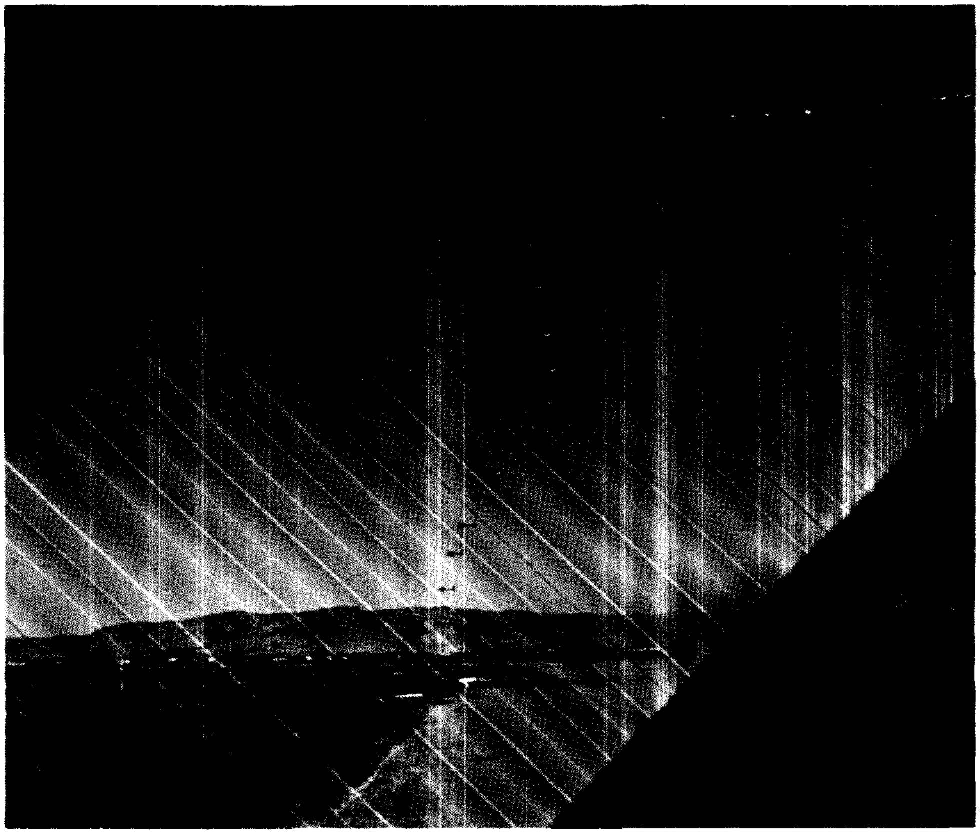
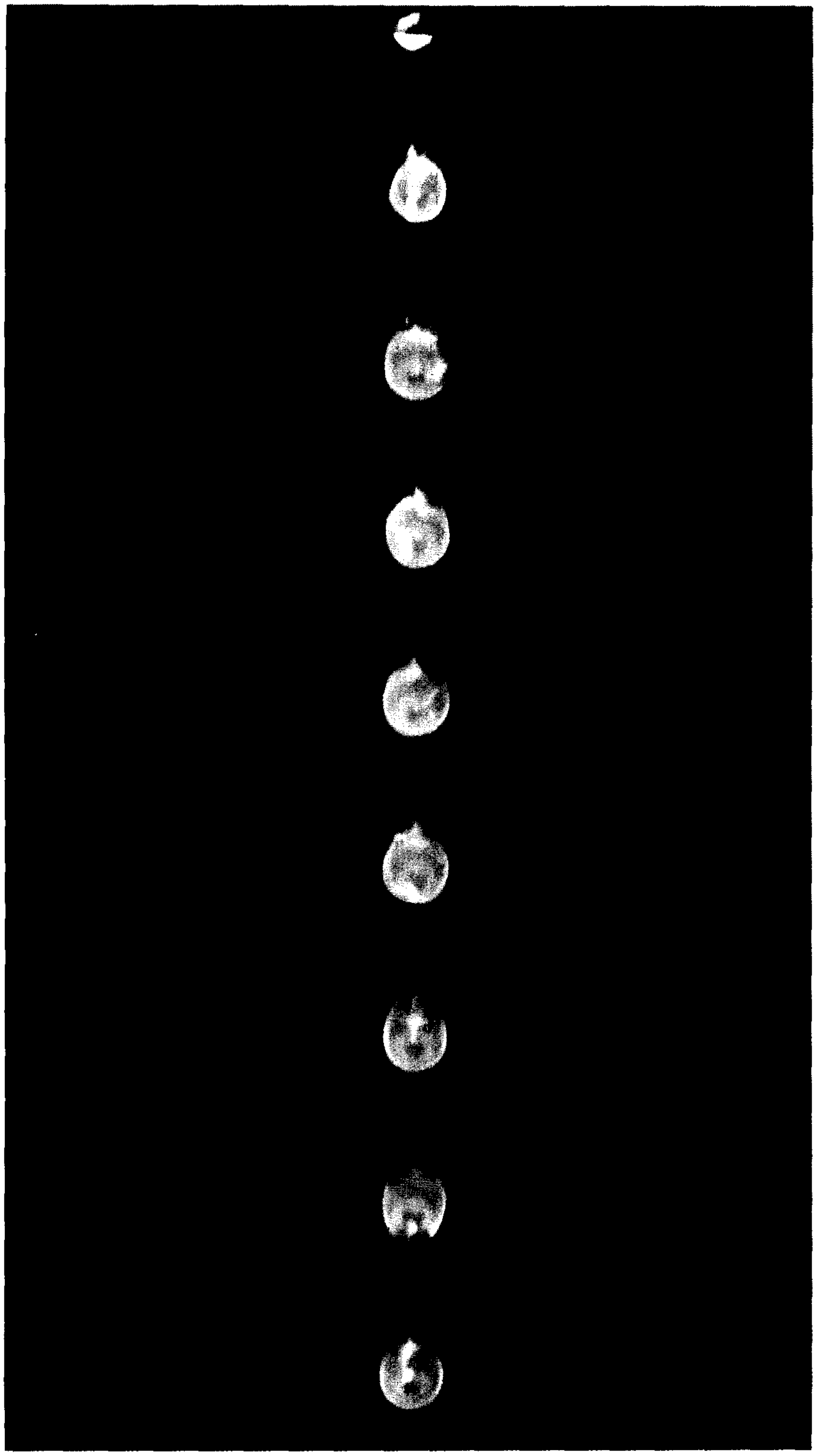
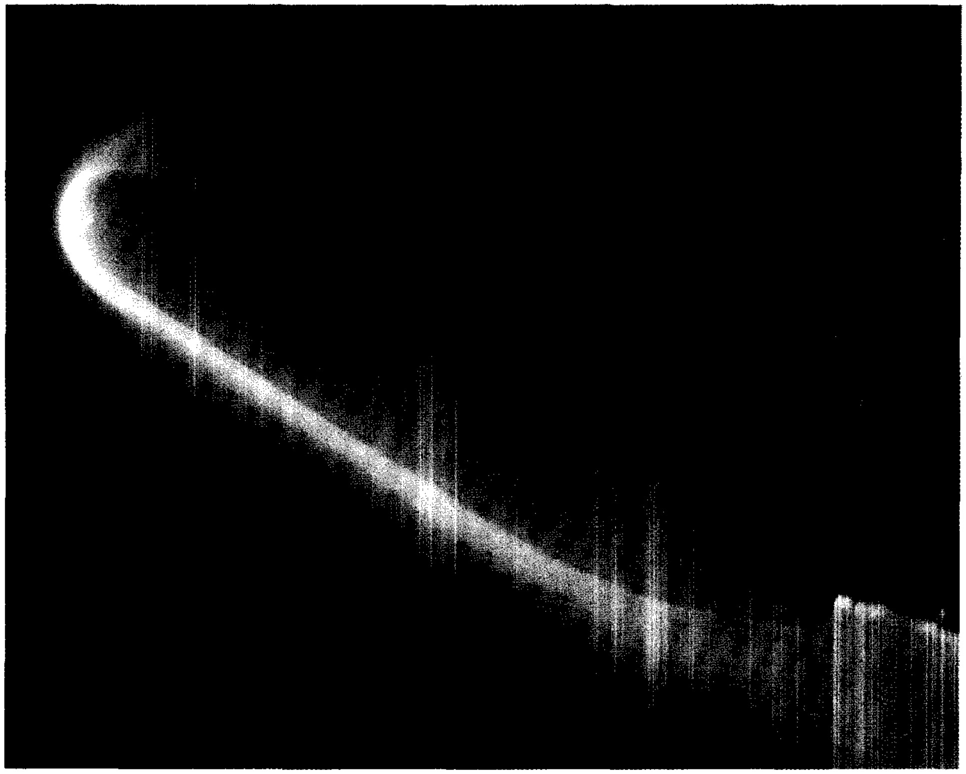


