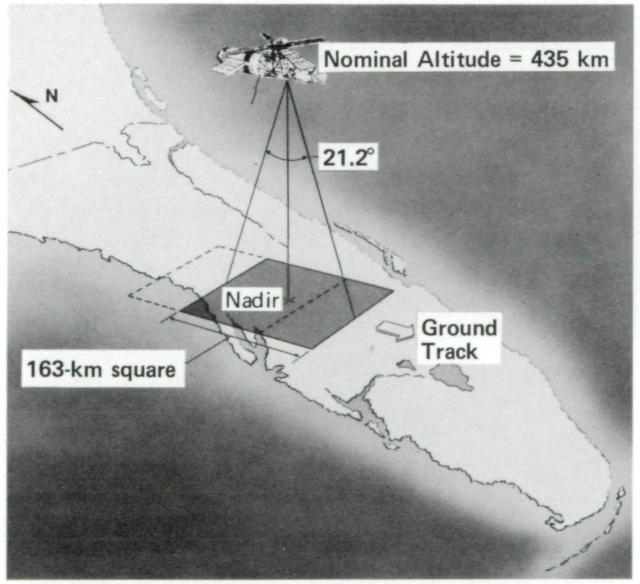


Figure 6a Picture Area—Multispectral Camera

These multispectral cameras provided 70-mm pictures of the same area with such accuracy that the six different images can be used individually or together to make a photograph. Photography of this type is a highly flexible and universal tool to investigators in all of the areas listed on page 5.

Earth Terrain Camera—This single camera had a focal length three times that of the multispectral photographic camera. It produced photographs of a smaller area on the ground, but with more detail than the other six cameras. The area of ground photographed in a single exposure is shown in Figure 6b. These photographs, taken in color, black and white, and color infrared, augment the photographs taken by the multispectral cameras and the other sensors described below.

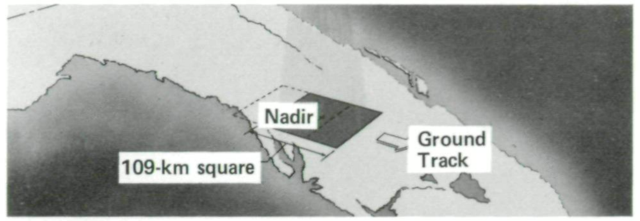


Figure 6b Picture Area—Earth Terrain Camera

Infrared Spectrometer—This sensor measured the radiation from a 0.5-kilometer spot on the ground. From the many wavelengths of energy that reached the spacecraft, this instrument measured the radiation in two wavelength bands—0.39 to 2.5 micrometers (reflected) and 5.82 to 15.99 micrometers (emitted). The short wavelength radiation was reflected from surface features illuminated by sunlight. The long wavelength radiation was energy emitted by the ground feature as a result of heating by sunlight or from heat sources within the ground.

The *spectral radiance* was measured at all wavelengths across each region. These measurements were converted into electrical signals and were recorded on magnetic tape.

The recorded signals can be processed to produce visible and infrared spectra of the scene in a form similar to Figure 2. In addition to the magnetically recorded data, a 16-mm movie camera was used to photograph the point on earth from which measurements were made.

The instrument was aimed by an astronaut and could be pointed at any feature within the area shown in Figure 6c. The inset shows the size of the image that the astronaut saw and what the camera photographed.

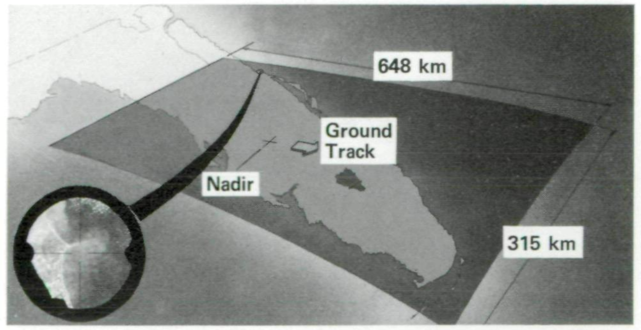


Figure 6c Scanning Area—Infrared Spectrometer

Data obtained will be used for studying the composition of the earth, identifying types of rocks and other mineral resources, location of underground water, and mapping of surface conditions such as snow cover, ice field locations, and high temperature areas like the hot springs in Yellowstone National Park.

