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LEVEL II

BACKGROUND SPECTRAL RADIANCE AND CONTRAST IN THE NEAR-UV, MID-IR, AND LWIR REGIONS

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A COMPILATION OF
GENERAL DYNAMICS
MEASUREMENT DATA

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ABSTRACT

Absolute spectral radiance signatures of a number of natural backgrounds have been measured in the following wavelength regions:

- Near - UV (0.30 - 0.44μ)
- MID - IR (1.5 - 5.4 and 2.0 - 5.4μ)
- LWIR (2 - 13μ)

The infrared data were obtained using an interferometer with high spectral and spatial resolution while the near-UV data were acquired using a dispersive-prism spectrometer. In addition to the individual background spectra, spectral contrast plots are presented for spatially adjacent background areas. These contrast plots can be used in conjunction with target spectra to derive optimized spectral regions of operation for target detection systems. Also included are photographs illustrating the spatial appearance of the various background areas in appropriate wavelength bands.

CONTENTS

Section 1
INTRODUCTION

Over the past decade, workers in the optical radiation field have expended considerable effort in the measurement of the radiation signatures of natural background and a large quantity of data exists. However, when one is required to use the data in a system application, certain problems arise. Most detection systems are contrast sensors and the primary response generated from backgrounds is due to non-homogeneity or contrasts within the backgrounds. Response to backgrounds can be calculated by spectrally subtracting the signatures of selected backgrounds and using this data in conjunction with other system parameters. This procedure has been used in the past, however, it often leads to erroneous results which can be particularly disastrous if one is attempting to select an optimum spectral region of operation which will maximize target to background signal ratios. Quite often the backgrounds areas which are selected for spectral subtraction are taken from spatially remote portions of the background, at different times of the day, at different site locations, or even with different instrumentation. Any of the aforementioned conditions (and others) can produce spectral contrast plots which are unrealistic and most often, unduly severe.

In view of the aforementioned problems and the desire to obtain data with higher spectral and spatial resolution, a background measurement program was initiated at the Pomon Division of General Dynamics in early 1969. The program ultimately will include the measurement of a wide variety of natural backgrounds within three principal spectral regions of interest, 0.2 to 0.6, 1.5 to 5.4, and 5 to 15 micrometers.

It is the objective of this report to present a compilation of General Dynamics background measurement data gathered during three separate field measurement efforts which took place between early 1969 and late 1974. Table 1-1 summarizes the type and quantity of data gathered during this time frame.

Table 1-1
SUMMARY OF BACKGROUND MEASUREMENT EFFORTS
AT GENERAL DYNAMICS, POMONA DIVISION

Measurement Phase No.	Time Period	Spectral Region Covered	Number of Background Scenes	Data Presented In Figures
I	4/21-4/24/69	1.5 - 5.4μ	15	3-1 through 3-15
II	1/29-6/15/70	2.0 - 5.4μ	25	4-1 through 4-25
	3/31-5/19/70	0.30-0.44μ	24	5-1 through 5-24
III	10/16/74	2.0-12.8μ	8	6-1 through 6-8

Section 2
INSTRUMENTATION

The spectral data presented in this report were taken with two basic instruments: (1) a rapid-scan, Michelson-type interferometer spectrometer (Figure 2-1), and (2) a dispersive-prism-type spectrometer (Figure 2-2). A complete measurement facility was housed in the Cortez Van shown in Figure 2-3. Besides the basic spectrometers, the van included a 10 kW power generator, a search/range radar, VHF/UHF communcations, an IRIG time code generator and search-control unit, a hybrid digital/analog recording system, a real-time 500 point spectrum analyzer for data assessment, and associated monitor and calibration instrumentation for the UV and IR systems.

Either visual-band, near-UV (0.35-0.40μ), or near-IR (0.7-0.9μ) photographs, as well as mid-IR (3.6-5.4μ) thermal images of the background areas being examined, were recorded simultaneous with the spectral measurements. The near-UV photos were obtained using a 35-millimeter Nikon camera equipped with Kodak Linagraph Ortho film, a 200 mm quartz lens, and a Jena-Schott UG-11/BG-38 dye filter combination. The near-IR photos were obtained using a similar camera equipped with Kodak type IR-135 film, 135 mm glass lens, and a Corning No. CS-57-1.92 optical bandpass filter. The thermal images were recorded using a Polaroid camera attachment to the CRT display of an AGA Corporation Thermovision instrument. The Thermovision utilizes an InSb detector and exhibits a half-power response bandpass of 3.6 to 5.4 microns.

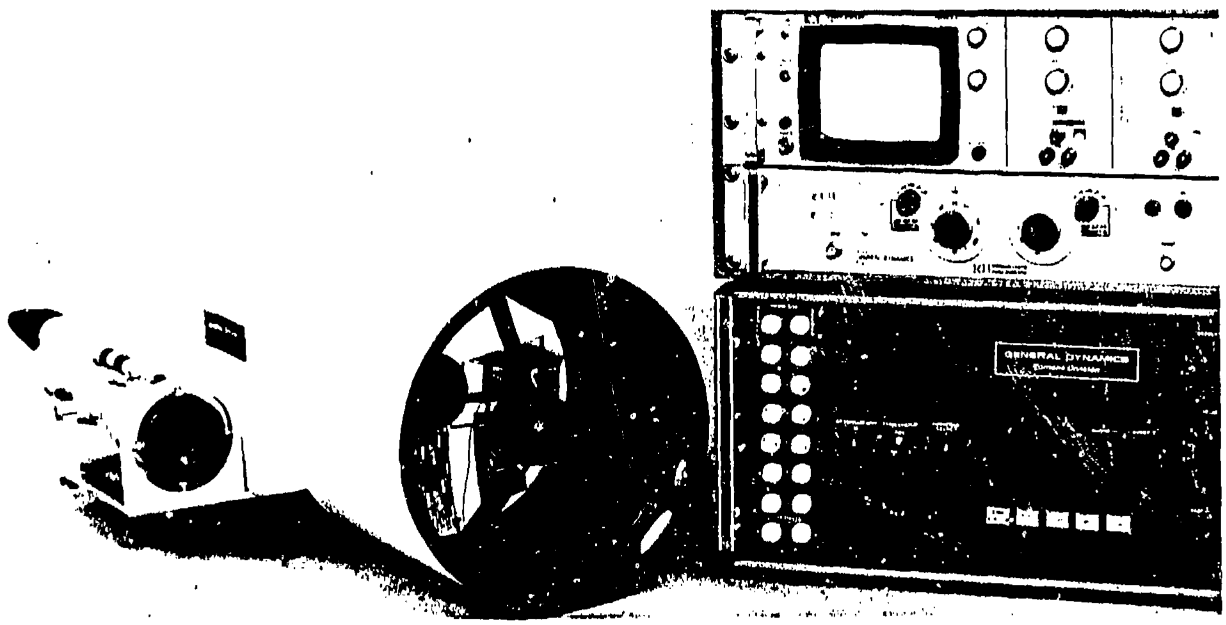

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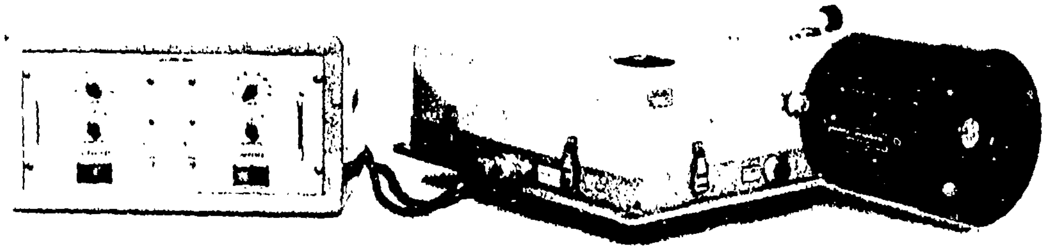
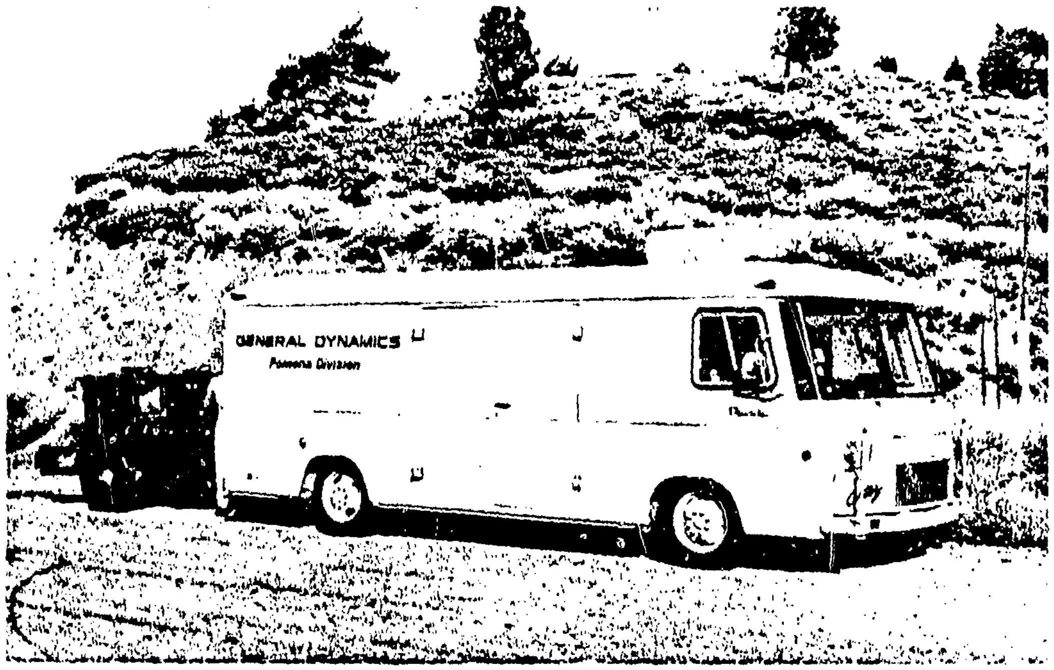
Figure 2-1. Fourier Spectrometer and Control Electronics



A63069

Figure 2-2. UV Prism Spectrometer and Control Electronics



A64147

Figure 2-3. Cortez Instrumentation Van

2.1 INFRARED INTERFEROMETER

The general operation of the infrared interferometer can be explained with the aid of the optical schematic shown as Figure 2-4. A standard Michelson interferometer optical cube is formed by the fixed mirror, the scanning mirror and the bisecting beamsplitter. These optical elements are arranged such that incident radiation entering the system is divided into two approximately equal beams of transmitted and reflected radiation. The reflected beam is directed to the fixed mirror and returned to the beamsplitter surface. The second beam is transmitted to the scanning mirror and also returned to the beam-splitter surface. These two component beams recombine at the beamsplitter surface in

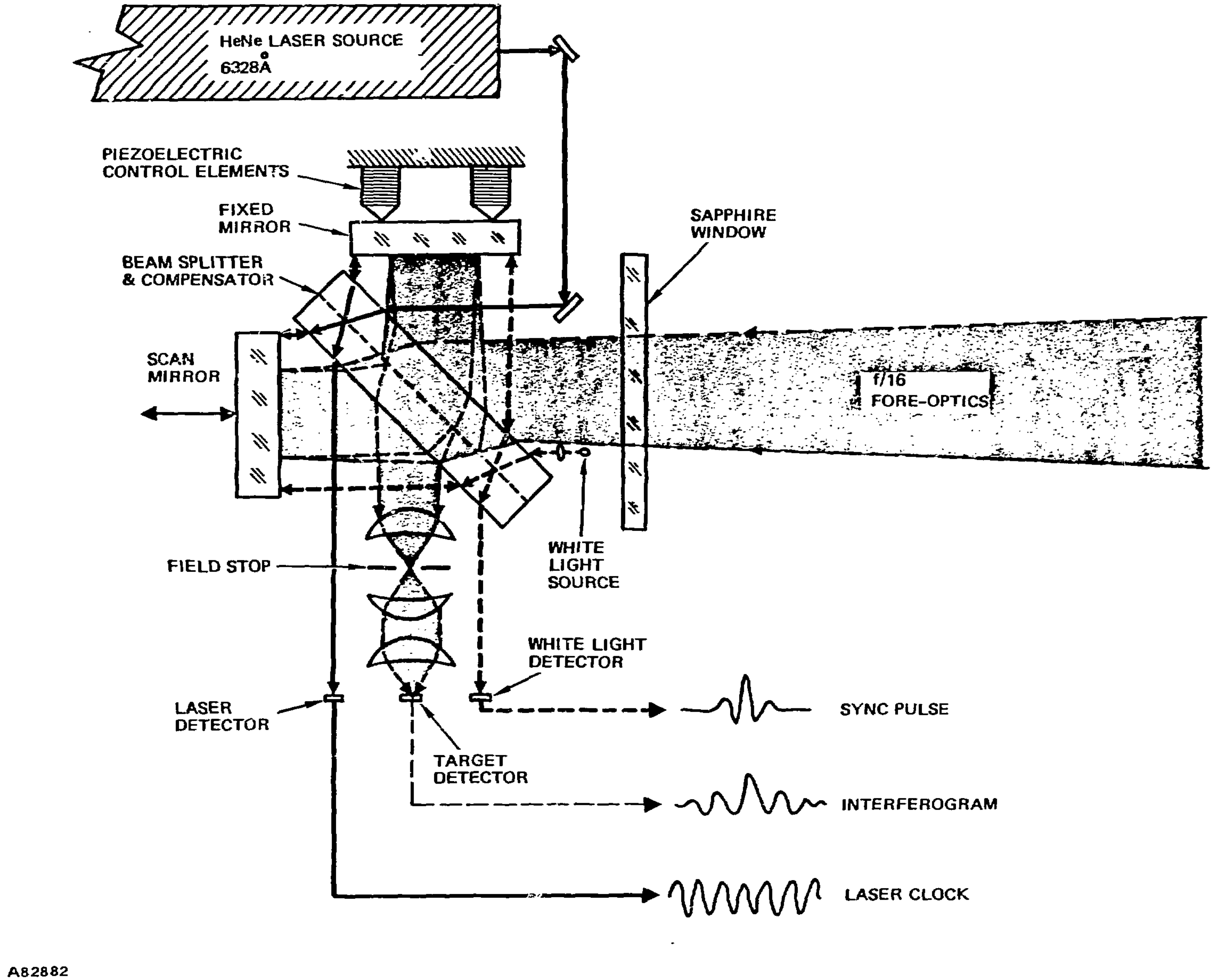


Figure 2-4. Optical Schematic of IR-Interferometer (Model PFS-201)

either a constructive or destructive manner, depending upon the differences in optical pathlengths (i.e., phase relationship). This time-varying interference pattern (termed as "interferogram") is observed by the liquid nitrogen cooled infrared detector. The temporal frequency associated with the generated interference pattern is a function of the mirror optical scanning speed and the wavelength of the incoming radiation. The wavelength spectrum of the incident radiation can be determined by performing a Fourier transformation of the electrical waveform generated by the detector.

The output of a 6328 Å He-Ne laser source is also passed through the optical cube producing a separate interference pattern which is detected by an uncooled silicon (Si) photovoltaic detector. Since the laser is essentially monochromatic, the interferogram output of the Si detector is sinusoidal at a single frequency, which can be directly related to the mirror optical scanning speed. The laser-detected interferogram provides the wavelength/frequency calibration for the target-detected interferogram and is also used to provide an optically linearized clock signal for conversion of the analog data to a digital form (which is done in real-time with a 15 bit A-D converter).

A third optical channel consisting of a broadband, "white-light" source and an uncooled Lead Selenide (PbSe) detector provides a reference interferogram for defining the optical center of the target interferogram produced in the main data channel. The white light source (an incandescent lamp) produces an interferogram with a very sharp peak which occurs at zero optical retardation (the point in the optical scan at which the pathlength traversed by the two split beams is equal). The location of the zero retardation point is necessary for certain data reduction processes which include the coherent addition or subtraction of target-generated interferograms.

Specific characteristics of the interferometers, used in the background measurements performed to date, are presented in Table 2-1.

2.2 NEAR-UV PRISM SPECTROMETER

UV spectral measurements were performed through the use of an ITT model SF103-RS prism-type spectrometer as pictured in Figure 2-2. This instrument consists of two basic parts. These are the control console and the spectrometer proper. The control console contains the function controls, amplifiers, gain and filter switches, and output connector. The spectrometer contains the collecting optics, the monochromator, the detector, and the mechanical components for scanning.

An optical schematic of the spectrometer is presented in Figure 2-5. Radiation is collected by the cassegrain foreoptics which focuses the optical beam on the entrance slit. A mechanical chopper is situated between the entrance slit and the second mirror, which directs the beam toward the slit, to provide a carrier frequency for the resultant signal from the detector. From the entrance slit the beam diverges, striking a third mirror which directs it to a fixed collimating reflector. The reflected, collimated radiation then passes through the LiF prism which disperses it. After striking a movable littrow mirror, situated in such a manner as to only properly reflect radiation to the exit slit which is centered about a specific wavelength, the beam is reflected back through the prism to the collimator. At this point, the collimator reverses its previous function and causes the radiation to converge on the detector after being reflected for a seventh time and passing through the exit slit to the detector.

Table 2-1
PRINCIPAL IR-INTERFEROMETER CHARACTERISTICS

Item	Measurement Phase			
	Phase I	Phase II		Phase III
		Prior to 2-1-70	After 2-1-70	
Model	IF-3	IF-3	IF-3	PFS-201
Detector Type	InSb	InSb	InSb	InSb/HgCdTe
Detector Size	0.5 mm dia.	0.5 mm dia.	1 mm dia.	.090 in. dia.
Detector Cooling	Liquid Nitrogen	Liquid Nitrogen	Liquid Nitrogen	Liquid Nitrogen
Spectral Coverage	1.5-5.4μ	2.0-5.4μ	2.0-5.4μ	2.0-12.8μ
Spectral Resolution	$\Delta\lambda = 4x10^{-3}\lambda$	$\Delta\lambda = 4x10^{-3}\lambda$	$\Delta\lambda = 4x10^{-3}\lambda$	$\Delta\lambda = 2.5x10^{-4}\lambda^2$
Spectrum Recording Rate	1/sec	0.5/sec	1/sec	0.7/sec
Collecting Optics	12 in. dia, F/8	12 in. dia, F/8	10 in. dia, F/8	14 in. dia, F/16
Optical Field-of-View (50 percent)	1.5 mrad	1.5 mrad	4.0 mrad	4.0 mrad
Wavelength Reference	0.63282μ HeNe Laser	0.63282μ HeNe Laser	0.63282μ HeNe Laser	0.63282μ HeNe Laser

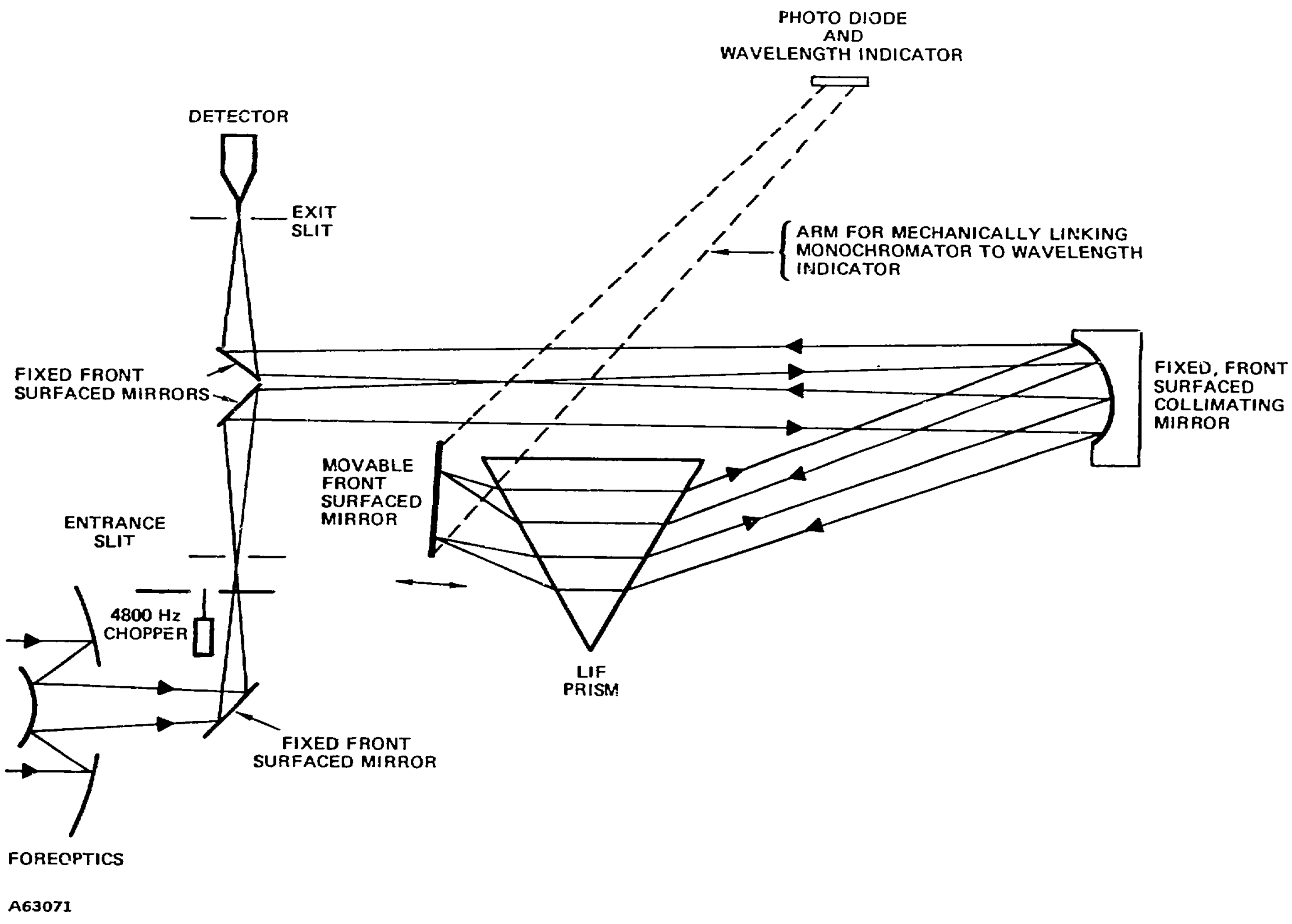


Figure 2-5. Optical Schematic of UV-Spectrometer (Model SF-103RS)

The spectrometer scans continually in a triangular waveform, alternately scanning from short to long wavelength, then from long to short wavelength. The scan is linear with respect to wavelength in both directions and the time rate of scan may be selected for any speed from 0.012 scans per second to 5 scans per second. Since wavelength selection within the instrument is determined solely by the position of the mirror behind the prism, a metal arm mechanically links the moving mirror to the wavelength indicator and photo diode which creates a pulse at the short wavelength end of each scan. When the instrument is scanning from short to long wavelengths a second pulse is electronically induced into the output, providing a rapid means of determining the scan direction. The detector output and wavelength marker pulses are converted to a digital form in real-time (15-bit A-D converter plus level detector).

The entrance and exit slits are controlled by the same dial on the instrument. This dial is graduated in 0.01 mm increments and permits manual opening or closing of the slits to a maximum of 2 mm slit width. The entrance slit has a Hartmann diaphram in a stepped design to permit narrowing of the slit height.

Specific characteristics of the UV-spectrometer, as used in gathering the background data presented herein, are presented in Table 2-2.

Table 2-2
PRINCIPAL UV-SPECTROMETER CHARACTERISTICS

Item	Measurement Phase II	
	Prior to 5-5-70	After to 5-5-70
Model	SF-103RS	SF-103RS
Detector Type	1P28, S-5 P.M.	1P28, S-5 P.M.
Prism	LiF	LiF
Spectral Coverage	0.20 - 0.44μ	0.20 - 0.44μ
Spectral Resolution	0.0025μ	0.0025μ
Spectrum Recording Rate	0.025/sec.*	0.225/sec.*
Collecting Optics	4.5 in. dia, F/9	4.5 in. dia, F/9
Optical Field-of-View (50 percent)	0.1x4 mrad	0.16x4 mrad
Modulation Frequency	4800 Hz	4800 Hz

*Note: Approximately 20 seconds required to cover the 0.30-0.44μ region.

SECTION 3

PHASE-I IR MEASUREMENT DATA
(1.5–5.4μ)

Section 3
PHASE-I IR MEASUREMENT DATA (1.5 – 5.4μ)

During the Phase I measurement effort, an attempt was made to obtain a variety of backgrounds with heavy concentration on those which were considered most severe to an infrared system. Spectral plots from this initial phase of the program are presented in figures 3-1 through 3-15 (Background Scenes number 1 through 15). The Background Scenes number 1 through 15, with letters "A" and "B" are absolute spectral signatures of the areas indicated on the infrared photographs. These plots are referenced to essentially zero temperature (77°K liquid nitrogen reference). The Background Scenes number 1 through 15, with letters "C" and "D" are contrast plots obtained by computer subtraction and are plotted in both linear and logarithmic formats. All contrast pairs were confined to a spatial separation of less than 1 degree and recorded within a 5 minute period of time. Up to 90 seconds of data (90 interferograms) were averaged to obtain some of the data presented in this section.

All of the spectra presented were measured during the daylight hours and exhibit various amounts of solar reflected energy in the 1.5 to approximately 3 micron region. Beyond 3 microns, the self-emission of the background areas predominates in most cases. The H_2O absorption bands are strongly evident at 1.8 and 2.7 microns and to a lesser extent in the 5 micron region where they appear as emission bands in most plots. Also the 4.3 CO_2 band appears as both absorption or emission, depending on the particular background conditions.

Beyond 3 microns, the spectral curves show little variation from one to another, whereas the radiation in the shorter wavelengths show considerable differences within the atmospheric window regions. These differences are reflected directly in the contrast plots which generally indicate a minimum beyond 4 microns.

The contrast plots can be used to calculate a system response to these backgrounds, given the system sensitivity and instantaneous field of view. Conversely, if the system is yet to be designed and the spectral characteristics of the target are known, the contrast data may be used to optimize the spectral region of operation. The optimization is performed by plotting a spectral ratio of apparent target irradiance to background contrast irradiance. For a maximization of target to background energy, the spectral region of operation should be confined to the narrow region (or regions) centered about the peak of the plot. The detection bandwidth of the system will be predicated on the system sensitivity, required detection range and background false alarm rate. The spectral signature used for the target should contain atmospheric absorption as expected under typical system operation.

Depending on the system application, certain types of backgrounds may be excluded from consideration. Certain classes of the contrast plots presented indicate trends or characteristics which may be used to advantage in a system design.

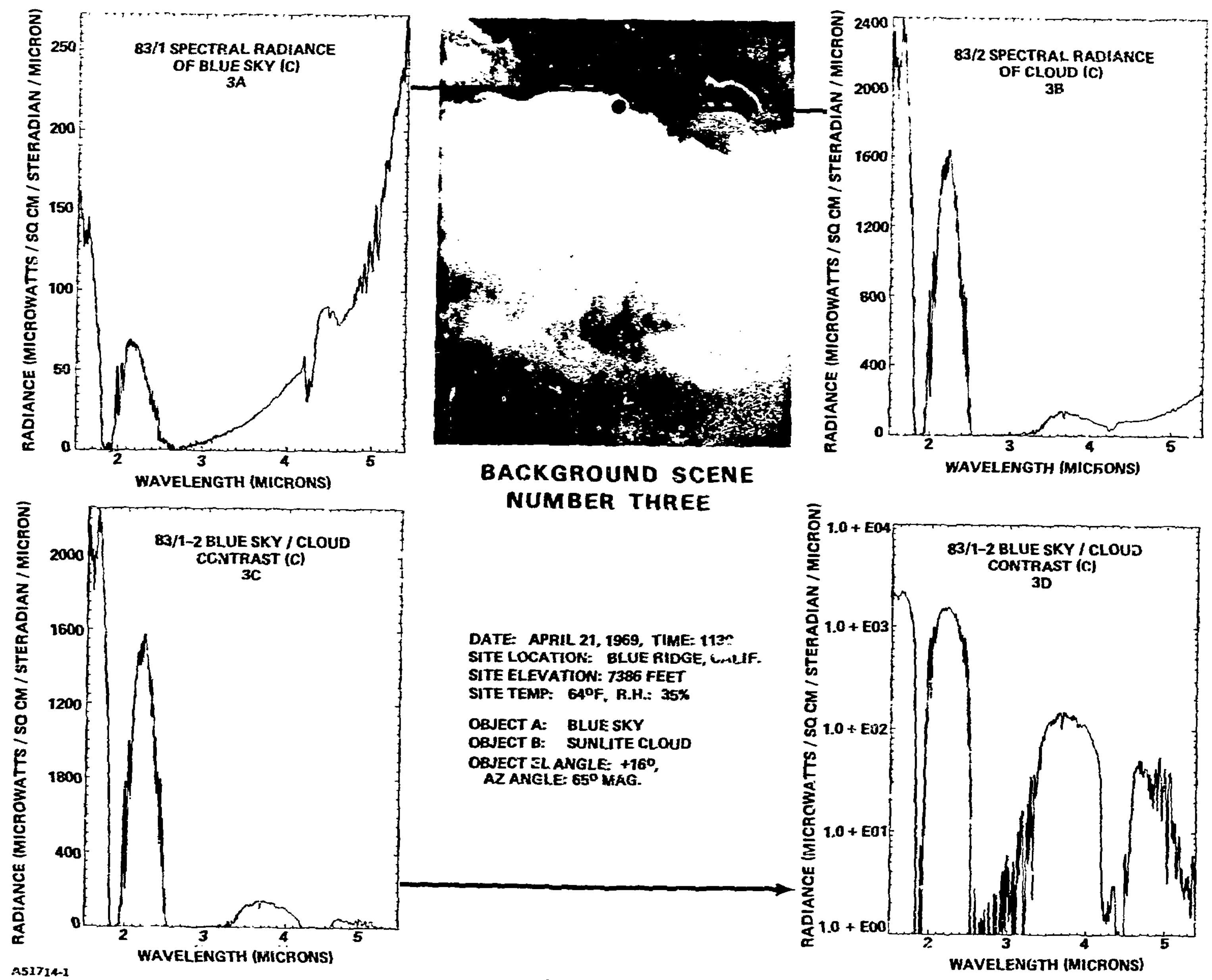

83/1 SPECTRAL RADIANCE OF BLUE SKY (C) 3A
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
83/2 SPECTRAL RADIANCE OF CLOUD (C) 3B
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
BACKGROUND SCENE NUMBER THREE
83/1-2 BLUE SKY / CLOUD CONTRAST (C) 3C
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
DATE: APRIL 21, 1969, TIME: 113?
SITE LOCATION: BLUE RIDGE, CALIF.
SITE ELEVATION: 7386 FEET
SITE TEMP: 64°F, R.H.: 35%
OBJECT A: BLUE SKY
OBJECT B: SUNLITE CLOUD
OBJECT EL ANGLE: +16°,
AZ ANGLE: 65° MAG.
83/1-2 BLUE SKY / CLOUD CONTRAST (C) 3D
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
A51714-1

Figure 3-1.