The time-displacement record of a V/TOL aircraft, the X–14, was made with a Fairchild Photographic Flight Analyzer Camera. The camera is arranged so that the entire background and fixed scene are properly exposed, but each element of the scene is exposed at the particular time when the aircraft passes over it. This time is determined by the tracking mechanism and the individual time of each image is recorded on the edge of a strip on the originally exposed film.

COLOR
PLATE
5

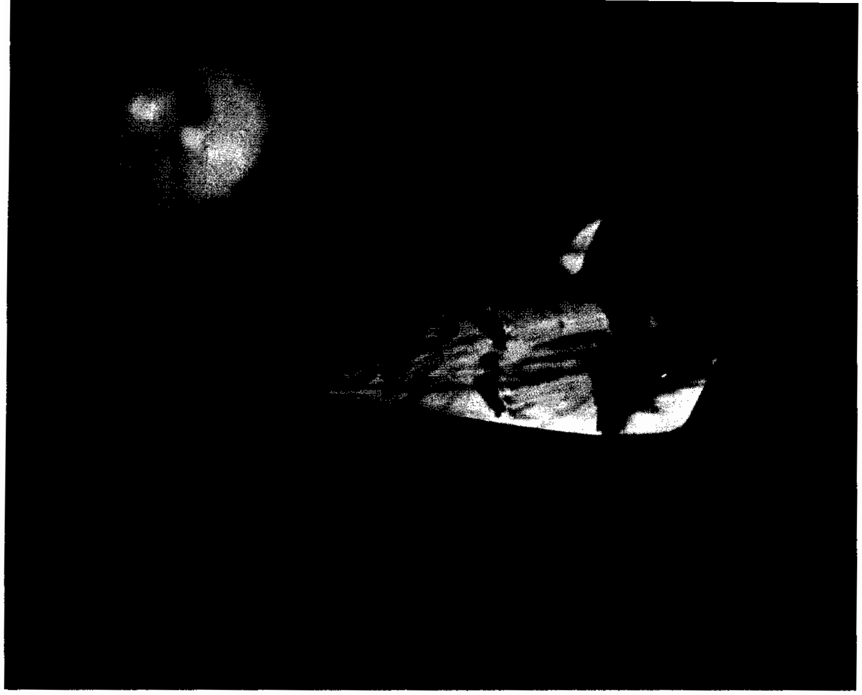


COLOR PLATE 6 A time-displacement photograph of the burning of an aluminum droplet.



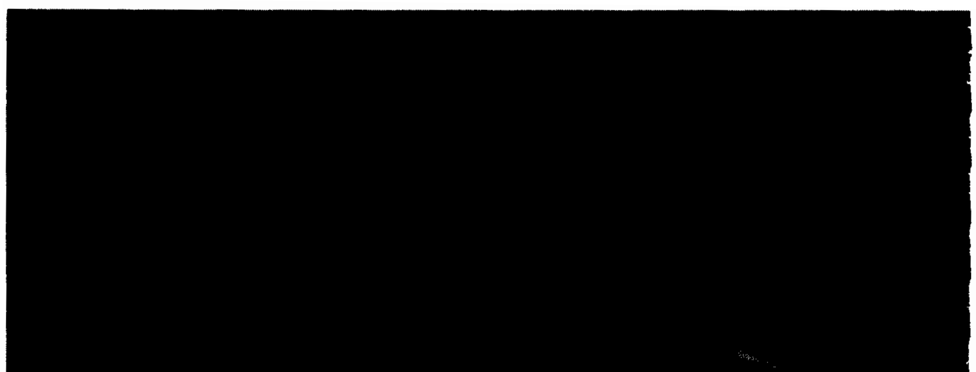
A model of the M–2 lifting body at Ames Research Center is shown during the heating phase of testing in a 1-foot Hypervelocity Wind Tunnel. The air flow velocity is 14,000 feet per second, producing gas temperatures at the blunt nose on the order of 9,000° F. Under certain conditions and at high altitudes, such a vehicle in actual flight would encounter temperatures well in excess of this level. When this picture was taken, the heat transfer distribution was being measured.

COLOR PLATE 7



Evaluation of a wind-tunnel model by photography with ultraviolet light exciting a fluorescent oil to record oil patterns of air flow.

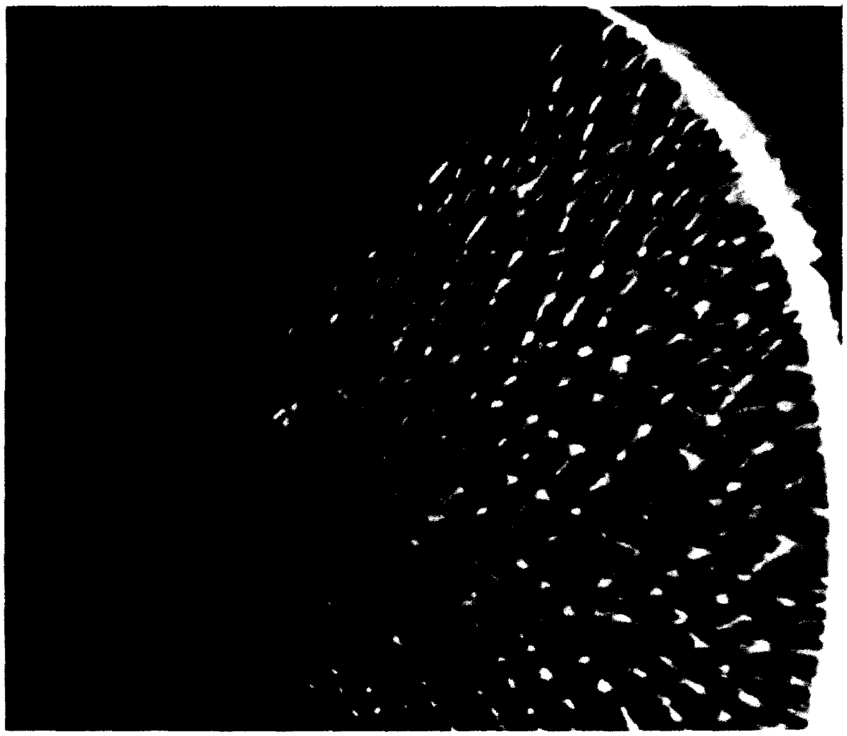
This delta-winged reentry glider shows evidence of glow discharge at high velocity in a hypersonic wind tunnel.



