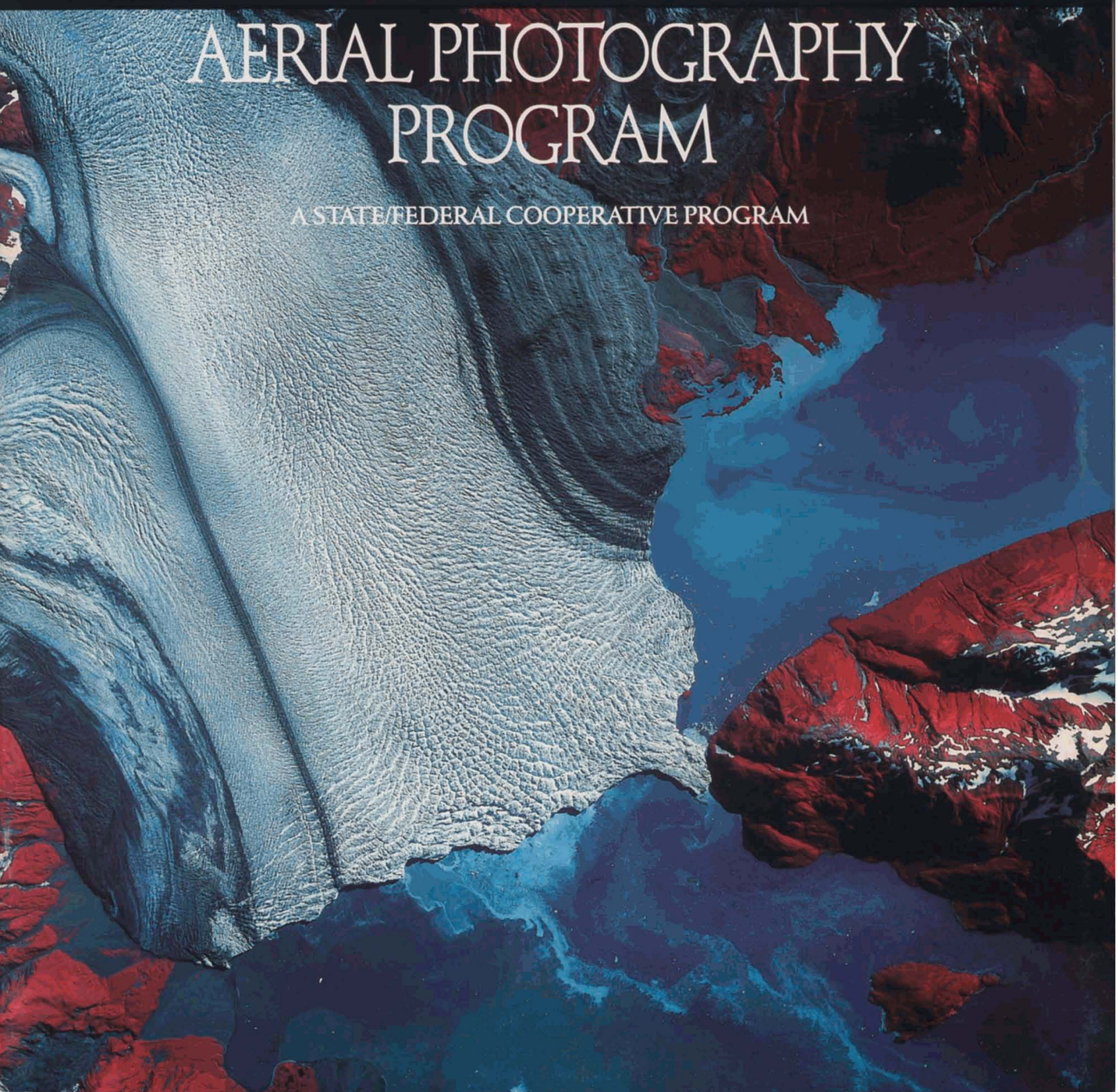
# The Alaska HIGH-ALTITUDE AERIAL PHOTOGRAPHY PROGRAM

A STATE/FEDERAL COOPERATIVE PROGRAM



# The Alaska HIGH-ALTITUDE AERIAL PHOTOGRAPHY (AHAP) PROGRAM

A STATE/FEDERAL COOPERATIVE PROGRAM

FEBRUARY, 1988

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# The Alaska HIGH-ALTITUDE AERIAL PHOTOGRAPHY (AHAP) PROGRAM

## Executive Summary


Until 1978, State and Federal land resource management organizations had been restricted in their oversight responsibilities by the lack of a uniform mapping database. Few maps had been made and those maps dated back to the Second World War. By the early 1970s, existing geographic information and aerial photographs were so outdated and inconsistent that they were unusable for current mapping.

In 1978, State and Federal agencies formed the Alaska High-Altitude Aerial Photography (AHAP) Program to develop a uniform aerial mapping photographic database. Funding was shared between the State of Alaska and the Federal government. Since the initiation of the program, approximately 90 percent of Alaska has been photographed.

The finished product of the AHAP Program is a set of unified and coordinated aerial photographs. Some of the uses of the AHAP photographs are the identification of diseased tree stands, monitoring shoreline changes, charting vegetation regrowth after a fire, delineating transportation corridors, making land conveyance determinations for bodies of water, and accelerating conveyance of land to the State and Native corporations.

Because of budget cuts at both State and Federal levels, the AHAP Program is at a critical point. Overflights in 1986 were minimal and none were conducted in 1987. If annual AHAP Program cooperative funding of $300,000 by both State and Federal governments is not approved for 1988/89 program, the AHAP Program will be discontinued.

The AHAP Program represents a $2.7 million investment by the State and Federal governments. However, much of the available data is now ten years old. If the AHAP Program is discontinued, State and Federal agencies will have to resort to the less efficient methods of field inspection. This will slow the conveyance of land to the State of Alaska, Native corporations, municipalities, land banks, and individuals.

Unless cooperative funding is approved for 1988/89, there will be a proliferation of single purpose aerial photography projects, resulting in increased overall cost, duplication of effort, and incompatible data. Perhaps most significant, agencies will be forced to make decisions based on data which is out-of-date.

# The Alaska HIGH-ALTITUDE AERIAL PHOTOGRAPHY (AHAP) PROGRAM

## Introduction

In 1978, many State and Federal agencies were confronted with a problem of monumental proportion caused by a growing number of management programs and oversight responsibilities required by legislation. Some lands had to be identified for conveyance to the Alaska Natives under the Alaska Native Claims Settlement Act (ANCSA) and substantial areas had to be transferred to the State of Alaska under the Statehood Act. Other lands had to be managed under the provision of Federal legislation, such as the Resources Planning Act, the Forest Practices Act, the Soil and Water Resources Conservation Act, the Public Land Policy and Management Act, the Water Pollution Control Act, the Alaska National Interest Land Conservation Act (ANILCA), and the Coastal Zone Management Act. Added to these responsibilities were the ongoing programs for fish and wildlife, forestry, recreation and mining.

Agencies of both State and Federal governments acknowledged the need for more advanced methods of obtaining aerial photographs of Alaska. Many areas of Alaska were — and still are — unsurveyed and resource maps were unavailable. Unfortunately, the satellite images which were available were too small in scale to be useful. Existing aerial photographs were as much as forty years old and provided only random coverage at different scales and were not compatible with needs of different agencies.