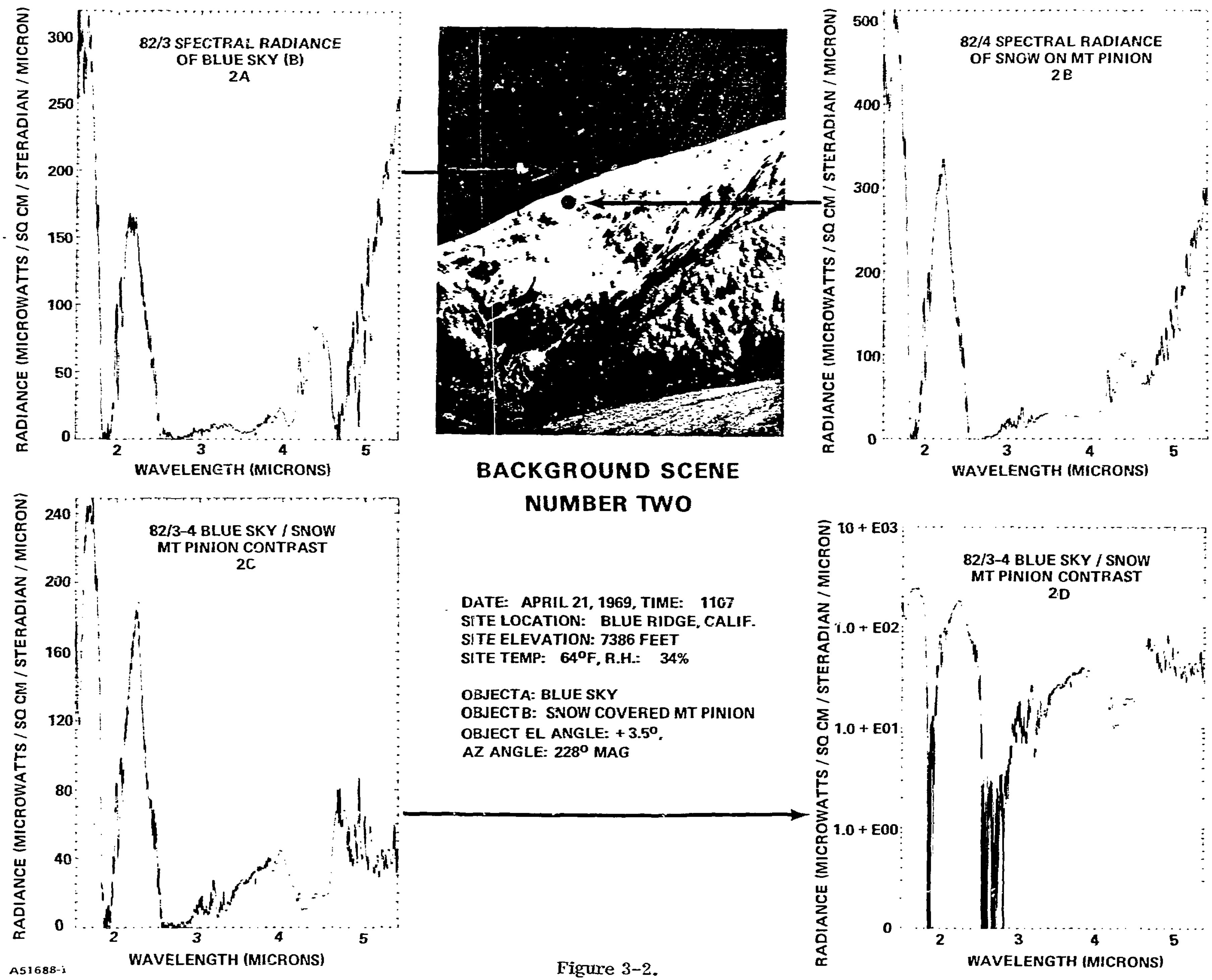

82/3 SPECTRAL RADIANCE OF BLUE SKY (B) 2A
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
82/4 SPECTRAL RADIANCE OF SNOW ON MT PINION 2B
82/3-4 BLUE SKY / SNOW MT PINION CONTRAST 2C
82/3-4 BLUE SKY / SNOW MT PINION CONTRAST 2D
BACKGROUND SCENE NUMBER TWO
DATE: APRIL 21, 1969, TIME: 1107
SITE LOCATION: BLUE RIDGE, CALIF.
SITE ELEVATION: 7386 FEET
SITE TEMP: 64°F, R.H.: 34%
OBJECT A: BLUE SKY
OBJECT B: SNOW COVERED MT PINION
OBJECT EL ANGLE: +3.5°,
AZ ANGLE: 228° MAG
A51688-1

Figure 3-2.

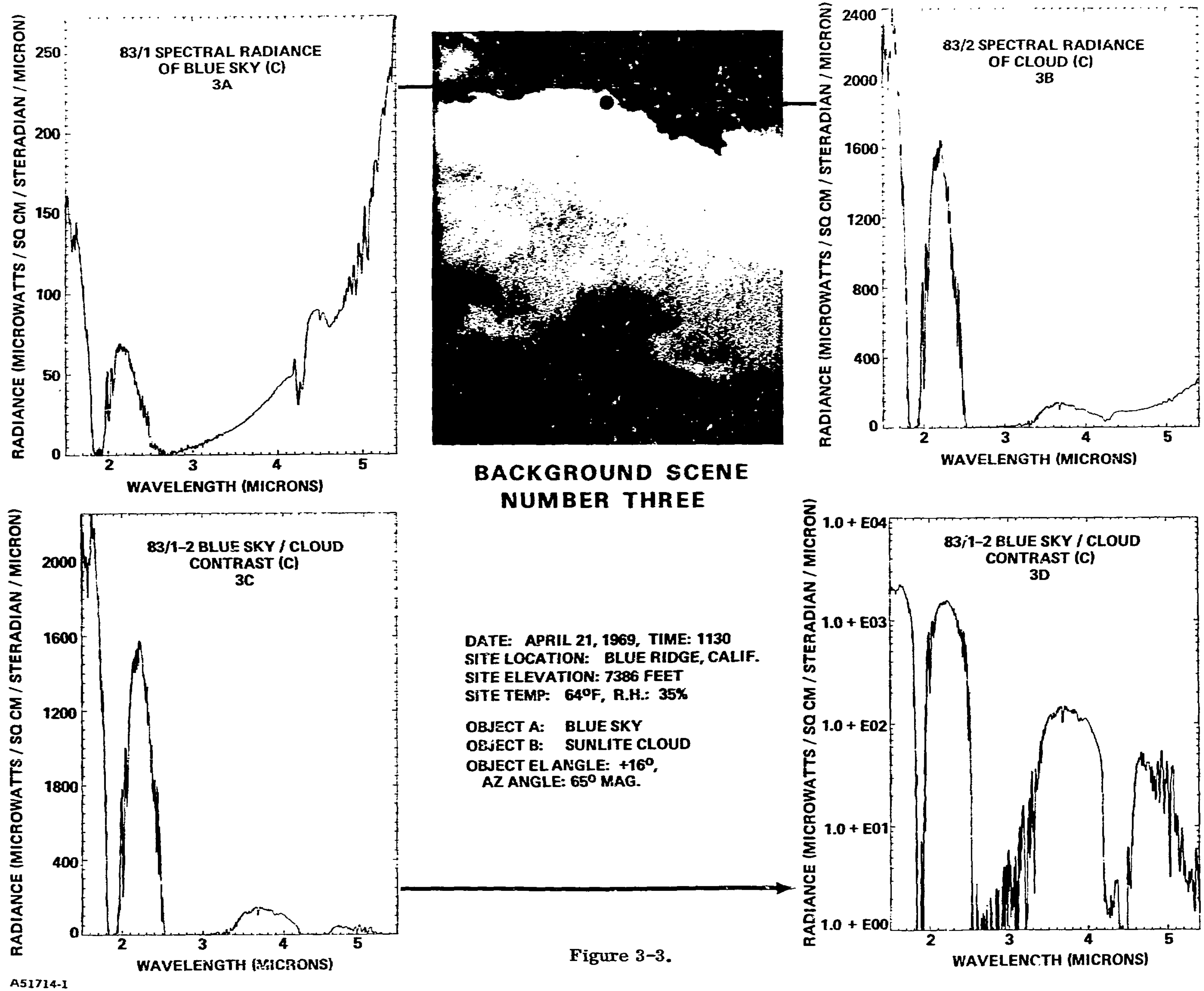

83/1 SPECTRAL RADIANCE
OF BLUE SKY (C)
3A
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
83/2 SPECTRAL RADIANCE
OF CLOUD (C)
3B
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
BACKGROUND SCENE
NUMBER THREE
83/1-2 BLUE SKY / CLOUD
CONTRAST (C)
3C
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
DATE: APRIL 21, 1969, TIME: 1130
SITE LOCATION: BLUE RIDGE, CALIF.
SITE ELEVATION: 7386 FEET
SITE TEMP: 64°F, R.H.: 35%
OBJECT A: BLUE SKY
OBJECT B: SUNLITE CLOUD
OBJECT EL ANGLE: +16°,
AZ ANGLE: 65° MAG.
83/1-2 BLUE SKY / CLOUD
CONTRAST (C)
3D
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
A51714-1

Figure 3-3.

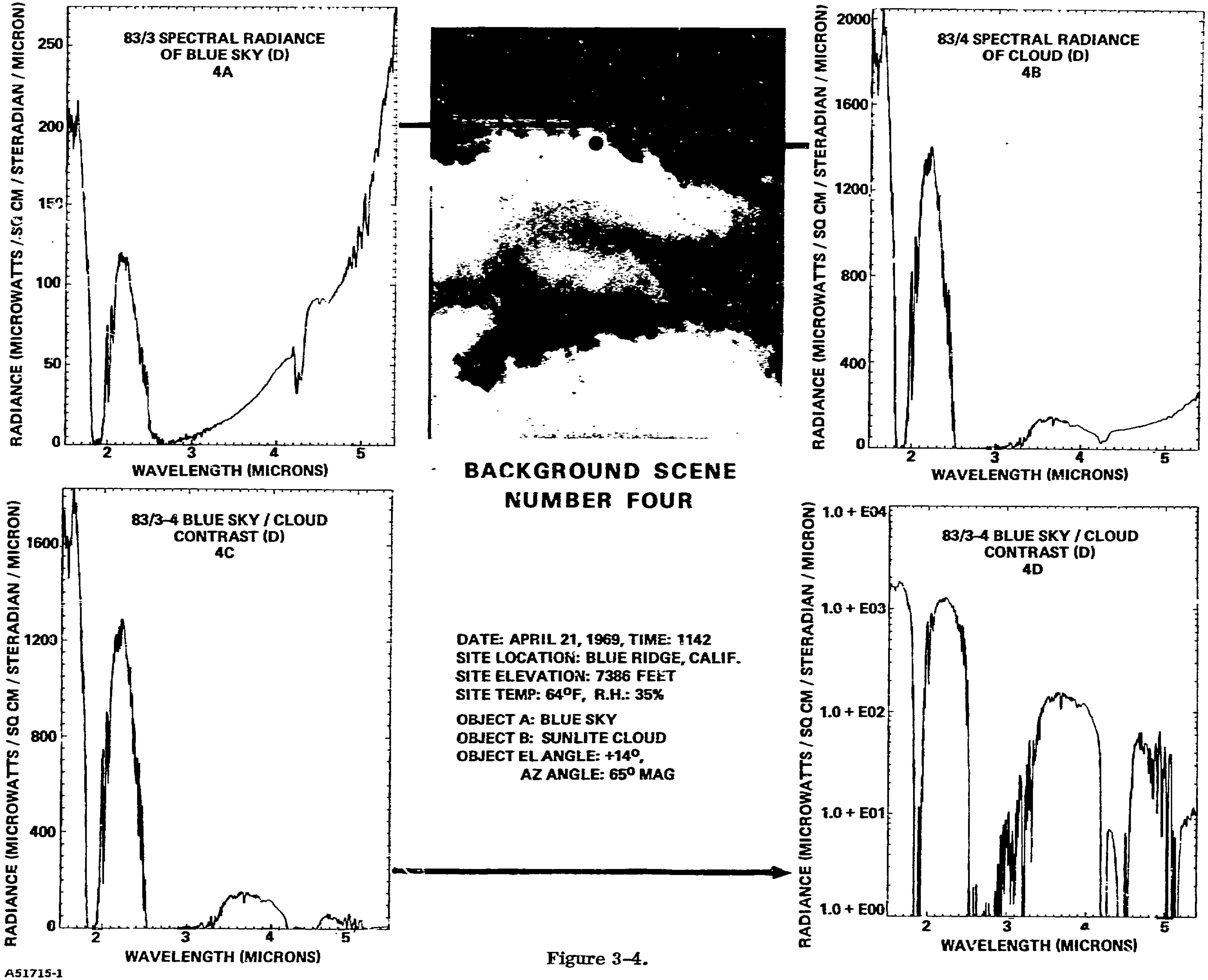

83/3 SPECTRAL RADIANCE
OF BLUE SKY (D)
4A
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
83/4 SPECTRAL RADIANCE
OF CLOUD (D)
4B
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
BACKGROUND SCENE
NUMBER FOUR
83/3–4 BLUE SKY / CLOUD
CONTRAST (D)
4C
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
DATE: APRIL 21, 1969, TIME: 1142
SITE LOCATION: BLUE RIDGE, CALIF.
SITE ELEVATION: 7386 FEET
SITE TEMP: 64°F, R.H.: 35%
OBJECT A: BLUE SKY
OBJECT B: SUNLITE CLOUD
OBJECT EL ANGLE: +14°,
AZ ANGLE: 65° MAG
83/3–4 BLUE SKY / CLOUD
CONTRAST (D)
4D
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
A51715-1

Figure 3–4.

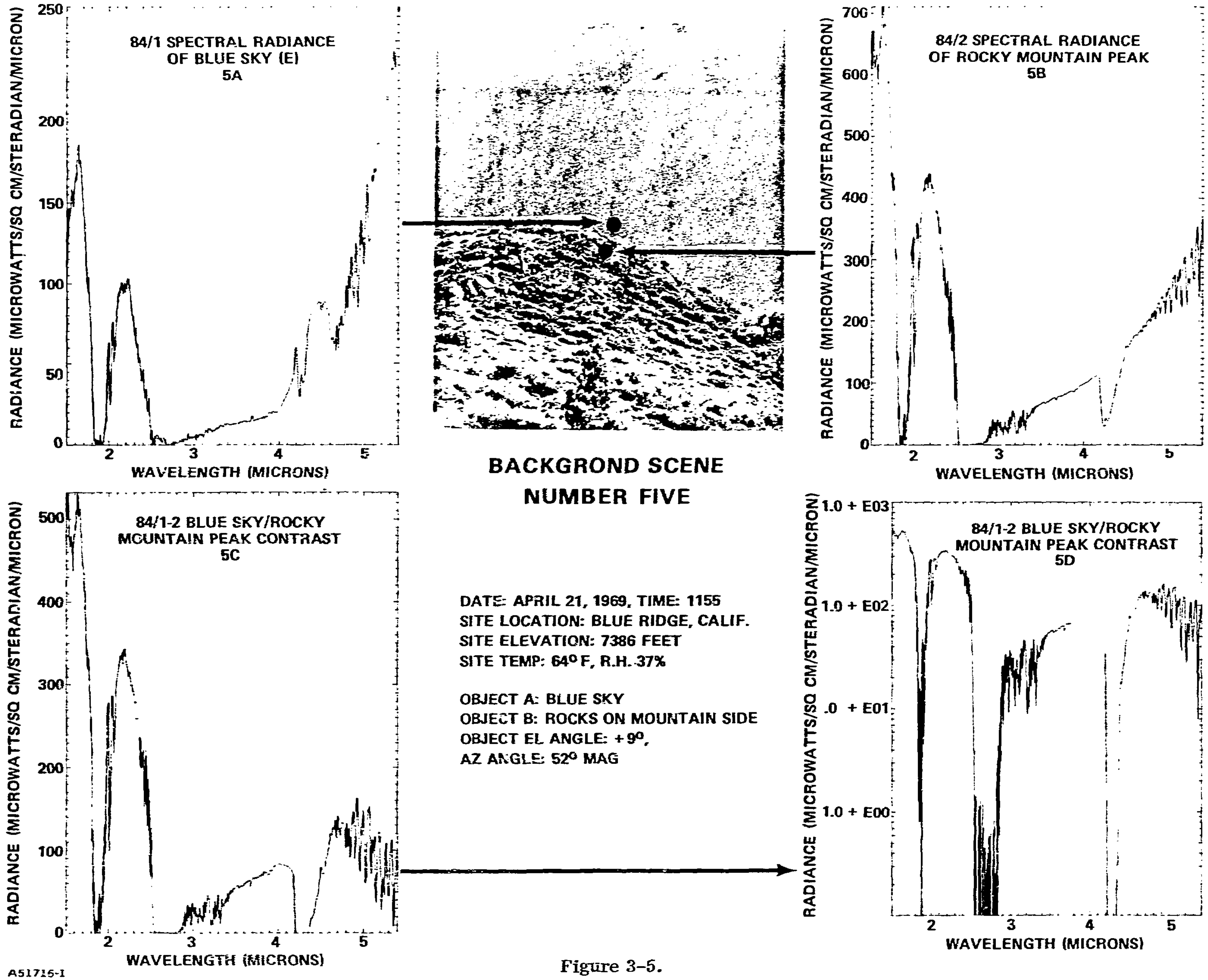
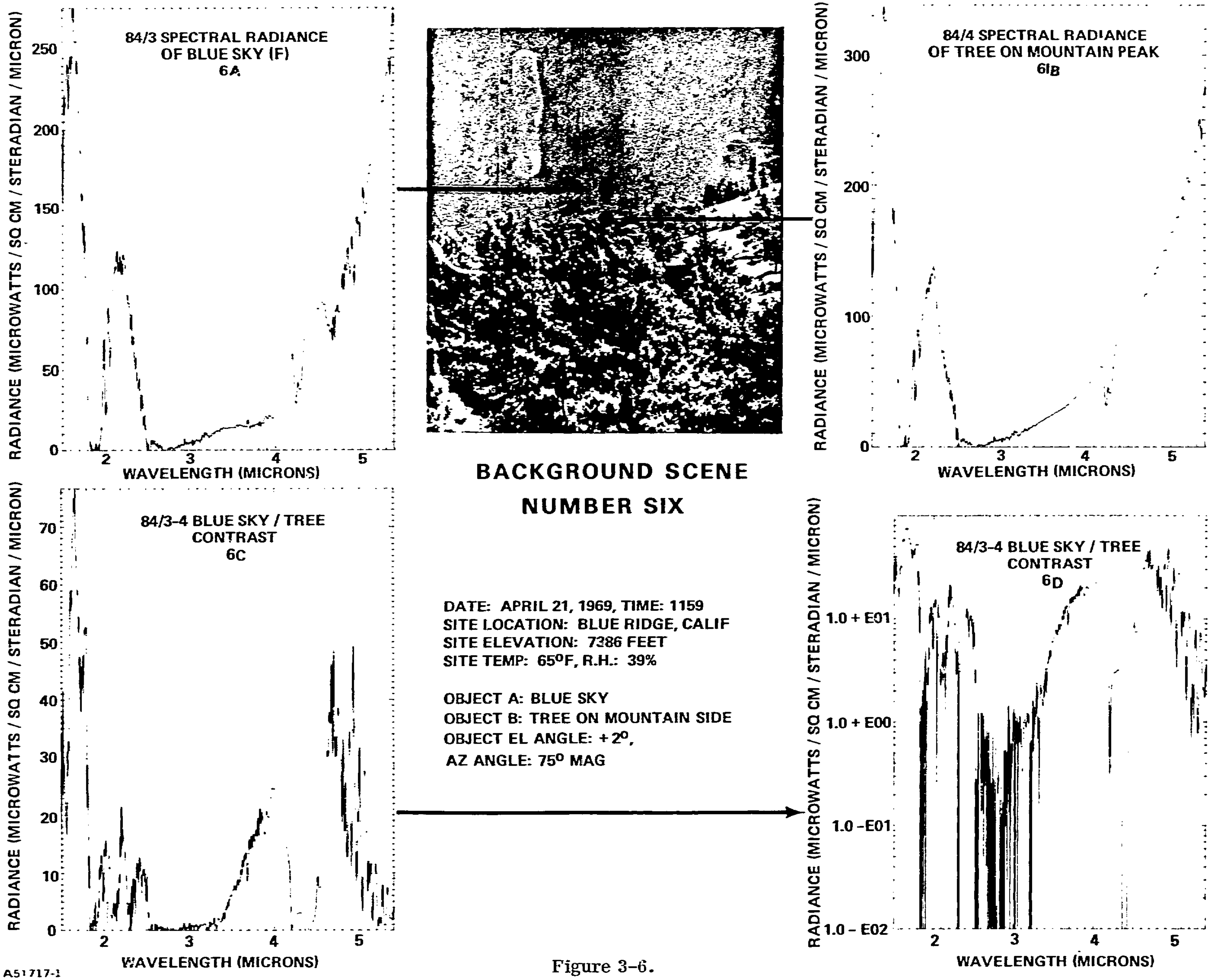

84/1 SPECTRAL RADIANCE OF BLUE SKY (E) 5A
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
84/2 SPECTRAL RADIANCE OF ROCKY MOUNTAIN PEAK 5B
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
BACKGROND SCENE NUMBER FIVE
84/1-2 BLUE SKY/ROCKY MOUNTAIN PEAK CONTRAST 5C
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
84/1-2 BLUE SKY/ROCKY MOUNTAIN PEAK CONTRAST 5D
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
DATE: APRIL 21, 1969, TIME: 1155
SITE LOCATION: BLUE RIDGE, CALIF.
SITE ELEVATION: 7386 FEET
SITE TEMP: 64° F, R.H. 37%
OBJECT A: BLUE SKY
OBJECT B: ROCKS ON MOUNTAIN SIDE
OBJECT EL ANGLE: +9°,
AZ ANGLE: 52° MAG
A51716-1

Figure 3–5.



84/3 SPECTRAL RADIANCE OF BLUE SKY (F) 6A
84/4 SPECTRAL RADIANCE OF TREE ON MOUNTAIN PEAK 6IB
84/3-4 BLUE SKY / TREE CONTRAST 6C
84/3-4 BLUE SKY / TREE CONTRAST 6D
RADIANCE (MICROWATTS / SQ CM / STERADIAN / MICRON)
WAVELENGTH (MICRONS)
BACKGROUND SCENE NUMBER SIX
DATE: APRIL 21, 1969, TIME: 1159
SITE LOCATION: BLUE RIDGE, CALIF
SITE ELEVATION: 7386 FEET
SITE TEMP: 65°F, R.H.: 39%
OBJECT A: BLUE SKY
OBJECT B: TREE ON MOUNTAIN SIDE
OBJECT EL ANGLE: +2°,
AZ ANGLE: 75° MAG
A51717-1

Figure 3-6.

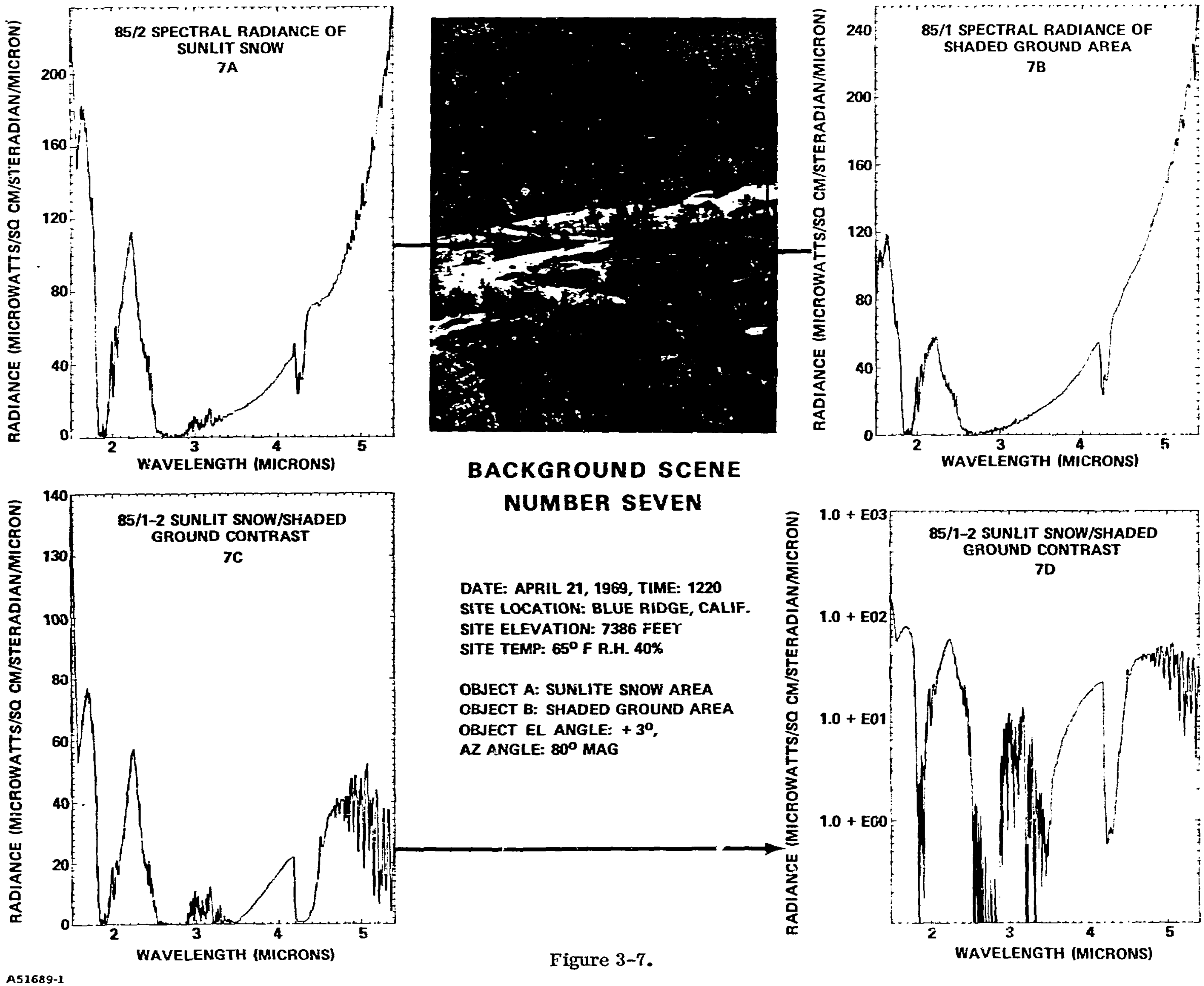

85/2 SPECTRAL RADIANCE OF SUNLIT SNOW
7A
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
85/1 SPECTRAL RADIANCE OF SHADED GROUND AREA
7B
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
BACKGROUND SCENE NUMBER SEVEN
DATE: APRIL 21, 1969, TIME: 1220
SITE LOCATION: BLUE RIDGE, CALIF.
SITE ELEVATION: 7386 FEET
SITE TEMP: 65° F R.H. 40%
OBJECT A: SUNLITE SNOW AREA
OBJECT B: SHADED GROUND AREA
OBJECT EL ANGLE: +3°,
AZ ANGLE: 80° MAG
85/1-2 SUNLIT SNOW/SHADED GROUND CONTRAST
7C
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
85/1-2 SUNLIT SNOW/SHADED GROUND CONTRAST
7D
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
A51689-1

Figure 3-7.