Multispectral Scanner—This sensor scanned the surface of the earth across a 74-kilometer-wide band beneath the spacecraft. Detectors measured the spectral radiance from earth in 13 different wavelengths and electronically converted each series of measurements into signals that were recorded on magnetic tape.

Twelve of the wavelengths recorded radiation in the visible through the infrared wavelength region reflected from earth features; the thirteenth wavelength recorded was long wavelength infrared emitted from earth. Some of the wavelengths measured by this instrument are beyond the range that can be recorded on photographic film.

By processing the data in computers, spectral signatures of the ground features (see page 3) can be developed and electronically constructed pictures can be prepared to aid in analysis of crop and field conditions, atmospheric and water pollution, and geothermal energy sources.

Figure 6d shows the ground track scanned by this instrument.

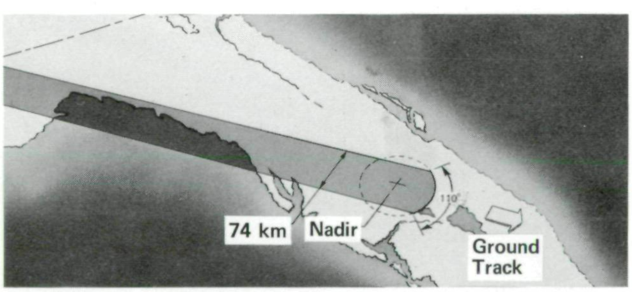


Figure 6d Scanning Track—Multispectral Scanner

Microwave Radiometer/Scatterometer and Altimeter—This single sensor performed three functions in the *microwave* radio range of the electromagnetic spectrum where the wavelengths are about 100,000 times the wavelengths in the visible range.

The radiometer measured the radiation emitted and reflected by the earth's surface. The radiation received provided information on the brightness temperature of the terrain. From the brightness temperature the actual surface temperature can be determined. The scatterometer transmitted a pulse to the ground and analyzed the differences detected when the reflected pulse was received back on Skylab.

The information obtained from this sensor indicated the roughness of the surface it scanned. Surface roughness results from the shape of the ground, or from vegetation such as forests. Roughness measurements made over the ocean indicate how rough the water is, which in turn is a guide to weather conditions.

As an altimeter, this sensor measured the time for a radar pulse to be sent to the ground and to be reflected back to the spacecraft. With this information it is possible to measure the relative heights of features on earth with considerable accuracy.

Figure 6e shows the area that this sensor can scan to obtain information.

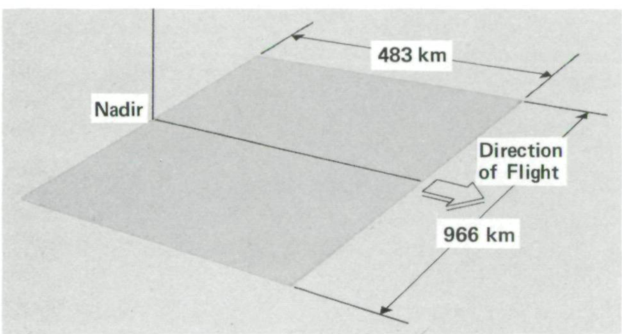


Figure 6e Scanning Area—Radiometer/ Scatterometer

L-Band Radiometer—The information obtained from this experiment was similar to the radiometer data obtained on the above microwave experiment except the information was recorded in a different frequency. Here the wavelength was about 1,000,000 times that of visible light. Again the data were recorded electronically on magnetic tape and measured the condition of land and sea surfaces and also gave considerable information relating to the study of cloud formations, wind conditions, and soil moisture content.