COLOR PLATE 8

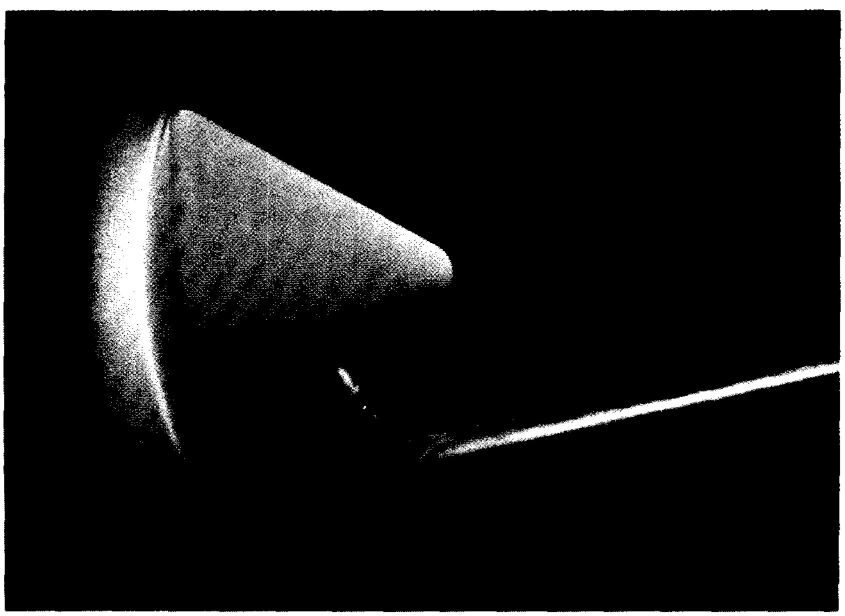
This photograph of an ablation test on the early Mercury capsule model was made in a wind tunnel which simulated reentry of the capsule through the Earth's atmosphere. The model, made of phenolic resin and fiber glass, was photographed during exposure to wind-tunnel conditions to determine the behavior of its components. Motion pictures are taken to obtain a full time sequence of the ablative behavior.

COLOR PLATE 9

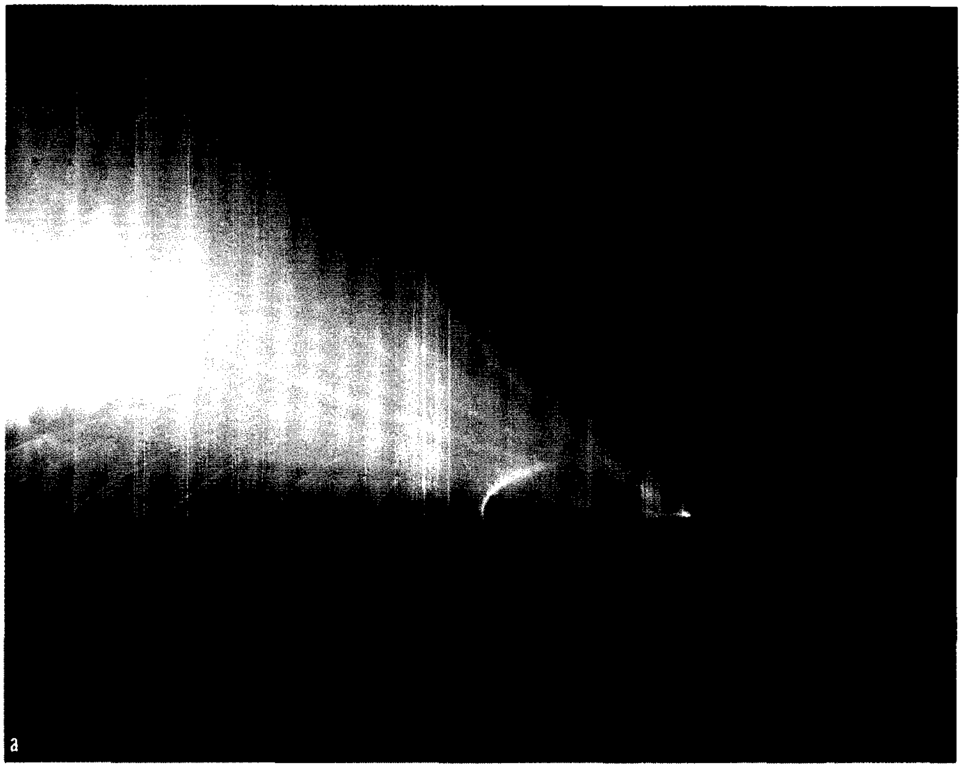


A closeup of patterns formed during ablation on a Lexan plastic model of a cone form. A sequence of pictures of this occurrence shows how the pattern forms as velocity increases and ablation develops.

This striking picture of an Apollo model capsule is one of a series used to evaluate heat transfer to the afterbody of the model. It was taken during one of the ablation tests which simulate reentry phenomena in a wind tunnel.

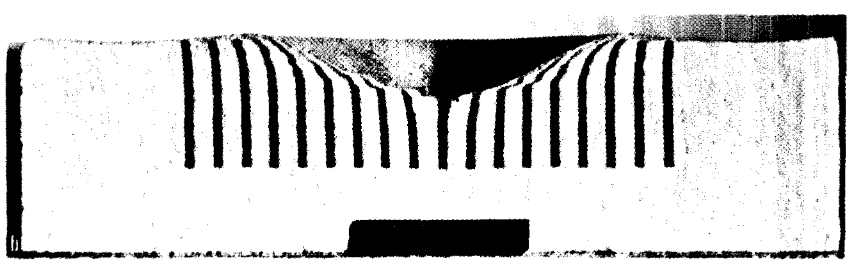


COLOR PLATE 10



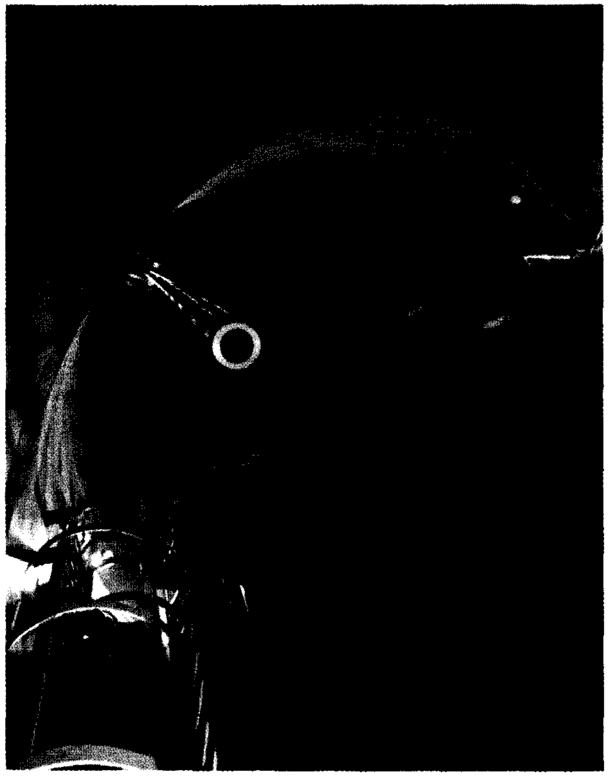
This photograph was made during engineering impact studies. A high-speed gun generates high-velocity particles which impact on a bed of sand. This picture of the impaction shows the shock heating of the particles. The contact area of sand has also been used to simulate the lunar surface and study the formation of craters.

This is an analysis photograph of the high impact studies on the sand target. After an impact, the sand target is baked. The bed of sand is mixed with a thermosetting resin which, upon baking, causes the hardening of the sand in the pattern that occurred as a result of impact. The sand also contains the color segments which are added as vertical elements to show the flow of the sand as impact occurs. After this sand target was baked, it was sawed in half to take the picture shown here, with graphical precision so actual measurements can be taken from striped patterns.