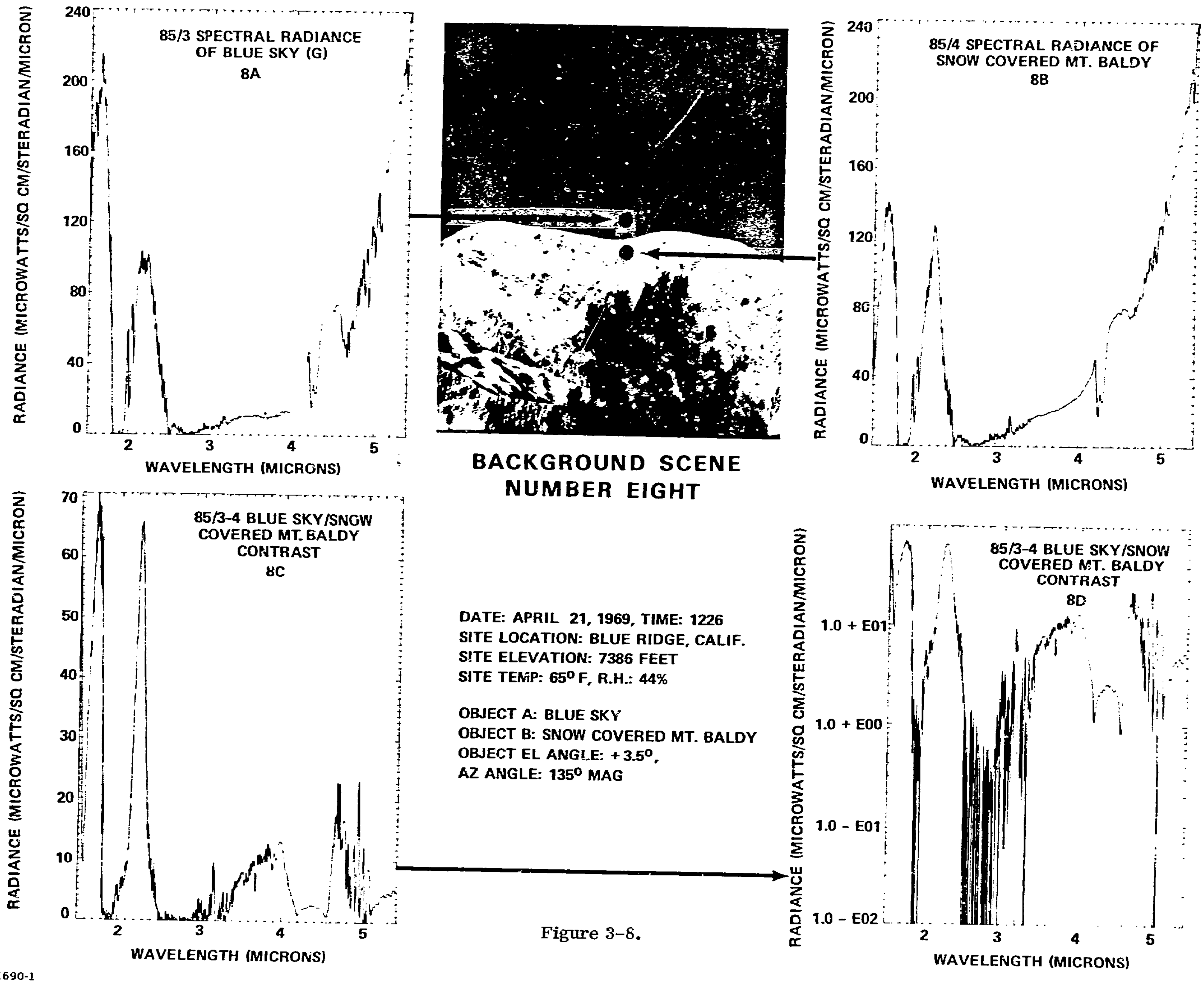

85/3 SPECTRAL RADIANCE OF BLUE SKY (G)
8A
85/4 SPECTRAL RADIANCE OF SNOW COVERED MT. BALDY
8B
85/3-4 BLUE SKY/SNGW COVERED MT. BALDY CONTRAST
8C
85/3-4 BLUE SKY/SNOW COVERED MT. BALDY CONTRAST
8D
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
1.0 + E01
1.0 + E00
1.0 - E01
1.0 - E02
BACKGROUND SCENE NUMBER EIGHT
DATE: APRIL 21, 1969, TIME: 1226
SITE LOCATION: BLUE RIDGE, CALIF.
SITE ELEVATION: 7386 FEET
SITE TEMP: 65° F, R.H.: 44%
OBJECT A: BLUE SKY
OBJECT B: SNOW COVERED MT. BALDY
OBJECT EL ANGLE: +3.5°,
AZ ANGLE: 135° MAG
A51690-1

Figure 3-8.

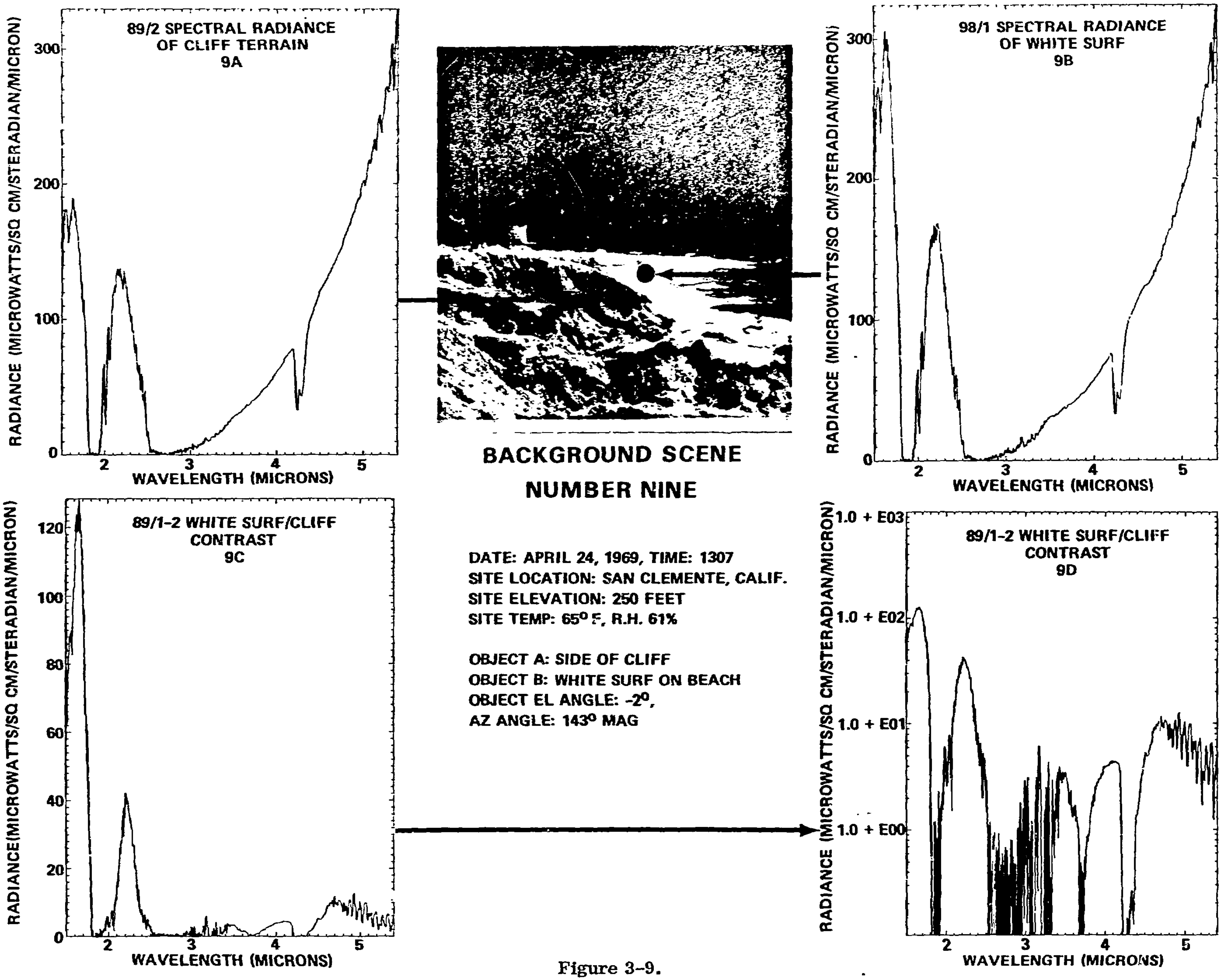


Figure 3-9.

A51691-1

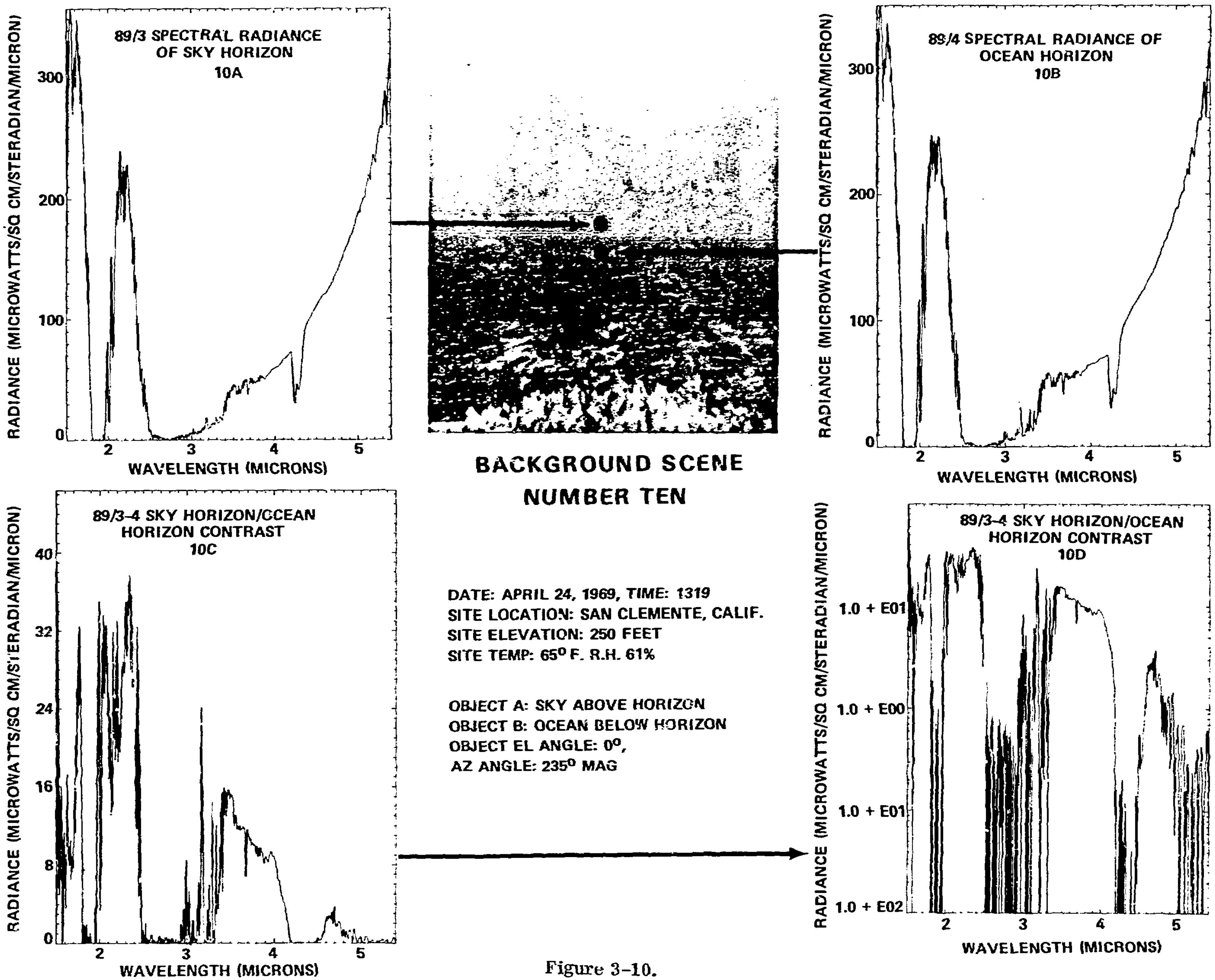

89/3 SPECTRAL RADIANCE OF SKY HORIZON 10A
89/4 SPECTRAL RADIANCE OF OCEAN HORIZON 10B
89/3-4 SKY HORIZON/OCEAN HORIZON CONTRAST 10C
89/3-4 SKY HORIZON/OCEAN HORIZON CONTRAST 10D
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
BACKGROUND SCENE NUMBER TEN
DATE: APRIL 24, 1969, TIME: 1319
SITE LOCATION: SAN CLEMENTE, CALIF.
SITE ELEVATION: 250 FEET
SITE TEMP: 65° F. R.H. 61%
OBJECT A: SKY ABOVE HORIZON
OBJECT B: OCEAN BELOW HORIZON
OBJECT EL ANGLE: 0°,
AZ ANGLE: 235° MAG

Figure 3-10.

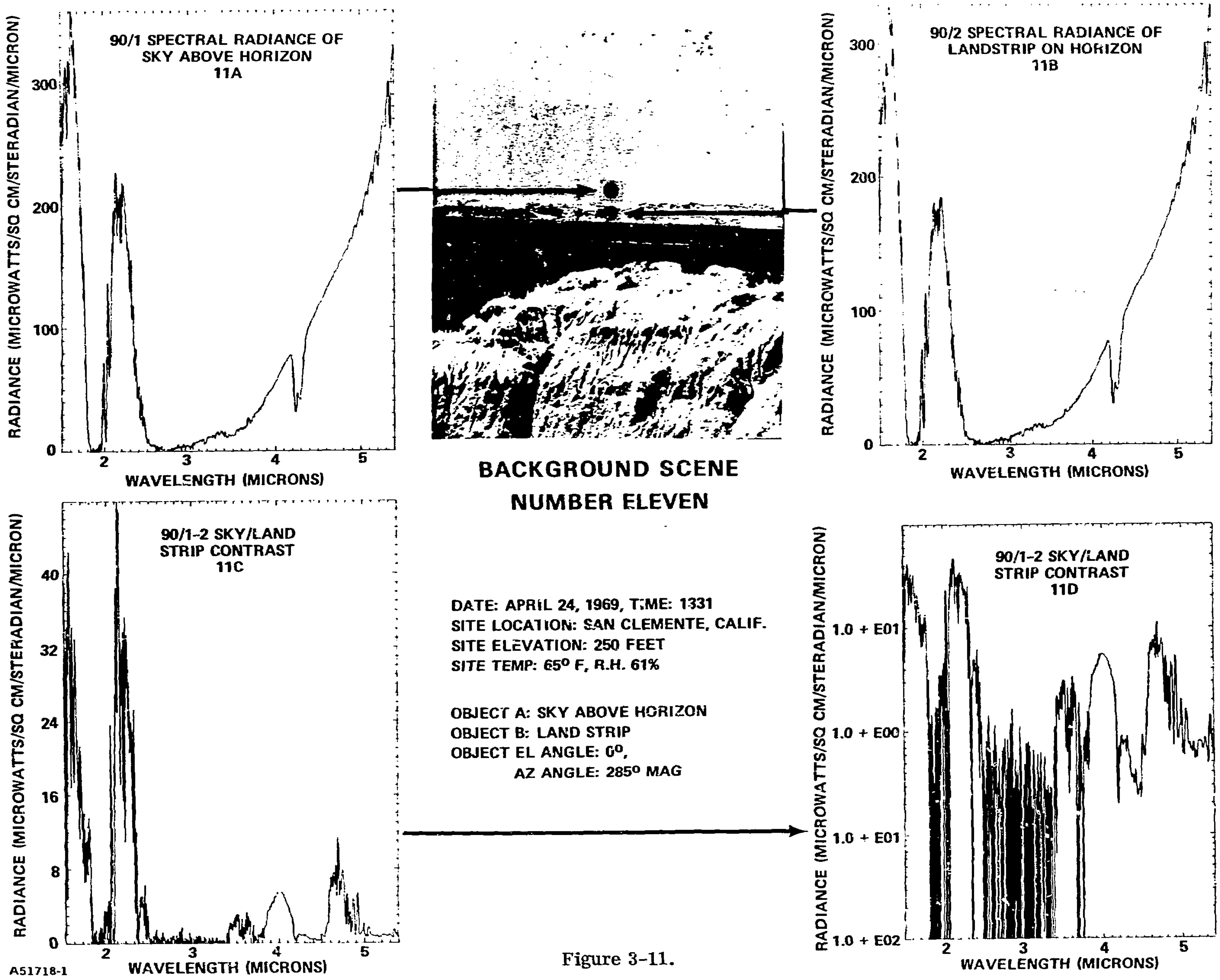

90/1 SPECTRAL RADIANCE OF SKY ABOVE HORIZON 11A
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
300
200
100
0
2
3
4
5
WAVELENGTH (MICRONS)
90/2 SPECTRAL RADIANCE OF LANDSTRIP ON HORIZON 11B
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
300
200
100
0
2
3
4
5
WAVELENGTH (MICRONS)
BACKGROUND SCENE
NUMBER ELEVEN
90/1-2 SKY/LAND STRIP CONTRAST 11C
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
40
32
24
16
8
0
2
3
4
5
WAVELENGTH (MICRONS)
A51718-1
DATE: APRIL 24, 1969, TIME: 1331
SITE LOCATION: SAN CLEMENTE, CALIF.
SITE ELEVATION: 250 FEET
SITE TEMP: 65° F, R.H. 61%
OBJECT A: SKY ABOVE HORIZON
OBJECT B: LAND STRIP
OBJECT EL ANGLE: 0°,
AZ ANGLE: 285° MAG
90/1-2 SKY/LAND STRIP CONTRAST 11D
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
1.0 + E01
1.0 + E00
1.0 + E01
1.0 + E02
2
3
4
5
WAVELENGTH (MICRONS)

Figure 3-11.

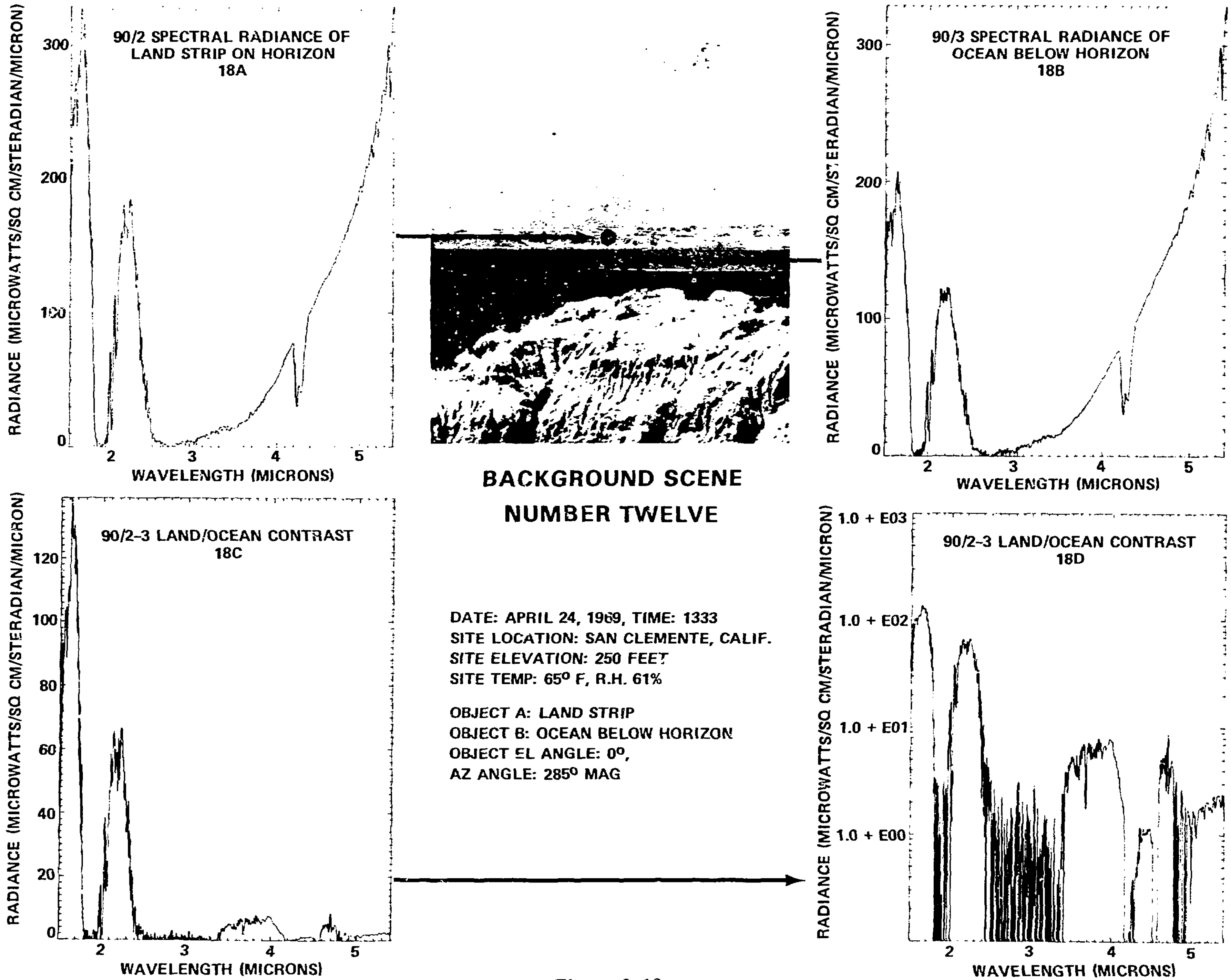
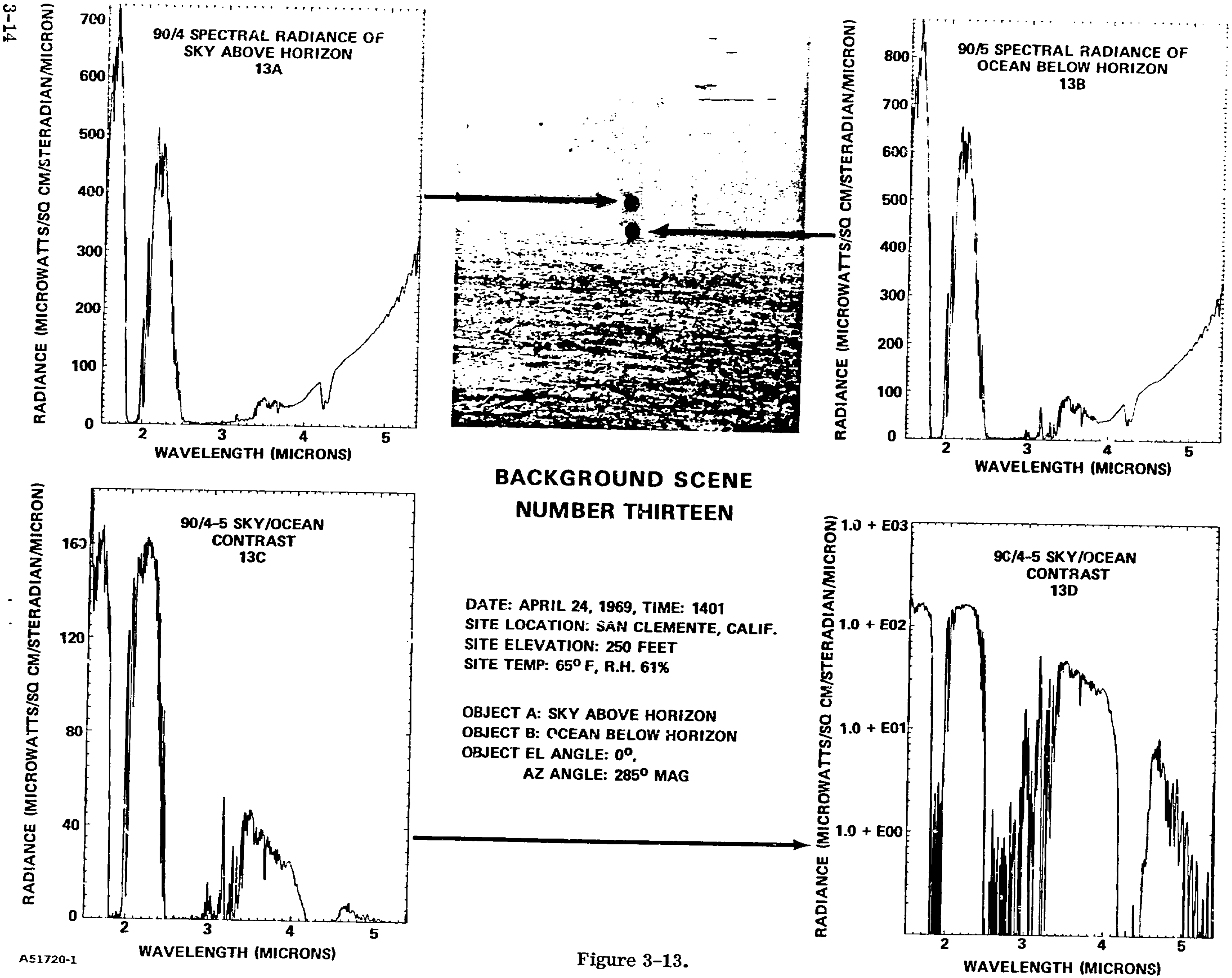

90/2 SPECTRAL RADIANCE OF LAND STRIP ON HORIZON 18A
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
300
200
100
0
2
3
4
5
WAVELENGTH (MICRONS)
90/3 SPECTRAL RADIANCE OF OCEAN BELOW HORIZON 18B
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
300
200
100
0
2
3
4
5
WAVELENGTH (MICRONS)
BACKGROUND SCENE NUMBER TWELVE
90/2-3 LAND/OCEAN CONTRAST 18C
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
120
100
80
60
40
20
0
2
3
4
5
WAVELENGTH (MICRONS)
DATE: APRIL 24, 1969, TIME: 1333
SITE LOCATION: SAN CLEMENTE, CALIF.
SITE ELEVATION: 250 FEET
SITE TEMP: 65º F, R.H. 61%
OBJECT A: LAND STRIP
OBJECT B: OCEAN BELOW HORIZON
OBJECT EL ANGLE: 0º,
AZ ANGLE: 285º MAG
90/2-3 LAND/OCEAN CONTRAST 18D
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
1.0 + E03
1.0 + E02
1.0 + E01
1.0 + E00
2
3
4
5
WAVELENGTH (MICRONS)
A51719-1

Figure 3-12.



90/4 SPECTRAL RADIANCE OF SKY ABOVE HORIZON 13A
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
90/5 SPECTRAL RADIANCE OF OCEAN BELOW HORIZON 13B
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
BACKGROUND SCENE NUMBER THIRTEEN
DATE: APRIL 24, 1969, TIME: 1401
SITE LOCATION: SAN CLEMENTE, CALIF.
SITE ELEVATION: 250 FEET
SITE TEMP: 65° F, R.H. 61%
OBJECT A: SKY ABOVE HORIZON
OBJECT B: OCEAN BELOW HORIZON
OBJECT EL ANGLE: 0°,
AZ ANGLE: 285° MAG
90/4-5 SKY/OCEAN CONTRAST 13C
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
90/4-5 SKY/OCEAN CONTRAST 13D
RADIANCE (MICROWATTS/SQ CM/STERADIAN/MICRON)
WAVELENGTH (MICRONS)
A51720-1

Figure 3-13.