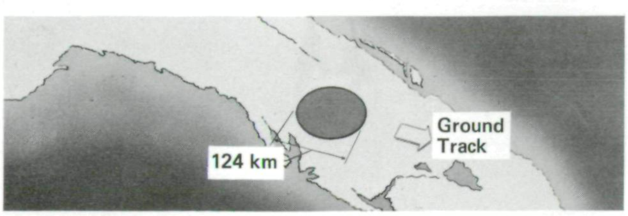


Figure 6f Observation Area—L-Band Radiometer

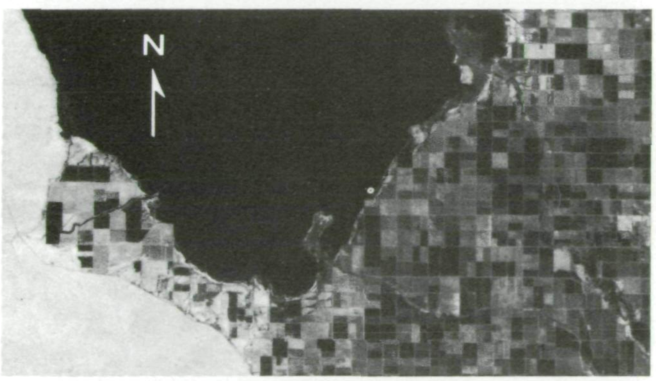
Earth Resources Data Analysis

Salton Sea, California—The six photographs shown on this page (Figure 7) are of the south end of the Salton Sea in southern California. They were obtained by Skylab's multispectral photographic cameras on September 15, 1973, from an altitude of about 435 kilometers. Each photograph represents a waveband in the visible or near infrared regions. The three pictures in the left column are in the visible range, and the three in the right column in the infrared. Remember that growing vegetation appears red on the color infrared photograph, Figure 7d (see pages 3 and 4).

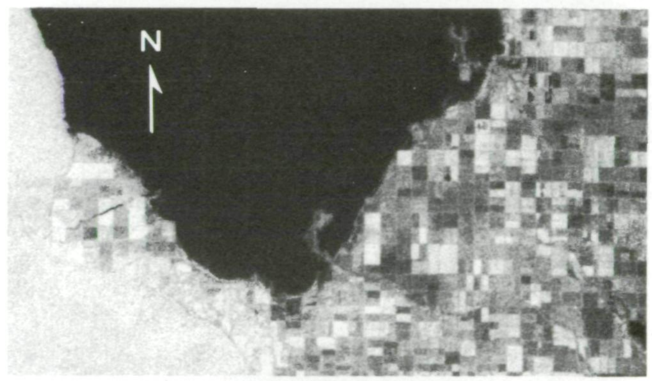
The area shown is outlined on the photograph of the Salton Sea on the cover of this booklet. The area outlined in Figure 7a is illustrated at a larger scale by a photograph obtained by the higher resolution, earth terrain camera (Figure 8). The scale of

a. Color Visible Light (0.4 to 0.7 Micrometers)

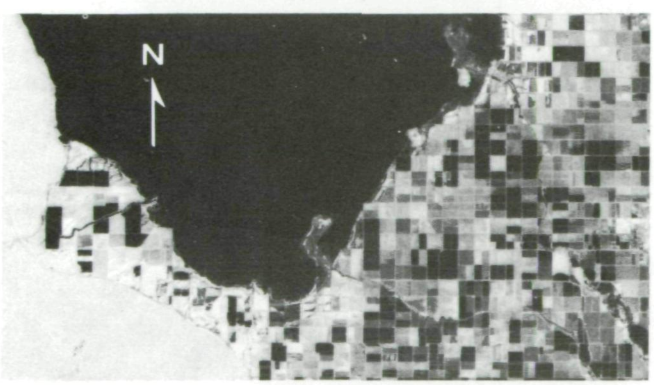
d. Color Infrared (0.5 to 0.88 Micrometers)



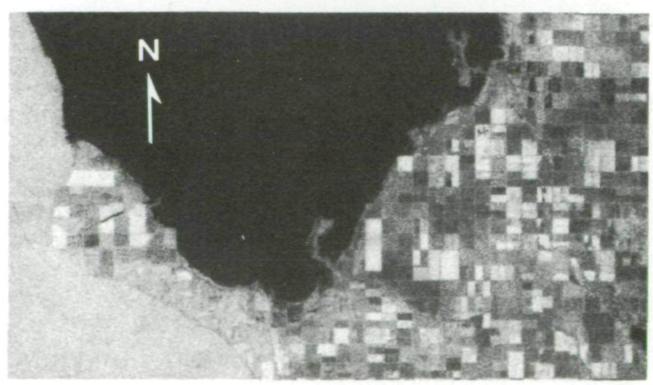
b. Black & White Photo (Green Waveband—0.5 to 0.6 Micrometers)



e. Black & White Photo (Infrared—0.7 to 0.8 Micrometers)



c. Black & White Photo (Red Wave Band—0.6 to 0.7 Micrometers)



f. Black & White Photo (Infrared—0.8 to 0.9 Micrometer)