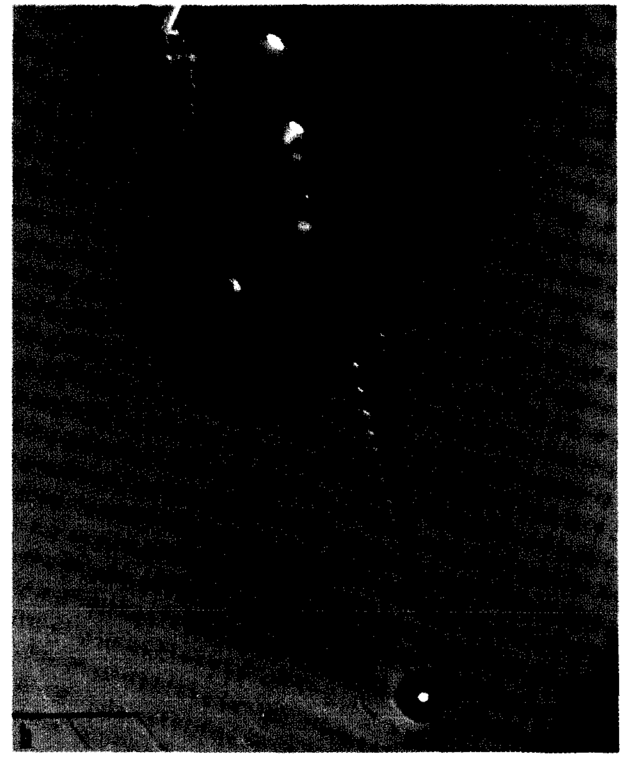


COLOR PLATE 11

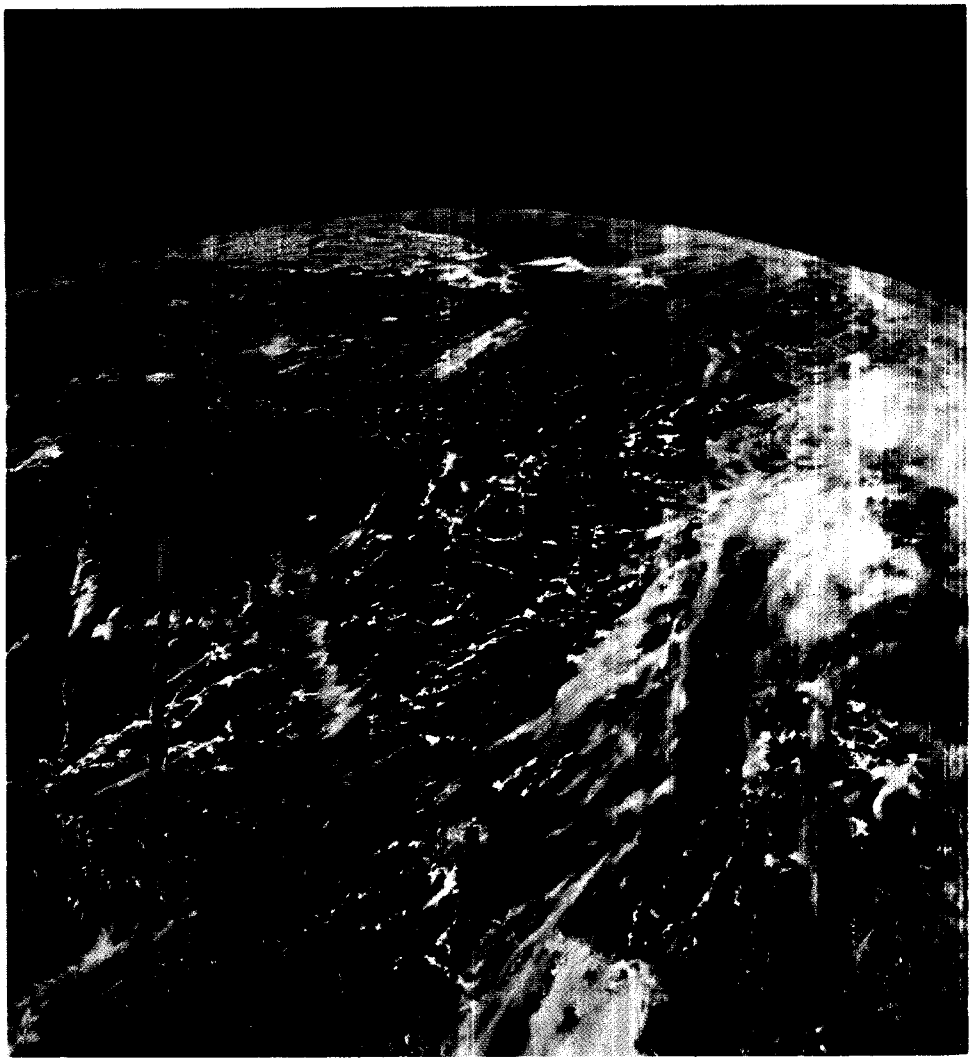
COLOR PLATE 12



A photograph of the Zero Gravity Drop Tower at Lewis Research Center in which photographic equipment is in the drop packages to record test events.

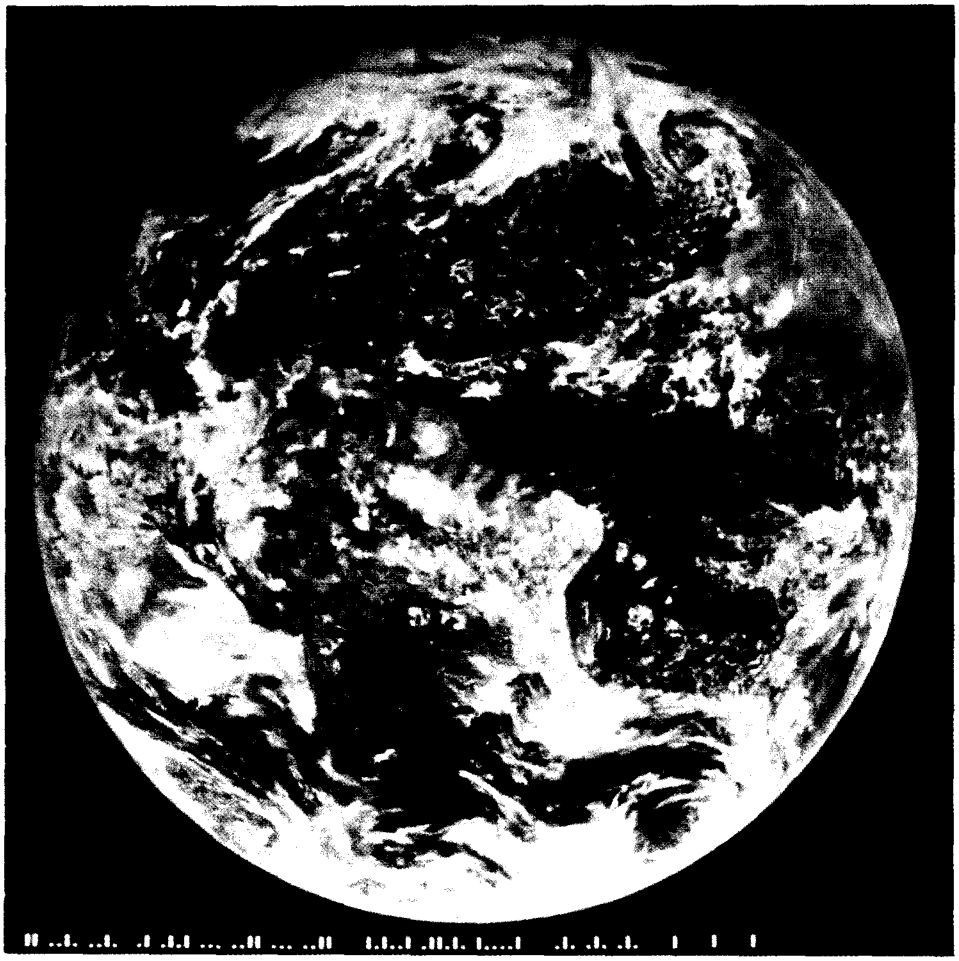


The installation of lighting and cameras in the Zero Gravity Drop Tower at Lewis was difficult because of the immensity of the test chamber. This figure depicts the raceway assembly for camera location along the vertical test path. Lighting is shown installed while the technicians are preparing a camera.



During the Gemini XI mission, the astronauts were able to see how clouds developed and changed in the brief time it took the spacecraft to circle the world. India and Ceylon are near the horizon at the left. Cumulus congestus, seen on the previous orbit over Ceylon, had become cumulonimbi, with elongated anvillike tops extending nearly 100 miles to the Indian coast, by the time this photo was taken. Over the Indian Ocean in foreground, dense cirrus and cirrostratus clouds hid many low-level convective clouds.