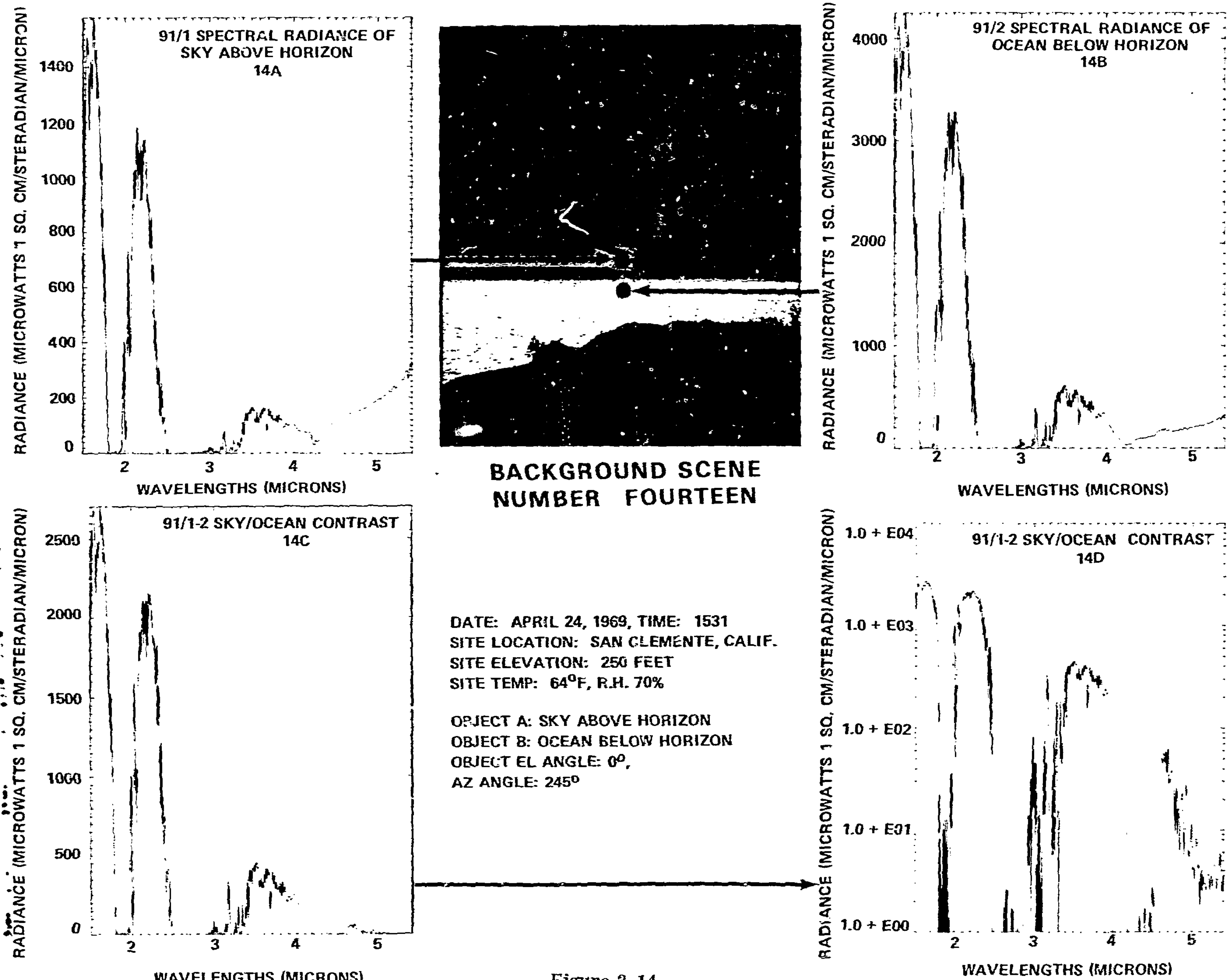


Figure 3-14.

A51693-1

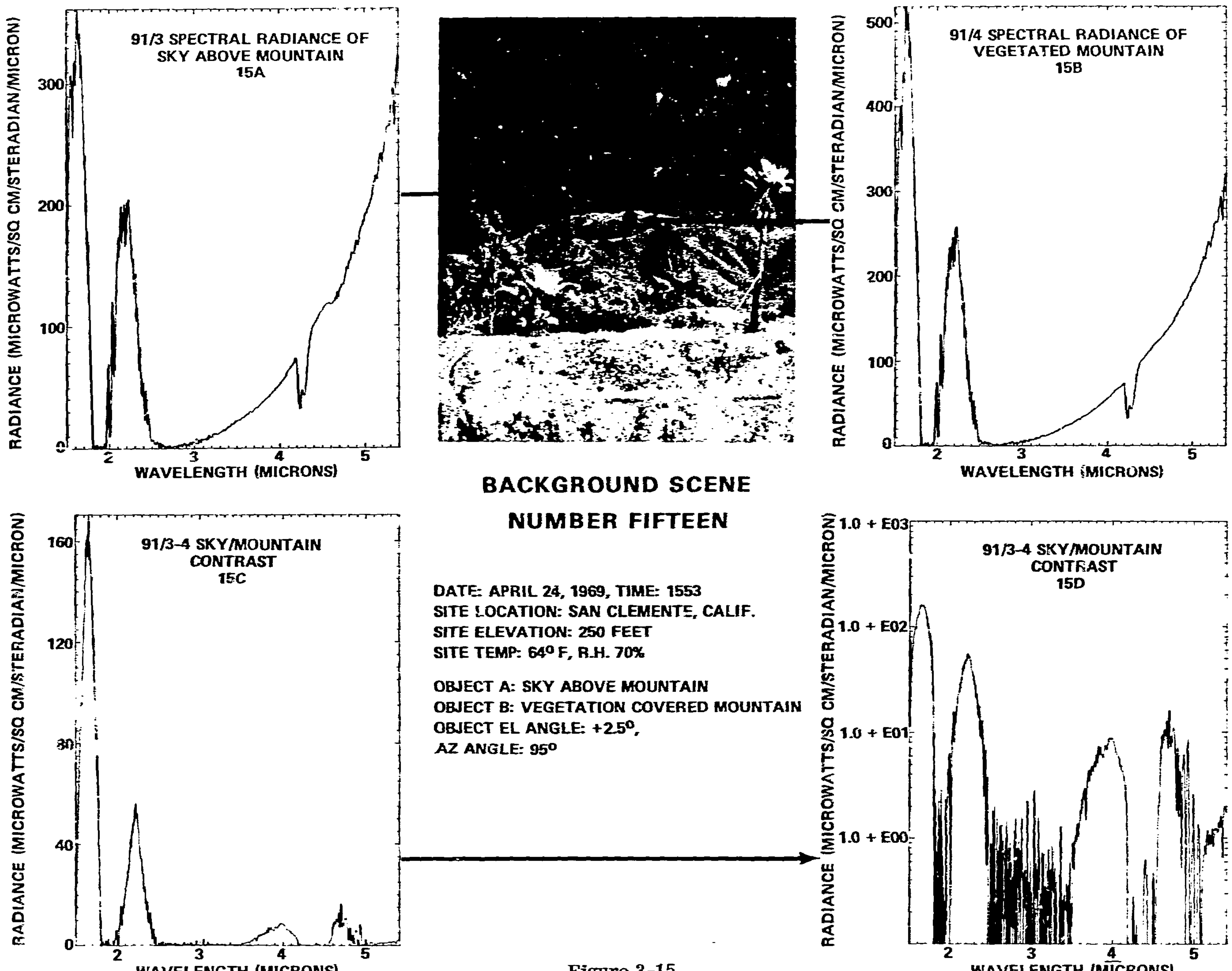


Figure 3-15.

A5] 694-1

SECTION 4

PHASE-II IR MEASUREMENT DATA
(2.0–5.4μ)

Section 4
PHASE-II IR MEASUREMENT DATA (2.0 – 5.4μ)

The Phase II infrared spectra taken from 25 natural background sites are presented in the following pages, (Figures 4-1 through 4-25). The near-IR photographs illustrate the spatial relationship which existed between the various plots while the thermal image data provides a first order feel for the appearance that these backgrounds present when integrated over the 2 to 5-micron region. Included with the data are the angular coordinates to the sites as referenced to the measurement location and corresponding sun angle positions. The elevation, temperature and relative humidity data are related to the measurement location. The 25 background sites are grouped and presented in the following sequence: clouds, sky, snow, terrain, and water. The data presented in this section typically represent the coherent average of interferograms recorded over a 10 second time period.

Particular care was taken with respect to absolute calibration of the spectrometer at each measurement site so that spectral curves can be cross-correlated. The calibration consisted of using a 600°C blackbody to establish the response function of the interferometer, a full-field 300°K blackbody for direct radiance calibration, and a liquid-nitrogen (77°K) calibration which is used as the reference for absolute radiance.

The actual spectra of the particular background areas are plotted from 2.0 to 5.4 microns. The ordinate values for each plot are automatically selected by the computer data reduction program and care must be exercised to observe these ordinate scales when comparing data. The contrast or difference spectra are plotted from 2.6 to 5.4 microns, excluding the high solar radiance values normally experienced in the 2.0 to 2.6 micron region. The difference plots can be positive or negative with respect to zero depending on the order in which they were subtracted.

Sites number 25, 8 and 6 (Figures 4-25, 4-8, and 4-6) have been selected for a brief discussion of the infrared spectral characteristics which are general to most of the backgrounds presented in this report. The primary interest in site 25 is the spectral signature of the sunlit lake which is shown in plot number 1. The spectra is the combined result of strong specular solar reflection, (which predominates in the region from 2.0 to about 4 microns) and the self-emission of the warm water (which produces the rise in radiance observed beyond 4 microns). Super-imposed over these two essentially graybody curves is the effect of atmospheric absorption in the shorter wavelengths and atmospheric emission at the longer wavelength end.

A second scan was made approximately one degree to the right of the lake, producing the spectral signature shown as plot number 2. There is a notable decrease of radiance at the short wavelength end of the second plot which has caused a factor-of-four reduction in the ordinate scale. At the longer wavelengths, both curves approximate a 300°K characteristic with superimposed effects of the intervening atmosphere.

Of particular importance to a contrast type seeker system is the spectral difference between the two plots discussed above. This difference is included in site 25 and labeled plot 1 - plot 2. Because of the large difference which typically exists at the shorter wavelengths from 2 to 2.6 microns, the difference plots were initiated at 2.6 microns to preclude a high ordinate scale. The difference plot is predominated by the solar reflection from the lake in the 3 to 4 micron region. Beyond 4 microns the radiance difference drops significantly due to the similarity in the radiating temperature of the two areas and the similarity in the atmospheric effects over the approximately equivalent pathlengths. The rather wide CO_2 absorption band existing from 4.1 to about 4.6 microns is also indicative of the long pathlength to the lake (approximately 25 miles).

Site number 8 (Figure 4-8) consists of spectral plots from four adjacent background areas and the six difference plots resulting from the subtracted pairs. The first two plots are of blue sky taken above Mt. Pinion. These two plots indicate radiance from scattered solar radiation in the 2.0 to 2.8-micron region and then the presence of self-emission and atmospheric effects beyond 2.8 microns to the end of the plot at 5.4 microns. The rather broad "bump" existing at 4.5 microns is due to the warmer atmospheric CO_2 close to the measurement site. The structure from about 5 microns on is predominately H_2O emission of the atmosphere. The difference plots for these two areas (plot number 1 - plot number 2) indicates an almost negligible contrast between the two. This difference plot is essentially the result of instrument noise in the shorter wavelengths and the slight differences in indicated temperatures at the longer wavelengths. (A temperature change of 1°C for a 300°K blackbody will produce a difference of about 4 microwatts per square centimeter-steradian - micron at 4 microns). Since the above plot shows a difference of less than 2 microwatts per square centimeter - steradian - micron at 4 microns, the difference is probably due to the slight change in effective temperature (approximately 0.5°C) over the different measurement paths or due to a temperature change which could have taken place during the two minute interval in which the two measurements took place.

Plots number 3 and 4 show spectra of sunlit snow and bare ground. The bare ground was warmer than the snow as evidenced by the thermal image and the higher radiance of plot number 4 in the 4.5 to 5.4-micron region (note the ordinate scale change). It is also interesting to note that the atmospheric structure in this same region of plot number 4 in phase reversed 180 degrees from that of the other three plots, indicating that the CO_2 and H_2O bands are absorbing the emitted radiation from the warmer ground. This phase reversal, which can best be examined by physically over-laying the two spectra, provides a good indication of the nature of the background radiance when comparing various sites.

The difference spectra involving plot number 4 appear similar to one another due to the relatively large radiance level of this particular plot which dominates the subtraction. The difference levels for these plots are negative due to the sign convention used in the subtraction. In addition, the CO_2 absorption band at 4.5 microns is not as wide as was noted for the difference plot involving the sunlit lake of site 25 (Figure 4-25). This is the result of the closer proximity of site 8.

Site number 6 (Figure 4-6) shows an interesting difference in the spectral radiance of blue sky which was taken at two different elevation angles. The spectral radiance at 3 degree elevation shows a large amount of scattered sunlight in the 2 to 2.5-micron region and the effects of transversing a long horizontal pathlength of essentially 300°K atmosphere. The spectral signature made at the higher 44 degree elevation angle is dominated by atmospheric molecular emission of warm CO_2 and H_2O. The scattered solar radiation and atmospheric graybody continuum is to such a low level that H_2O molecular line emission can be seen in the 3.2 to 3.5-micron region. The predominate H_2O emission is at the longer wavelength end of the spectrum between 4.7 to 5.4 microns. The radiance level of the dense CO_2 at 4.4 microns is fairly independent of elevation angle.

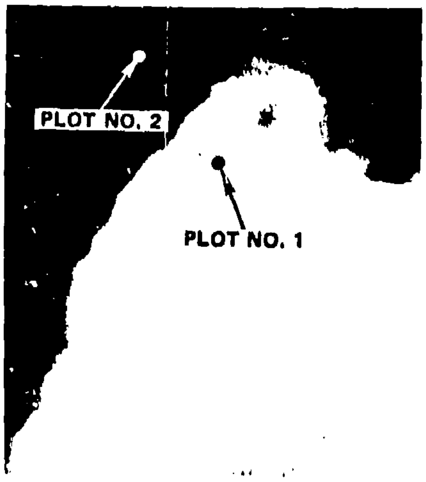
An anomaly that is present in most of the IR background spectral data is the small double dip of CO_2 absorption centered at 4.25 microns. The spectral plots presented are referenced to essentially absolute zero by comparing each background to a full field blackbody at the temperature of liquid nitrogen. In physically performing the liquid nitrogen measurement, the small amount of residual CO_2 that is within the instrument produces a small amount of absorption at 4.25 microns that is carried through to the reduced plots. This absorption does not appear in the difference plots, however, since it is automatically eliminated during the subtraction process.

INFRARED BACKGROUND SITE NO. 1

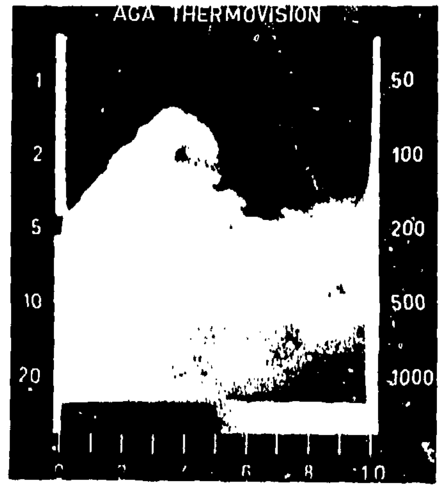
LOCATION: BLUE RIDGE
DATE: JUNE 15, 1970
TIME: 1334 PST
ELEVATION: 7386 FT
TEMPERATURE: 63°F
RELATIVE HUMIDITY: 37%
SUN ANGLE: 64° EL 230° AZ MAG

PLOT NO. 1: BRIGHT CLOUD
EL ANGLE: 24° AZ ANGLE: 310° MAG

PLOT NO. 2: BLUE SKY
EL ANGLE: 24.5° AZ ANGLE: 309.5° MAG

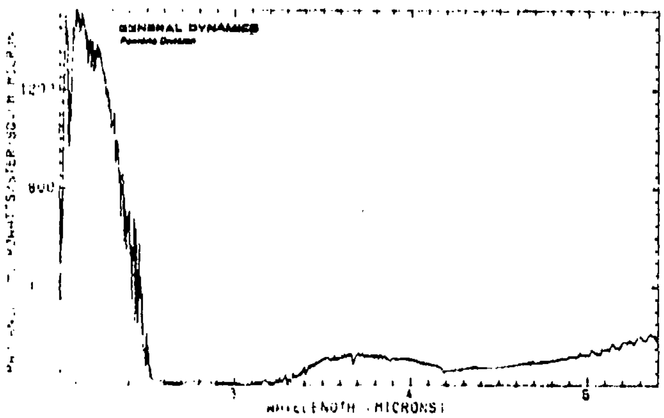


PHOTOGRAPH 0.7 – 0.9 MICRONS

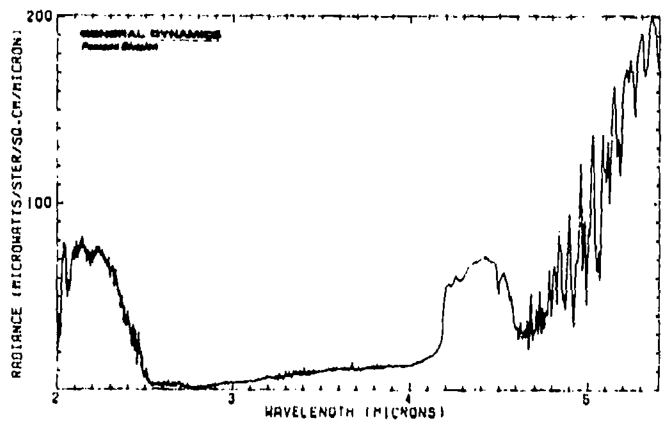


THERMAL IMAGE 2–5 MICRONS

PLOT NO. 1 – BRIGHT CLOUD



PLOT NO. 2 – BLUE SKY



INFRARED BACKGROUND SITE NO. 1
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2

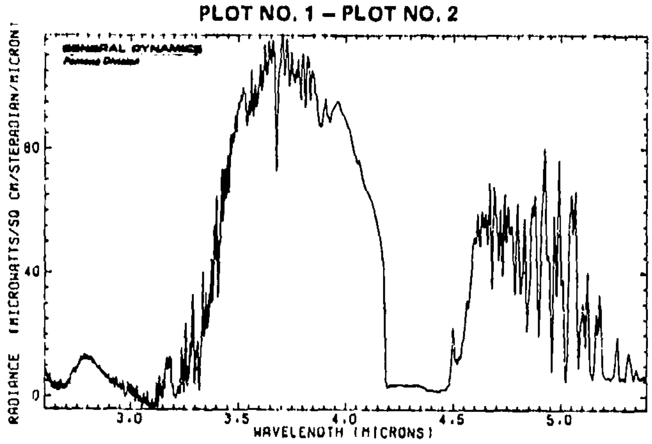


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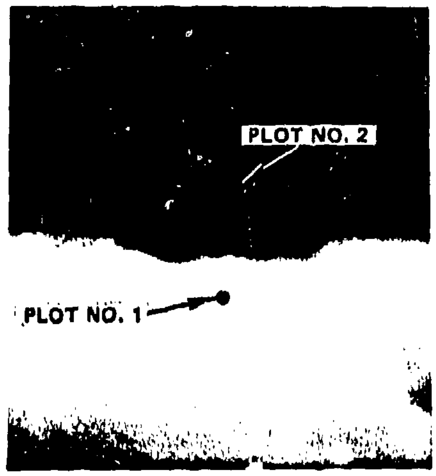
Figure 4-1.

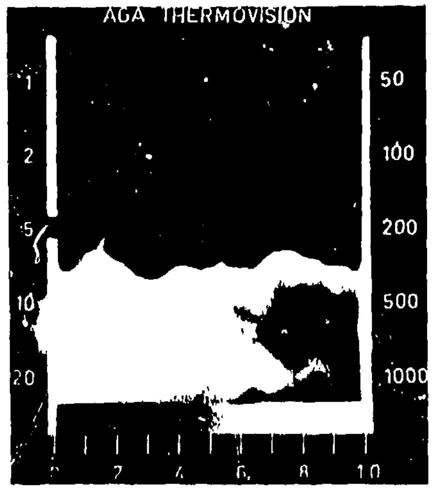
LOCATION: BLUE RIDGE
DATE: JUNE 15, 1970
TIME: 1322 PST
ELEVATION: 7386 FEET
TEMPERATURE: 63°F
RELATIVE HUMIDITY: 37%
SUN ANGLE: 67° EL 228° AZ MAG

PLOT NO. 1: BRIGHT CLOUD EDGE
EL ANGLE: 19° AZ ANGLE: 235° MAG

PLOT NO. 2: BLUE SKY
EL ANGLE: 20° AZ ANGLE: 235° MAG

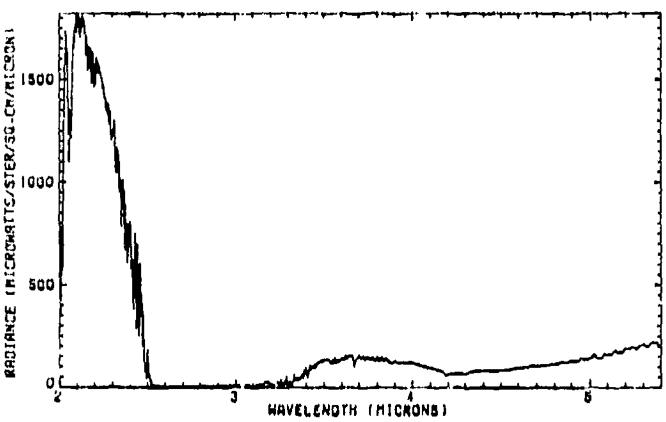


PHOTOGRAPH 0.7 – 0.9 MICRONS

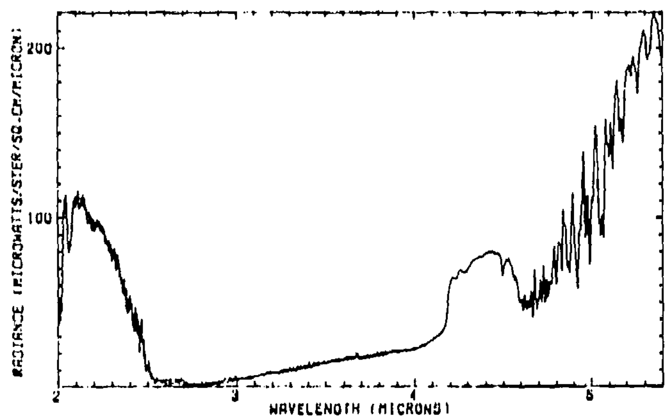


THERMAL IMAGE 2 – 5 MICRONS

PLOT NO. 1 – BRIGHT CLOUD EDGE

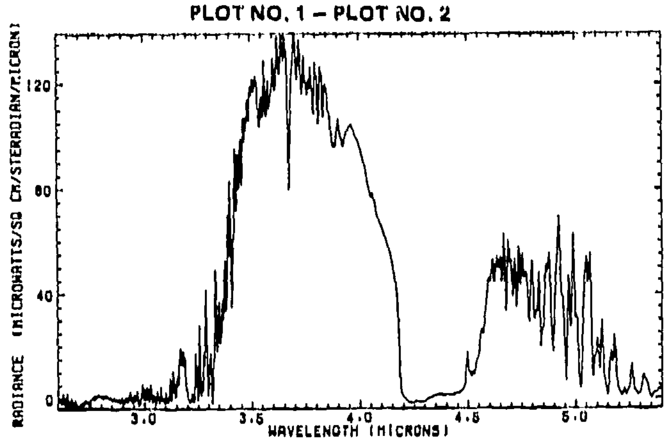


PLOT NO. 2 – BLUE SKY



INFRARED BACKGROUND DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



A63895-1A

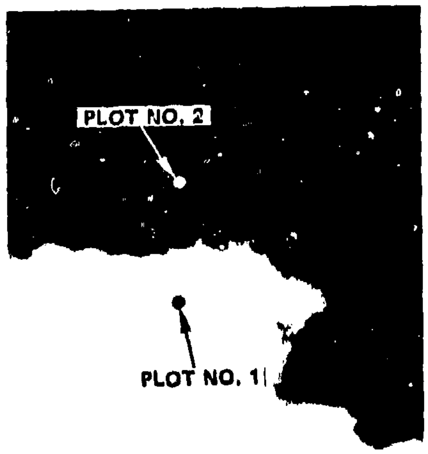
Figure 4-2.

INFRARED BACKGROUND SITE NO. 3

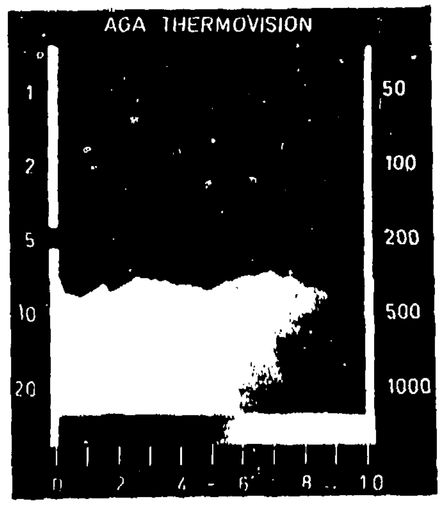
LOCATION: BLUE RIDGE
DATE: JUNE 15, 1970
TIME: 1358 PST
ELEVATION: 7386 FEET
TEMPERATURE: 63°F
RELATIVE HUMIDITY: 35%
SUN ANGLE: 57° EL 235° AZ MAG

PLOT NO. 1: BRIGHT CLOUD
EL ANGLE: 20° AZ ANGLE: 340° MAG

PLOT NO. 2: BLUE SKY
EL ANGLE: 21° AZ ANGLE: 340° MAG

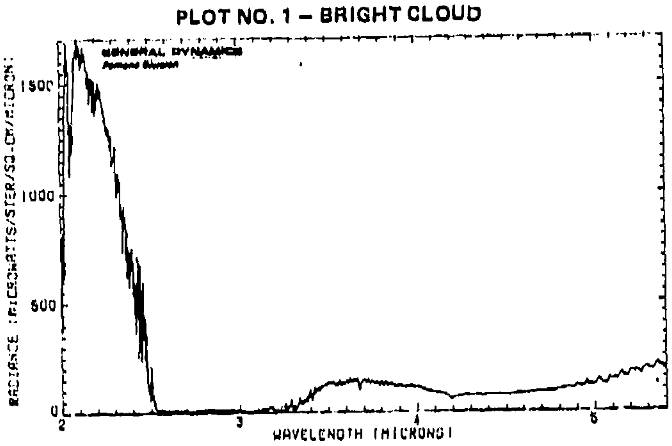


PHOTOGRAPH 0.7 – 0.9 MICRONS

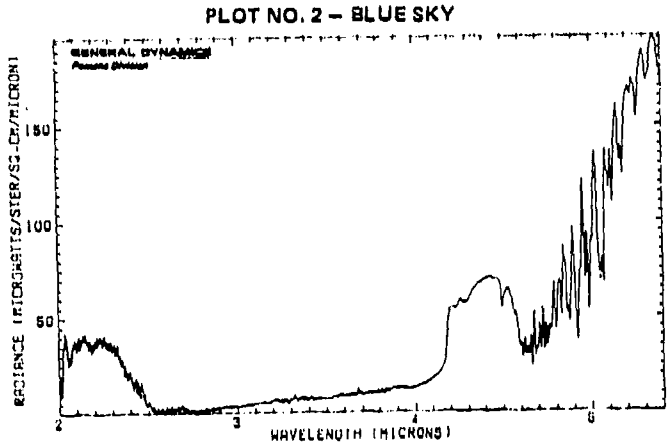


THERMAL IMAGE 2 – 5 MICRONS

PLOT NO. 1 – BRIGHT CLOUD

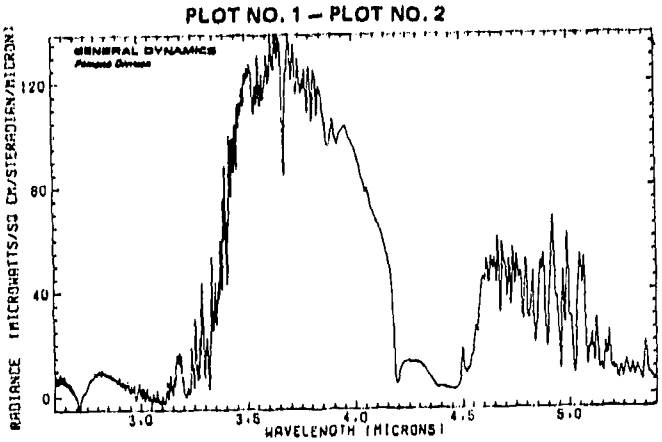


PLOT NO. 2 – BLUE SKY



INFRARED BACKGROUND SITE NO. 3
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



A63897-1

Figure 4-3.

