COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

# BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

**RECORDS:**

RECORD NO. 1968/10


# INFRARED AERIAL PHOTOGRAPHY TESTS,

## QUEENSLAND 1966

*by*

*E.J. POLAK and W.A. WIEBENGA*



5928/65

RECORD NO. 1968/10

# INFRARED AERIAL PHOTOGRAPHY TESTS, QUEENSLAND 1966

*by*

*E.J. POLAK and W.A. WIEBENGA*

## CONTENTS



## ILLUSTRATIONS



## SUMMARY


Infrared and panchromatic films were used to take air photographs over North Stradbroke Island and Crib Island, Queensland. The photographs are compared and differences and similarities are discussed and explained on theoretical grounds. Some avenues of further work are indicated.



1968/10

## 1. INTRODUCTION

The use of infrared photography for the interpretation of ground and surface hydrology has been attempted in several countries, but the published data are rather scarce. To gain a first hand experience in infrared photography, a set of air photographs was taken during the acceptance test flight of the Bureau of Mineral Resources D.C.3. VH-MIN plane in Brisbane on December 8th 1966, between the hours of 12.00 noon and 2.00 p.m. During the flight two F24 cameras were used, one with black and white infrared film, the second with panchromatic. The photographs were taken by A.G. Spence and K. Mort. The camera was adapted for infrared photography by W. Olbrich of the Design Group of the BMR. A set of photographs has been obtained. In this report the infrared photographs are compared with panchromatic ones. An attempt is made to interpret the differences between the photographs on the basis of published data of other surveys, from theoretical considerations, and from the knowledge of local conditions in the area where the photographs were taken. The interpretation will be checked in the field. It was hoped that the comparison would reveal:

1) mixing of fresh and salt water in coastal waters,

2) infiltration of salt water into an aquifer, and

3) the lines of future research of infrared air photographs.

## 2. INFRARED RADIATION

Infrared radiation is a form of electromagnetic radiation identical with light. It has the same wave and polarisation properties. Plate 2a shows a diagram of the electromagnetic spectrum, the infrared extends over a wavelength range of about 0.75 microns to about 1000 microns. The emanation of this part of the spectrum is invisible to the human eye.

Infrared radiation is thermal in its origin and like other forms of radiation originates when bodies are heated to a certain temperature. This kind of radiation covers a broad continuous spectrum of wavelengths, as is shown by the spectrum of solar emittance in Plate 2b. The waves falling on a body are absorbed or reflected in different proportions depending on how 'dark' or 'bright' their surface colouration appears to be (Simon, 1966; Suits, 1960 )

## 3. INFRARED PHOTOGRAPHY

Some photographic emulsions can be made sensitive to the infrared portion of the spectrum image from about 0.75 to 1.30 microns, but for the aerial infrared film this range is reduced still further to about 0.75 to 0.90 microns. This reduction is due to the consideration of stability and 'speed' of the film. These films are also sensitive to the full range of visible spectrum, if no filter is used. (Colwell, 1961; Takakazu & Motomitsu, 1960).

Infrared film gives a light rendering of green vegetation. This property is called 'chlorophyll effect'. It is produced by the transparency of the chlorophyll to infrared vibrations so the internal tissues of the leaves are free to reflect the radiation and also the leaves emit strong fluorescent radiation in the near infrared when they are illuminated by white light (Simon, 1966). The maximum reflectance from the leaves in the visible spectrum occurs in the middle green; minimum reflectance in the low red; and a very high emission in the near infrared. This emission is much higher than in any portion of the visible spectrum (Lueder, 1959).

As a result green vegetation is rendered in dark tones on the panchromatic photographs, and on infrared photographs it registers light, the tone of registration depending on the chlorophyll content of the leaves. Salt water vegetation contains more salt and less chlorophyll than fresh water vegetation: hence, on an infrared photograph this salt water vegetation shows up darker. Moreover, salt water areas just contain less vegetation.

Some coniferous trees are dark on infrared photographs as a result of the physical configuration of the needles (Brock, 1952). The chlorophyll content and the shape of the tree are used as basis of identification of trees in infrared photography as applied to forestry (Clark, 1946; Haack, 1962; Schulte, 1951).

Natural water absorbs appreciably the radiation on the extreme red end of the spectrum; radiation of more than 1.4 microns wavelength is nearly completely absorbed. Generally natural waters photograph black on infrared film because there is no reflection from the deeper bottom. Reflections from a depth of greater than one foot will not show up.

Infrared photography cannot distinguish between fresh and salt, or warm and cold, water. But suspended material within one foot from the surface will show up by lighter tones because of the brighter reflectivity. Warm and cold water with temperature differences in excess of 0.75 $^{o}$C can be distinguished by a spectrometer, recording the emission spectrum in the middle infrared range.

In haze, infrared photographs are slightly better than panchromatic, but in fog and cloud the scatter of infrared is as large as the scatter of visual radiation.

## 4. ARRANGEMENTS OF TESTS

### Cameras

Two Vinten F24 cameras with 5-inch f4 lenses were used. One of the cameras was adapted for infrared photography; the focal distance was increased (by 0.018 inch) to compensate for the difference in wavelength. The second camera had standard 5-inch focal distance.

Films

For infrared photography the Kodak infrared Aerographic Film Type 5424 was used. To confine exposure to the infrared, Kodak Wratten Filter No.25 was used giving a film response between 0.7 and 0.88 microns. The photographs were taken with aperture set at f8 and shutter speed at 1/300 sec.

For panchromatic photography, the aperture was also set at f8 and the shutter speed at 1/300 sec.

Flight arrangements

The choice of the areas to be photographed was governed by the following factors.

1. the proximity of the Eagle Farm Airport, where the overhaul of the plane was carried out,

2. the knowledge of the area, and

3. the easy ground access necessary to check factors that could affect the photographs.

After consideration three areas were chosen, two of them on Stradbroke Island, the third one on Crib Island (see Plate 1).

Stradbroke Island is divided from the mainland by Moreton Bay. The island is built mostly of sand dunes; only in some parts is solid rock found above sea level. The area was geologically mapped by Gardner (1955). An extensive geophysical survey was carried out there by Polak and Kevi (1965) and Kevi and Milsom (1966).