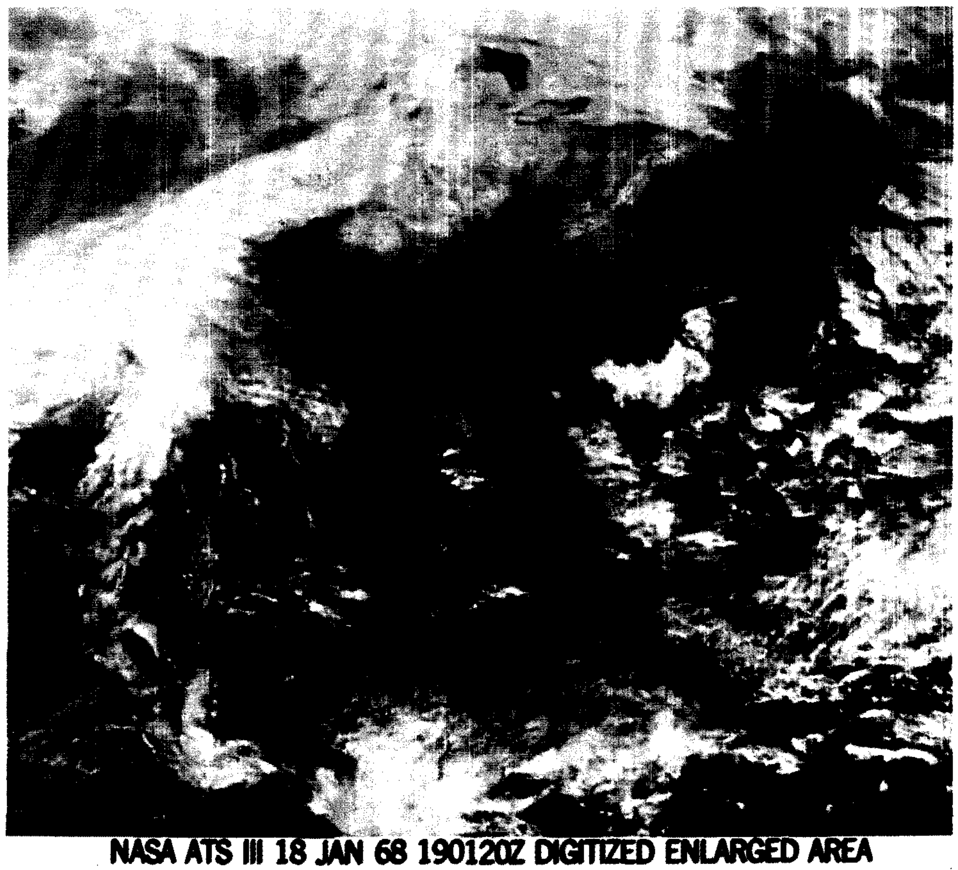
COLOR PLATE 13



NASA ATS III MSSCC 18 NOV 67 150303Z SSP 49.16°W 00.03°S ALT 22240.59 SM

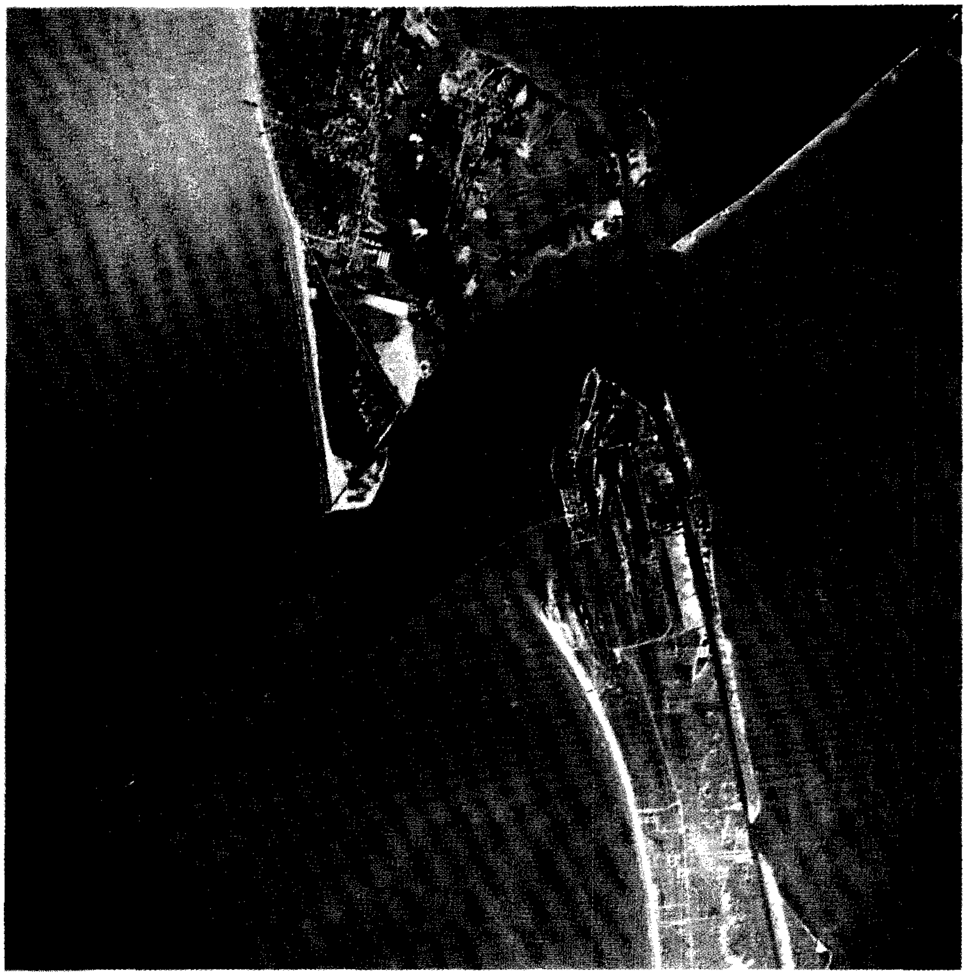
This color photograph of the Earth came from the Application Technology Satellite (ATS III). Real-time video scanners stored information on magnetic tape aboard the vehicle. The information was then transmitted to the ground and used by the Environmental Science Services Administration to reconstruct this view for weather analyses.

COLOR
PLATE
14



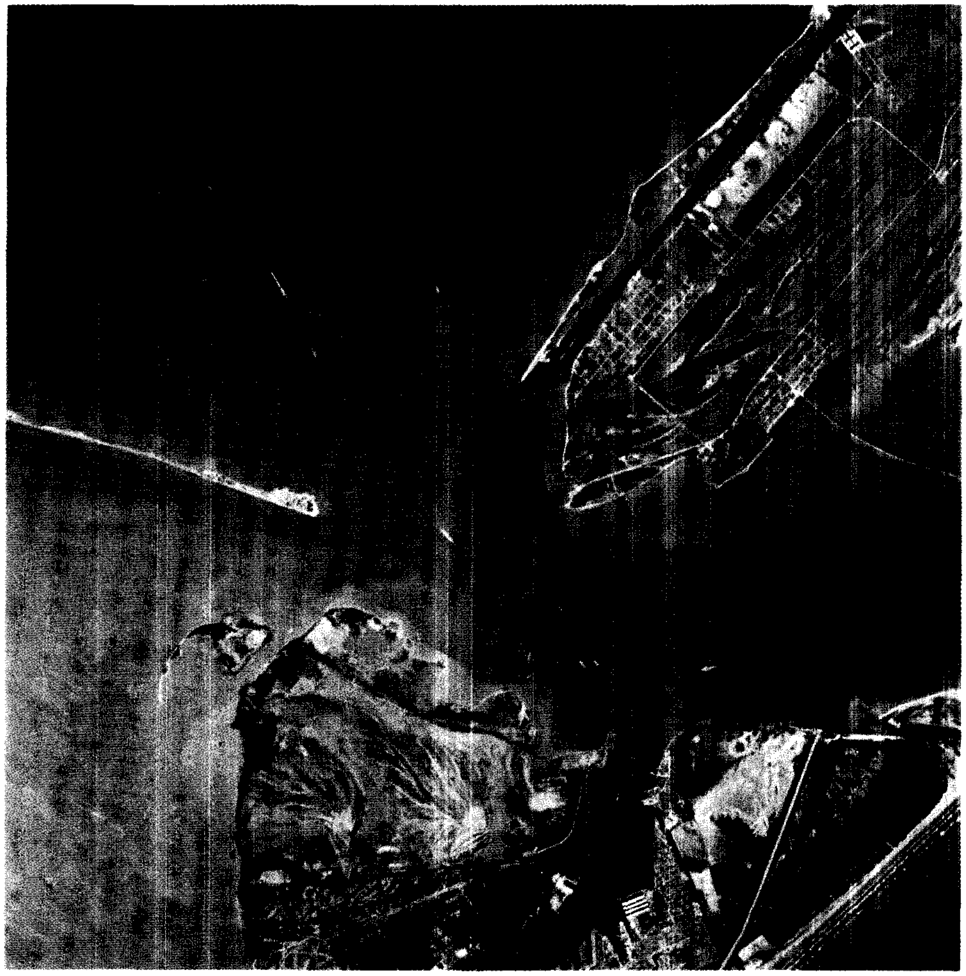
This figure demonstrates the sampling of a picture. It is a portion of a view of the entire world from the Application Technology Satellite (ATS III); it shows the Gulf of Mexico surrounded by Mexico, United States, Florida, and the Caribbean Islands. This reconstruction is done on a digital basis; commercial television reconstructs picture elements in an analog or continuous variation form.