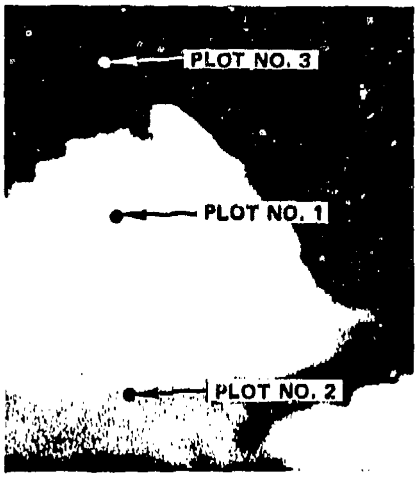
INFRARED BACKGROUND SITE NO. 4

LOCATION: BLUE RIDGE
DATE: JUNE 15, 1970
TIME: 1406 PST
ELEVATION: 7386 FEET
TEMPERATURE: 62°F
RELATIVE HUMIDITY: 34%
SUN ANGLE: 54° EL 236° AZ MAG

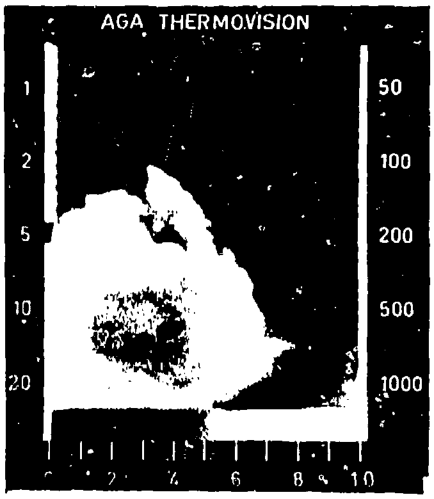
PLOT NO. 1: BRIGHT CLOUD
EL ANGLE: 10° AZ ANGLE: 130° MAG

PLOT NO. 2: DARK CLOUD
EL ANGLE: 9° AZ ANGLE: 130° MAG

PLOT NO. 3: BLUE SKY
EL ANGLE: 11° AZ ANGLE: 130° MAG

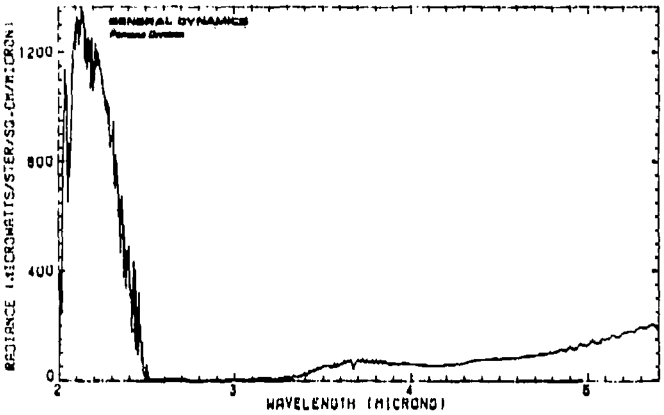


PHOTOGRAPH 0.7 – 0.9 MICRONS

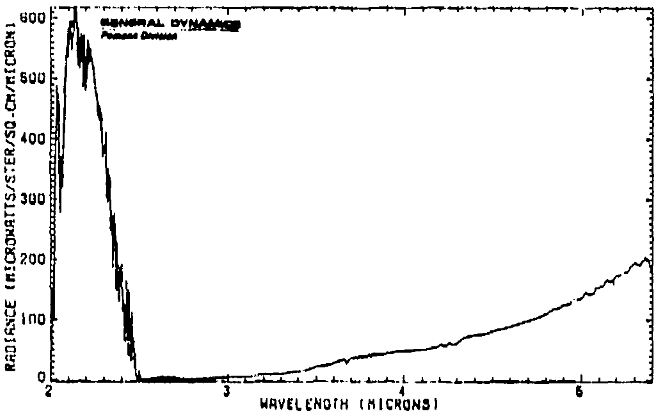


THERMAL IMAGE 2 – 5 MICRONS

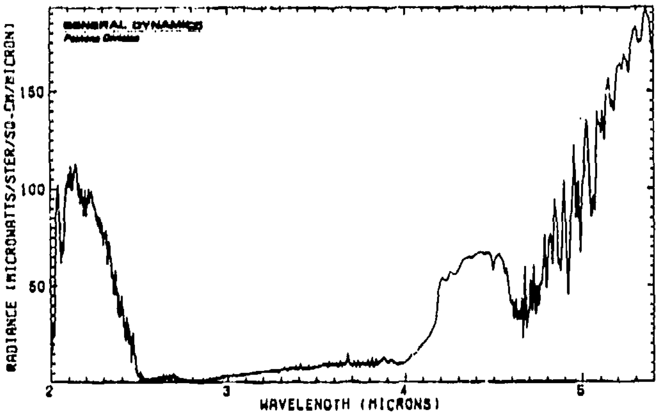
PLOT NO. 1 – BRIGHT CLOUD



PLOT NO. 2 – DARK CLOUD



PLOT NO. 3 – BLUE SKY

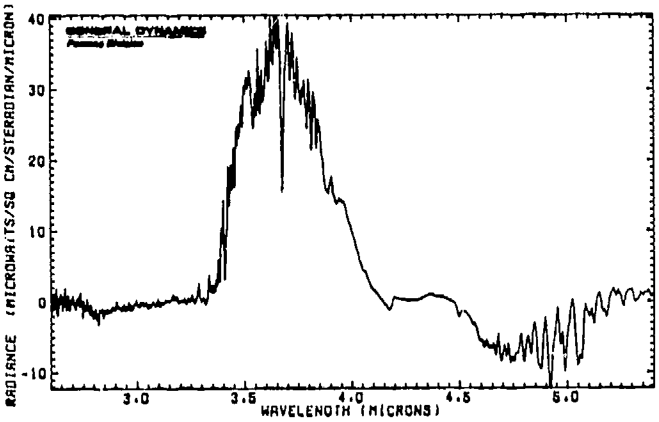


A63898-1

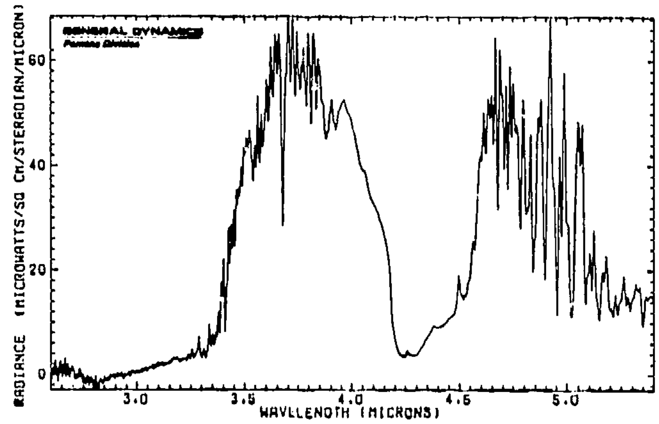
Figure 4–4.

INFRARED BACKGROUND SITE NO. 4
DIFFERENCE PLOTS

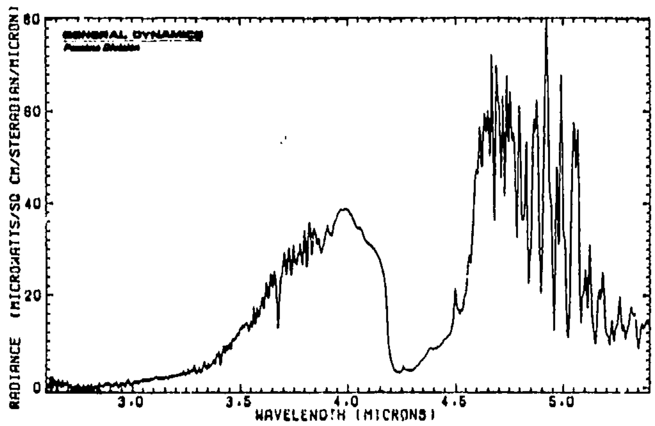
PLOT NO. 1 – PLOT NO. 2



PLOT NO. 1 – PLOT NO. 3



PLOT NO. 2 – PLOT NO. 3



A63899

Figure 4–4 (Continued)

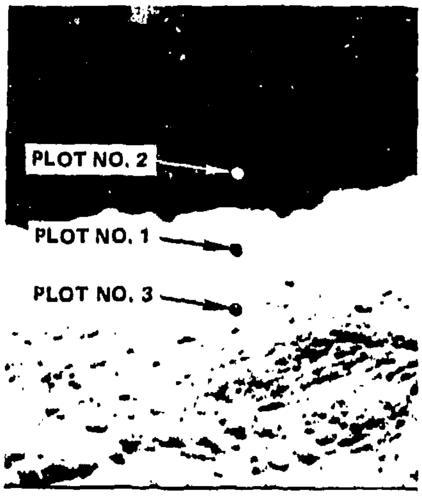
INFRARED BACKGROUND SITE NO. 5

LOCATION: SAN ONOFRE
DATE: APRIL 28 1970
TIME: 1456 PST
ELEVATION: 110 FEET
TEMPERATURE: 64°F
RELATIVE HUMIDITY: 32%
SUN ANGLE: 39° EL 230° AZ MAG

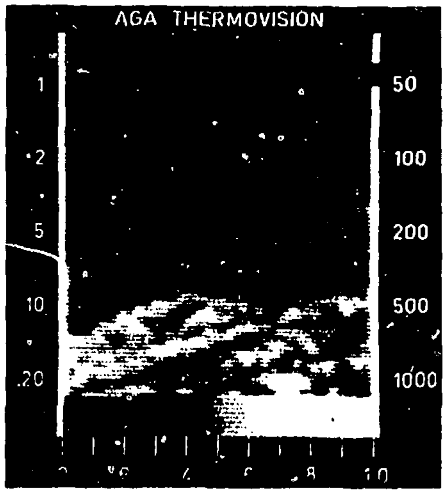
PLOT NO 1: CLOUD
EL ANGLE: 8.5° AZ ANGLE: 24° MAG

PLOT NO. 2: BLUE SKY ABOVE CLOUD
EL ANGLE: 9° AZ ANGLE: 24° MAG

PLOT NO. 3: HILLSIDE
EL ANGLE: 8° AZ ANGLE: 24° MAG

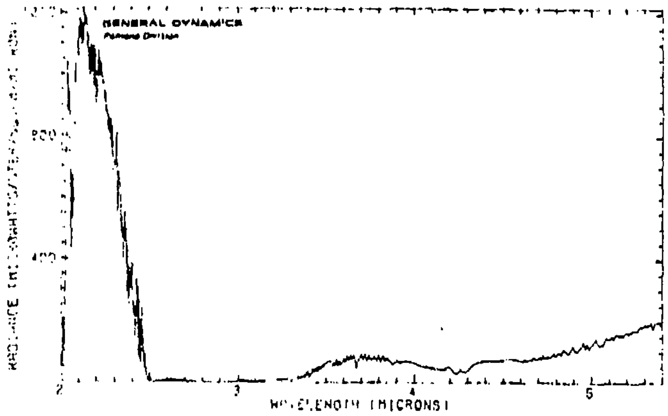


PHOTOGRAPH 0.7 – 0.9 MICRONS

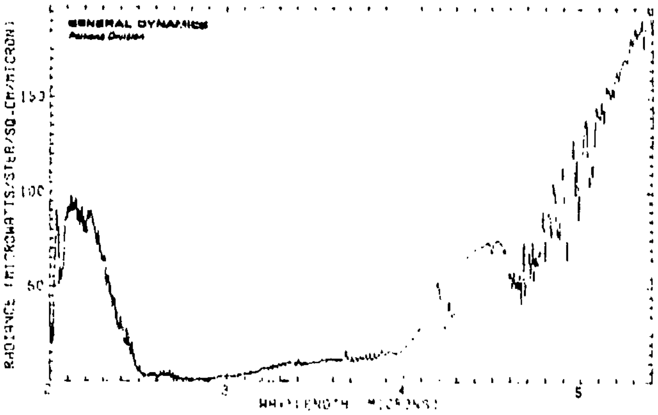


THERMAL IMAGE 2–5 MICRONS

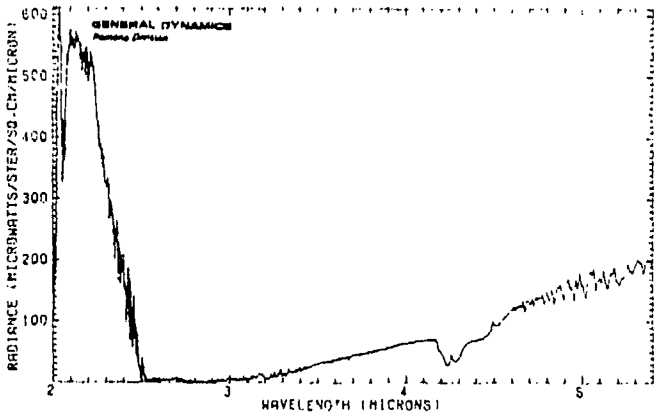
PLOT NO. 1 – CLOUD



PLOT NO. 2 – BLUE SKY ABOVE CLOUD



PLOT NO. 3 – HILLSIDE

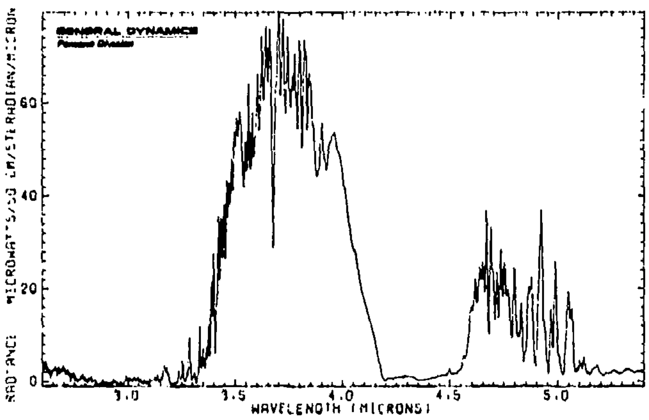


A63888-1

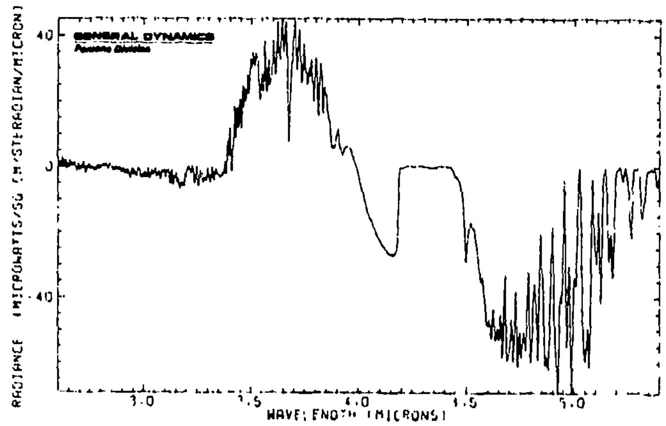
Figure 4-5.

INFRARED BACKGROUND SITE NO. 5
DIFFERENCE PLOTS

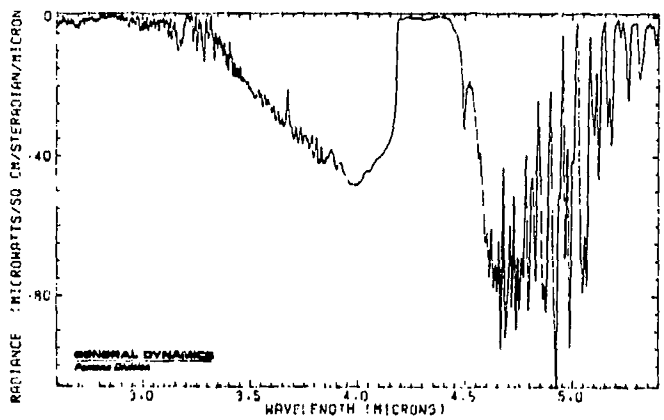
PLOT NO. 1 – PLOT NO. 2



PLOT NO. 1 – PLOT NO. 3



PLOT NO. 2 – PLOT NO. 3



A63889

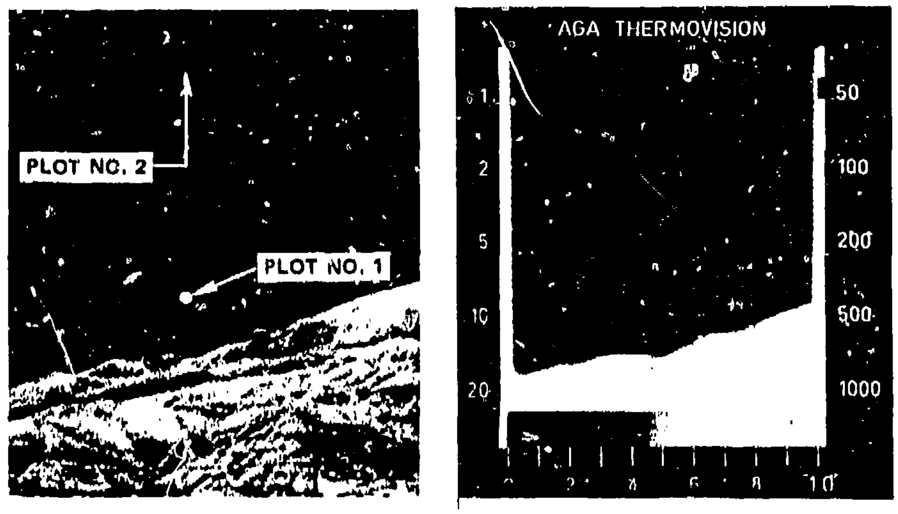
Figure 4-5 (Continued).

INFRARED BACKGROUND SITE NO. 6

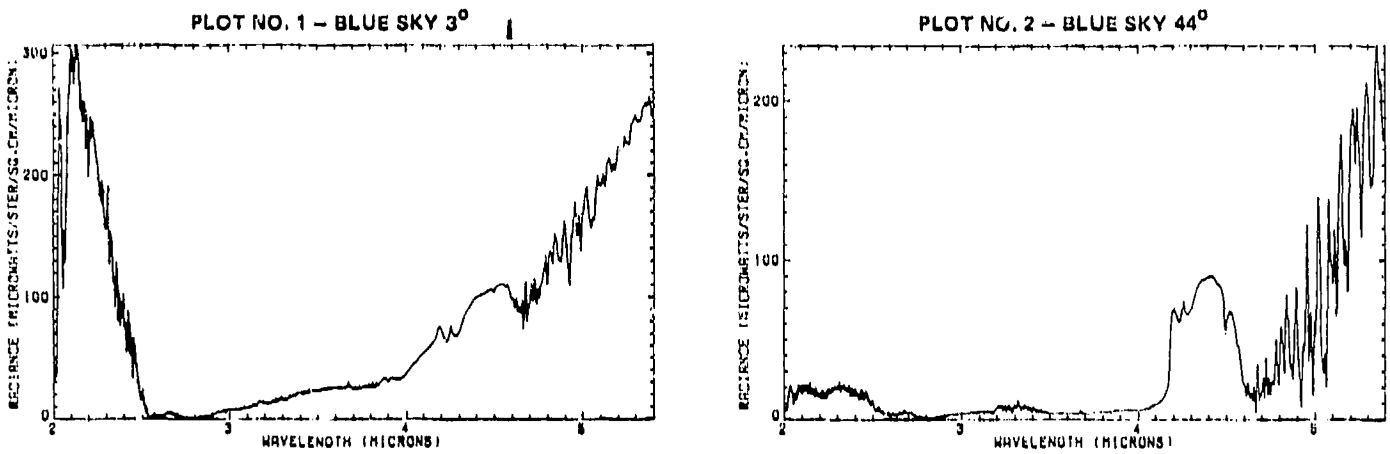
LOCATION: DESERT HOT SPRINGS
DATE: APRIL 23, 1970
TIME: 1237 PST
ELEVATION: 1087 FEET
TEMPERATURE: 76°F
RELATIVE HUMIDITY: 9%
SUN ANGLE: 65.7° EL 192° AZ MAG

PLOT NO. 1: BLUE SKY 3°
EL ANGLE: 3° AZ ANGLE: 345° MAG

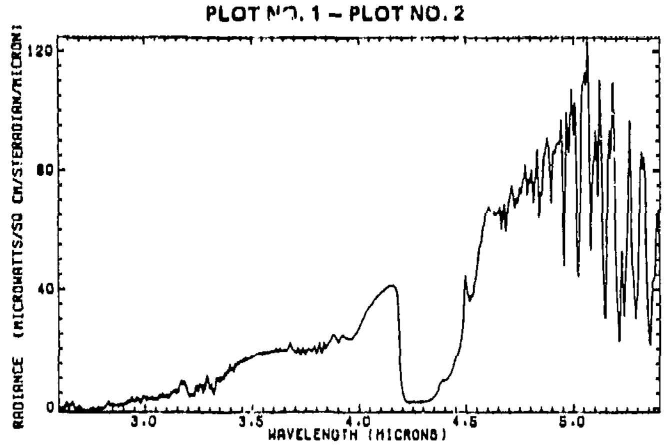
PLOT NO. 2: BLUE SKY 44°
EL ANGLE: 44° AZ ANGLE: 345° MAG



PHOTOGRAP... .9 MICRONS   THERMAL IMAGE 2–5 MICRONS



INFRARED BACKGROUND SITE NO. 6
DIFFERENCE PLOT
PLOT NO. 1 – PLOT NO. 2



A63906-1

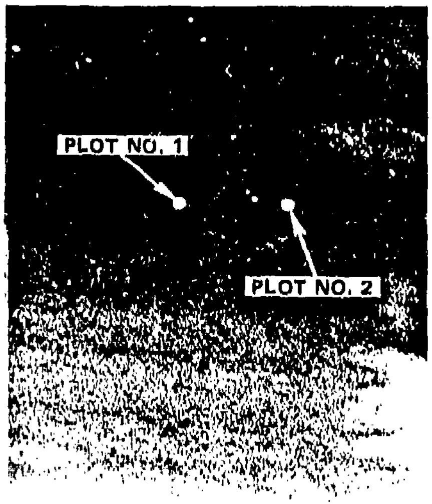
Figure 4-6.

INFRARED BACKGROUND SITE NO. 7

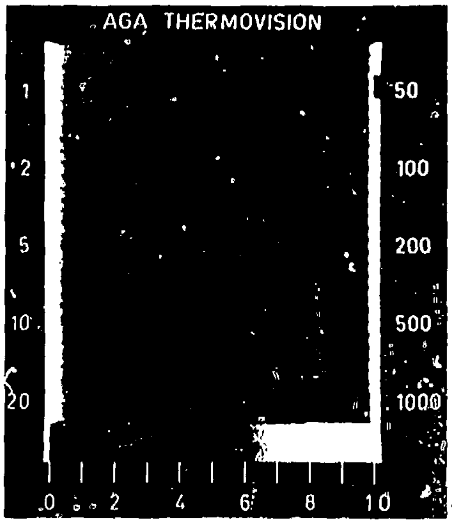
LOCATION: BLUE RIDGE, CALIF.
DATE: JAN 29, 1970
TIME: 12:21 PST
ELEVATION: 7386 FEET
TEMPERATURE: 49°F
RELATIVE HUMIDITY: 13%
SUN ANGLE: 38° EL, 170° AZ MAG

PLOT NO. 1: BLUE SKY
EL ANGLE: 12° AZ ANGLE: 220° MAG

PLOT NO. 2: BLUE SKY
EL ANGLE: 12° AZ ANGLE: 220.6° MAG

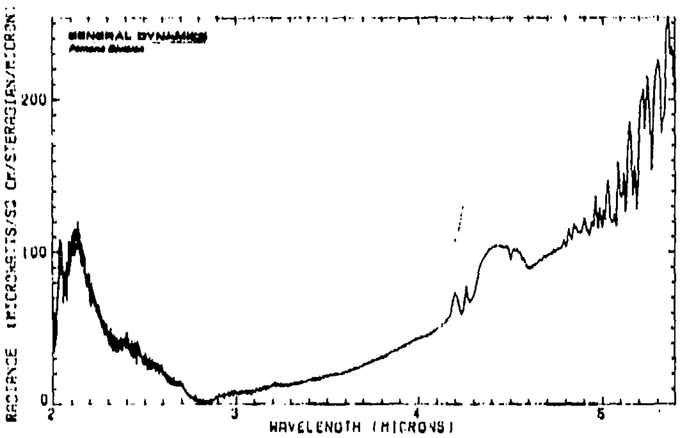


PHOTOGRAPH 0.7 – 0.9 MICRONS

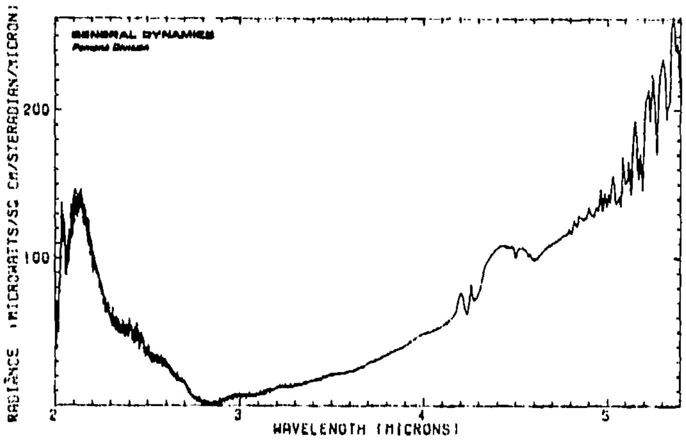


THERMAL IMAGE 2 – 5 MICRONS

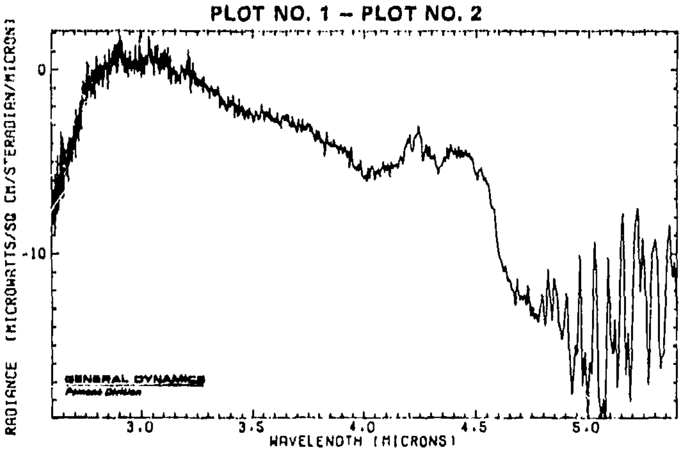
PLOT NO. 1 – BLUE SKY



PLOT NO. 2 – BLUE SKY



INFRARED BACKGROUND SITE NO. 7
DIFFERENCE PLOT
PLOT NO. 1 – PLOT NO. 2



A63055-1

Figure 4-7.