Two flights were made at 1600 feet above ground level in an east-west direction from Point Lookout to Amity Point. The flights crossed the fresh water swamp, high dunes, and terminated over the beach south of Amity Point. One flight at 8000 feet above ground level was made along the northern part of the Eighteen Mile Beach, starting from the line of the Titanium and Zirconium Industries old cable-way and finishing at Point Lookout. The strip of land covered by the photographs includes beaches, fresh water swamps, and high dunes.

Crib Island is a partly reclaimed area at the mouth of Brisbane River. Five short flights were made at 4000 feet above ground level.

## 5. DISCUSSION OF RESULTS

In Plates 3 to 12, pairs of photographs of the same area taken simultaneously are shown. The left photograph on each plate was taken on infrared film, the right photograph on panchromatic. In the following sections the similarities and differences between the photographs are discussed and the possible explanations for the differences

are also given. This explanation is obtained from published data of other surveys or from theoretical consideration. The locations where some supporting evidence for interpretations has been found are also mentioned.

Plate 3, Photograph 11

The photographs represent the outflow of the fresh water swamp near the Rocky Point Beach on Stradbroke Island. The location was visited several times during the geophysical survey in 1964. On the infrared photographs the trees are shown light and their shape is well defined. It is possible to recognise three main types of trees: (a) gum tree ; (b) banksia ; and (c) tee-tree. The trees on the panchromatic are dark, and types are not distinguishable.

The water on the outflow of the marsh is shown black on both photographs. To the left of pool (d) the water is shallow (probably less than one foot deep) showing the shape of the bottom more clearly on the infrared than on panchromatic photographs.

The marsh areas are clearly indicated on the infrared photographs showing the very wet sections (e) and ridge (f). Two man-made pools (g) are clearly indicated on infrared photographs, whereas one of them is completely blended with trees on panchromatic. Two other symmetrical objects seen on panchromatic photographs (h) could be identified as pools with water, but they are shown grey on infrared and therefore they may not contain deep water.

The fisherman's huts and bush tracks are easier to recognise on the panchromatic photographs than on infrared.

Plate 4, Photograph 12

The plate is the continuation to the west of the photograph shown in Plate 3. The same types of trees are easily recognised from the infrared photographs and different shading indicates deeper and shallower marsh. A large pool of deep water (a) is shown clearly on the infrared photograph, whereas on panchromatic it may be interpreted as a marsh.

Plate 5, Photograph 28

The photographs show the Bechive corner of the Point Lookout - Amity Road. Infrared photographs show clearly the areas of deep open water in the marsh (a) and the ridge (b). This ridge is shown on both types of photographs.

Plate 6, Photograph 83

The photographs show the cliffs at Point Lookout. The rock in this area is rhyolite. The same features are shown on both photographs.

Plate 7, Photograph 145

The photographs represent a section of the Eighteen Mile swamp on Stradbroke Island. The area was visited during the 1964 and 1965 surveys. On the deeper sections of the swamp saw grass is growing abundantly while the shallower parts are covered with swamp coutch grasss. The blades of saw grass are similar in structure to the needles of pine trees and therefore it is expected that they will show dark on the infrared photographs. The swamp couch grass will show light on infrared photographs. The distribution of creeks and drainage pattern is more visible on the infrared photograph.

Plate 8, Photograph 147

These photographs were included in the report to show that the penetration power of both films through the clouds is the same.

Plate 9, Photograph 90

The photographs were taken over Lytton on the right bank of Brisbane River. The construction in the centre is the Ready Mix Concrete plant. The area round the plant was reclaimed several years ago, using the material dredged from the river, which is tidal in this area. The chlorophyll effect on the infrared photograph is very clear, therefore it is expected that the salt content of the soil was lowered by rainwater. The area to the north-west across the creek is subjected to continual tidal inundation and therefore the salt content in this area is high; the chlorophyll effect is much lower as shown on infrared photographs. The panchromatic photograph does not show any difference between these areas.

The infrared photograph also gives better definition of the old island (a).

Plate 10, Photograph 93

The photographs show the outflow of the Brisbane Sewer (a). The spreading of the suspended matter is shown on both photographs, but infrared shows it more clearly. A tidal creek near (b) can be interpreted as a footpath but the infrared photograph shows clearly the slopes of the creek's banks.

Plate 11, Photograph 119

The photographs show the tidal part of the creek on Crib Island. It shows clearly the difference in definition between infrared and panchromatic. The actual creek bed (a) is better defined on the infrared and also more details of the tree cover are shown (b), but the footpaths (c) are better defined on panchromatic. The black background of the trees at (d) on the infrared photograph indicate that the trees are standing in deep water.

Plate 12, Photograph 87

The photographs are included to illustrate the fact that the panchromatic and infrared photographs will show the same details when an industrial plant is photographed.

## 6. CONCLUSIONS AND RECOMMENDATIONS

Considering different aspects of aerial photography interpretation, the following conclusions can be reached.

### Water areas

Streams and water bodies appear black on infrared photographs, where they are more than one foot deep. They are much better defined than on panchromatic photographs. Water with suspension appears lighter in some shade of grey depending on the concentration of suspended matter. Shallower water shows the structure of the bottom on both types of film.

### Vegetation

The infrared photographs show much more detail of dense forest or bush, and some types of trees can be easily recognised. One infrared photograph indicates the area where excessive salt water flooding exists by showing a low chlorophyll effect (to be checked in the field).

### Soil type

A study was not attempted as all the photographs were taken in an area of one soil type.

### Geology

Only one photograph shows rock outcropping; all the details are shown in the same way on both types of photographs.

### Man-made features

Industrial plants and houses seem to be shown clearly on both types of photographs, the bush paths across the dunes are more clearly defined on panchromatic photographs.

### General

In conclusion, it can be said that the use of infrared photography is an addition by which the range of tonal values can be extended, but the infrared photography should not be used on its own. A combination of infrared and panchromatic photography widens the scope for interpretation.