COLOR PLATE 15



For hydrology studies, pictures such as this taken with conventional color from aircraft, yield significant information about turbidity and the flow of turbulent materials, which can be helpful in dealing with air and water pictures.

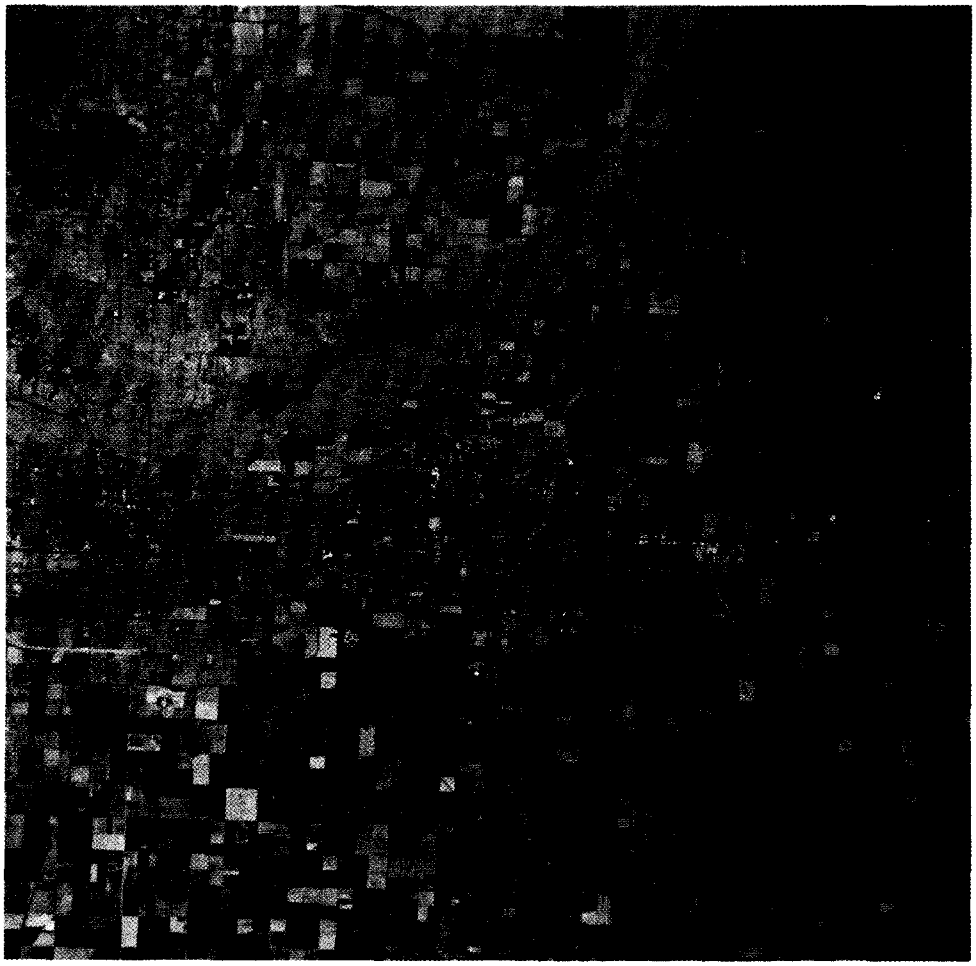
COLOR PLATE 16



The false-color infrared pictures taken of water areas provide a high degree of sensitivity to botanical growth in water which influences feeding patterns of fish.

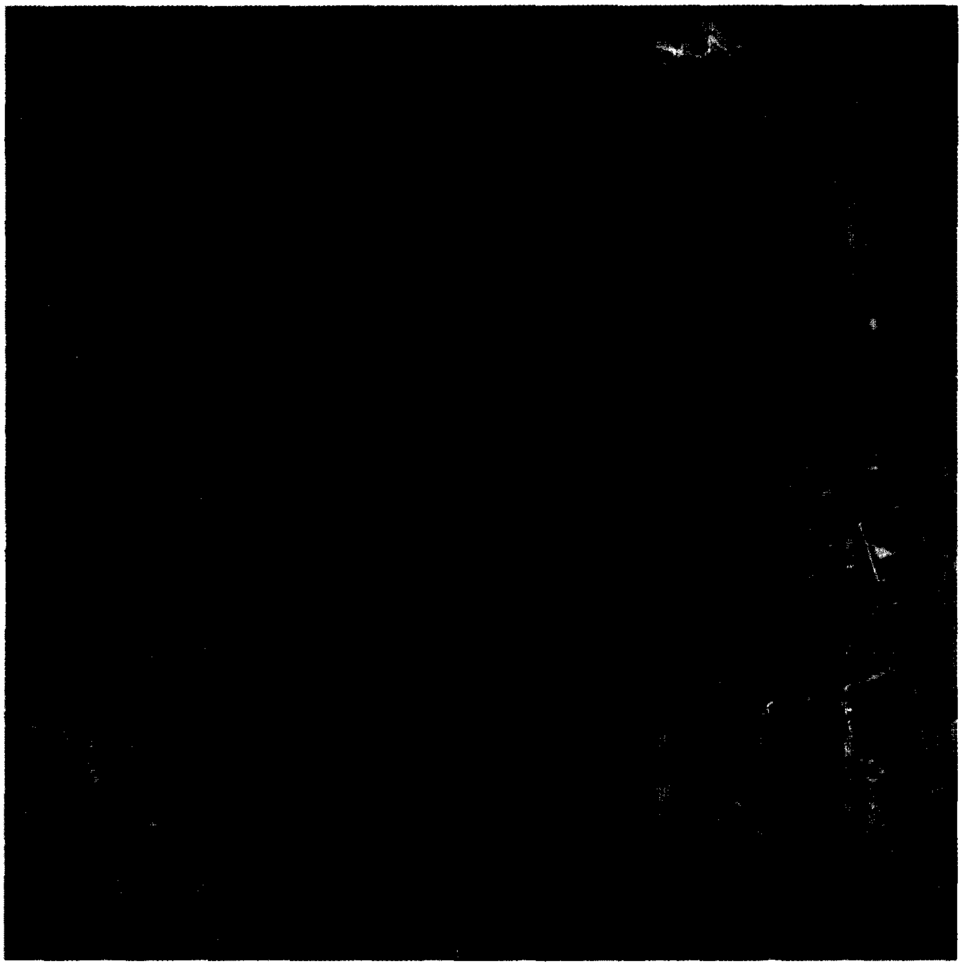
COLOR
PLATE
17

False-color infrared film is used to study agricultural problems. The high reflectivity of chlorophyll to infrared radiation is significant in noting plant growth. The arability of various land masses is reflected in the amount of chlorophyll developed in the plants and, consequently, in the depth of the infrared reflectivity.