INFRARED BACKGROUND SITE NO. 8

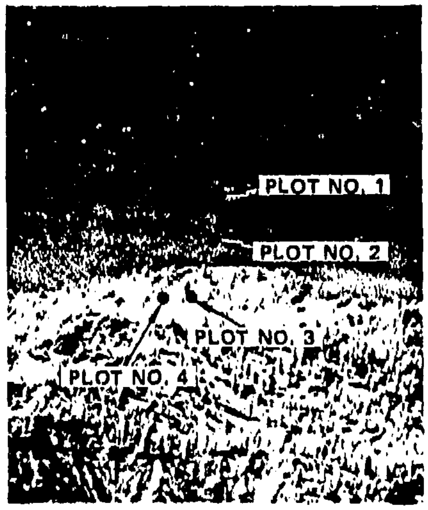
LOCATION: BLUE RIDGE, CALIF.
DATE: JAN 29, 1970
TIME: 11:32 PST
ELEVATION: 7386 FEET
TEMPERATURE: 49°F
RELATIVE HUMIDITY: 12%
SUN ANGLE: 37° EL, 155° AZ MAG

PLOT NO. 1: BLUE SKY ABOVE MT. PINION
EL ANGLE: 9° AZ ANGLE: 230° MAG

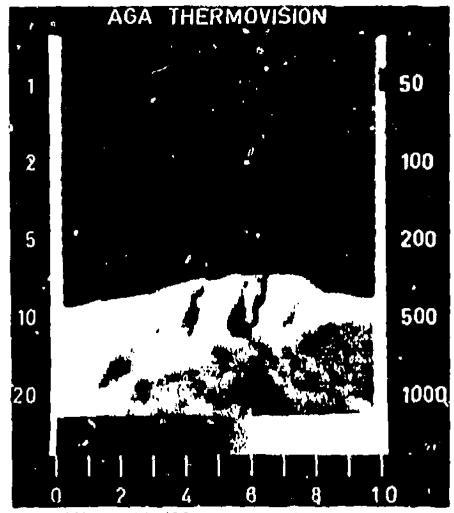
PLOT NO. 2: BLUE SKY ABOVE MT. PINION
EL ANGLE: 8.5° AZ ANGLE: 230° MAG

PLOT NO. 3: SNOW COVERED PEAK
EL ANGLE: 8° AZ ANGLE: 230° MAG

PLOT NO. 4: BARE GROUND
EL ANGLE: 8° AZ ANGLE: 229.5° MAG

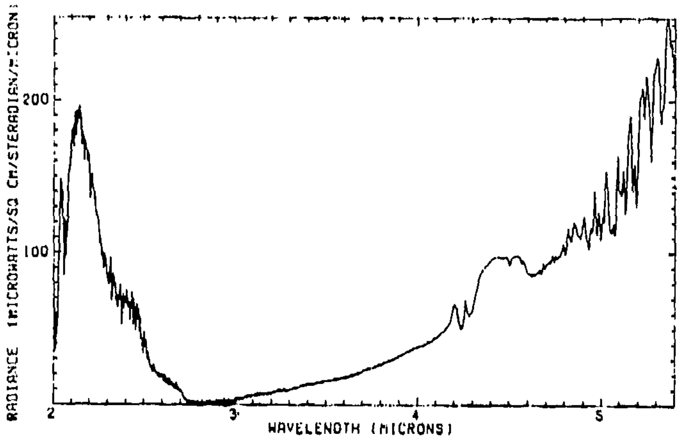


PHOTOGRAPH 0.7 – 0.9 MICRONS

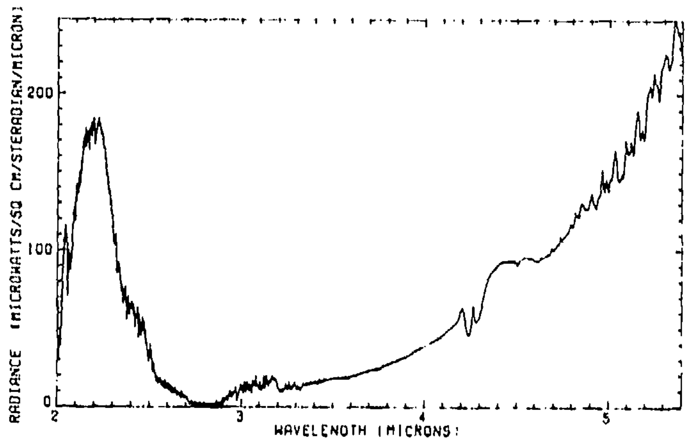


THERMAL IMAGE 2 – 5 MICRONS

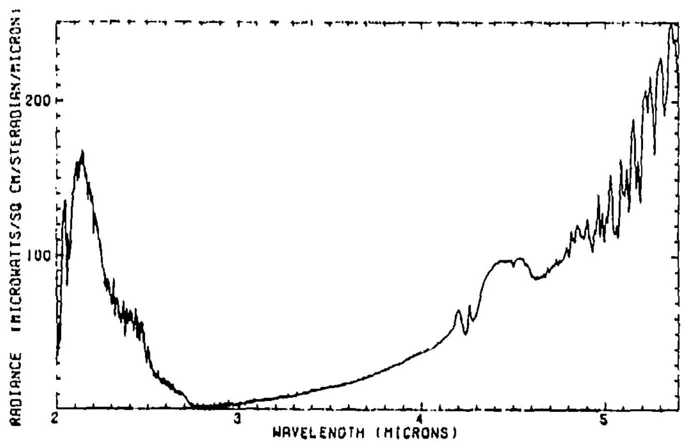
PLOT NO. 1 – BLUE SKY ABOVE MT. PINION



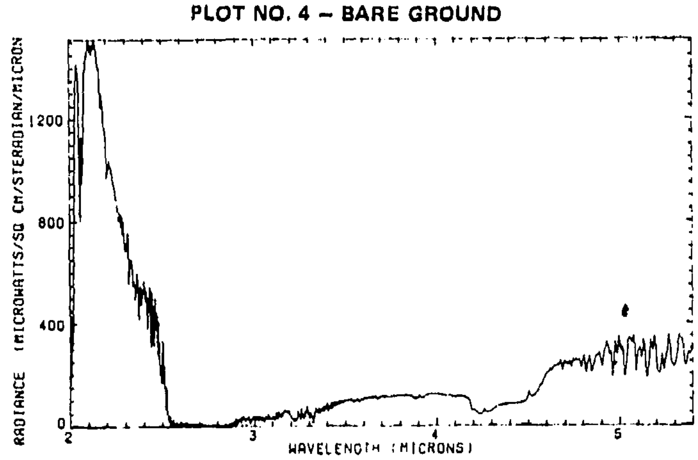
PLOT NO. 3 – SNOW COVERED PEAK



PLOT NO. 2 – BLUE SKY ABOVE MT. PINION



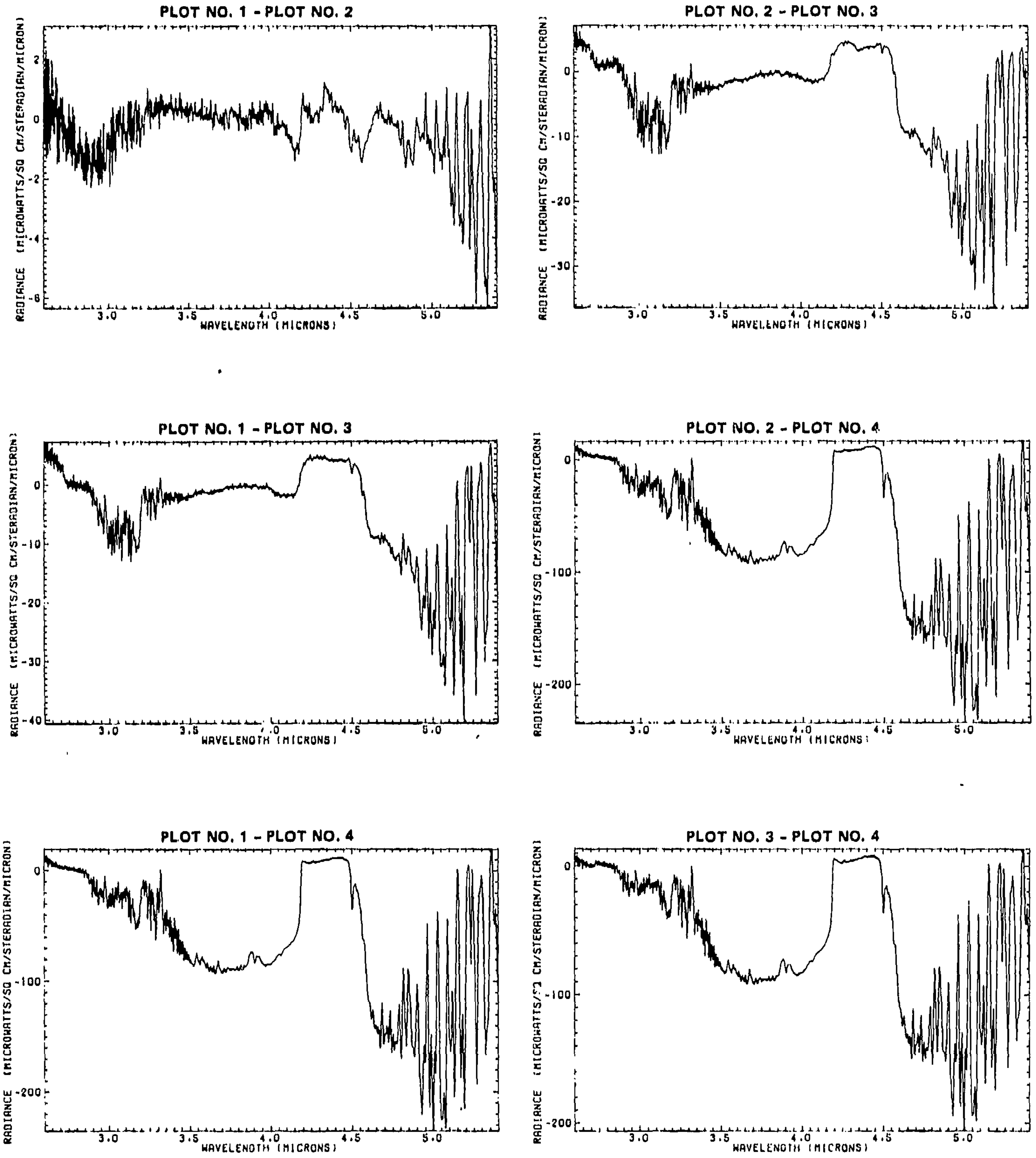
PLOT NO. 4 – BARE GROUND



A63051-1A

Figure 4-8.

DIFFERENCE PLOTS OF IR BACKGROUND SITE NO. 8



A53058B-1 775

Figure 4-8 (Continued).

INFRARED BACKGROUND SITE NO. 9

LOCATION: BLUE RIDGE, CALIF.
DATE: JAN 29, 1970
TIME: 11:54 PST
ELEVATION: 7386 FEET
TEMPERATURE: 49°F
RELATIVE HUMIDITY: 12%
SUN ANGLE: 38° EL, 162° AZ MAG

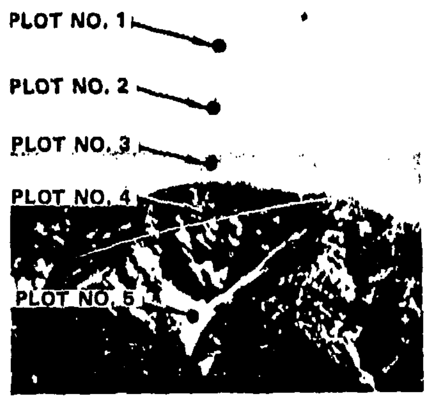
PLOT NO. 1: CLOUD COVER OVER MT. BALDY
EL ANGLE: 7.0° AZ ANGLE: 138°MAG

PLOT NO. 2: CLOUD COVER
EL ANGLE: 6.2° AZ ANGLE: 138° MAG

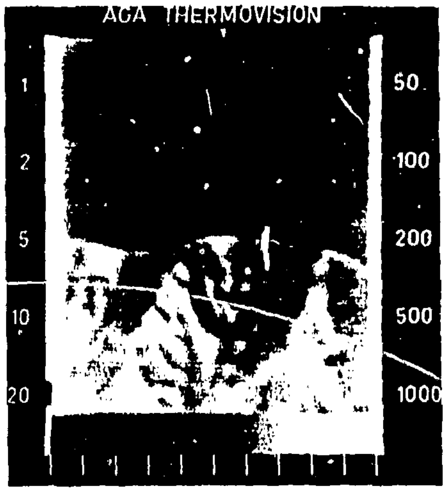
PLOT NO. 3: BLUE SKY
EL ANGLE: 5.5° AZ ANGLE: 138° MAG

PLOT NO. 4: SNOW & ROCK
EL ANGLE: 5.3° AZ ANGLE: 138° MAG

PLOT NO. 5: SNOW PATCH
EL ANGLE: 4.7° AZ ANGLE: 138° MAG

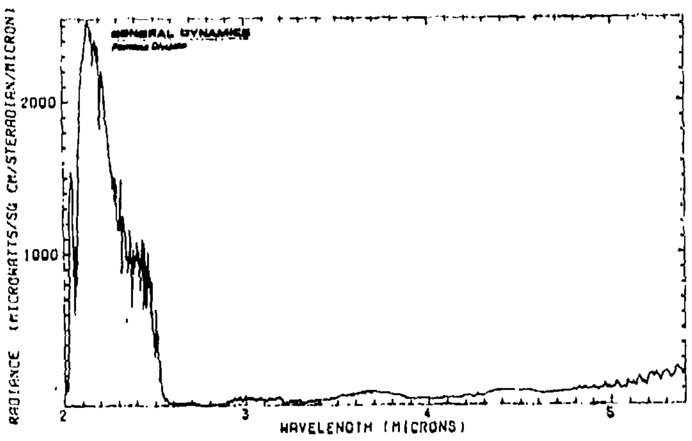


PHOTOGRAPH 0.7 – 0.9 MICRONS

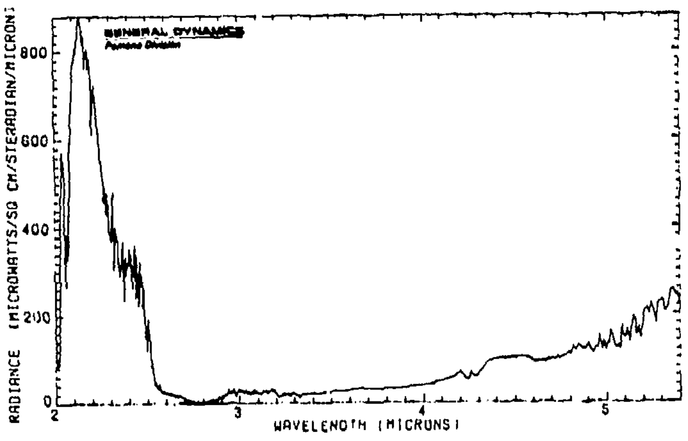


THERMAL IMAGE 2 – 5 MICRONS

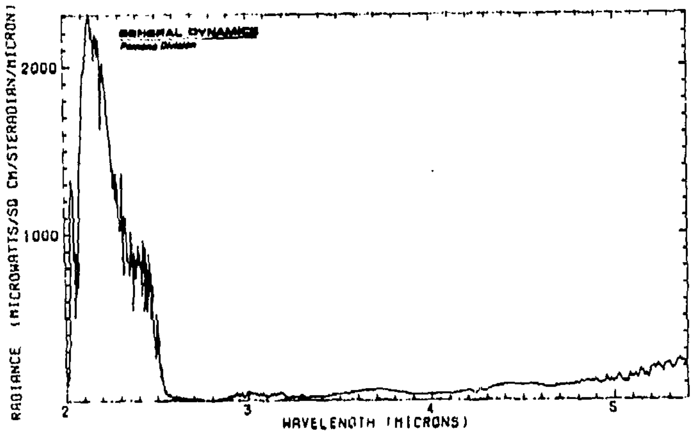
PLOT NO. 1 – CLOUD COVER OVER MT. BALDY



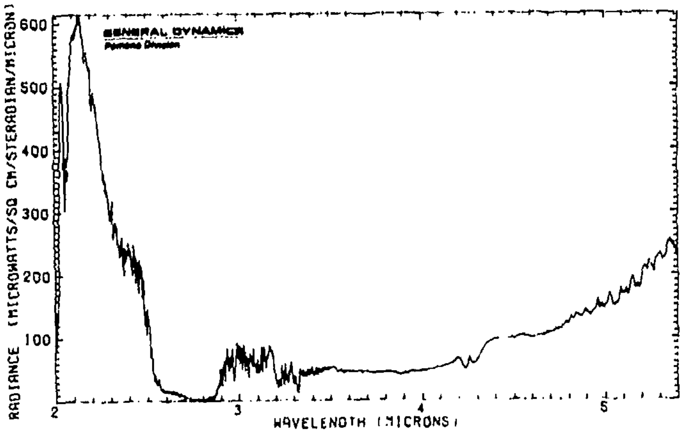
PLOT NO. 3 – BLUE SKY



PLOT NO. 2 – CLOUD COVER



PLOT NO. 4 – SNOW & ROCK

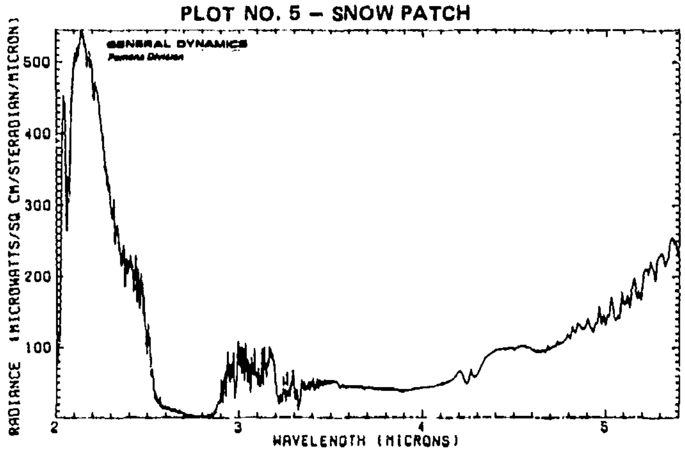


A63053-1

Figure 4-9.

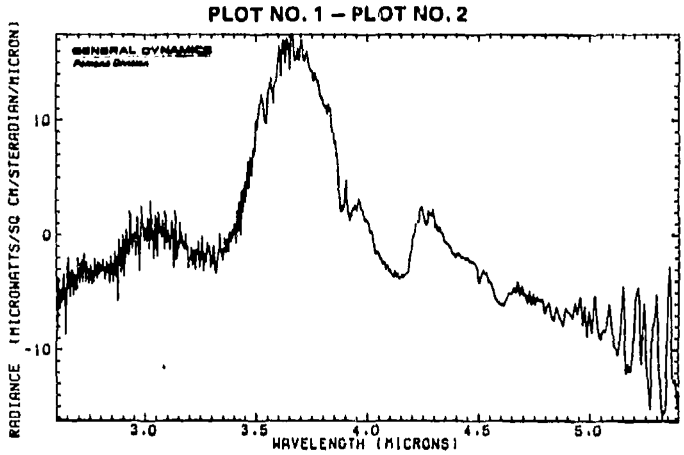
INFRARED BACKGROUND SITE NO. 9

PLOT NO. 5 – SNOW PATCH

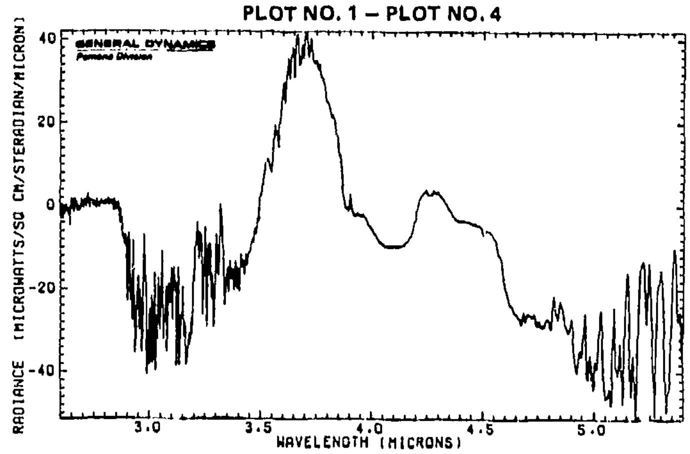


INFRARED BACKGROUND SITE NO. 9 DIFFERENCE PLOTS

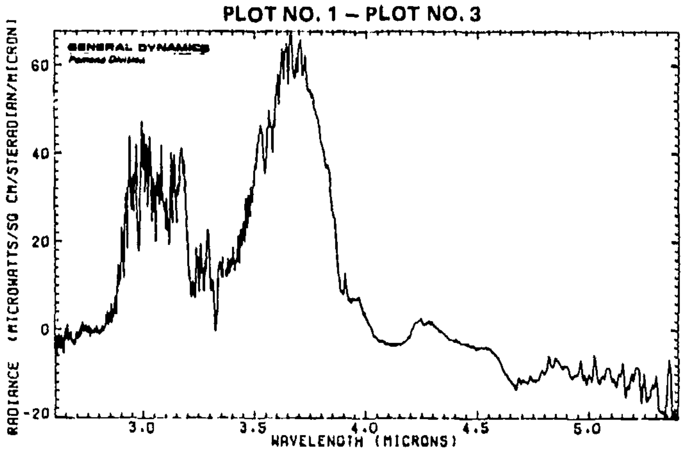
PLOT NO. 1 – PLOT NO. 2



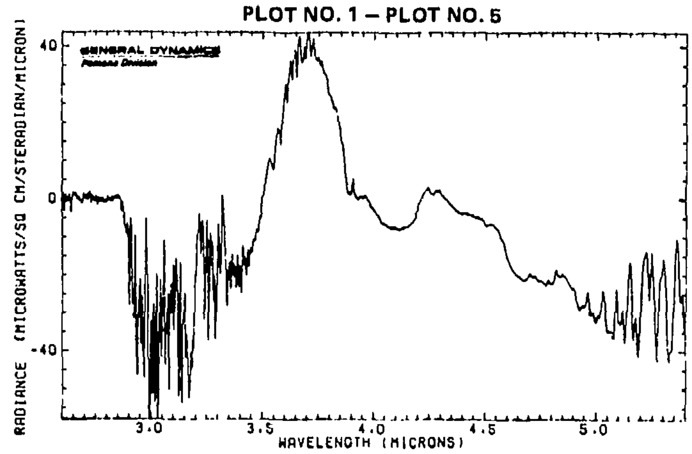
PLOT NO. 1 – PLOT NO. 4



PLOT NO. 1 – PLOT NO. 3



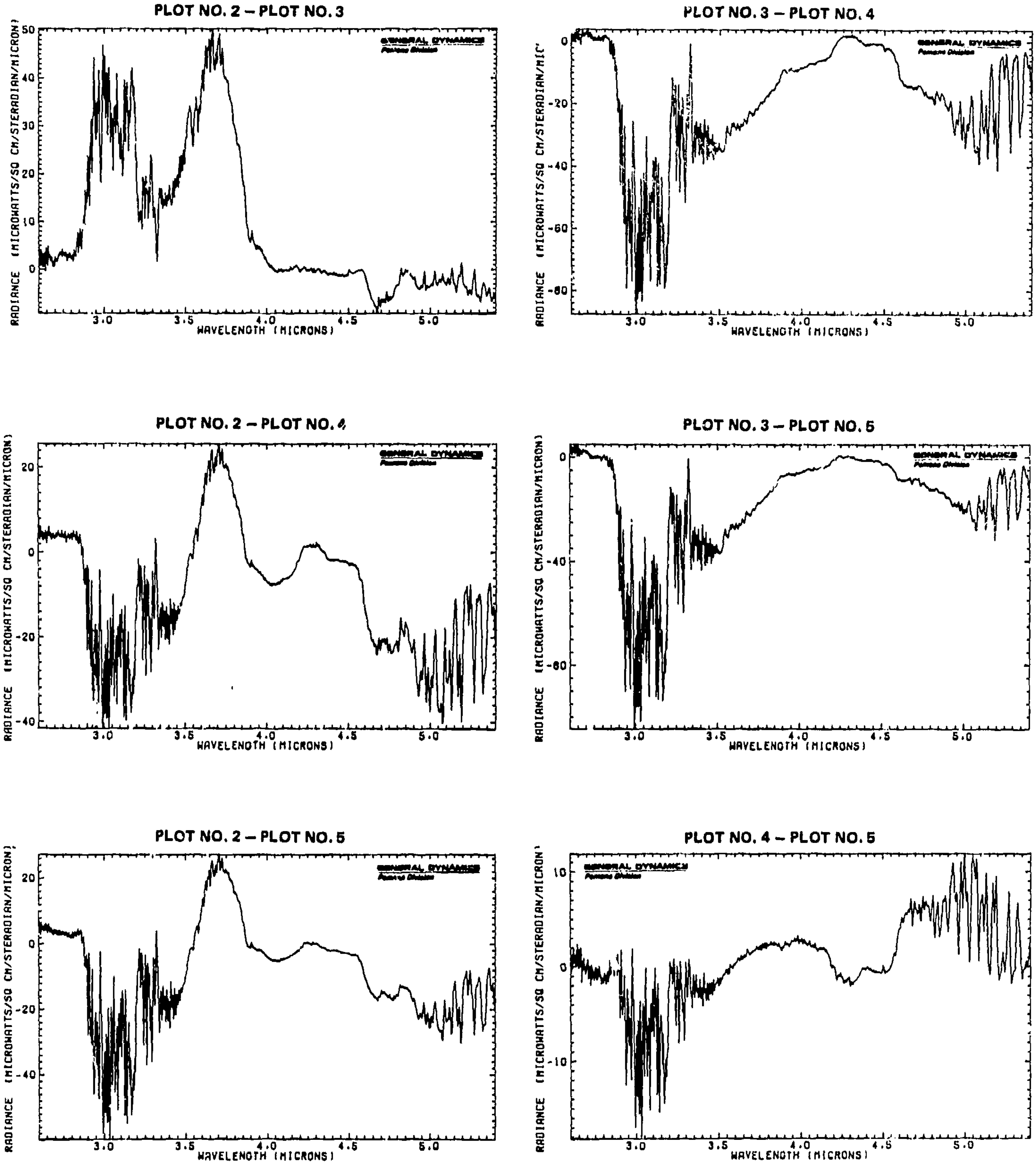
PLOT NO. 1 – PLOT NO. 5



A63100

Figure 4-9 (Continued).

INFRARED BACKGROUND SITE NO. 9
DIFFERENCE PLOTS



A63054

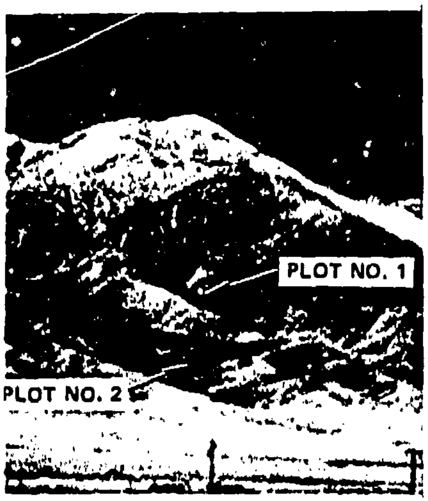
Figure 4-9 (Continued).

INFRARED BACKGROUND SITE NO. 10

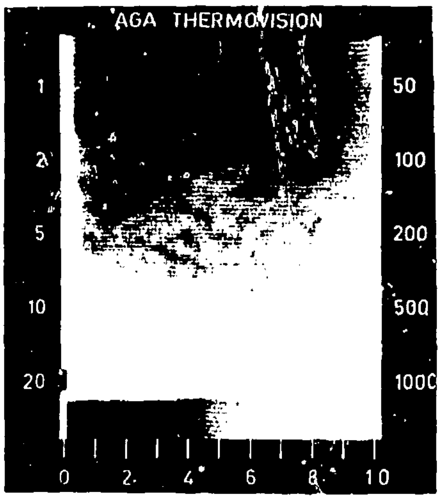
LOCATION: DESERT HOT SPRINGS
DATE: APRIL 23, 1970
TIME: 1154 PST
ELEVATION: 1087 FEET
TEMPERATURE: 76°F
RELATIVE HUMIDITY: 9%
SUN ANGLE: 68° EL 168° AZ MAG

PLOT NO. 1: DISTANT HILL
EL ANGLE: 2.2° **AZ ANGLE:** 285° MAG

PLOT NO. 2: HOT HILL
EL ANGLE: 1.8° **AZ ANGLE:** 285° MAG

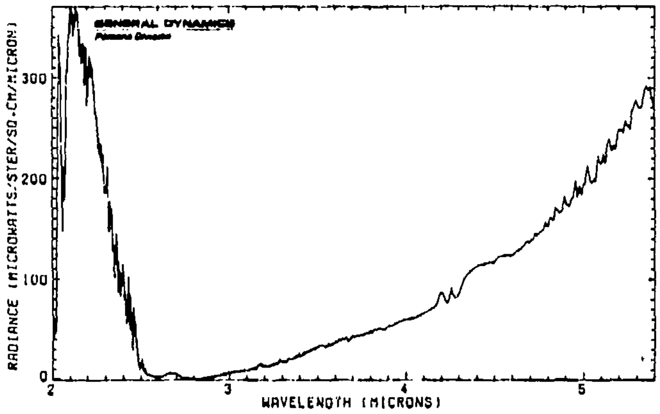


PHOTOGRAPH 0.7 – 0.9 MICRONS

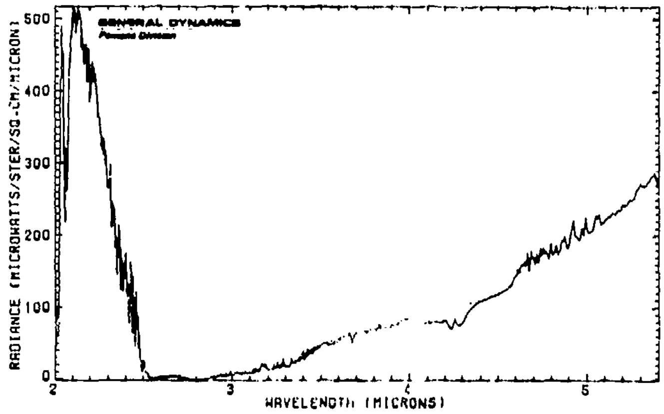


THERMAL IMAGE 2–5 MICRONS

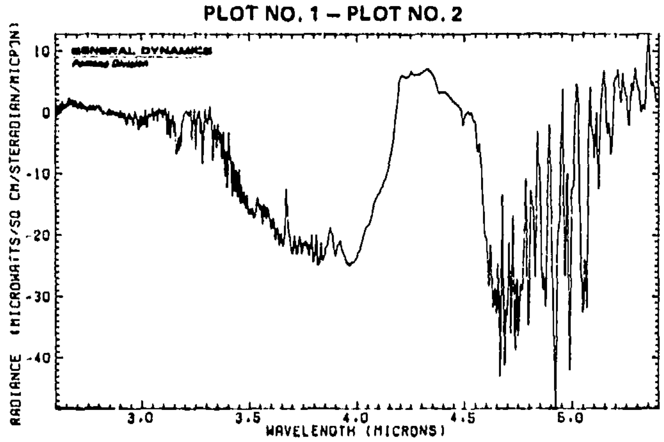
PLOT NO. 1 – DISTANT HILL



PLOT NO. 2 – HOT HILL



INFRARED BACKGROUND SITE NO. 10
DIFFERENCE PLOT
PLOT NO. 1 – PLOT NO. 2



A63892-1

Figure 4-10.