Figure 7 Multispectral Camera Photographs of the Salton Sea this picture in comparison with the scale of the set in Figure 7 reflects the size of the fields of view and focal lengths of the two cameras. The spectral waveband in the Figure 8 photograph is the same as in Figure 7d; therefore the colors of the fields are very similar. The resolution, or clarity, of the image is much better in Figure 8 than can be achieved even by magnifying frame 7d to the same size because the earth terrain camera had a larger focal length.

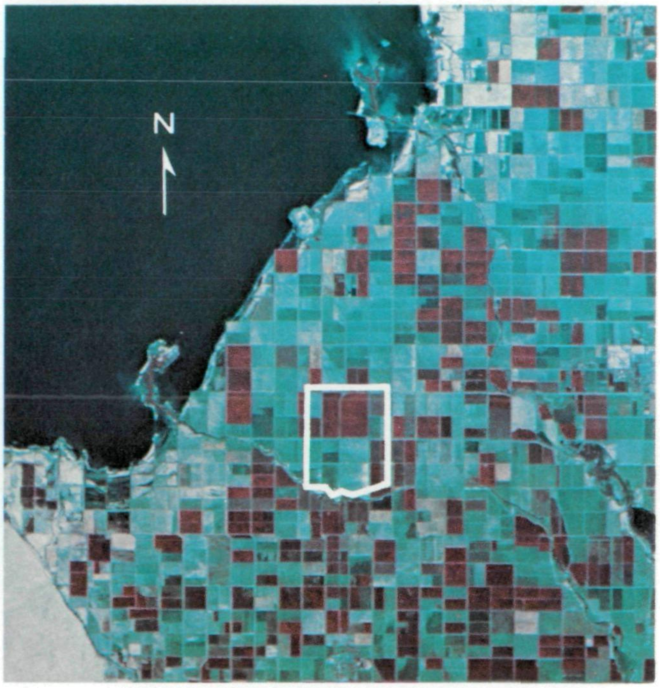


Figure 8 Color Infrared (Earth Terrain Camera)

The red spot in the water seen in Figure 7d is a flaw in the film. Because the spot occurred over water it was easy to detect as a flaw. If the flaw had occurred over cultivated ground, it might have caused confusion. However, it still would have been detected because it would not have been visible on the other five pictures.

These six multispectral photographs of the same scene demonstrate the way in which surface features appear different in each of the wavelengths of radiant energy used. Just to the right of the center of the image is a river called the New River. The New River enters the lake at the base of a peninsula that juts out about a mile and a half into the lake. The peninsula is visible in frames 7a and 7d, almost disappears from frames 7e, 7f, and 7c and is barely discernible in frame 7b.

After studying the photographs, differences can be seen in the appearance of the fields. Looking at the strip of land enclosed by the small rectangle extending north from the New River (shown in Figure 8), notice that a number of fields nearest to the river show up lighter on frames 7a, 7b, 7c, and 7d than the group of fields immediately to the north. The relative brightness is reversed in frames 7e and 7f, the northern group of fields being very much brighter.

Going back to frames 7a and 7d, particularly 7d, you will see differences in tone in the group of fields in the south. These differences cannot be seen in the two infrared frames 7e and 7f, but are discernible in the red and green wavelengths of frames 7b and 7c.

Returning to frame 7d we can see that, in the northern end of the rectangle, two fields appear a bright red color. These are the two fields that show up so brightly in the same rectangle on frames 7e and 7f. Immediately to the north of the eastern field of these two are two smaller fields that appear in frame 7d as a slightly darker red tone. This difference is more prominent in frames 7e and 7f but is not detectable in the visible light frames 7a, 7b, and 7c.

What does this tell us? It tells us that, once we know what the crops are in those two smaller fields and the conditions of those crops, we may deduce that other fields with the same tones as these in all three infrared frames should have the same crops with similar conditions ("conditions" means plant growth, soil moisture, etc).

Such deductions can only be made for this particular set of photographs. If photographs taken at a different time are to be used, the specific conditions prevailing on the known crops must be defined for the time the photographs were taken before comparisons between sets can be made.