To resolve these problems, representatives from State and Federal agencies established the Alaska High-Altitude Aerial Photography (AHAP) Program to obtain aerial photographs that would meet their collective requirements. By pooling their resources, these agencies shared the cost of a comprehensive, standardized program to obtain state-wide aerial photographs of the entire state at a uniform scale. This cooperative effort was the first such program in the United States.

## How Does Aerial Photography Support Mapping?

Aerial photographs are needed to compile topographic maps which show the shape of the land and give the elevation of mountains and valleys. Topographic maps have lines and symbols to indicate physiographic and manmade features, and show mountains, forests, meadows, valleys, and rivers and other geographic features. Topographic maps are very popular with Alaskans primarily because they are inexpensive; but many of them were created using aerial photographs from the 1940's and 1950's.

Aerial photographs provide the most accurate view of the surface of the earth. The sophistication of computerized technology allows for adjustments to the photographs for problems due to lens distortion, the effect of terrain relief, and the tip and tilt of the aircraft.

The AHAP Program uses NASA high-altitude aircraft which fly at 65,000 feet along prescribed flight lines to photograph the terrain.

# Why Is High-Altitude Aerial Photography Important to Mapping in Alaska?

Cruising at 400 knots, two cameras simultaneously photograph the earth. One camera takes black-and-white photographs at a scale of approximately ½-inch to a mile, with each photographic frame covering about 250 square miles on the ground. The other camera takes color-infrared photographs at a scale of approximately 1-inch to a mile, and each photographic frame covers about 64 square miles of terrain. The cover of this report is an example of the detail shown on the color-infrared photographs.

AHAP Program photographic conditions require clear weather. NASA has obtained aerial photographs as funding, time, and weather permitted, although cloud cover sometimes made acquisition of photography impossible. A large portion of the Alaska Peninsula and scattered areas throughout Alaska have not been photographed for precisely this reason.

NASA has completed coverage for about 90 percent of Alaska. Since 1978, more than 76,000 nautical flight line miles have been completed. These AHAP Program photographs are available to State and Federal agencies and the general public.

One of the most valuable products from the AHAP Program is the orthophotoquad. Orthophotoquads are scale-accurate, distortion-free photographic images produced on a quadrangle format. The photographic images are differentially rectified to remove distortions and are then printed in their correct orthographic positions. The orthophotoquads are printed at the same scale of 1:63,360 as the traditional topographic maps, and they comply with national map accuracy standards. A comparison of an orthophotoquad to a corresponding topographic map can be found on the back cover of this report.

High-altitude aerial photographs are critical to the mapping of Alaska because so much of the state is not easily accessible. Surveying on foot is difficult, if not impossible in some areas, and ground transportation is not practical.

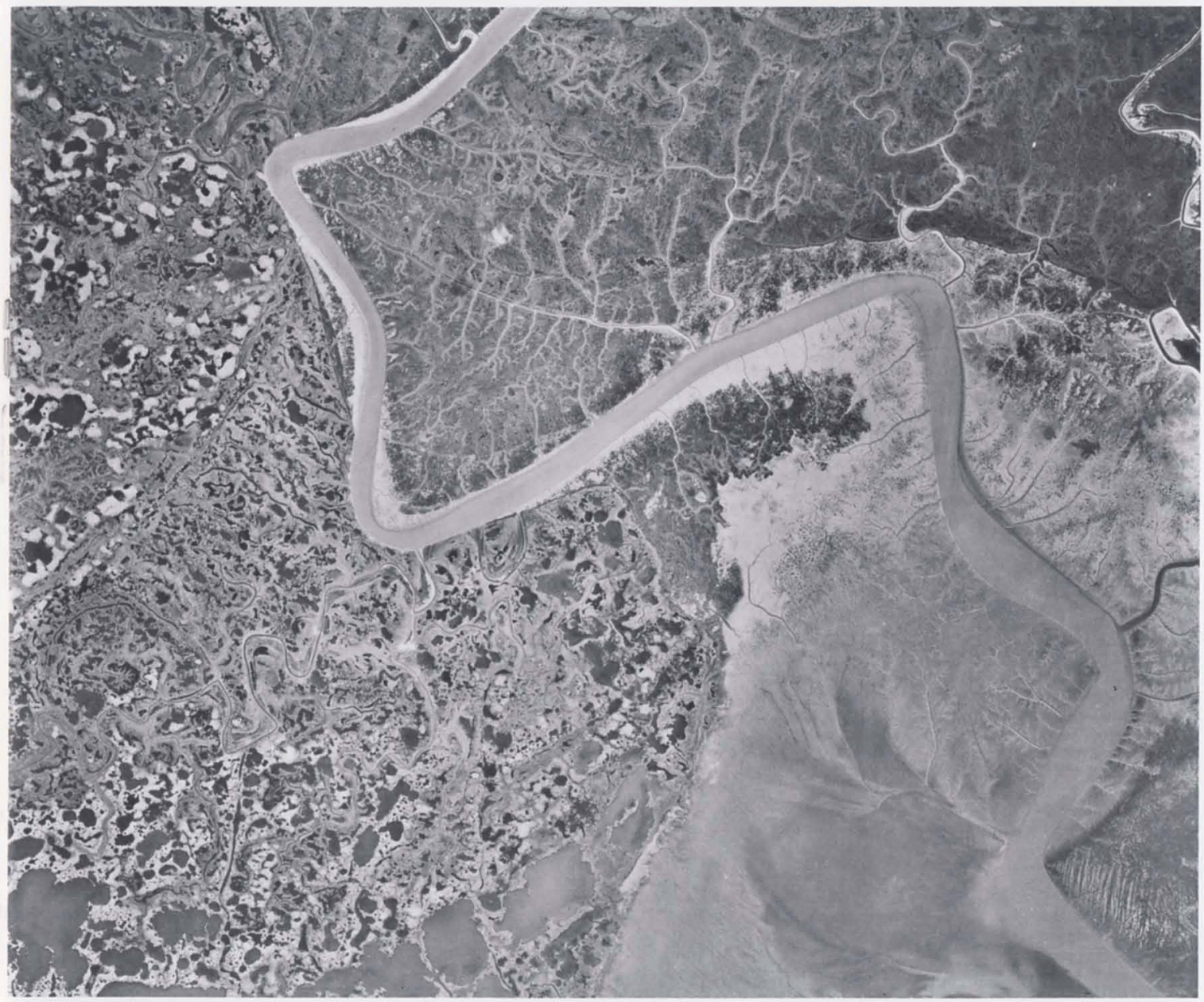
The inventory and development of Alaska's mineral resources depend on infrastructure and transportation corridors which are both economically and environmentally sound. This information can be derived from new maps and photographic products created from the AHAP Program. AHAP provides a reliable source of information on topography, soil, vegetation, and hydrography. Aerial photographs, together with available resource maps, enable engineers and resource managers to select transportation corridors and associated infrastructure sites in the most economically and environmentally sound manner possible. Black-and-white aerial photographs are principally used for the statewide USGS orthophotoquad program and for revisions of existing topographic maps. The color-infrared photographs have a wider variety of uses. Color-infrared photographs, in conjunction with orthophotos, are used to define the size of water bodies. This is a significant matter in the transfer of land by the Bureau of Land Management to the State and the settlement of Native claims. In the Alaska Native Claims Settlement Act, for instance, land is defined as all areas excluding acreage which contain:

1) a body of water larger than 50 acres,
2) navigable waterways
3) streams wider than 198 feet.