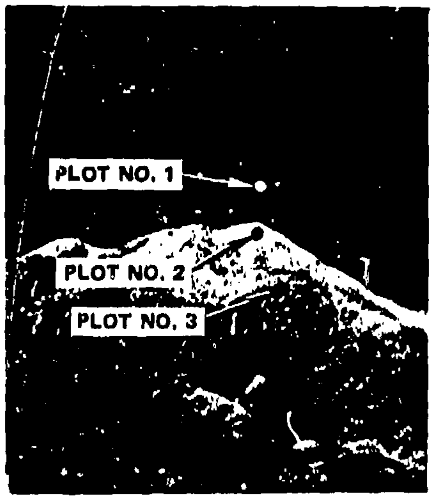
INFRARED BACKGROUND SITE NO. 11

LOCATION: DESERT HOT SPRINGS
DATE: APRIL 23, 1970
TIME: 1145 PST
ELEVATION: 1087 FEET
TEMPERATURE: 76°F
RELATIVE HUMIDITY: 9%
SUN ANGLE: 68° EL 162° AZ MAG

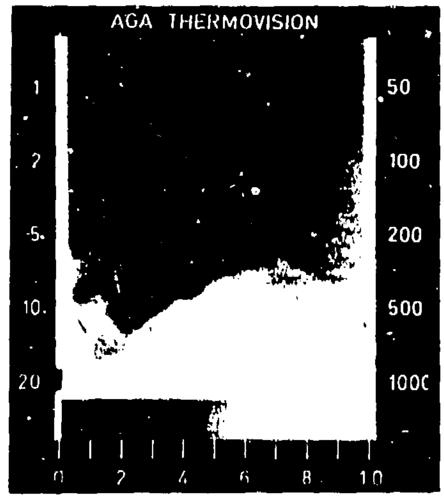
PLOT NO. 1: BLUE SKY
EL ANGLE: 5.2° AZ ANGLE: 285° MAG

PLOT NO. 2: SNOW ON SAN GORGONIO
EL ANGLE: 4.8° AZ ANGLE: 285° MAG

PLOT NO. 3: SECOND MT. PEAK
EL ANGLE: 3.0° AZ ANGLE: 285° MAG

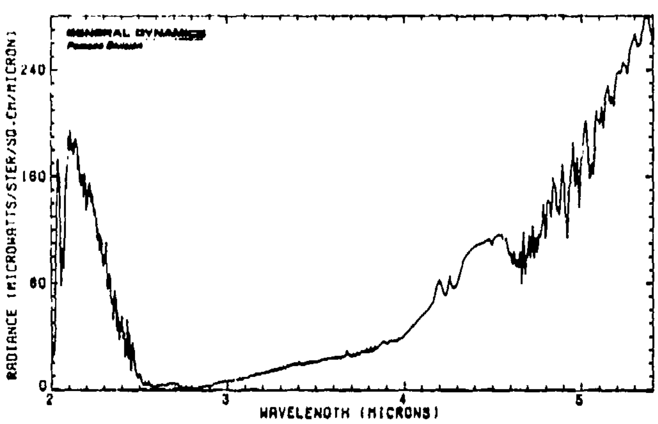


PHOTOGRAPH 0.7 – 0.9 MICRONS

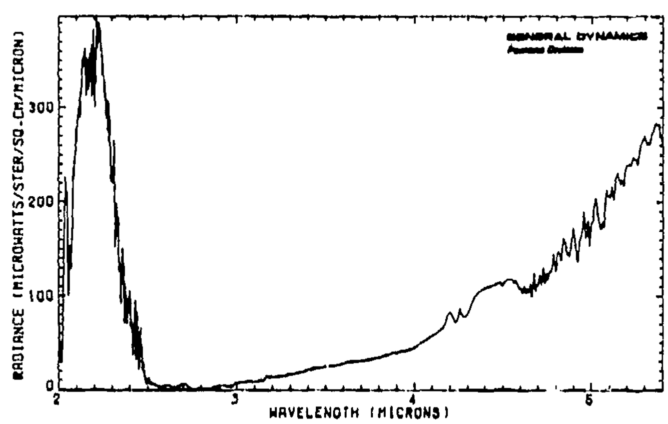


THERMAL IMAGE 2–5 MICRONS

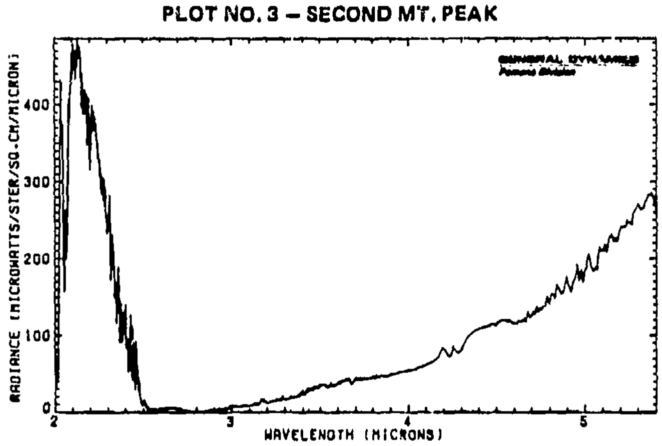
PLOT NO. 1 – BLUE SKY



PLOT NO. 2 – SNOW ON SAN GORGONIO



PLOT NO. 3 – SECOND MT. PEAK

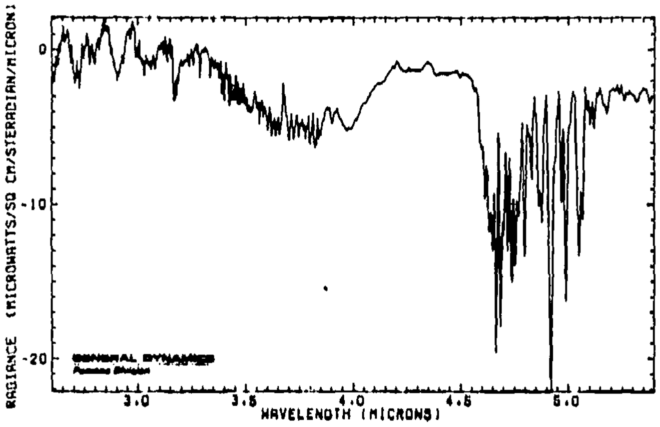


A63893-1

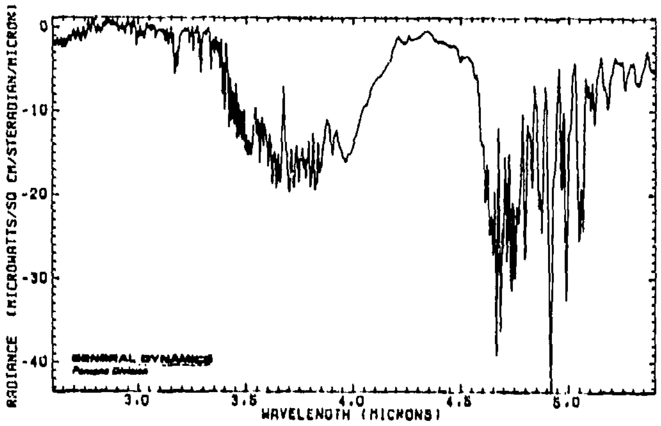
Figure 4-11.

INFRARED BACKGROUND SITE NO. 11
DIFFERENCE PLOTS

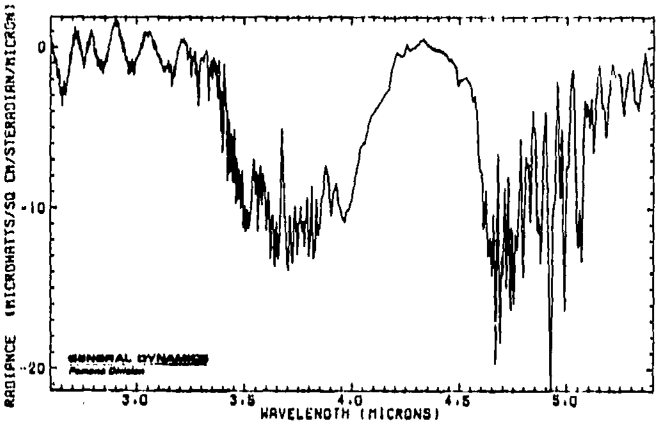
PLOT NO. 1 – PLOT NO. 2



PLOT NO. 1 – PLOT NO. 3



PLOT NO. 2 – PLOT NO. 3



A63894

Figure 4-11 (Continued).

INFRARED BACKGROUND SITE NO. 12

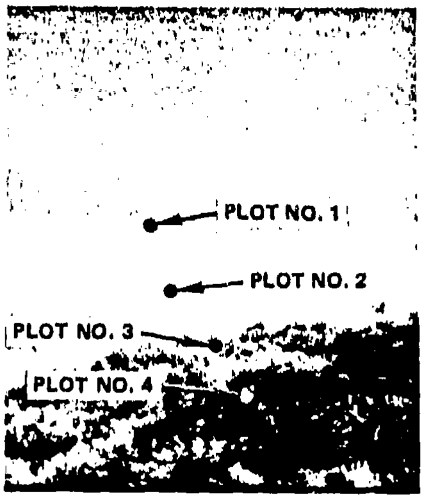
LOCATION: SAN MARCOS PASS
DATE: MAY 18, 1970
TIME: 16:22 PST
ELEVATION: 1850 FEET
TEMPERATURE: 73°F
RELATIVE HUMIDITY: 46%
SUN ANGLE: 19° EL, 242° AZ MAG

PLOT NO. 1: BLUE SKY
EL ANGLE: −2° AZ ANGLE: 179.2° MAG

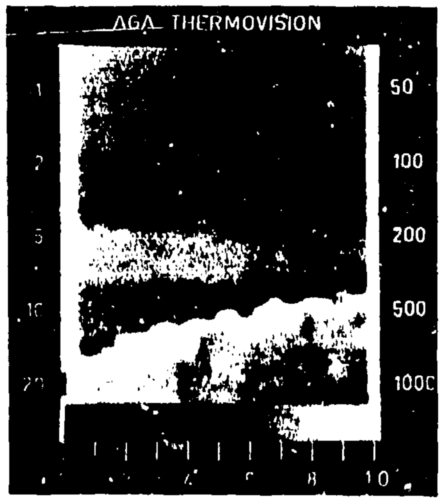
PLOT NO. 2: FOG BANK
EL ANGLE: −2.4° AZ ANGLE: 179.5° MAG

PLOT NO. 3: SUNLIT ROCK
EL ANGLE: −3° AZ ANGLE: 180° MAG

PLOT NO. 4: GREEN FOLIAGE
EL ANGLE: 3.5° AZ ANGLE: 180.5° MAG

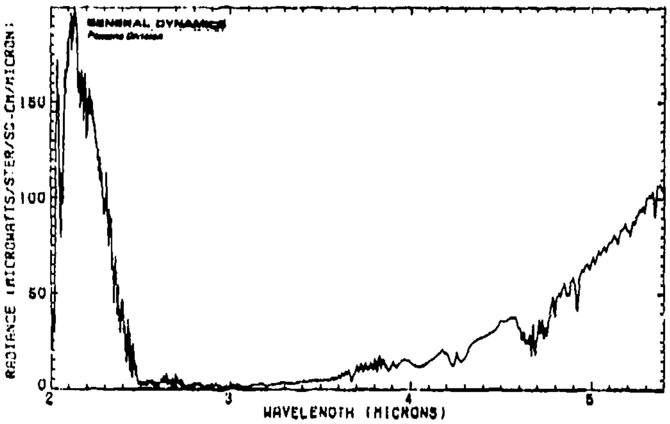


PHOTOGRAPH 0.7 – 0.9 MICRONS

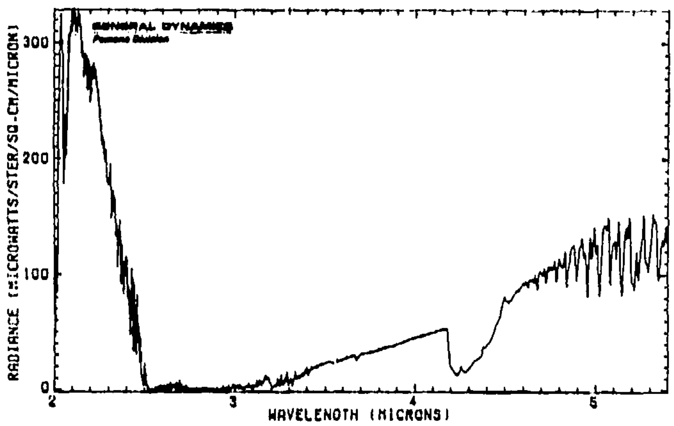


THERMAL IMAGE 2–5 MICRONS

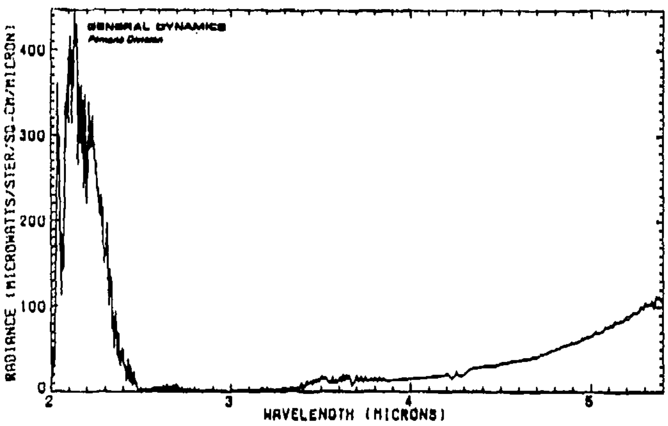
PLOT NO. 1 – BLUE SKY



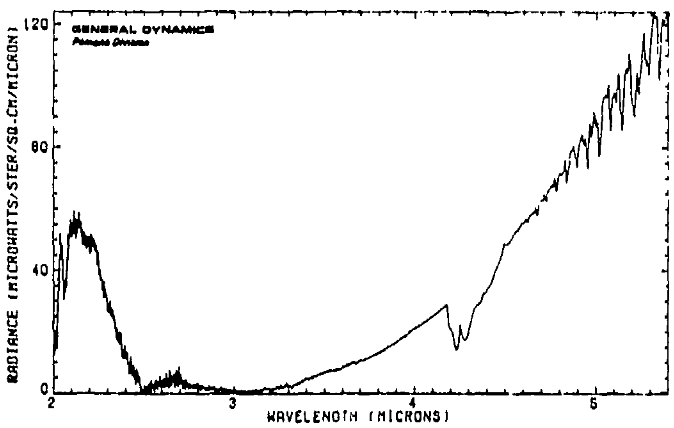
PLOT NO. 3 – SUNLIT ROCK



PLOT NO. 2 – FOG BANK



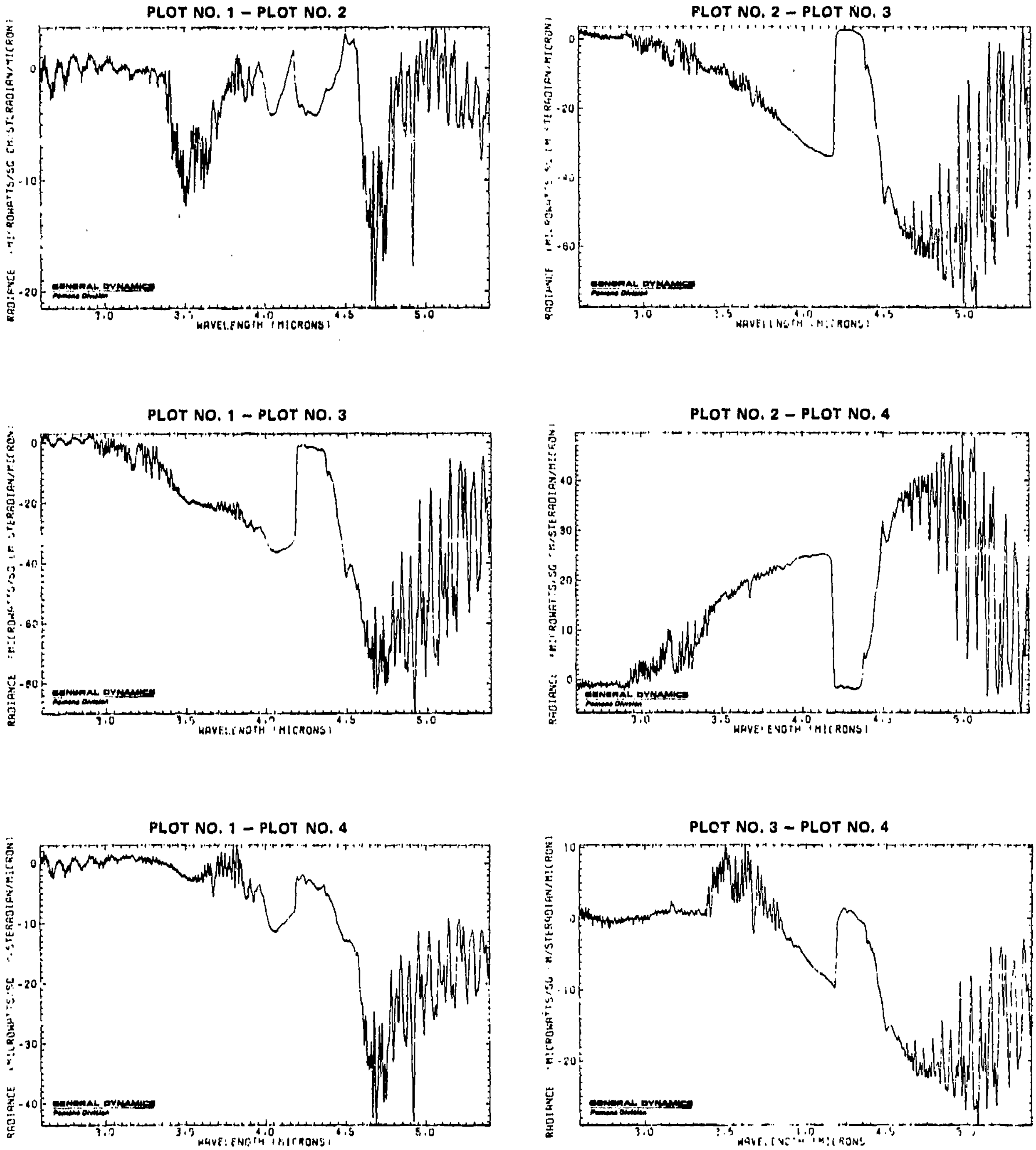
PLOT NO. 4 – GREEN FOLIAGE



A63939-1

Figure 4-12.

INFRARED BACKGROUND SITE NO. 12
DIFFERENCE PLOTS



A63940

Figure 4-12 (Continued).

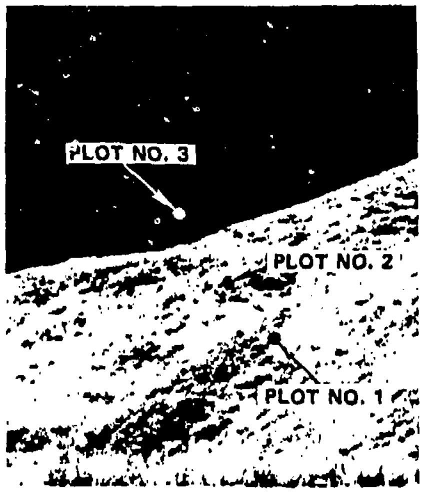
INFRARED BACKGROUND SITE NO. 13

LOCATION: SAN ONOFRE
DATE: MAY 14, 1970
TIME: 15:59 PST
ELEVATION: 110 FEET
TEMPERATURE: 72°F
RELATIVE HUMIDITY: 60%
SUN ANGLE: 25° EL 240° AZ MAG

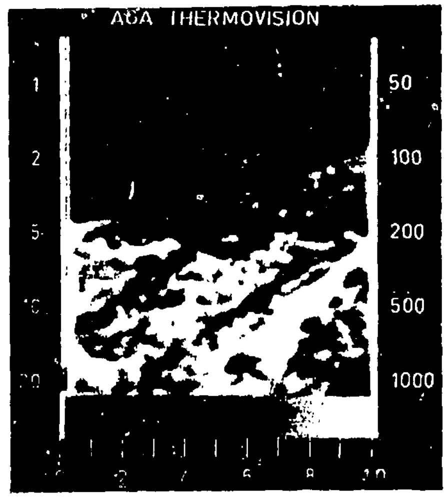
PLOT NO. 1: BROWN DIRT
EL ANGLE: +8° AZ ANGLE: 25.5° MAG

PLOT NO. 2: GREEN BUSH
EL ANGLE: +9° AZ ANGLE: 25° MAG

PLOT NO. 3: BLUE SKY
EL ANGLE: +9.4° AZ ANGLE: 24.5° MAG

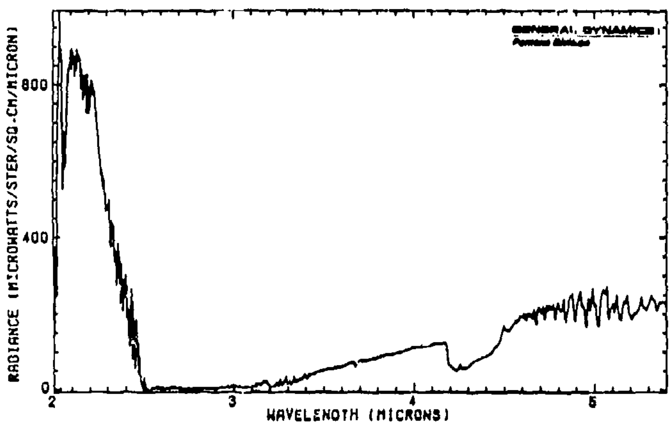


PHOTOGRAPH 0.7 – 0.9 MICRONS

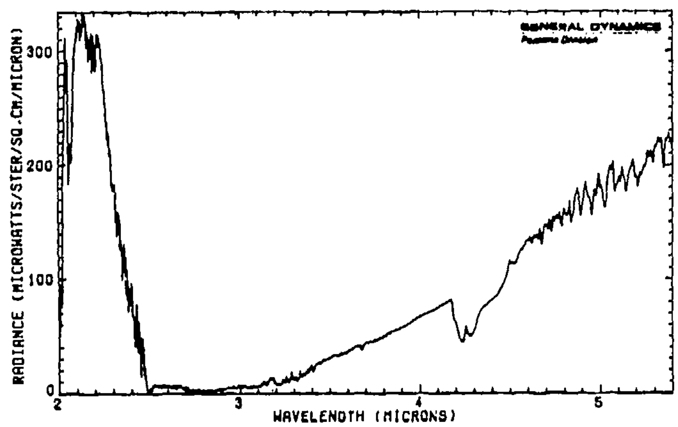


THERMAL IMAGE 2–5 MICRONS

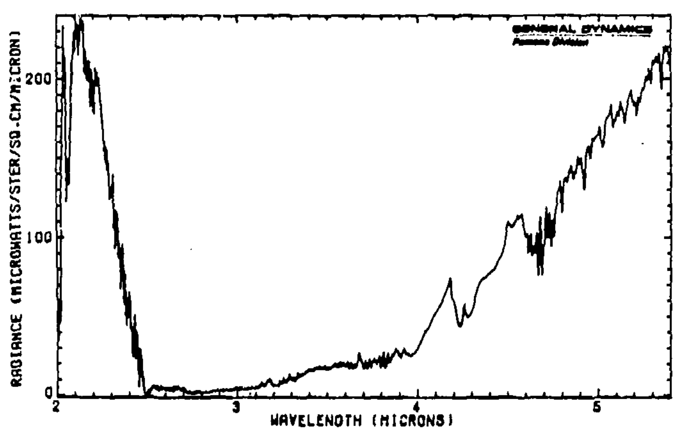
PLOT NO. 1 – BROWN DIRT



PLOT NO. 2 – GREEN BUSH



PLOT NO. 3 – BLUE SKY

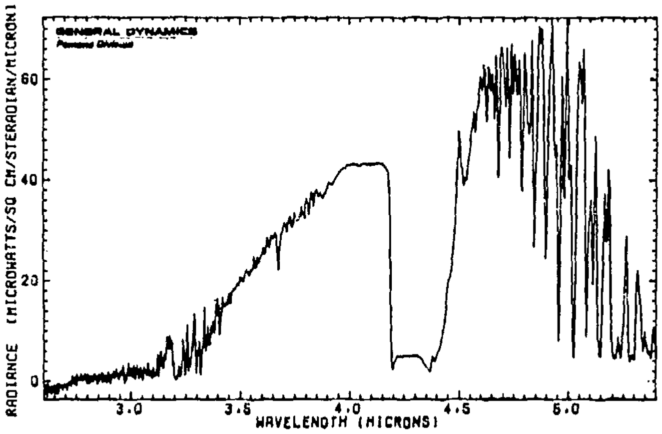


A63972-1

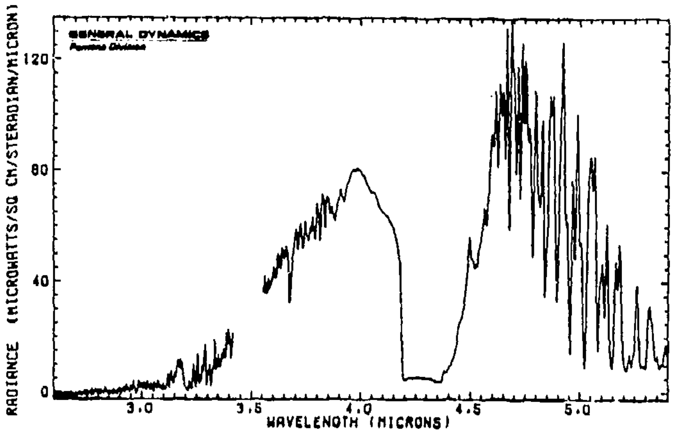
Figure 4-13.

INFRARED BACKGROUND SITE NO. 13
DIFFERENCE PLOTS

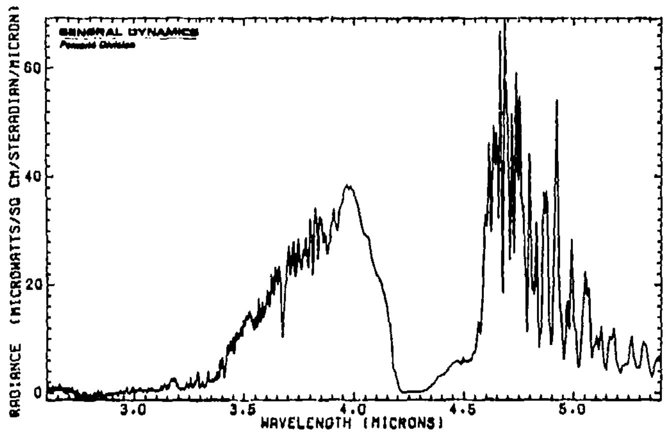
PLOT NO. 1 – PLOT NO. 2



PLOT NO. 1 – PLOT NO. 3



PLOT NO. 2 – PLOT NO. 3



A63973

Figure 4-13 (Continued).