COLOR PLATE 18

This is a conventional color photograph from an aircraft. It shows land mass in a way applicable to recording geographical and cartographical information.



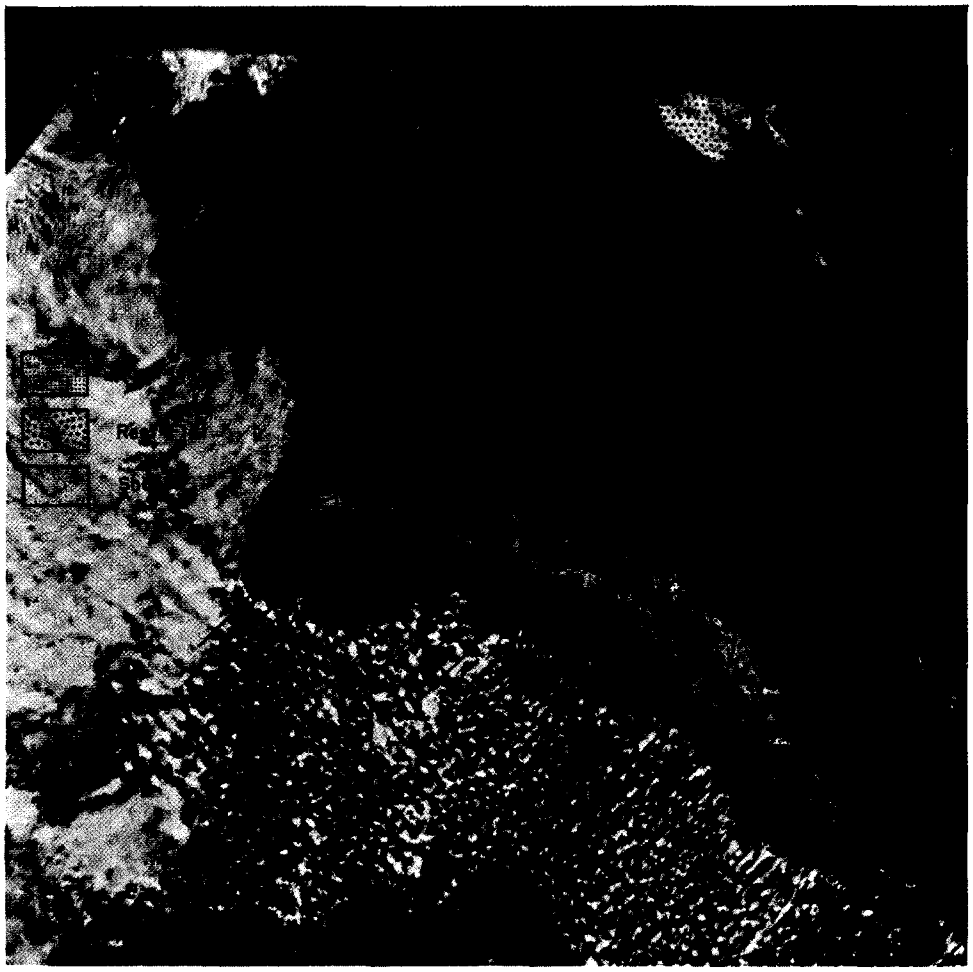
COLOR
PLATE
19

False-color infrared film is used to define geological structure in a more definitive manner than ordinary color film.

COLOR PLATE 20

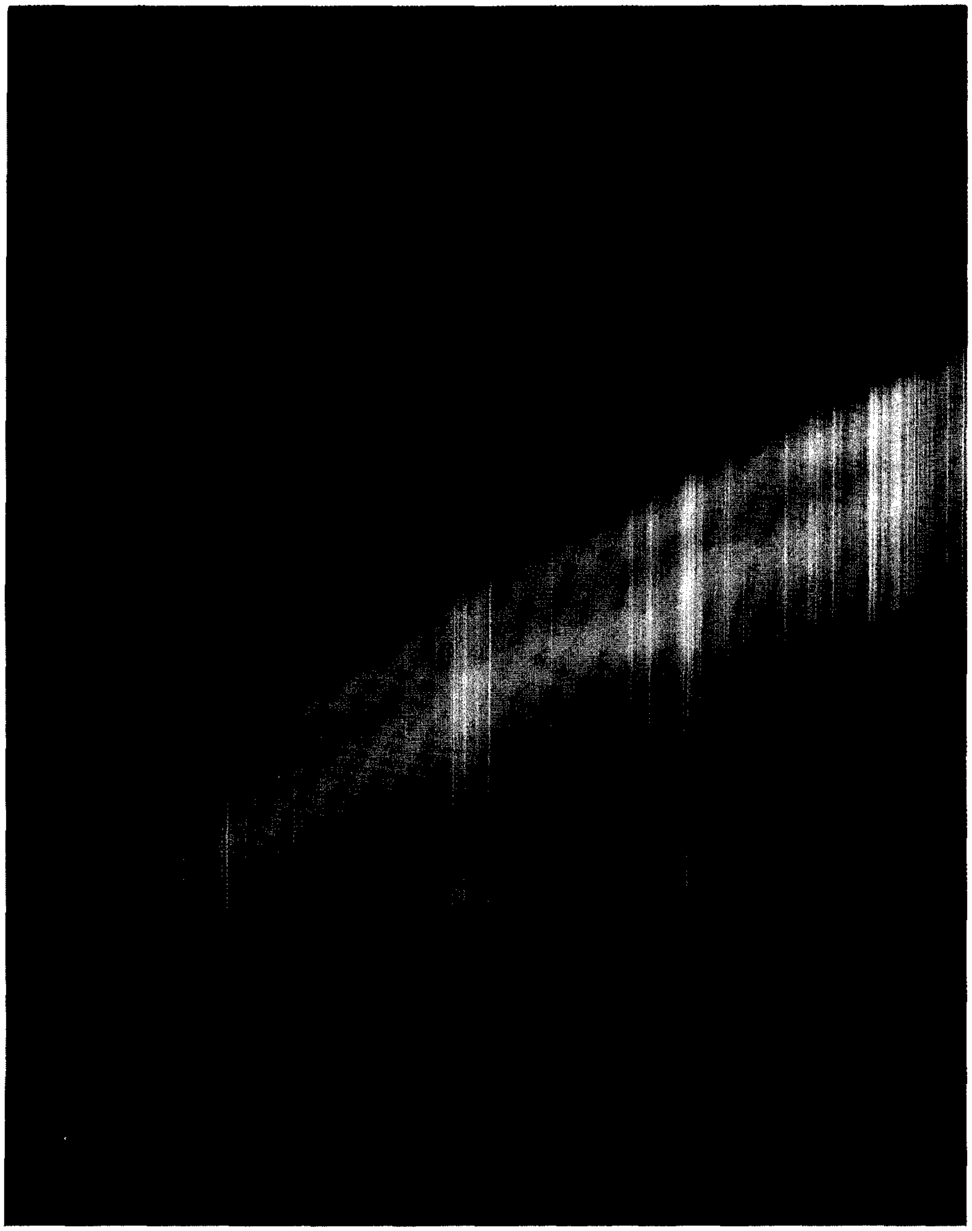
This photograph was taken at Walker Lake, Nevada, a desert region. The red patterns in the water show plankton algae growth.

COLOR PLATE 21



A typical Earth Resource picture shown with overlay data printed on the picture. This is a view of Cuba's northern coast, the Great Bahama Bank, and the Tongue of the Ocean, taken from Gemini VII.

COLOR
PLATE
22



In the 1968 and 1969 Airborne Auroral Expeditions, the NASA Convair 990 airplane, "Galileo," was used as a high-altitude, mobile platform for observing the aurora borealis. This photo is typical of the many taken from the airplane. It was taken just before midnight on November 26, 1969, from an altitude of 39,000 feet near Fort Churchill, Manitoba, Canada.