To aid in the understanding of the information contained in this set of photographs, a map based on the U.S. Geological Survey map of the area is included as Figure 9. The crops growing on September 15 (the day the photographs were taken) are marked on the map.

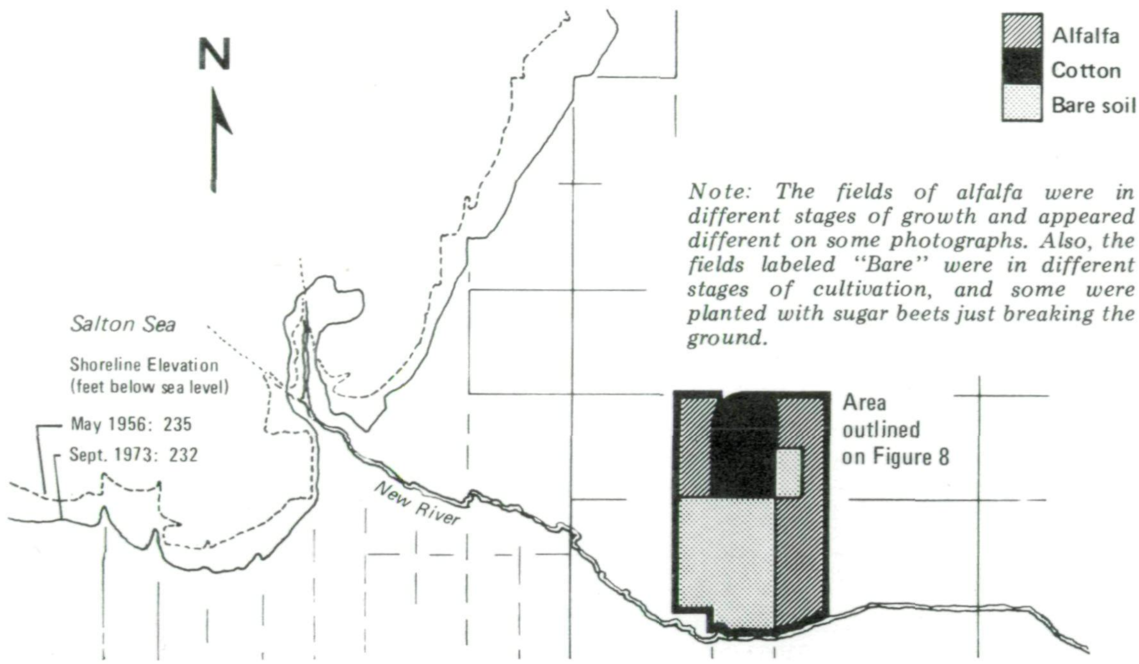


Figure 9 Crop Identification

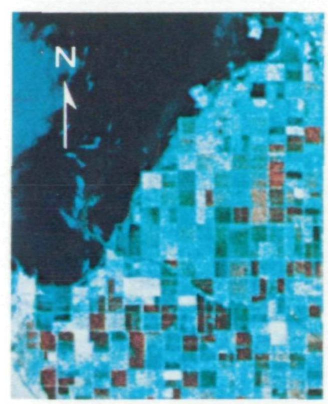
While preparing this booklet, two incidents occurred that illustrate some of the potential practical applications of Skylab data.

First, while comparing Figures 8 and 9 we discovered the shoreline in the photograph did not match the map. By plotting the "new" shoreline on the map, we deduced that the level of the lake had risen from 235 feet below sea level in 1956 to 232 feet in September 1973. The U.S. Geological Survey Office in southern California confirmed the deduction. Thus, the use of Skylab data to confirm existing maps or to create new ones has been demonstrated in a very practical way.

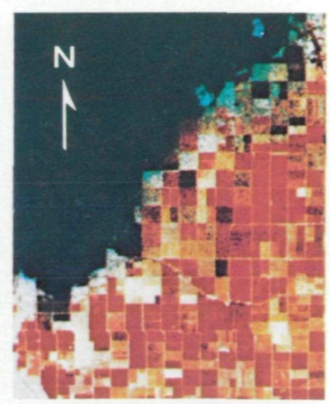
Second, when we requested the crop information shown in Figure 9, the Agricultural Commissioner for Imperial County recognized the value of the Skylab data to survey the weed growth in the area. The commissioner has asked for Skylab photographs for that purpose.