### Recommendation

The study of the application of infrared photography should be extended to:

1. Include photographs taken early in the morning. The infrared emission is based on the temperature of a body, and the temperature of the different bodies will be more uneven soon after sunrise. The test could be done

using Polaroid infrared film in Land cameras.

2. Infrared Ektachrome should be tested; it has higher resolution, it is less influenced by focusing, and if used as false colour will disclose the details of the bottom of water to the depth of about 20 ft.

## 8. BIBLIOGRAPHY


ANSON, A. 1966 Colour photo comparison. Photogrammetric Engineering 132, 286-297.

BROCK, C.C. 1952 PHYSICAL ASPECTS OF AIR PHOTOGRAPHY. Longmans, Green & Co. Ltd, London

CLARK, W. 1946 INFRARED PHOTOGRAPHY. Chapman and Hall, Ltd, London

COLWELL, R.N. 1961 Some practical applications for multiband spectral reconnaissance. Am. Sci. 49 (1) 9-36.

GARDNER, D.E. 1955 Beach sand heavy-mineral deposits of Eastern Australia. Bur.Min.Res. Aust.Bull. 28.

HAACK, P.M. 1962 Evaluating color, infrared and panchromatic aerial photos for the Forest Survey of Interior Alaska. Photogrammetric Engineering 28, 592-598,

KEVI, L. and MILSOM, J.S. 1966 North Stradbroke Island geophysical survey of underground water. Bur.Min.Res.Aust.Rec. 1966/190.

LATTMAN, L.H. and RAY, R.G. 1965 AERIAL PHOTOGRAPHY IN FIELD GEOLOGY. Holt, Rinchart, and Winston.

LUEDER, D.R. 1959 AERIAL PHOTOGRAPHIC INTERPRETATION. McGraw Hill Book Co. Ltd, New York

MOTT, P.G. 1966 Some aspects of colour photography in practice and its applications. The Photogrammetric Record 5, 221-240.

1963 Report on some uses of infrared photography in Western Australia. Cartography 5 (122), 5-7

| | | |
|---|---|---|
| POLAK, E.J. and KEVI, L. | 1965 | North Stradbroke Island geophysical survey for underground water. Bur.Min.Res.Aust.Rec. 1965/248. |
| SCHULTE, C.W. | 1951 | The use of panchromatic, infrared, and color aerial photography in the study of plant distribution. Photogrametric Engineering 17 (5). |
| SCOTT BAR, E. | 1960 | Historical survey of the early development of the infrared spectral region. Am. J. Phys. 28 (42). |
| SIMON, L. | 1966 | INFRARED RADIATION. Van Nostrand Momentum Book No. 12. |
| SWANSON, L.W. | 1960 | Photogrammetric surveys for nautical charting use of colour and infrared photographs. Photogrammetric Engineering 26, 137-141. |
| STRANBERG, C.H. | 1966 | Water quality analysis. Photogrammetric Engineering 32, 234-248. |
| SUITS, G.H. | 1960 | The Nature of Infrared Radiation and ways to photograph it. Photogrammetric Engineering 26 (5), 763-772 |
| TAKAKAZU MARUYASU MOTOMITSU NISHIO | 1960 | On the study and application of infrared aerial photography. Report of the Institute of Industrial Research University of Tokyo, 10, No. 1. |

PLATE 1

153°00'
153°15'
153°30'
153°45'
27°15'
27°30'
27°45'

BRUCE HWY.
REDCLIFFE
SANDGATE
MORETON
BAY
MORETON
ISLAND
SOUTH
PACIFIC
OCEAN
CRIBB ISLAND
119
93
90 & 87
LYTTON
WYNNUM
WELLINGTON
POINT
Brisbane
River
BRISBANE
PEEL
ISLAND
CLEVELAND
REDLAND
BAY
AMITY POINT
BECHIVE
28
11 & 12
83
Rocky Pt Beach
POINT LOOKOUT
147
145
NORTH
STRADBROKE
ISLAND
Blue Lake
Swamp
Mile
Eighteen
Beach
RUSSELL
ISLAND
SOUTH
STRADBROKE
ISLAND
BEENLEIGH
River
River
Logan
BRISBANE
SYDNEY
HIGHWAY
RLY
BRISBANE
ENGLAND
SOUTH
PACIFIC
RAILWAY
BRANCH
COAST
HIGHWAY
NEW
BEAUDESERT
CANUNGRA