COLOR PLATE 23

This low-level photo of the South Peninsula region along San Francisco Bay illustrates use of photography for regional and local control of land-use development and zoning conformity. Notice how well one can define the existence, style, and shape of improvements such as swimming pools and detect changes in housing and developments for which permits and specifications are required, and obtain rapid information for tax assessments. The color infrared sensitive film also shows the health of vegetation.

COLOR PLATE 24

Photographic Films

Many types of photographic film are available to NASA and several types are generally used in individual operations. This chapter presents a consolidated review of the principal film characteristics and a listing of the representative types of films that NASA has used, with comments on their general availability for use by industry in solving many similar problems. Reference 26 is a comprehensive report on requirements of photographic film on the lunar surface, with specific recommendations for films to meet operational requirements.

The photographic materials or films described here are those in which a silver-salt reaction is the basis of the photochemical process. Such silver-salt reactions provide the fastest speed or the greatest sensitivity to light or other radiation. Non-silver-salt processes are broadly applied, but they are not associated with pictorial or picture-taking photography. A general discussion of the basic principles of the photographic process, excerpted from a NASA report, is presented as an appendix.

Photographic films may be defined by the characteristics of the film material, application, color sensitivity, tone reproduction, contrast, and speed. The following is a set of generally accepted definitions, based on these parameters, of the various types of photographic film.

MATERIAL CHARACTERISTICS

A *negative-working material,* which is typical of the basic silver-salt process, is one in which the tones are reversed in making the reproduction. Where there is brightness or a highlight in the original scene, there is darkness in the picture that is generated. Conversely, the shadows or dark areas of the original scene appear as light areas in the reproduction. This is also true of materials which are used to reproduce other photographic originals. In these white becomes black and black becomes white, giving reverse tone rendition.

A *positive-working material,* which is characteristic of some nonsilver system, is able to reproduce a tone directly, lights appearing as lights in the reproduction and darks appearing as darks.

A *reversal material* is a silver material whose inherent characteristics may be reversed by means of a multiple-step process, so that a positive working image is produced on the material. The distinguishing characteristic of the film is that the positive rendition is generated in the subsequent processing of the film, rather than being an inherent characteristic of the photosensitive system itself.

APPLICATION

Unfortunately, ambiguities have crept into the vocabulary of photographic science over the years and the trade names of many products incorporate these ambiguous definitions. Thus, the term "negative" is used to define films both on the basis of their characteristics and that of their applications. A *negative* film is one which has negative working characteristics and is basically used as the camera film for taking the picture of the original scene.

A *positive* is also a negative-working material, but this identifying terminology derives from the fact that it is a reproducing material used, in the second stage of the photographic process, to print from the negative the tone values of the original scene. In basic photography, the negative is defined as that which is taken by the camera, while the positive is the paper or other print resulting from the development process. The term *positive* is also applied to print material used to make a working projection transparency or a motion-picture film that renders the tone of the original scene.

The term *reversal* is employed here in the same sense as implied under *Material Characteristics*. Reversal film is used to produce a first-generation positive working reproduction of the original scene by manipulation of the development process.

COLOR SENSITIVITY

The third characteristic used to define films is the basic color sensitivity of the photosensitive material.

A blue-sensitive material has the inherent sensitivity of the silver salt to the ultraviolet and blue light of the visible spectrum.

An orthochromatic material is one that has an extended sensitivity to provide response to both the blue and green regions of the visible spectrum.

A panchromatic material is one that has full sensitivity to all colors of the visible spectrum including the blues, greens, and reds.

An extended red panchromatic material is the basic panchromatic material but with the sensitivity extended as far as possible in the visible red region of the spectrum and approaching the very near infrared in its response.

An infrared-sensitive film is one that has been sensitized to respond to the near-infrared radiation of the spectrum. Such films retain their characteristic sensitivity to blue light and near ultraviolet and thus require a filter that absorbs the ultraviolet radiation if the full benefit of infrared recording is to be obtained.

TONE RENDITION

Films may also be defined by the type of tones that are reproduced. A *black and white,* or *monochromatic,* film is one that reproduces all the values of the luminance in the original scene in terms of a nearly neutral scale without respect to the color which produced original scene brightness. The basic silver process produces all tones, regardless of the color which caused them, in some shade of black, gray, or white.

A *color film* is one which, by using separate layers, is capable of reproducing different colors of the visible spectrum in terms of different colors in the reproduction. When not otherwise specified, a color film is identified as one which reproduces all the colors of the spectrum in terms of their original hue, saturation, and lightness as faithfully as the process will allow. Color negative films, in addition to reproducing reversed tone values, also reproduce in complementary colors so that a second generation, or copy, of a color negative produces the positive with approximately correct tone, hue, and saturation.

There are two basic types of color film: daylight A type which, as its name implies, is balanced for pictures taken under ordinary daylight conditions, and tungsten A type which is balanced for pictures taken under artificial studio lighting.

A color film which reproduces scenes in colors other than the naturally expected colors of the scene (and this has certain advantages in some scientific work) is generally called *false color* film. Reference 27 reports the decision to utilize outdoor-type color reversal films following experiments with calibrated color targets exposed during Gemini X extravehicular activity (EVA). The purpose of the experiment was to seek an explanation for the frequent differences between the crew's interpretation of color rendition and that shown in flight films. Normal outdoor color film is balanced for a combination of sunlight and blue skylight which is not present in space. It can be stated, nevertheless, that available color film is generally balanced to the solar spectrum in space and that the effect of ultraviolet energy appears to be negligible to image degradation.

CONTRAST

Another identification is by the contrast of the system. A physically ideal film would reproduce tone values in exactly the same order and magnitude as they appear in the original. It has been shown, however, that pictures acceptable for viewing generally reproduce tone values with somewhat larger differences than those in the original scene. Films that give reproduced tone values in which the degree of separation between individual tones is less than in the original are usually described as low-contrast materials. A low-contrast material is generally used as an intermediate step. High-contrast materials, where the degree of tone separation is greater than that reproduced, are generally employed as the end product for evaluation or inspection. For certain scientific applications, pictures are taken on high-contrast negatives that are evaluated without further reproduction.

SPEED

One other measured characteristic used to define films is speed or sensitivity. This is a measure related to how much or how little light is required to produce a usable image on the film. Films used

TABLE 4.—*Some Typical Photographic Films Used in Space Missions*

Name	Manufacturer	Type	Speed*	Availability
Super Anscochrome	GAF	Color Reversal	125	Superseded
Ultraspeed Anscochrome	GAF	Color Reversal	200	Superseded
Anscochrome D-200	GAF	Color Reversal	200	Basic film—yes Special base—no

TABLE 4.—*Some Typical Photographic Films Used in Space Missions*

Name	Manu-facturer	Type	Speed*	Availability
Anscochrome D–50	GAF	Color Reversal	50	Superseded
SO–217	EK	Color Reversal	64	Available as Ektachrome MS (this base on special order)
SO–368	EK	Color Reversal	64	Available as Ektachrome MS (this base on special order)
SO–168	EK	Color Reversal	160/1000	Available as Ektachrome EF
Eastman Color Negative	EK	Color Negative	32	Commercial Type 5251
Ektachrome Infrared Color SO–180	EK	False Color Reversal	100	Commercial Type 8443
Blue Insensitive SS48895	GAF	False Color Reversal	800/1000	Experimental—Special Request
SO–164	EK	Black and White or Negative	20	Available as Panatomic X Recording Type 3400
Type 2475	EK	Black and White or Negative	1250	Commercial
Type 2485	EK	Black and White or Negative	1250/8000	Commercial
SO–121	EK	Color Reversal	50	Commercial, High Definition Color Film
SO–246	EK	Black and White Infrared		Commercial, Type 5424
SO–267	EK	Black and White		Commercial, Type X 2405
Type 3400	EK	Black and White		Commercial, Plus Aerial
SO–349	EK	Black and White	20	

GAF=General Aniline & Film Corp.; EK=Eastman Kodak.

*Film speed is given in typical exposure index values that are used for determining camera settings.