Figure 10 consists of two images of the south end of the Salton Sea prepared by the Itek Corporation, the developer of the multispectral photographic cameras. Figure 10a is an enlargement of an infrared photograph obtained on a different day from that shown in Figure 7, and shows the different colors and tones of the various crops in the area. It is evident in this photograph that the spatial resolution—that is, the definition of small details such as roads and ditches—and the color representation is less than in Figure 10b. This picture is the same size enlargement of the same area, but it is a combination of the images from three cameras. The black-and-white infrared (0.7 to 0.8 micrometer) and the green and red images are superimposed in an example of color enhancement (see page 4).

The value of color in representations of this type is that the eye can detect small color variations much more readily than variations in gray tones, a concept demonstrated in this figure by comparing the figure to the black-and-white pictures in Figure 7.



a. Color Infrared



b. Composite

Figure 10 Color Enhancement

Figure 11 is an example of how information obtained from electronic sensors in digital format can be processed to make a color photograph. The area shown includes Lake Powell in Utah.

While the resolution in this computer-constructed photograph is not as good as in the camera photographs, there are several reasons for obtaining this type of information. The electronic equipment used to make this photograph can record the scene in 13 different wavebands simultaneously. Some of these wavebands are in the infrared regions and beyond the limits of photography. Therefore, the spectral signatures of elements at these frequencies cannot be obtained in any other manner. By using computer methods, the 13 different measurements can be combined to enhance the usefulness of the data to the investigator.

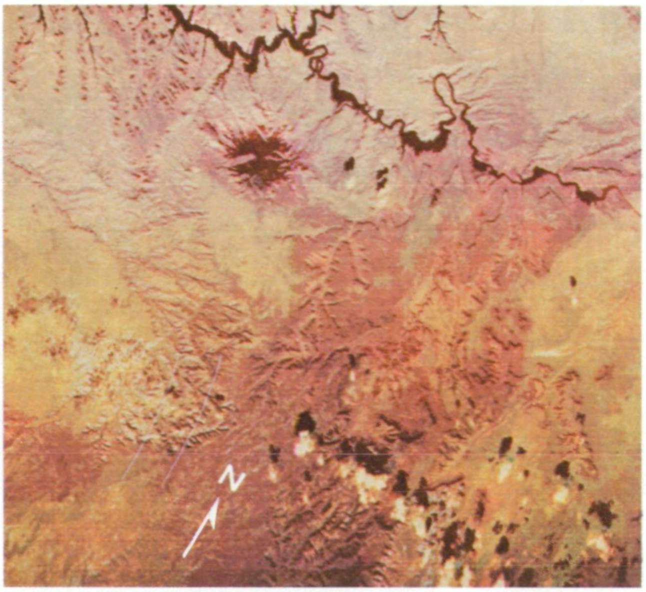


Figure 11 Computer Constructed Picture

Columbia, South America—The Skylab microwave radiometer was an electronic instrument that very rapidly measured and recorded data relating to the surface temperature of the earth below. The average surface brightness temperature of a ten-kilometer-diameter area was measured even though a cover of clouds prevented visual observation. By rapidly scanning a larger area of interest, a plot can be made of the different brightness temperatures over the area. Also by applying blue colors to low temperatures and graduating to red for the highest temperatures, the distribution of temperatures becomes more apparent. This is another example of color enhancement development.

Figure 12a is a plot of the north coast of Colombia, South America. Comparison of the location of brightness temperature spots with a map of the area showed that the sensor had detected a shallow bay even though the temperature spots were 10 kilometers in diameter. The shore line is superimposed on the plot. An earth terrain camera photograph of the same area is shown as Figure 12b for comparison.

A future instrument of this type with much finer detail could be used for surface mapping regardless of cloud conditions.