As an example of how this definition affects a conveyance, the Federal government counts a 55-acre lake as 'water' and it is not charged against the Native land entitlement. Considering the large number of lakes and streams in Alaska and the value of land in dollars, the accurate exclusion of water bodies from the land transfer process is a high value item to both the State of Alaska and Alaska Native corporations.

Color-infrared photography is an effective indicator of land and water boundaries. Significant features measuring 1/10 of an acre in size are easily discernible on the color-infrared photographs. This provides land managers with a practical tool for determining the upland/wetland boundaries and ensures that land entitlements are accurate. For the State of Alaska and Alaskan Natives, this is an important use of the AHAP products. An example of AHAP Program photographs of a wetland area can be seen below.

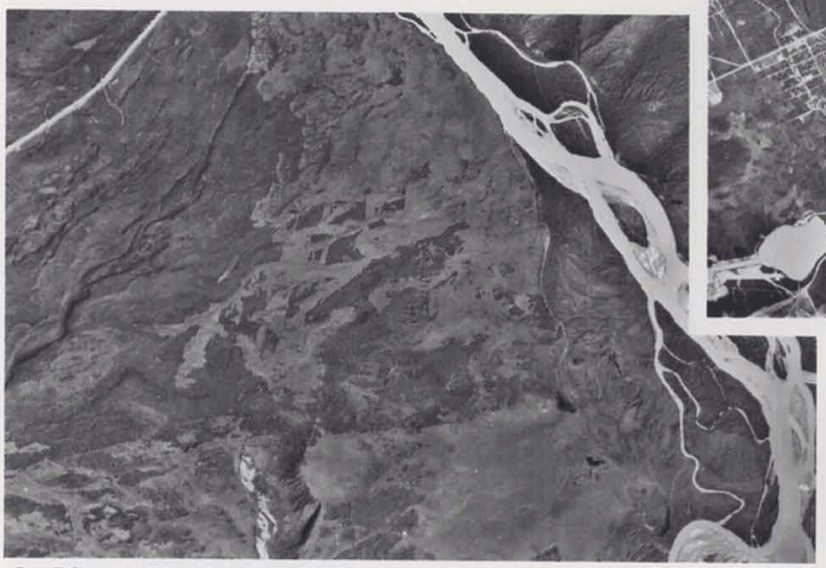
High-altitude photographs are also important because each photograph covers such a large area. Foresters use the color-infrared photographs to map and delineate vegetation. They can differentiate among the species of trees, shrubs, grasslands, and tundra; separate wetlands from uplands; and accurately delineate river and stream channels. Color-infrared photographs also indicate insect infestation areas and the overall health of vegetation, document recovery rate of burned areas, and identify potential areas for timber sales.



*1. Yukon Delta Wetlands*

Wildlife managers and game biologists find color-infrared photographs an important tool in studying wildlife refuge vegetation and caribou wintering ranges. The photographs can also show patterns of use, such as off-road vehicle trails across the tundra, which can be instrumental in the expansion of the roads.

The private sector uses the color-infrared in land trades, land banks, Native allotments, resource development, mining, trapping, flying, commercial and sport fishing, as well as hunting and camping. High-altitude photographs can also show the growth of communities as can be seen by the samples in this report. (See plates 2&3, 4&5, 6&7).



*2. Above: Big Delta 1949*
*3. Below: Big Delta Agriculture Project 1986*

*4. Above: Anchorage 1950*
*5. Below: Anchorage 1985*

For environmental purposes, aerial photography is important because it gives regulatory organizations a view of a region **before** permits are issued as well as an ongoing historical record of the impact on the region. The AHAP photographs can also be used to identify lands affected by recreational use, as well as provide maps needed for park enforcement and search-and-rescue operations. Changes in the environment can be identified and rates of erosion, man-made as well as natural, can be quantified. Permanent snowfields, icefields and glaciers are also easily identifiable.

Another important use of color-infrared photographs is to support the charting of the shorelines of Alaska. Alaska will receive 104 million acres of land under the Statehood Act which includes 34,000 miles of detailed shoreline, tideland and submerged lands. These land resources add millions of dollars to the State's treasury. The State of Alaska, Department of Natural Resources, in cooperation with the United States Minerals Management Service, National Ocean Service, and other Federal agencies, performs ongoing shoreline reconnaissance and marine boundary surveys using the AHAP Program photographs. These surveys have a direct and immediate effect on the State's money-making ability. Offshore oil resources which are within three miles of the tidelands are owned by the State. Proper identification of these areas has substantiated State ownership and helped to minimize legal disputes between parties. The use of high-altitude aerial photographs has enabled State resource managers to accurately assess the State's share of oil lease acreage to ensure that oil royalties remain in the State rather than go into the Federal treasury.

*6. Above: Valdez 1957, before Earthquake*
*7. Below: Valdez 1978*

# How Else Are The Finished AHAP Products Used?

Alaskans put high-altitude aerial photographs to many uses. Some examples are:

*"I used the high-altitude aerial photographs to locate my farm. I found them very useful and convenient. I could have used private photographers but that would have been very expensive."*

*Louise Kellog,*
*Spring Creek Farm, Palmer*

*"Legislators should be aware that with the push to diversify our economy, particularly in the areas of forestry and mineral development, current and accessible aerial photographic data for the entire state is vitally important. This information is the foundation upon which resource development will build and should be considered a necessity."*

*John Maisch, Forestry Director*
*Tanana Chief Conference, Inc., Fairbanks*

*"(The Valley Hospital) has a high-altitude photograph of the Palmer/Wasilla area in our Board Room. We use it as a focal point of our discussions for long range planning and other demographic issues. In fact, we need another one for the Wasilla to Willow area. At $5 a copy from the USGS, it saves us the expense of contracting for just one photograph."*

*Charles Vancura,*
*Community Relations Specialist,*
*Valley Hosptial, Wasilla*

*"I use high-altitude photographs when I backpack into an area. They only cost about $5 a piece which is a good investment in safety. (The last high-altitude photos) I bought were of Anchorage. The infrared almost makes it look like artwork. But with that photo I can see what changes man has made to the land better than any other form of map."*

*Stanley Davis,*
*Recreational backpacker, Anchorage*

*"As a private consulting engineering and land surveying firm, we use high-altitude aerial photography approximately once a month for project planning and reconnaissance purposes. We obtain our material through the GeoData Center at the Geophysical Institute, UAF and find this service extremely valuable as it is often the sole source of up-to-date information."*

*Neil Eklund, Vice President*
*Stutzman Engineering, Fairbanks*

*"(Anchorage Municipal Light & Power) (ML&P) uses high-altitude photographs for a variety of reasons. Though we have contracted with private photographers, we usually buy from USGS. The quality is good, the price is inexpensive and it makes no sense to try to duplicate (photographs) that are already available."*

*Mio Kaiser, Assistant to the Chief Engineer*
*ML&P, Anchorage*

# Who is Funding the Alaska High-Altitude Aerial Photography (AHAP) Program?

State and Federal agencies that have joined to fund the AHAP Program are:

**State of Alaska**
- Department of Natural Resources
- Department of Transportation and Public Facilities
- Department of Fish and Game
- Department of Environmental Conservation
- University of Alaska

**United States Government**
- Department of the Interior
- Department of Commerce
- Department of Defense
- Department of Agriculture
- Department of Energy
- Alaska Power Administration

These agencies are interested in high-altitude aerial photographs for a variety of reasons. The Federal government will retain ownership of 250 million acres in Alaska while the State, Native corporations and other private owners will own the remaining acreage. Much of this land is being transferred with minimal surveying and virtually no other ground identification. Further, there are the issues of third party interests, mineral rights, and transportation corridors on the lands as well as the mapping and oversight of monuments, wildlife refuges, State and National parks and forests, and other land management categories.