## INFRARED PHOTOGRAPHY PRELIMINARY TESTS
## DECEMBER 8TH 1966

MILES
0 1 2 3 4 5 10

LEGEND

Area covered with close flightlines on Cribb Island

Flightlines on Stradbroke Island

28 Location of photographs used in the records

TO ACCOMPANY RECORD Nº 1968/10

G56/B5-44

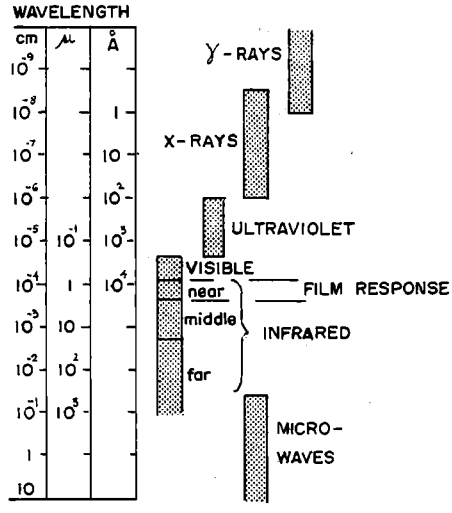



Fig. 1 ELECTROMAGNETIC SPECTRUM

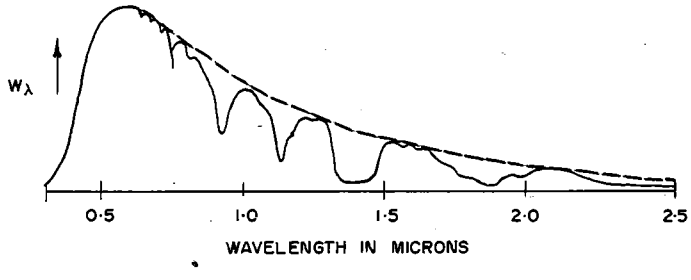
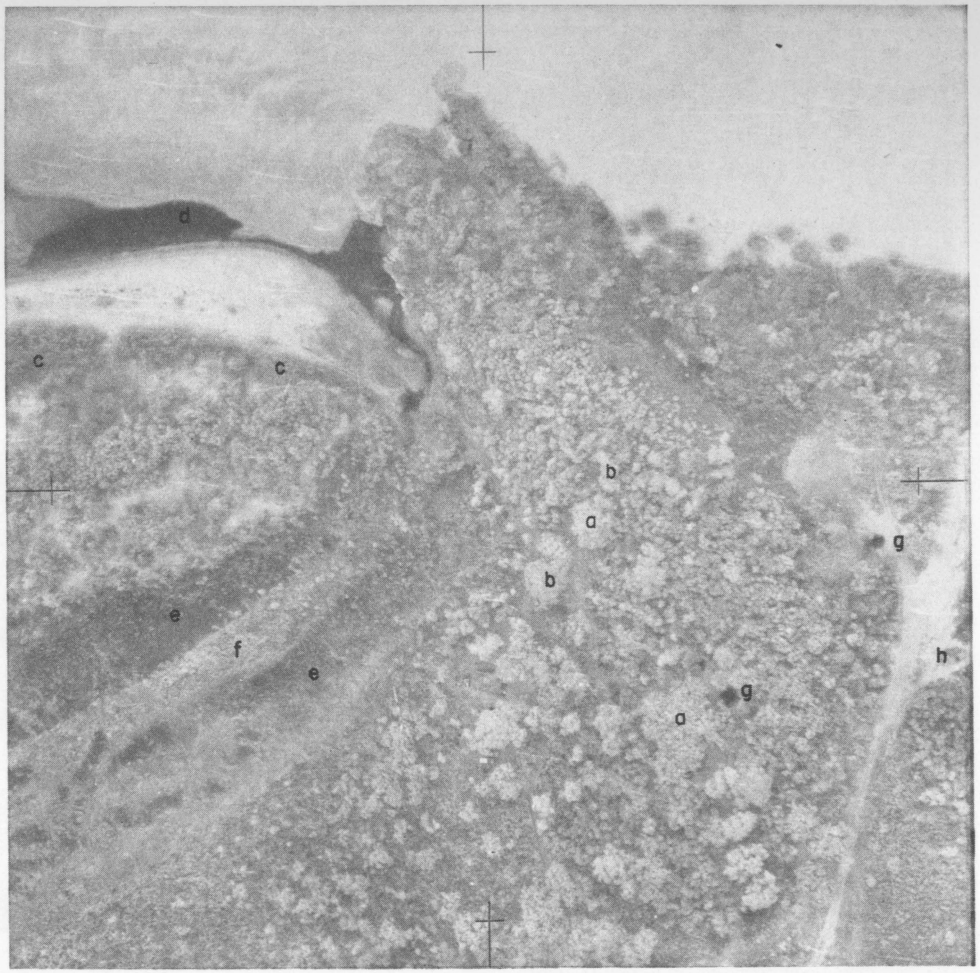
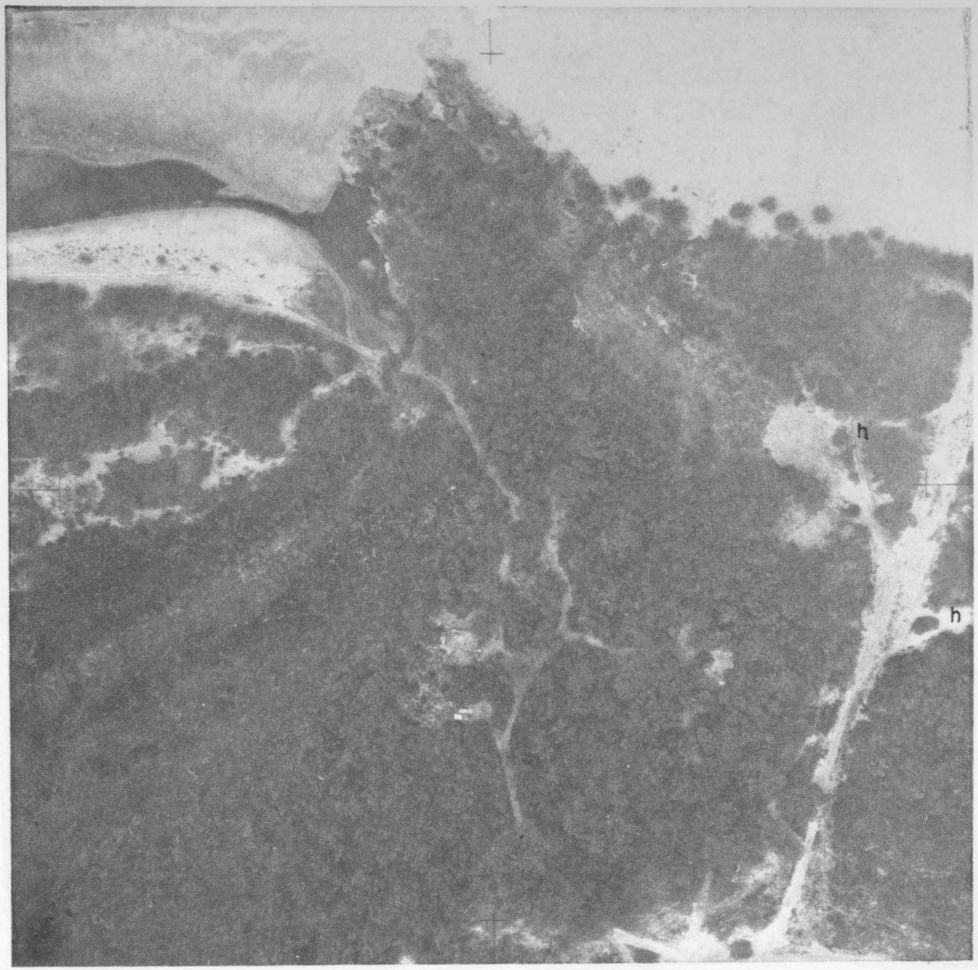