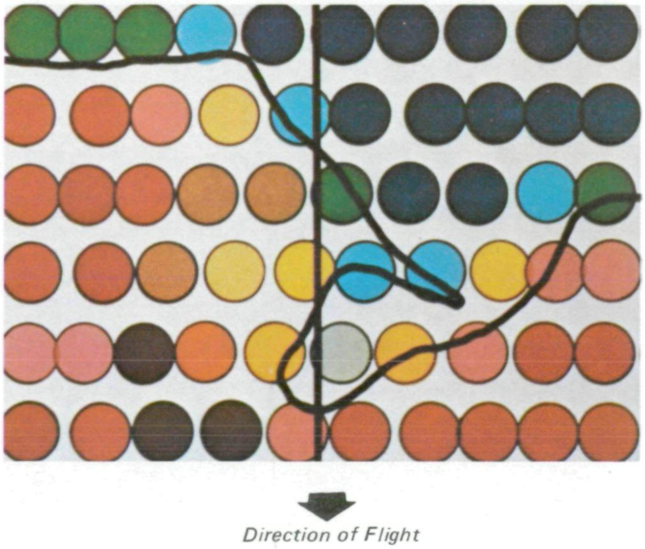


Figure 12a Surface Brightness Temperature Plot

Figure 12b High Resolution Photograph

Checking the Sea Level– For hundreds of years the surface of a body of water was considered to be flat. Then, careful observations of the surfaces of long, straight canals were used to verify the curvature of the earth. The surface of the oceans was assumed to represent the true shape of our planet and altitudes were measured from sea level.

The tides and the waves in the ocean were recognized as variations from a nominal "mean sea level".

The flights of satellites in orbit around the earth have produced data that have indicated that the earth is not a uniform body—differences in density or mass exist. These differences affect the gravitational forces which cause different heights of the oceans.

On January 31, 1974, Skylab's radio altimeter measured the altitude of the oceans' surfaces continuously all around the earth (the only land masses encountered were North and South America). Figure 13 is a plot of the altitude changes above and below a theoretical mean smooth surface of the earth.

You will notice that the maximum range of the altitude variations is about 130 meters.

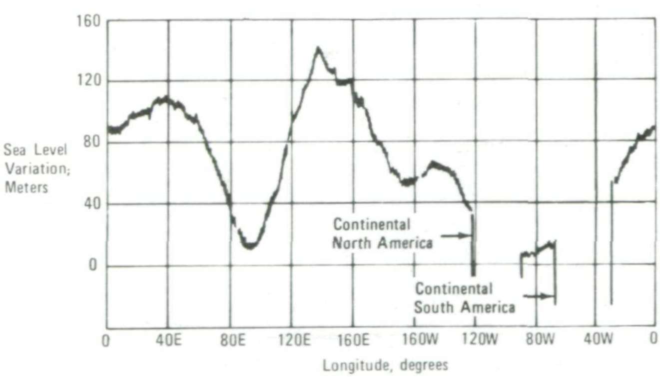


Figure 13 Sea Level around The World

By using the same radio altimeter on a pass in a southeasterly direction from the United States over the Atlantic Ocean, the altitude of the ocean surface was measured and was found to vary in close relationship to the variation in the shape of the ocean floor. Figure 14 shows the ocean surface and the ocean floor profiles. Figure 15 shows the area over which the sensor data was recorded.

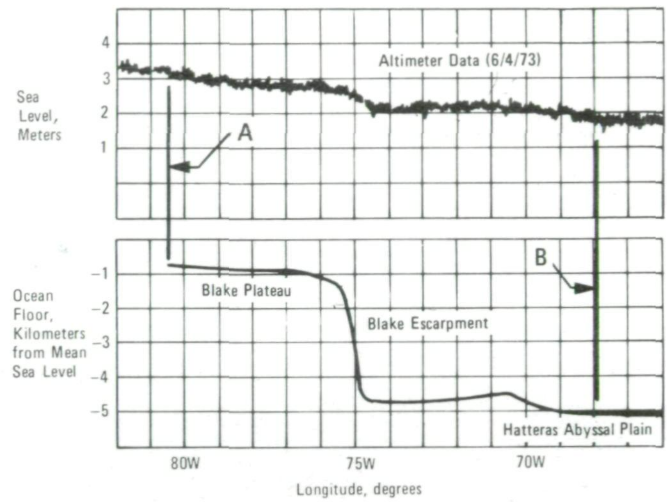
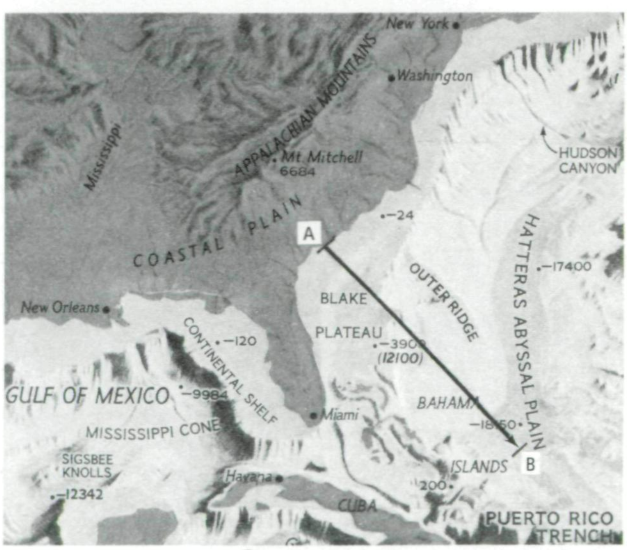