# What is The Cost of High-Altitude Aerial Photography?

Cooperating agencies in the AHAP Program have contributed $2.7 million to provide a photographic database for Alaska. Joint funding of the project was practical since many of the agencies needed the same area coverage for different purposes. By pooling resources and coordinating their needs, these agencies have reduced duplicative efforts and have benefited from a more cost-effective operation. Copies of AHAP photographs are now available to the public for the cost of reproduction and distribution. Copies of the AHAP photographs are held by several agencies in Alaska and can be viewed at the following locations:

United States Geological Survey
National Cartographic Information Center
4230 University Avenue
Anchorage, Alaska 99508-4664
(907) 271-4159

GeoData Center
Geophysical Institute, UAF
C.T. Elvey Building
903 Koyukuk Drive North
Fairbanks, Alaska 99775-07800

# What is The Future of the AHAP Program?

The AHAP Program is now at a critical point. Due to State and Federal budget cuts, photographic acquisition has virtually stopped. There were minimal photographic acquisitions in 1986 and no acquisitions in 1987. Unless State and/or Federal funding is forthcoming soon, there will not be an AHAP program in 1988.

If new high-altitude photographs are not available, the cost of obtaining new photographs could delay or even prevent consideration of the development of a resource area. While this may not be significant to large mining companies, it would be a considerable cost to smaller resource development firms. In addition, State and Federal agencies need photographs to make management and regulatory decisions. Native corporations and villages rely on AHAP photographs for resource management decisions. Engineers use the photographs to determine land suitability/capability, not only for development projects, but also for transportation corridors. Environmental groups, as well as

*8. Above: Hubbard Glacier 1978*
*9. Below: Hubbard Glacier 1986*

campers, hunters, wildlife photographers, backpackers, bush pilots, and guides, all benefit from the use of AHAP products.

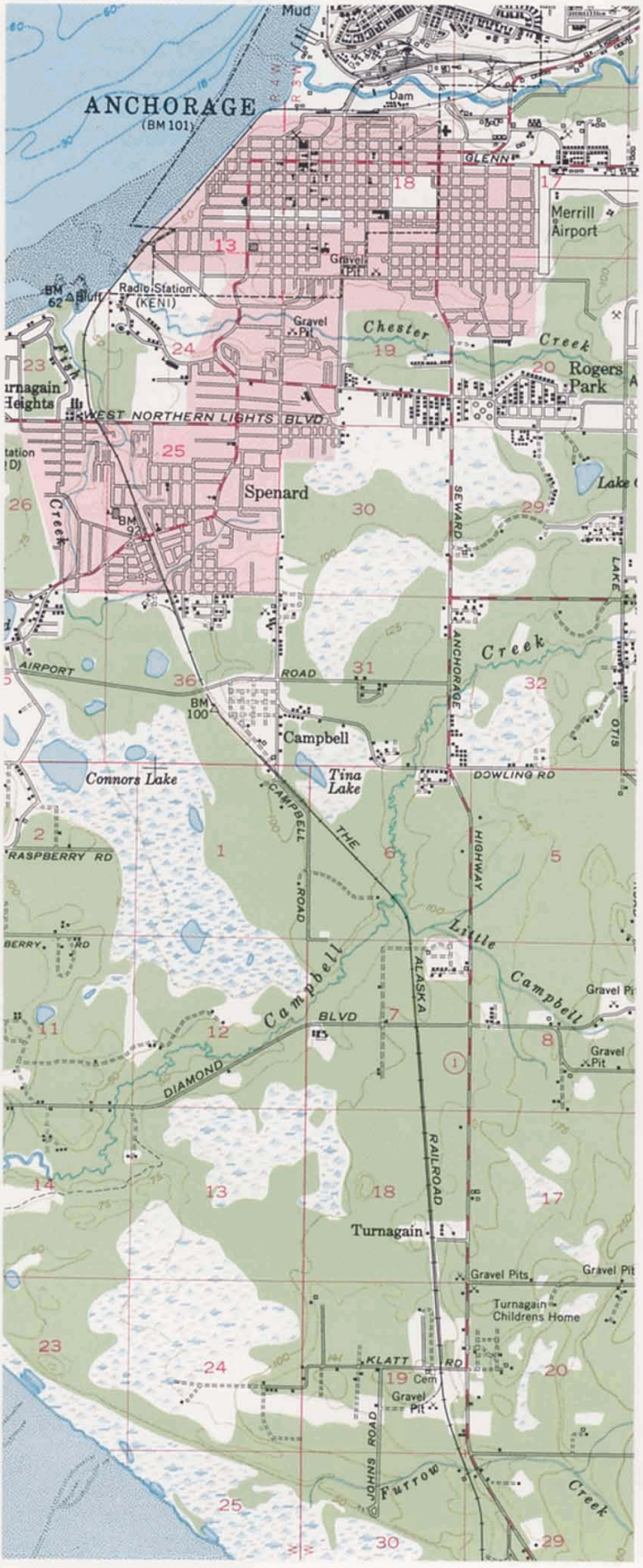
Many of the existing photographs are nearly 10 years old. During that time, rivers have altered their course, wetlands have expanded, landscape has changed because of fire, lowlands have been inundated from floods, communities have expanded, and road networks have developed. While the basic topographic features of the earth may not have changed, these other alterations can be significant.

The process of correcting aerial photographs has changed radically in recent years and improvements in black-and-white and color-infrared film have dramatically increased the quality of the photographs. If the AHAP Program is continued, new advancements will continue to be available to Alaskans. The quality of the finished product has improved in the last ten years as shown by the two representations of the Hubbard Glacier, (See plates 8&9).