Fig.2 LANGLEY'S CURVE OF SOLAR EMITTANCE
The dips in the curve are caused by absorption in the atmosphere, mostly by water vapour

PHOTOGRAPHS Nº 11




INFRA-RED




PANCHROMATIC

FEET
0 500 1000

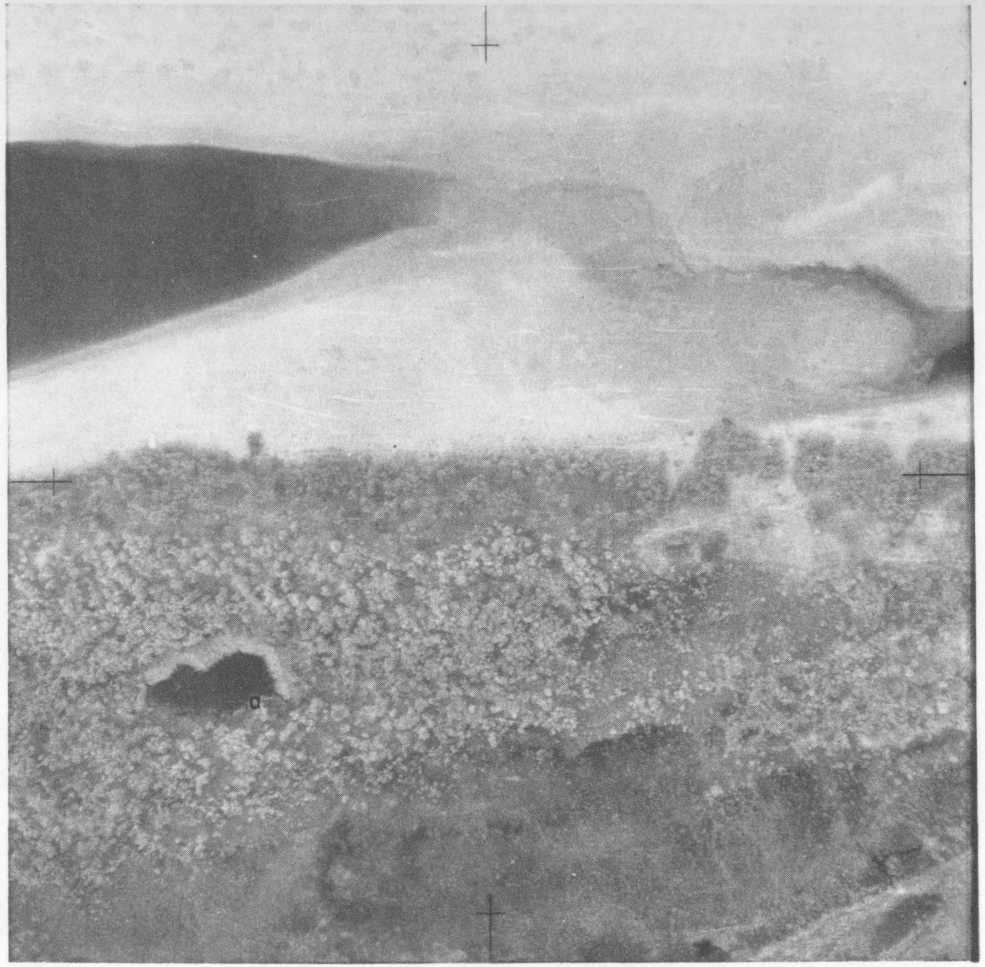
PLATE 3

*Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.*

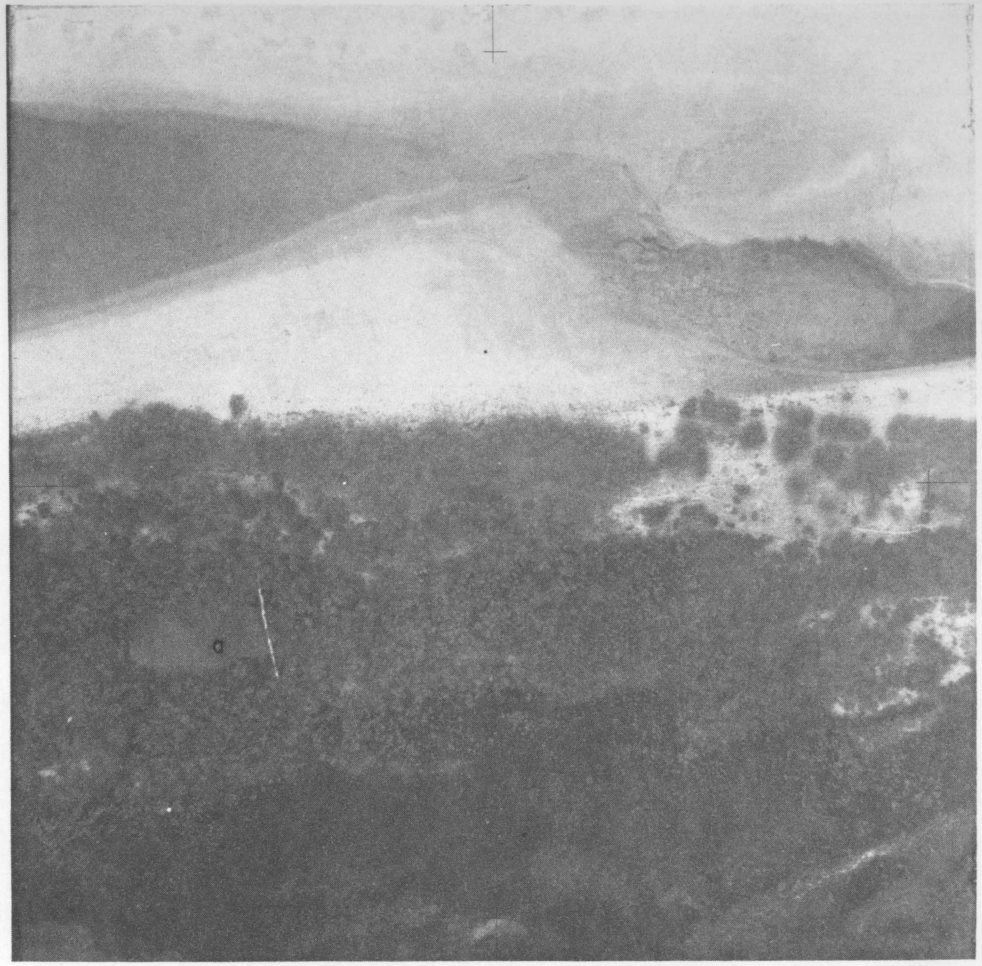
TO ACCOMPANY RECORD No. 1968/10

G56/B5—53

PHOTOGRAPHS Nº 12




INFRA-RED




PANCHROMATIC

FEET
0 500 1000

PLATE 4

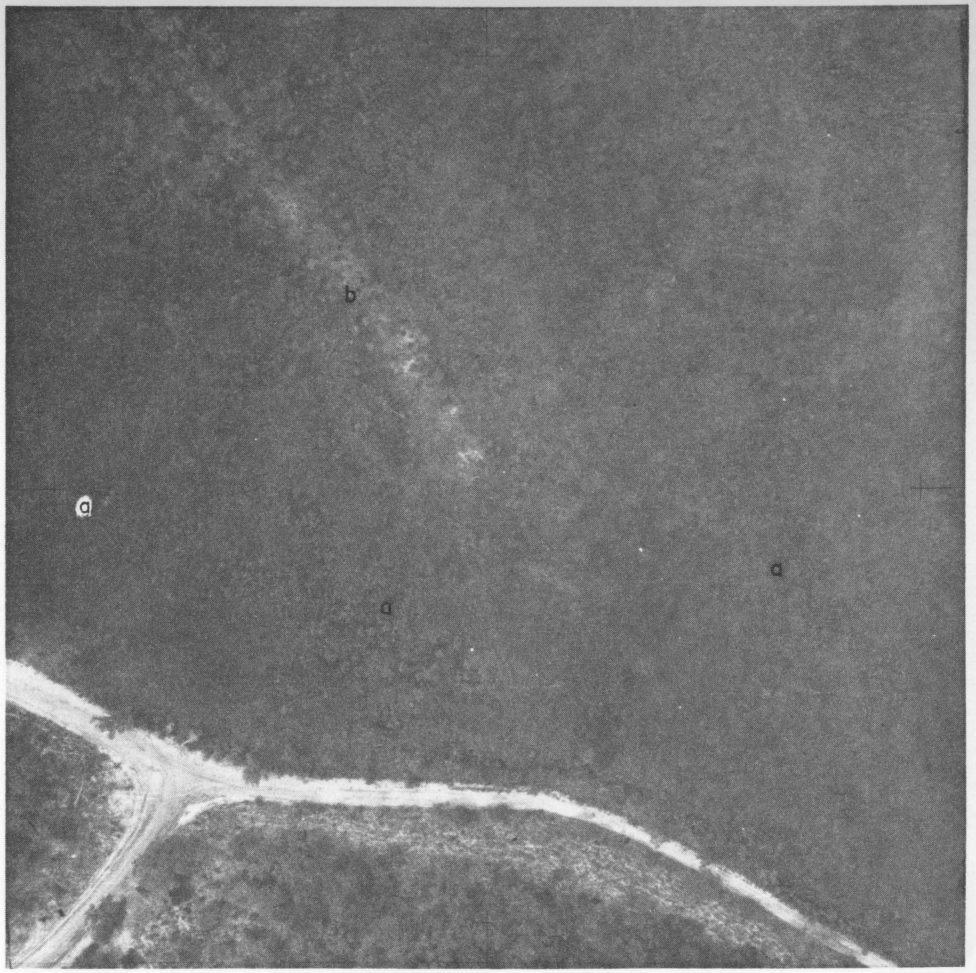
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