Figure 14 Sea Level vs Ocean Floor



Courtesy of National Geographic Society

Figure 15 Skylab Flightpath

Availability of Skylab Data

The last Skylab earth resources pass was flown on February 1, 1974. The amount and quality of data obtained during the three missions exceeded every pre-mission expectation. The sensors were operated singly or in various combinations depending on the scientific requirements or other factors, such as bad weather and each instrument's ability to penetrate it. The data were recorded on film and magnetic tape and returned to the NASA Johnson Space Center for initial processing. From the three Skylab missions, a total of approximately 35,000 frames of 70 millimeter and 5,600 frames of 5-inch film and approximately 1,320 feet of 16 millimeter film were returned to earth. Also, a total of 228,000 feet of magnetic tape was returned. Extensive data were obtained over North America, Central America, South America, the Gulf of Mexico, Eastern United States coastal waters, the Northern Atlantic and Pacific oceans in the areas shown in Figure 4. Considerable data were obtained over Europe, parts of Africa, Southeast Asia, Japan, Indonesia, and Australia. The Skylab data, coupled with data from the Earth Resources Technology Satellite (ERTS) can be used in school activities such as: comparing the new data with local maps to identify changes, making land use surveys, mountain snow cap surveys, studying the relationships of cities and natural features, etc.

How to Obtain Earth Resource Data

The EROS Data Center in Sioux Falls, South Dakota, is operated by the Topographic Division of the Geological Survey for the Earth Resources Observation Systems Program of the Department of the Interior. This center provides access to satellite earth resources imagery, aerial photography, and NASA aircraft data for the general public, United States government agencies, and foreign governments.

Data can be obtained from the EROS Data Center by phone, in person, or by letter.

1) Telephone
   7:00 a.m. to 7:00 p.m.
   (605) 339-2270

2) Visit
   7:45 a.m. to 4:30 p.m.
   EROS Data Center
   10th and Dakota Avenue
   Sioux Falls, South Dakota

3) Write to:
   EROS Data Center
   Data Management Center
   Sioux Falls, South Dakota 57198

If no assistance is required to identify the desired data, the following information must be furnished to EROS: location, number of copies, types of copies, etc.

If assistance is required from EROS to identify the desired data, the following information must be furnished:

1) Geographic area of interest;
2) What the data will be used for;
3) How the data will be used;
4) Particulars regarding photograph.

As of June 1, 1974, EROS Data Center contained nearly 5,000,000 frames of film:

6,000 from Apollo and Gemini;

31,000 from Skylab;

400,000 from ERTS;

1,300,000 NASA Aircraft photos;

3,000,000 Department of Interior mapping photos.

Additional film is continually being added to the EROS files.

Price lists and more detailed information are available from EROS upon request. The current prices of black and white reproductions of Skylab photographs are shown in the accompanying table.

Color reproductions are available at about three times the price of black and white. For more information, contact EROS.

Image Size	Print Price	B&W Transparency Price	Scale
2.2 inch	—	$2.00	1:2,850,000
6.4 inch	$ 2.00	—	1:1,000,000
12.8 inch	$ 5.00	—	1:500,000
25.6 inch	$12.00		1:250,000

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National Geographic Society, Washington, D.C. (Figure 15). ©1968 National Geographic Society

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