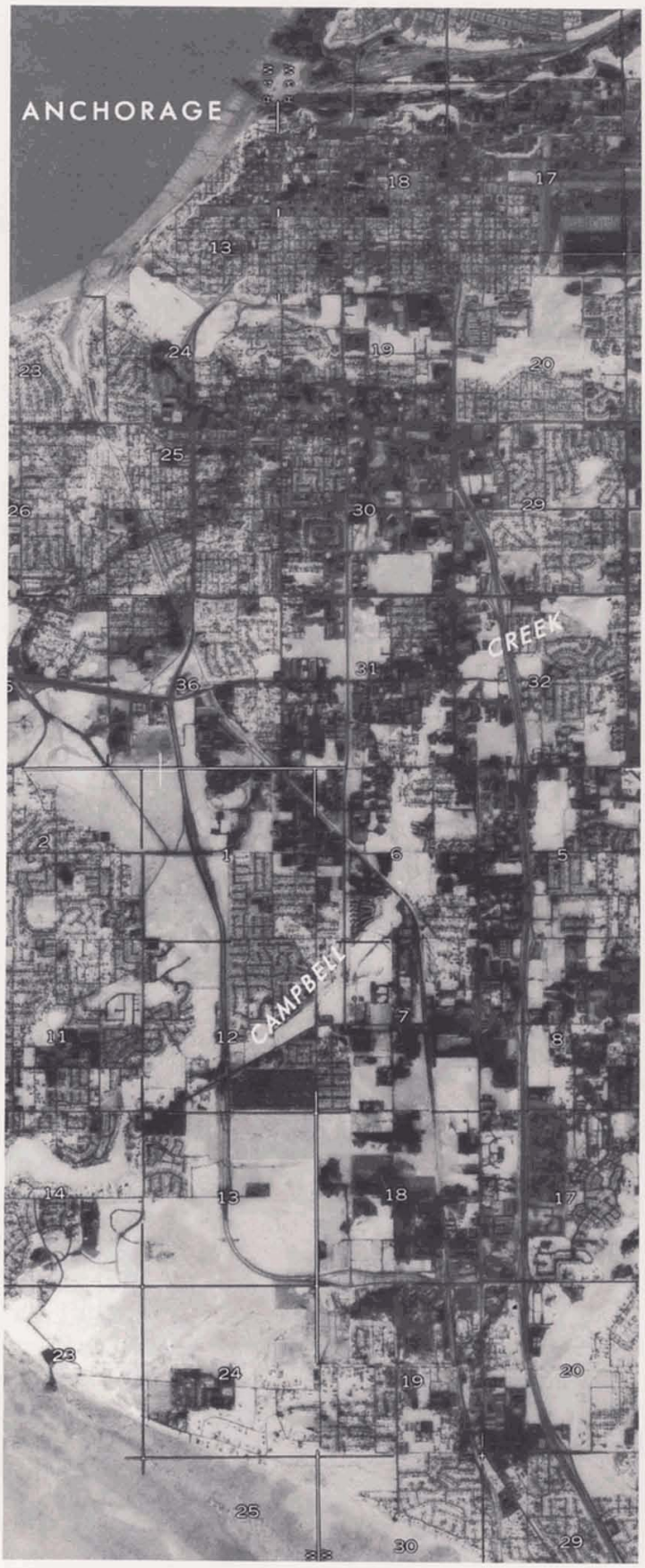
# Conclusion

Since 1978, the AHAP Program has invested $2,678,000 to acquire high-altitude aerial photographs for Alaska. Annual funding of $300,000, equally split between the State of Alaska and the United States government, is needed to continue and maintain the AHAP Program.

Sufficient funding to complete or maintain the AHAP Program does not exist. If the existing photographic database is not maintained, it will quickly become outdated and ineffective. Applications for the photographs still exist: land transfers, land exchanges, recreation, forestry, wildlife, environmental and developmental concerns. Since the photographs are needed by so many users, the impact of losing a viable program would be felt by State and Federal agencies, as well as private sector firms and individuals. If both the State and Federal government continue to contribute to a maintenance program, the State of Alaska will be able to maintain the photographic database, as well as upgrade the system with new film products on a ten-year cycle. By working together, State and Federal agencies can maintain a high-quality, state-of-the-art photographic database useful to organizations in the government and private sector, as well as sport and recreation enthusiasts. However, if the AHAP Program is discontinued in 1988/89 the State of Alaska will lose a valuable source of information.




*Topographic Map (Partial)*
*Anchorage, Alaska 1951*




*Orthophotoquad (Partial)*
*Anchorage, Alaska 1982*

# High Altitude Aircraft Program

NASA

National Aeronautics and Space Administration

**Ames Research Center**

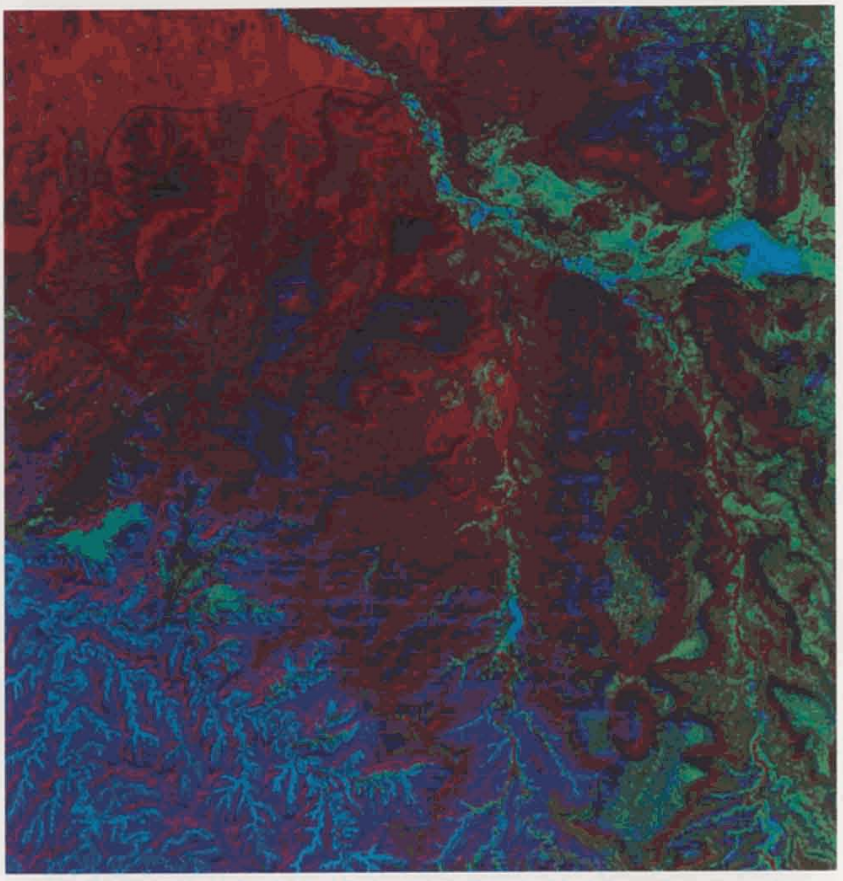
## Thematic Mapper Simulator

The images on this page were created from digital data collected by the Daedalus Thematic Mapper Simulator (TMS)*, a multispectral scanner flown by NASA U-2s that simulates the performance of the LANDSAT-4 Earth resource satellite scanner system. These images reveal information about the composition and condition of the Earth's surface that would otherwise remain beyond the range of human vision. They indicate the wide range of uses for TMS data, as well as some of the ways multispectral data can be handled using image display systems.