G56/B5-54

TO ACCOMPANY RECORD No. 1968/10

PHOTOGRAPHS Nº 28


INFRA-RED



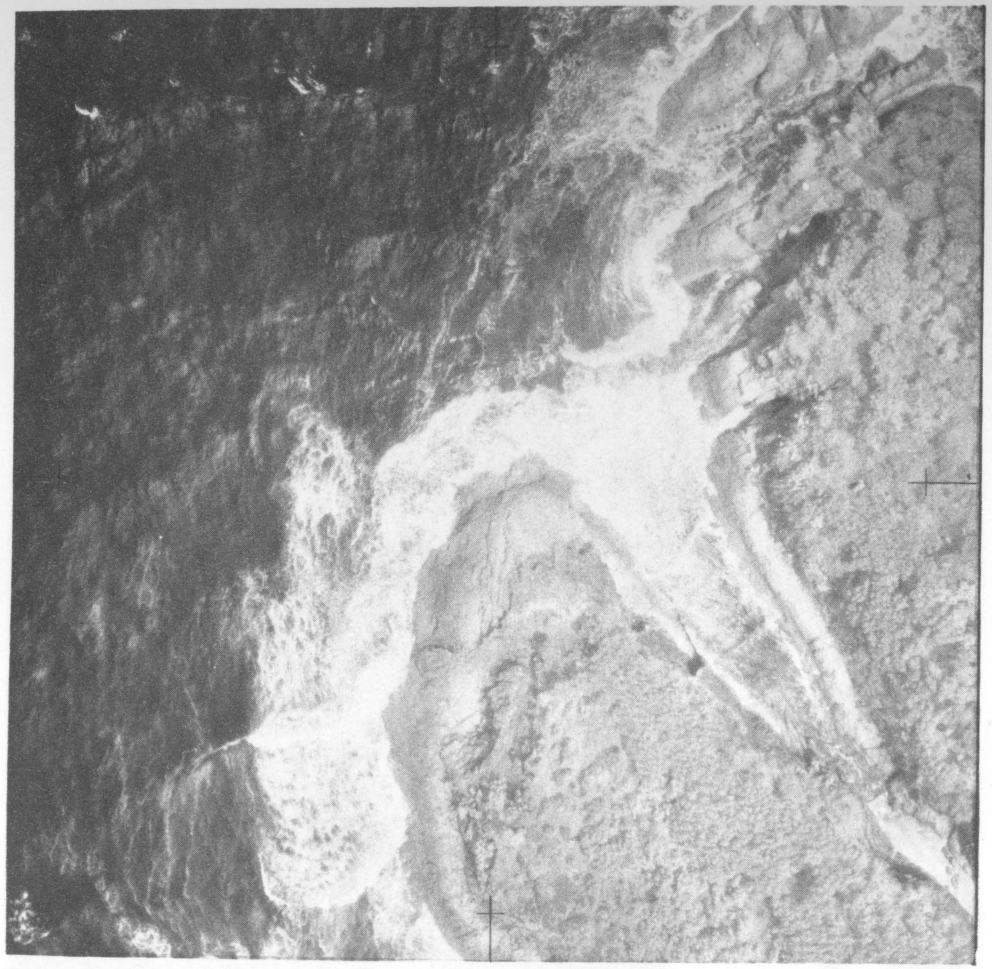

PANCHROMATIC

FEET
0 500 1000

PLATE 5

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.
G56/B5-55
TO ACCOMPANY RECORD No. 1968/10