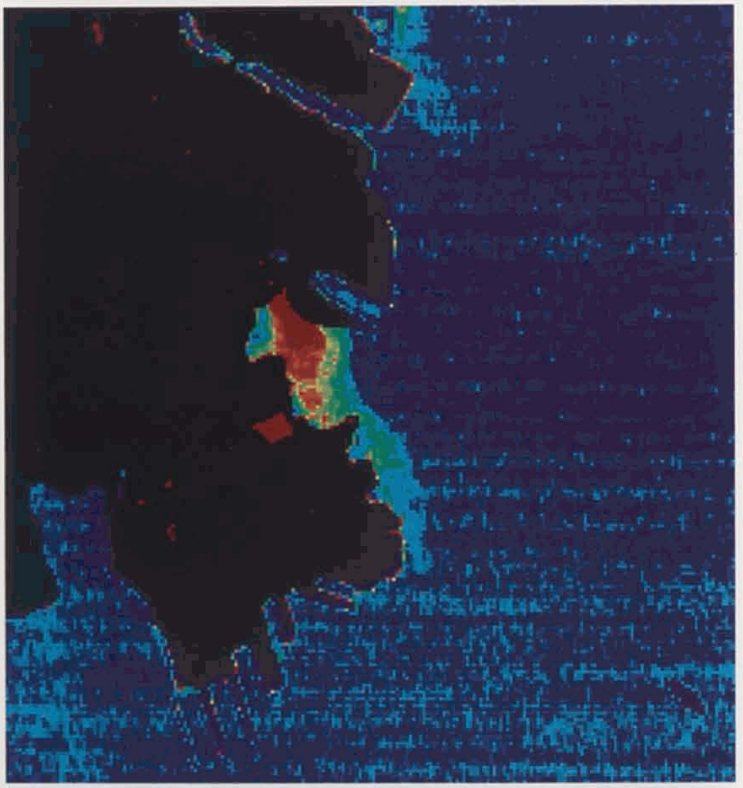
The TMS measures the radiance of Earth surface materials. It records the intensity of reflected sunlight and emitted thermal energy from within 11 discrete wavelength bands of the visible and infrared portions of the spectrum. Its detailed measurements of light and heat can, with the aid of a computer, produce maps that make even subtle variations in surface composition appear as visibly distinct regions of color. Patterns that emerge in these images can reveal very specific information about large areas of land or water. By using different combinations of wavelength band data with display system enhancements, users can isolate, identify, and analyze the spectral patterns that suit their interests.

TMS data enables users to discern and tabulate differences in health, maturity, and species of vegetation; in temperature and sediment content of water; and in temperature, moisture content, and types of soil. Frequent applications of TMS data include water pollution monitoring, land use planning, watershed management, timberland inventorying, crop yield forecasting, and natural disaster assessment. Recent innovative uses of TMS data include the analysis of chlorophyll movement in ocean waters, the correlation of specific vegetative covers with soil types, and the mapping of types of clays with mineral deposits.

*Product of Daedalus Enterprises, Inc.



**Landcover Classification:** The image above shows a portion of Davis Canyon, Utah, after six spectral bands of TMS data were digitally ratioed in order to clearly delineate varieties of rock formations and vegetation. Sandstones, siltstones, and shales appear in several shades of blue, green, and purple, respectively; windblown sands appear red; and sage and salt-cedar concentrations appear light blue. The data for this image were acquired for a Department of Energy geologic mapping project.



**Water Surface Temperature Mapping:** The Thematic Mapper Scanner records both the optical infrared (light) and the thermal infrared (temperature) portions of the spectrum. The TMS thermal infrared channel has a resolution of 28 m and is useful for monitoring water quality and thermal pollution. In the image on the right, the scanner's thermal channel has detected thermal outfall in the water adjoining an electrical generating plant in San Francisco. The image shows a thermal plume of six colors, with red representing the warmest temperatures. The land on the left side of the image has been "masked off" in a single color (black) to help highlight variations in water temperature. This kind of information is now being used by Pacific coast fishing fleets to follow ocean thermal upwellings, where marine life is most abundant.

**Water Enhancement and Color Infrared Imaging:** These two images illustrate multiple applications of a single TMS data set. The water-enhancement image (left) uses TMS channels 1, 2, and 3 to show the transport patterns and distribution of suspended sediments as clear ocean water mixes with the outfall of the Sacramento River. The color infrared image (right) uses visible infrared waveband data to point up vegetation and land use features. Color infrared images are generally very useful for distinguishing between basic land cover types (vegetation, water, bare earth, and urban settlement) as well as for distinguishing type, maturity, or condition of specified areas of vegetation. The data for the images above were acquired for a NASA Ames study of estuary processes.

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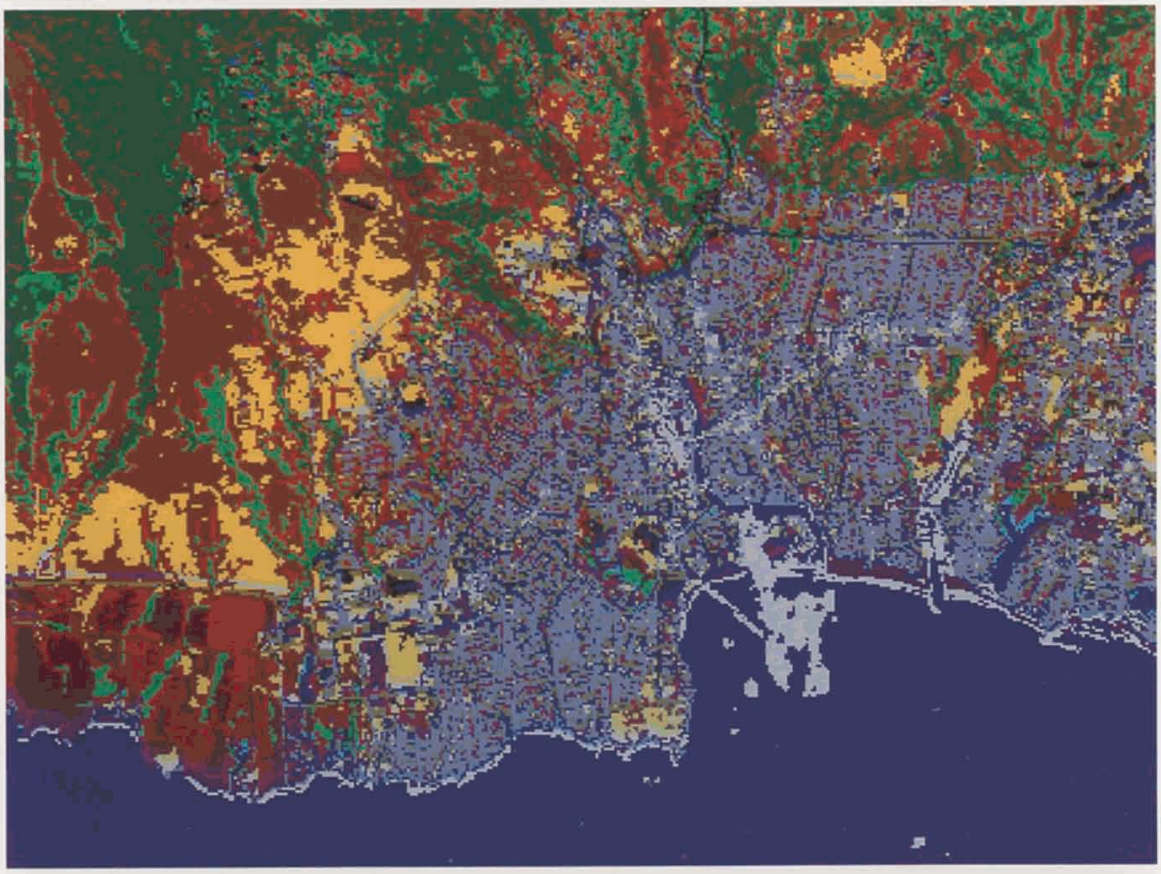
**Land Use Mapping:** TMS data and a computer classification algorithm were used to produce this land use map of Santa Cruz, California (right). Twelve classes of land cover are differentiated, including six of natural vegetation, four of urban, and two of crop type. Natural vegetation appears in the upper part of the image as follows: redwood forest (dark green); mixed redwood, tan oak, and madrone (light green); mixed Douglas fir and redwood (brown); wet natural pastureland (rust); dry natural pastureland (yellow); and riparian vegetation (turquoise). Areas without vegetation are, in this case, reflecting more light: commercial strips, clouds, and surf (white); residential areas (gray); cleared areas and sand (purple); and deep water and wide asphalt streets (dark blue). In the lower left, artichoke fields (red) are distinguished from brussels sprout fields (brownish red). This kind of presentation of TMS data is useful for urban planning, vegetation mapping, and crop and resource inventorying.



## Color Infrared Photography

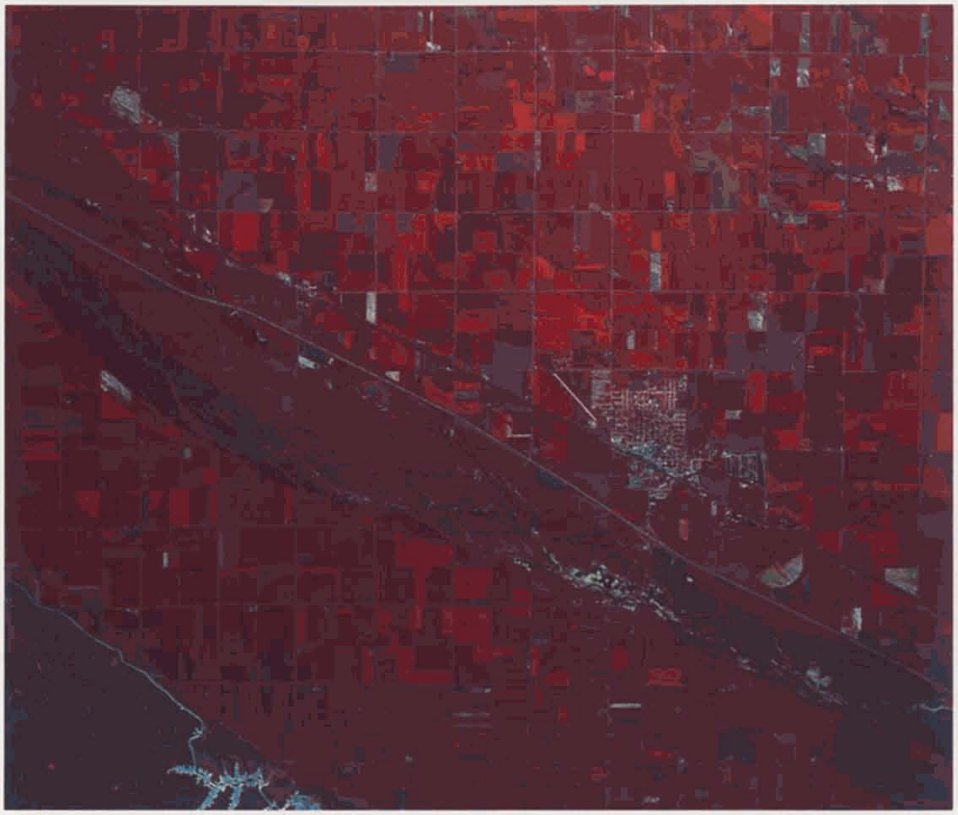
During the past 10 years, NASA U-2s have photographed large portions of the United States. For the most part, color infrared systems have been employed because, like multispectral scanners, they relay spectral information that is normally unobservable.

Color infrared film accentuates the differences between cover types — between clear and turbid water, healthy and diseased plants, moist and dry soils, or one type of vegetation and another. It is particularly sensitive to the high infrared reflectance levels in vegetation, and is therefore used extensively in timberland inventories, crop surveys, and land use mapping. Because color infrared film does not record the low end of the visible portion of the spectrum (blue light), it penetrates haze, a distinct advantage over natural color film.

NASA high-altitude photography user options include film type, film format size and focal length. Focal length in combination with film format size determines ground resolution and coverage; from an altitude of 65,000 ft, U-2 camera systems provide a nominal resolution of 2 to 15 ft and a maximum coverage of 256 square nautical miles per frame. Conventional black and white or natural color film can be used in place of, or in combination with, color infrared film. Camera combinations are often flown to provide multiple resolution, format, and film-type coverage of the same area.

**Crop Discrimination:** The image above is a high altitude, color infrared photograph of Burley, Idaho, reduced by approximately 50 percent. It shows an urban node in an agricultural area and discriminates between alfalfa fields at different stages of development: the more mature the crop, the more intense the red. Fallow or newly planted fields appear gray, and harvested fields with stubble remaining appear in shades of white. Two fields with quarter-section, central-pivot irrigation can be seen at the bottom. These fields are 0.5 mile in diameter, covering 160 acres. This infrared treatment highlights the old riverbed at the sides of the present river as well as the presence of sediment (white) in the water. This is a portion of the original 9 x 18 in. frame, showing 32 square nautical miles at a resolution of approximately 8 ft.

**Landcover Discrimination:** This color infrared photograph of Santa Cruz, California (left), emphasizes the diverse nature of the California coastal terrace region: forest, natural pasture, agriculture, and urban development. In addition, although the photo was taken from a U-2 at 65,000 ft, it shows details that are relatively easy to identify — a yacht harbor, a golf course, parking lots, trailer parks, creeks, industrial parks, commercial streets, and residential areas. This picture has been reduced by approximately 60 percent from the 9 x 18 in. original, which was taken with a 24-in. lens.



**Land Use Mapping:** A U-2, color infrared photograph of the area surrounding Cozad, Nebraska (left), is paired with a section from a land use map of the same area (below). The map illustrates land use distribution in the Central Platte Natural Resources District, Nebraska. It was prepared by the Remote Sensing Center at the Institute of Agriculture and Natural Resources, the University of Nebraska. The major source of information for map categories was NASA high-altitude, color infrared photographs. There are 16 categories of land use inventoried on the map on a 10-acre legal subdivision grid cell (see legend, below). The original NASA photograph was taken with a 6-in. lens and covered 256 square nautical miles at a resolution of 10 to 15 ft.

RESIDENCES—areas of single- and multiple-unit dwellings, including those of seasonal occupancy.

COMMERCE/INDUSTRY—areas used for sale of products and services, including light and heavy manufacturing.

PUBLIC SERVICES—areas dominated by transportation, communication, and utility facilities, including sewage lagoons.

INSTITUTIONS—areas occupied by educational, religious, health, correctional, or government facilities, including cemeteries.

OTHER URBAN—areas having no obvious use but associated with urban areas, probably transitional between uses.

ROW CROPS—areas principally of corn, sorghum, and soybeans.

SMALL GRAIN—areas of wheat, oats, and minor amounts of rye and barley.

PASTURE—areas of grasses and legumes primarily associated with intensive cropping activities.

RANGELAND—areas of grasses (predominantly native) and legumes associated with ranch operations.

FARMSTEAD/FEEDLOT—farm residences and associated buildings, including feedlots and small miscellaneous open areas.