PHOTOGRAPHS Nº 83



INFRA-RED

PANCHROMATIC

FEET
0 500 1000

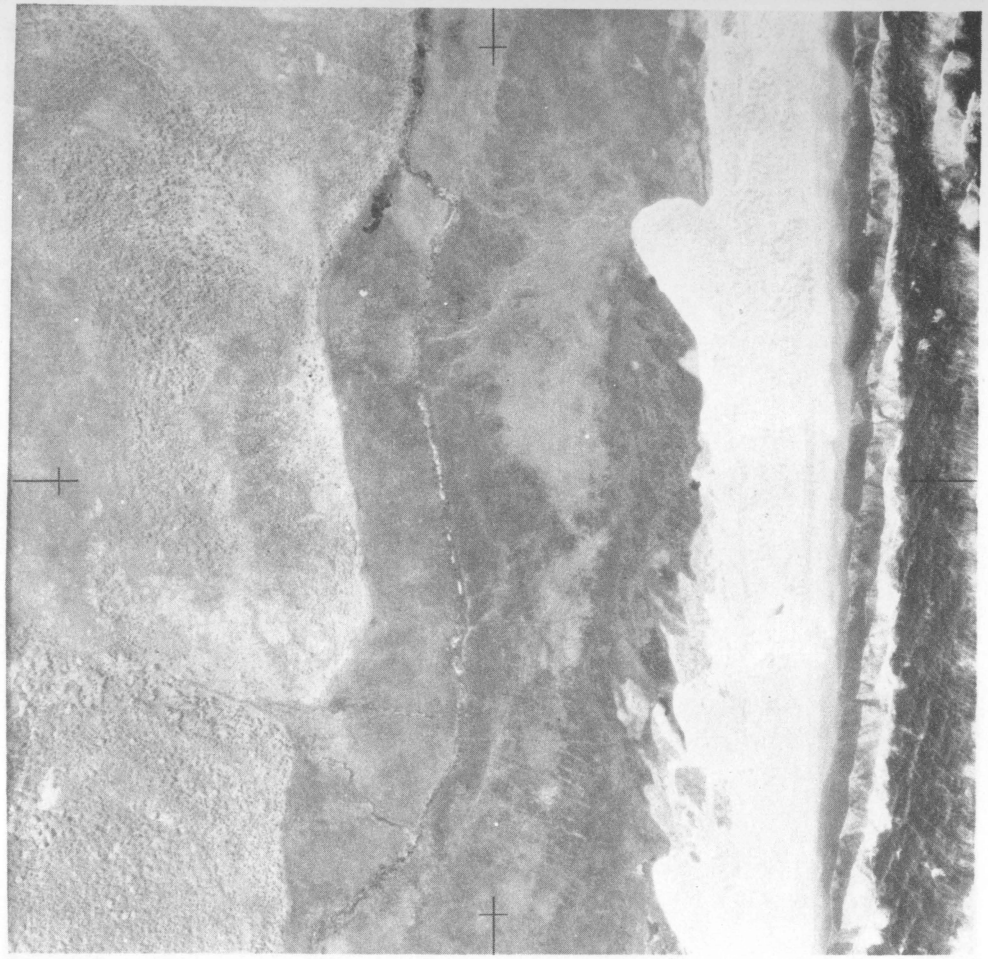
PLATE 6

*Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.*

G56/B5-56

TO ACCOMPANY RECORD No. 1968/10

PHOTOGRAPHS N° 145



INFRA-RED

PANCHROMATIC

FEET

0 2500 5000

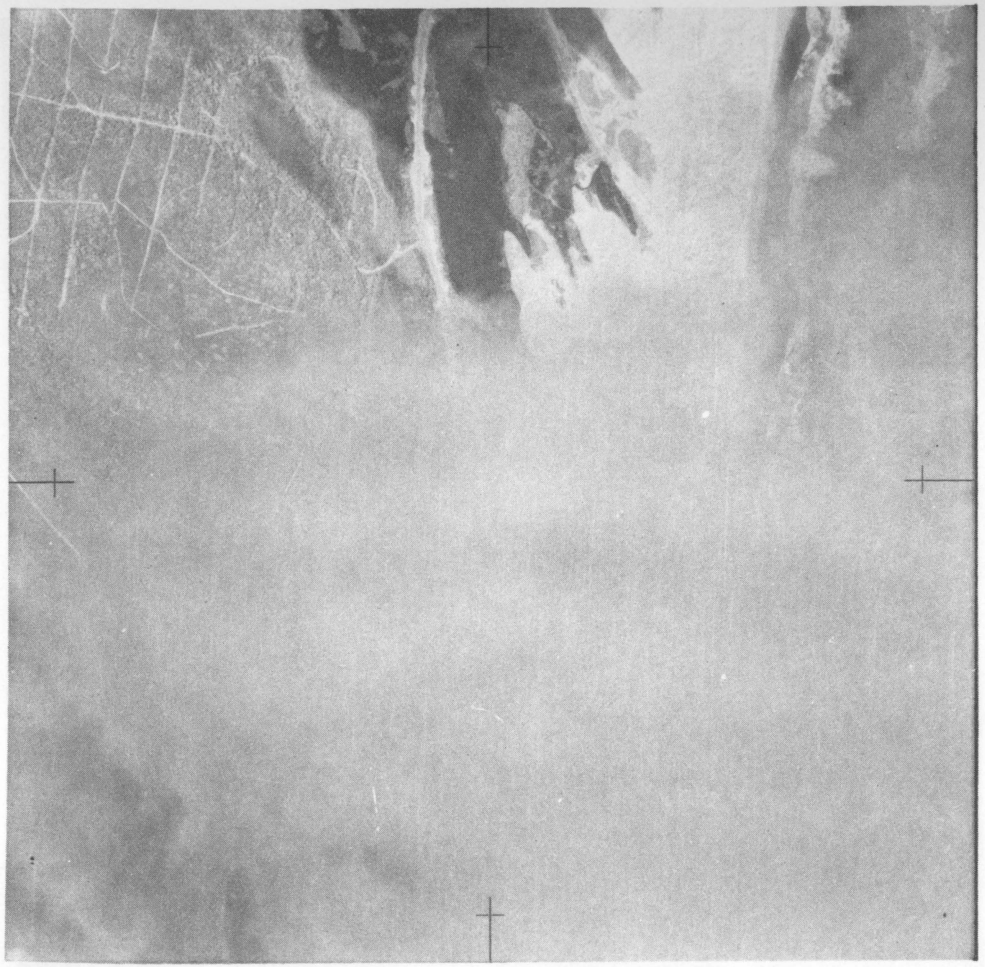
PLATE 7

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

TO ACCOMPANY RECORD No. 1968/10

G56/B5-57

PHOTOGRAPHS Nº 147



INFRA-RED

PANCHROMATIC

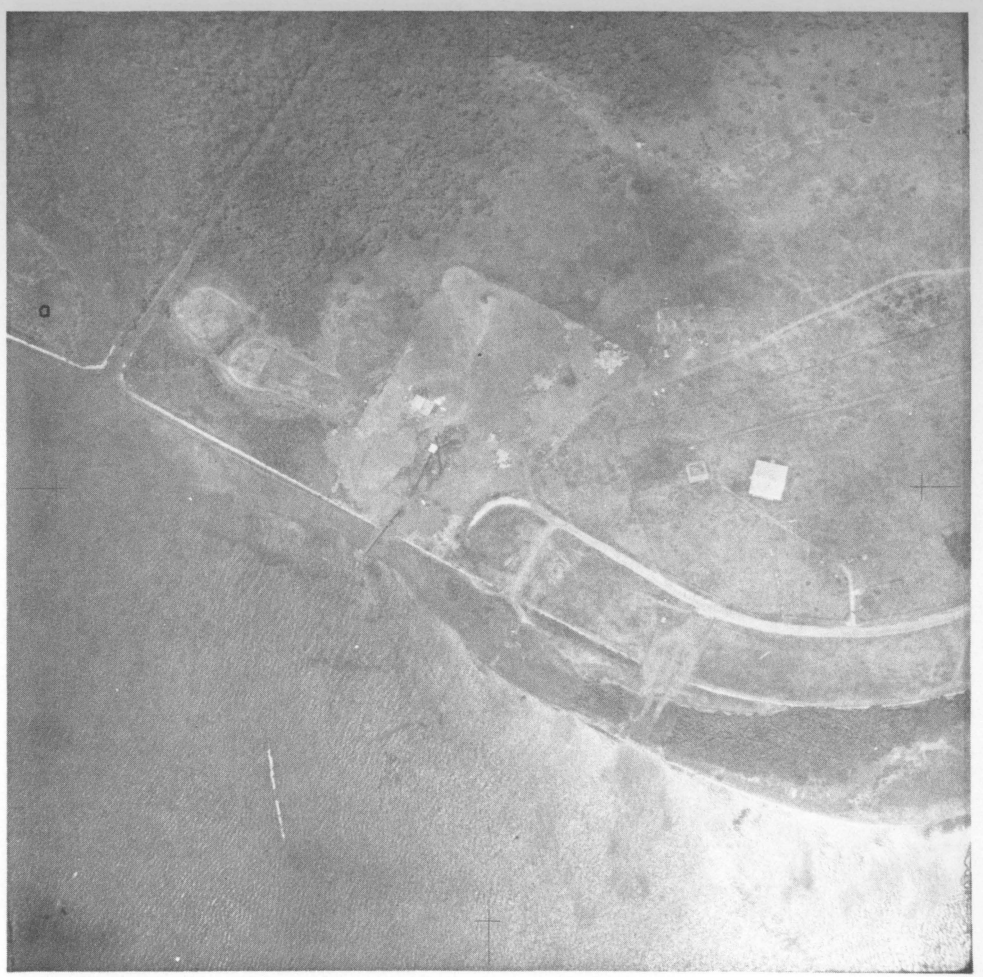
FEET

0 2500 5000

PLATE 8

PHOTOGRAPHS Nº 90

INFRA-RED



PANCHROMATIC

TOPS OUT

FEET

0 1000 2000 3000

PLATE 9

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

TO ACCOMPANY RECORD No. 1968/10

G56/B5-59

PHOTOGRAPHS Nº 93


INFRA-RED


PANCHROMATIC

FEET

0 1000 2000 3000

PLATE 10

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

G56/B5-60

TO ACCOMPANY RECORD No. 1968/10

PHOTOGRAPHS Nº 119


INFRA-RED


PANCHROMATIC

FEET

0 1000 2000 3000

PLATE 11

PHOTOGRAPHS Nº 87

INFRA-RED

PANCHROMATIC

FEET

0 1000 2000 3000

PLATE 12

*Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.*

G56/B5-62

TO ACCOMPANY RECORD No. 1968/10