FALLOW LAND—unvegetated areas managed to accumulate soil moisture; includes areas of drought crop failures.

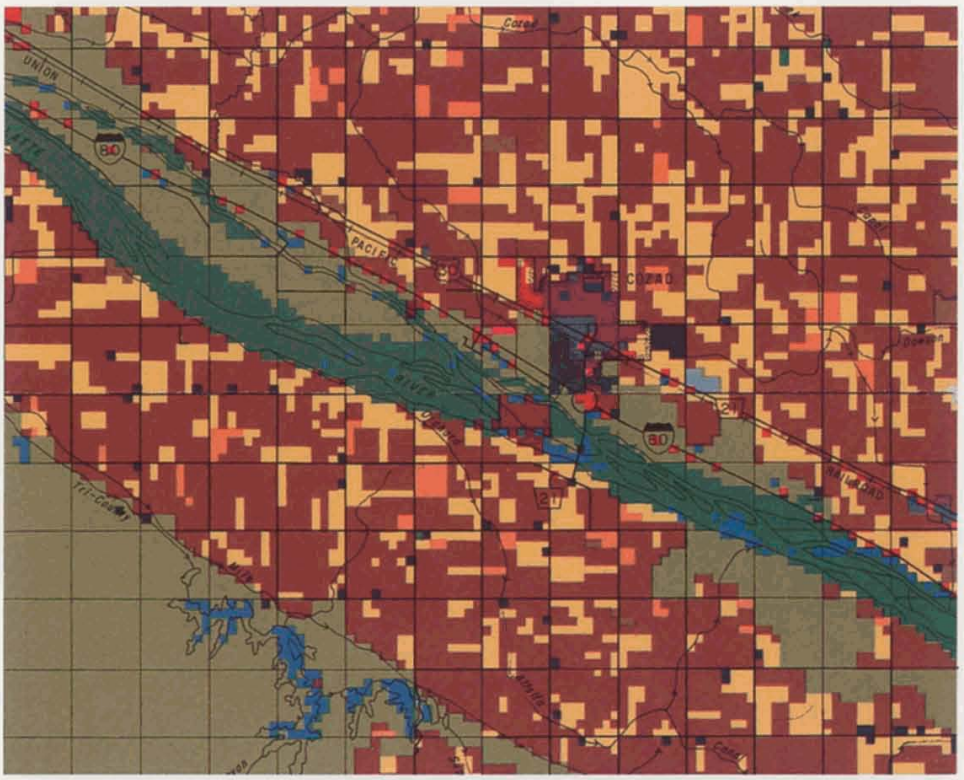
FOREST—areas having more than 50 percent tree cover and no evidence of special use.

WATER—areas predominantly or persistently water covered.

WETLANDS—areas where permanent vegetation is predominantly influenced by a near-surface water table.

RECREATION—areas of public and private leisure activity; includes golf courses, parks, and other public facilities.

PITS AND QUARRIES—areas used primarily for extracting sand and gravel, including supporting facilities.



## Operational Support

The Applications Aircraft Data Management Facility at NASA/Ames Research Center provides full technical support for high altitude remote sensing activities, from initial planning stages through delivery of processed data to the user. This includes flight coordination, film processing, scanner data conversion to computer-compatible tape, data quality assurance procedures, data archiving, and assistance with image analysis. Attention is also given at the Facility to developing new applications for the data collected.

## Data Distribution

Flight requesters normally receive processed data and a Flight Summary Report within 30 days of a flight. The Flight Summary Report contains a flight track map along with descriptions of sensors, flight conditions, data quality, magnetic tape formats, and sensor calibration procedures. Since imagery from a single flight often pertains to the interests of more than one group, copies of processed data are kept for public use at the Data Management Facility and at the EROS Data Center, operated by the U.S. Department of the Interior at Sioux Falls, South Dakota. Additional copies of tapes and photographs can be purchased from the EROS Data Center.

## Data Archive

Flight users and other interested parties can schedule viewing of all previously collected high-altitude imagery on display systems at the Data Management Facility (subject to the Facility's operational requirements). The Image Selection System (ISS) is a computerized database of the 500,000-frame photographic archive, giving users quick access to frame numbers that match specified requirements. ISS selection parameters include scale, film type, data format, data quality, weather conditions, and spectral band. Light tables, stereo viewers, a transfer scope, and microfilm copies of all photographic imagery are also available for use.

The Interactive Display Image Manipulation System (IDIMS)* is available on a limited basis for TMS image display and training. IDIMS is an advanced interactive system for complete multispectral scanner data manipulation and analysis. Its capabilities include pseudo- and false-color composites, multiband ratioing, principal components analysis, density slicing, data compression, mosaicking, and graphics overlay. Equipment is available for hard copy generation of IDIMS imagery.

*Product of ESL, Inc.

**High-Resolution Panoramic Photography:** These two images illustrate the capabilities of the Itek IRIS panoramic camera, flown by NASA high-altitude aircraft. The IRIS photographs a 2 x 37 nautical mile swath with each frame and has the highest resolution potential of NASA cameras for all film types (2 ft with black and white film). It is used by the Environmental Protection Agency to detect waste dumping and by the Department of Forestry to monitor gypsy moth timber stand defoliation. The image on the right is a 300-percent reduction of a full 3-ft-long IRIS color infrared frame taken over an agricultural area near Sacramento, California. A small section (above), enlarged 300 percent, shows the towns of Walnut Grove and Locke, California, along the Sacramento River, and surrounding walnut groves, vineyards, and vegetable fields at different stages of maturity (different hues of red). Individual walnut trees can be distinguished, as can details of the town, river, and canals.

**Resource Mapping:** The two color infrared photographs on this page are products of NASA's Alaska High Altitude Photography Program, which was commissioned by a consortium of federal and state agencies to inventory the resources of the entire state of Alaska. The program is an effort to meet increased pressure for development and exploitation of natural resources with responsible and timely administration of public lands. The sponsoring agencies include the Bureau of Land Management, the U.S. Geological Survey, and the State Department of Natural Resources.

The photograph of Palmer, Alaska, (left) shows again how color infrared film can aid in distinguishing different types of land cover. Here urban development, forest, water bodies, agricultural areas, and natural land features are clearly defined. The photograph shows a highly glaciated, braided river (blue) depositing glacier silt (pale blue) at the sides of its many channel courses. Below is a color infrared photograph of Bremner Glacier, in southeastern Alaska. Tundra (red), ice (white), and rock (gray) are clearly discriminated in this picture. The gray streaks in the glacier are lateral moraines — pieces of rock scraped off by the source glaciers. This rock debris will eventually be deposited in the terminal moraines, shown here as the gray perimeter at the bottom of the glacier. Both photographs on this page are 30 percent reductions of original 9 x 9 in. frames. They were taken with a 12-in. lens, yielding a 64-square nautical mile coverage at a resolution of 5 ft.

## Flight and Data Requests

NASA High Altitude Aircraft Program remote sensing services are available through NASA and federal, state and local government agencies for Earth resource research within the continental United States. (Under special conditions, flights are sometimes conducted beyond United States borders.) Interested parties are invited to visit the Applications Aircraft Data Management Facility at Ames Research Center for consultation with the technical staff and a closer look at the services offered. For further information about remote sensing operations, flight requests, or use of previously collected data, contact:

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