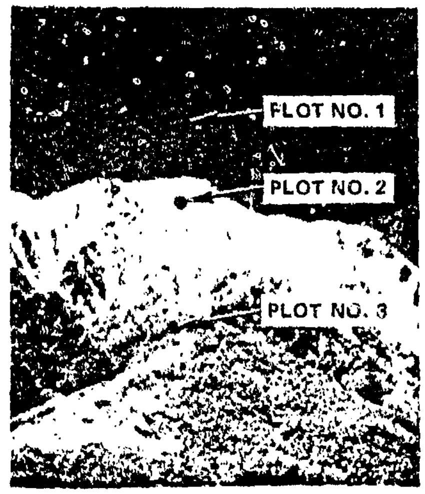
INFRARED BACKGROUND SITE NO. 14

LOCATION: DESERT HOT SPRINGS
DATE: APRIL 23, 1970
ELEVATION: 1087 FEET
TEMPERATURE: 76°F
RELATIVE HUMIDITY: 9%
SUN ANGLE: 67.5° EL 176° AZ MAG

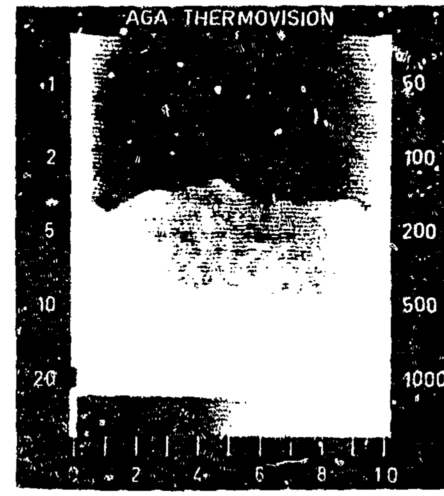
PLOT NO. 1: BLUE SKY
EL ANGLE: 8.5° AZ ANGLE: 210° MAG

PLOT NO. 2: SNOW AND ROCKS
EL ANGLE: 8.2° AZ ANGLE: 210° MAG

PLOT NO. 3: HOT SPOT BELOW PEAK
EL ANGLE: 7.0° AZ ANGLE: 210° MAG

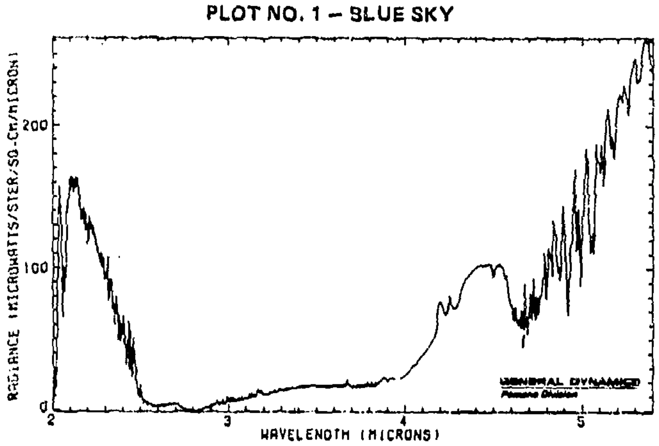


PHOTOGRAPH 0.7 – 0.9 MICRONS

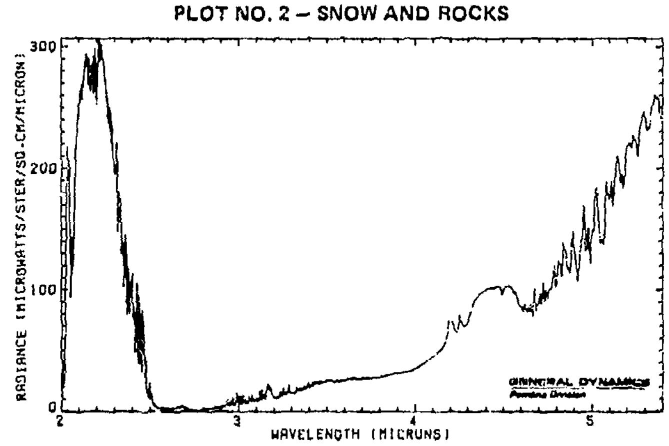


THERMAL IMAGE 2–5 MICRONS

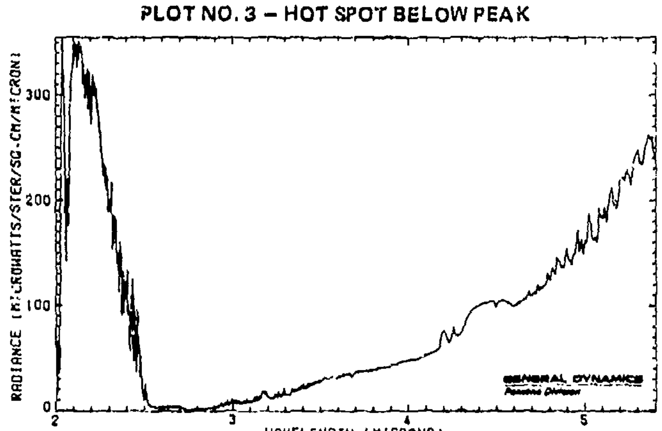
PLOT NO. 1 – BLUE SKY



PLOT NO. 2 – SNOW AND ROCKS



PLOT NO. 3 – HOT SPOT BELOW PEAK



A63890-1

Figure 4-14.

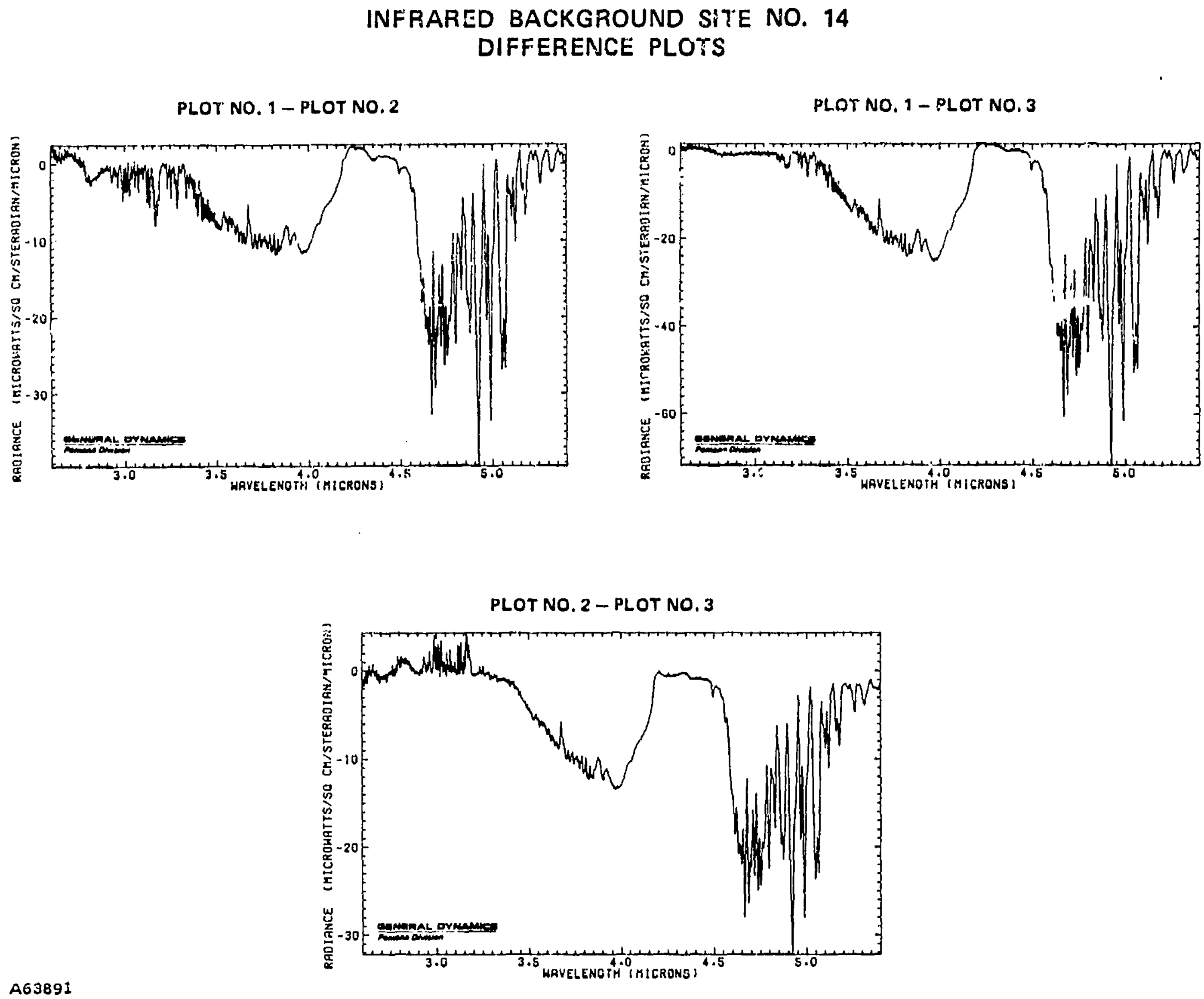


Figure 4-14 (Continued).

INFRARED BACKGROUND SITE NO. 15

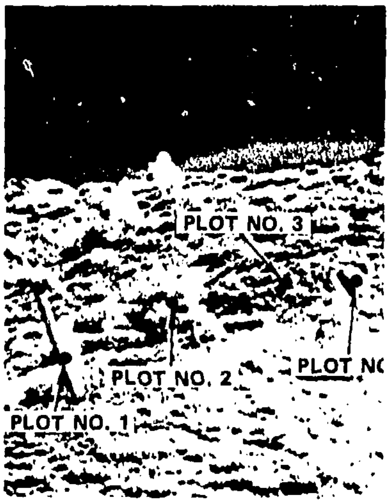
LOCATION: BLUE RIDGE, CALIF.
DATE: JAN 29, 1970
TIME: 12:37 PST
ELEVATION: 7386 FEET
TEMPERATURE: 49°F
RELATIVE HUMIDITY: 13%
SUN ANGLE: 37.5° EL, 174° AZ MAG

PLOT NO. 1: TREE TRUNK
EL ANGLE: 6° AZ ANGLE: 60° MAG

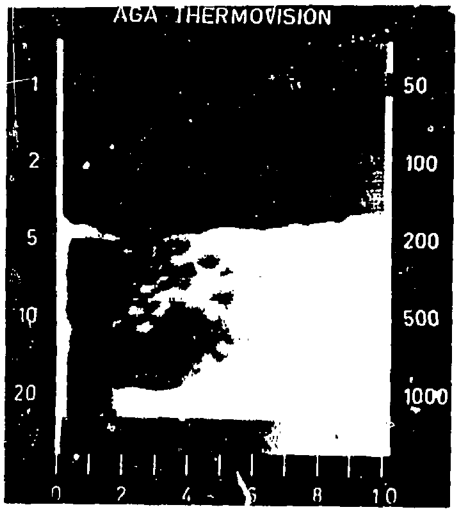
PLOT NO. 2: PINE TREE
EL ANGLE: 6° AZ ANGLE: 61° MAG

PLOT NO. 3: BRUSH
EL ANGLE: 6° AZ ANGLE: 62° MAG

PLOT NO. 4: ROCK
EL ANGLE: 6° AZ ANGLE: 63° MAG

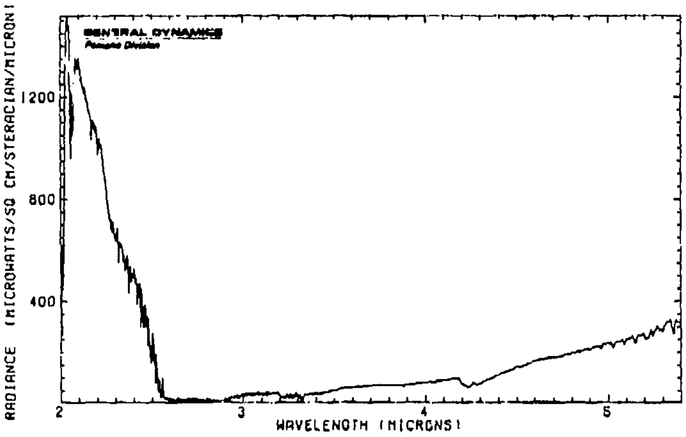


PHOTOGRAPH 0.7 – 0.9 MICRONS

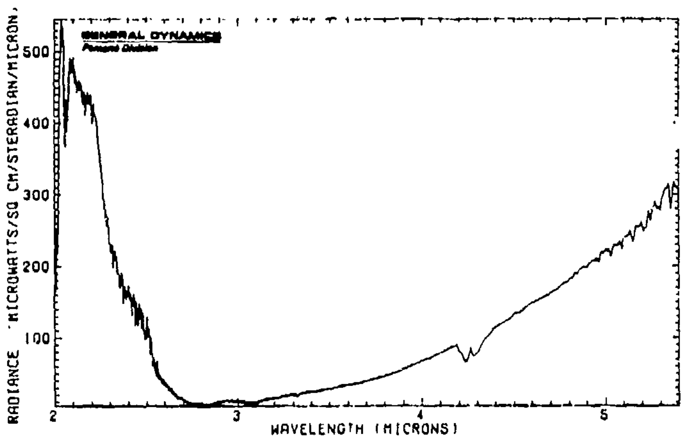


THERMAL IMAGE 2 – 5 MICRONS

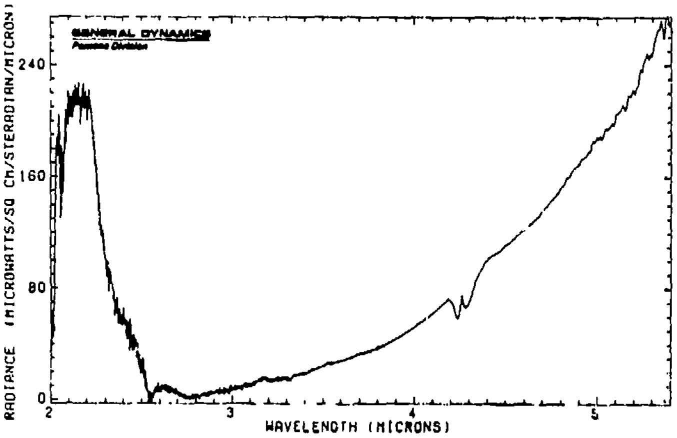
PLOT NO. 1 – TREE TRUNK



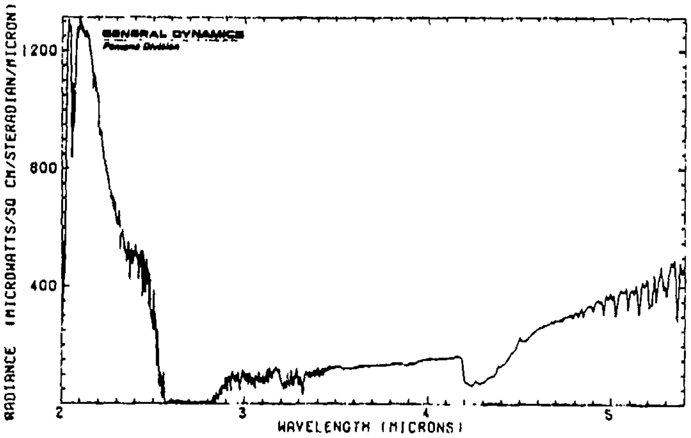
PLOT NO. 3 – BRUSH



PLOT NO. 2 – PINE TREE



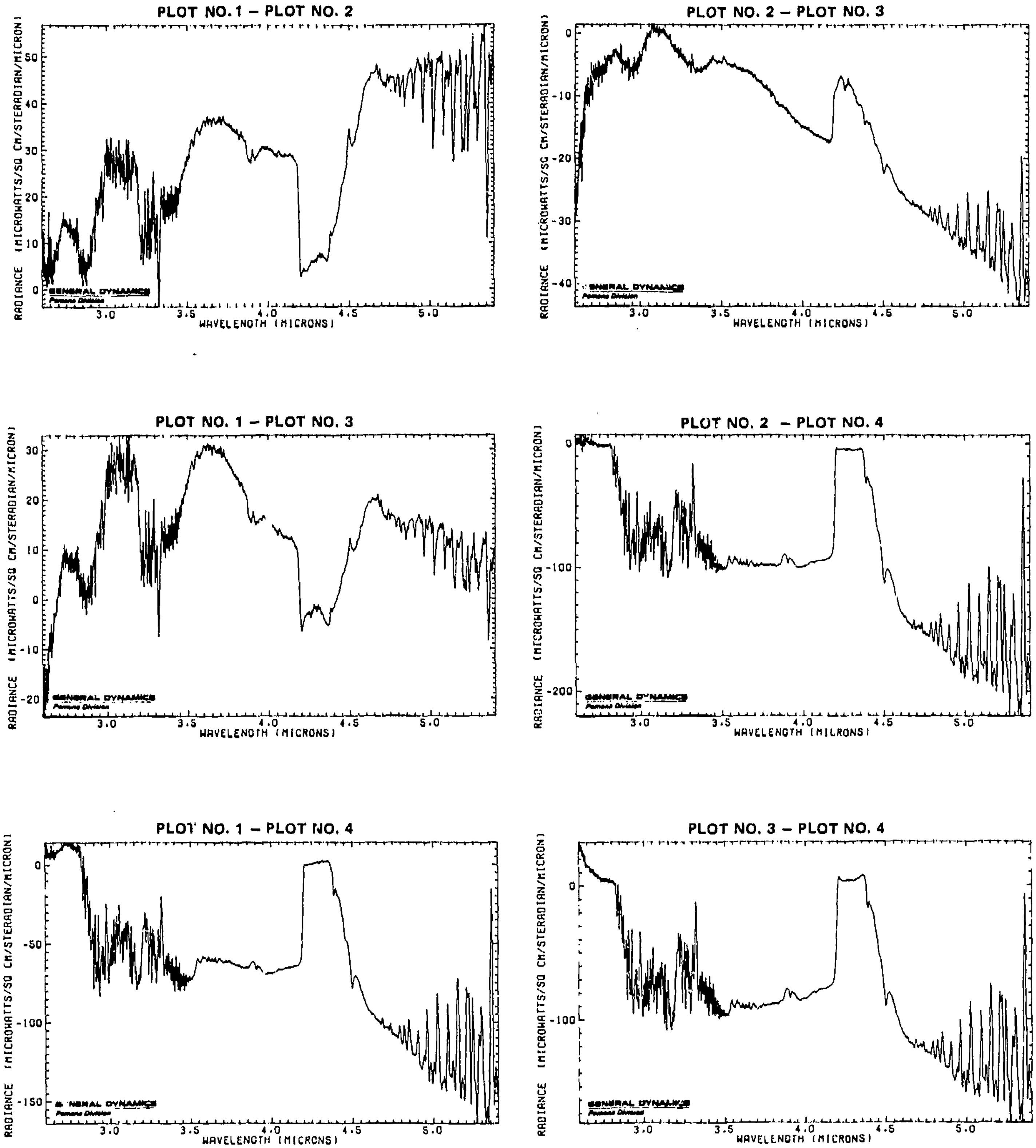
PLOT NO. 4 – ROCK



A63057-1

Figure 4-15.

INFRARED BACKGROUND SITE NO. 15
DIFFERENCE PLOTS



A63052

Figure 4-15 (Continued).

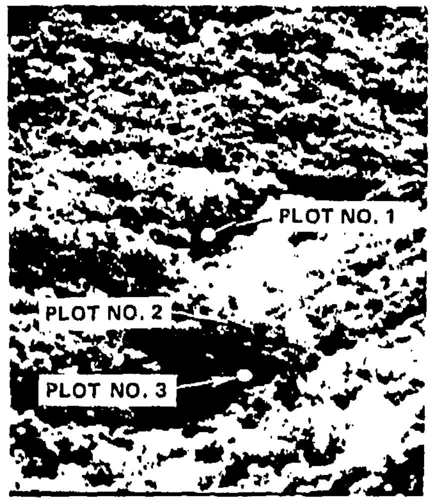
INFRARED BACKGROUND SITE NO. 16

LOCATION: SAN MARCOS PASS
DATE: MAY 18, 1970
TIME: 16:03 PST
ELEVATION: 1850 FEET
TEMPERATURE: 73° F
RELATIVE HUMIDITY: 46%
SUN ANGLE: 24° EL 240° AZ MAG

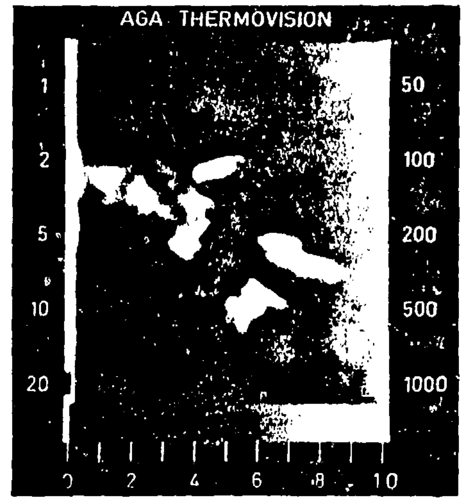
PLOT NO. 1: BROWN SPOT
EL ANGLE: -12° AZ ANGLE: 160° MAG

PLOT NO. 2: SUNLIT ROCK
EL ANGLE: -13° AZ ANGLE: 161° MAG

PLOT NO. 3: SHADOW OF ROCK
EL ANGLE: 13.2° AZ ANGLE: 161° MAG

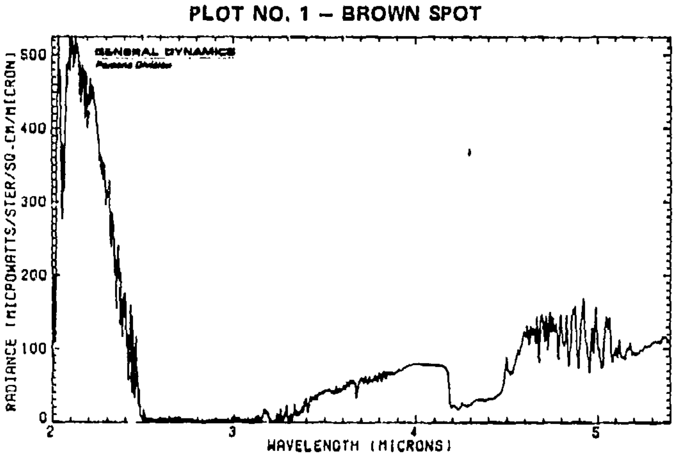


PHOTOGRAPH 0.7 – 0.9 MICRONS

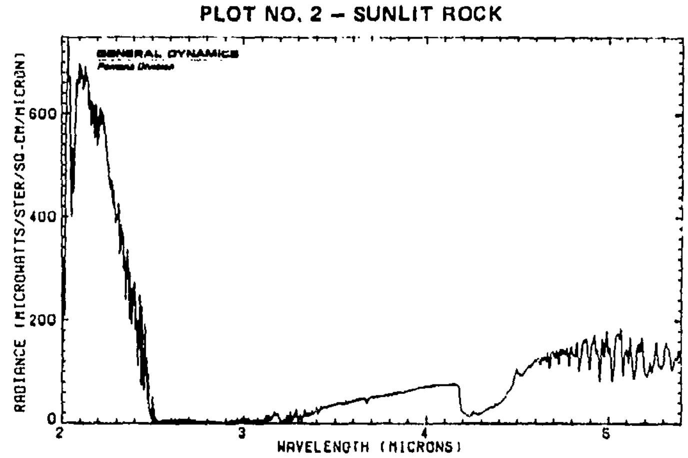


THERMAL IMAGE 2–5 MICRONS

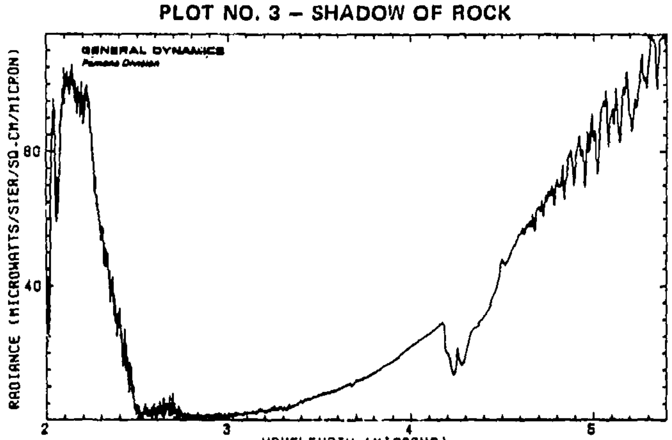
PLOT NO. 1 – BROWN SPOT



PLOT NO. 2 – SUNLIT ROCK

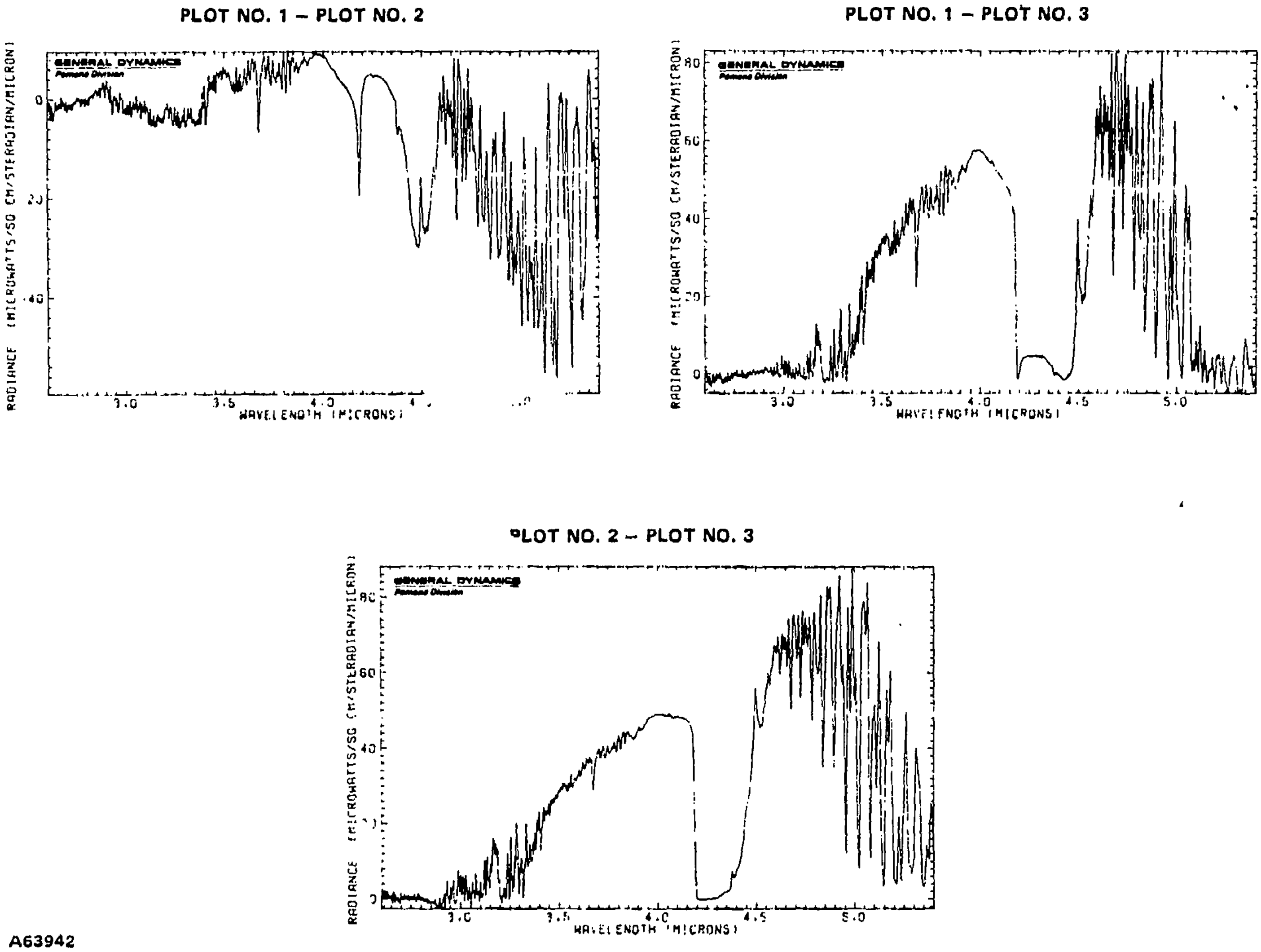


PLOT NO. 3 – SHADOW OF ROCK



A63941-1

INFRARED BACKGROUND SITE NO. 16
DIFFERENCE PLOTS



A63942

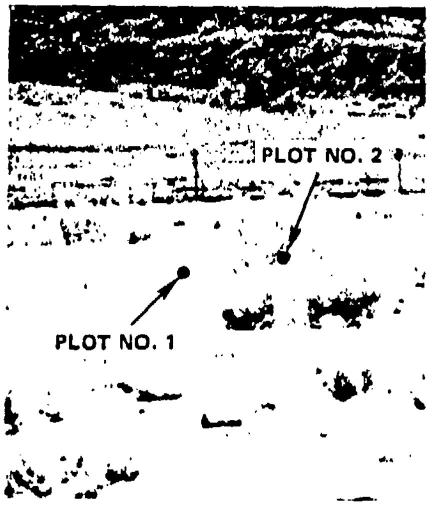
Figure 4-16 (Continued).

INFRARED BACKGROUND SITE NO. 17

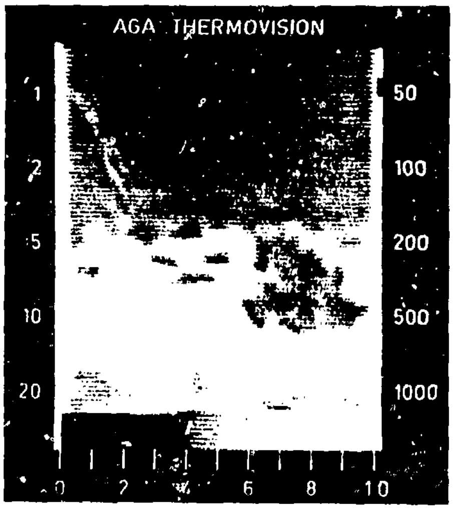
LOCATION: DESERT HOT SPRINGS
DATE: APRIL 23, 1970
TIME: 1222 PST
ELEVATION: 1087 FEET
TEMPERATURE: 76°F
RELATIVE HUMIDITY: 9%
SUN ANGLE: 66.8° EL 184° AZ MAG

PLOT NO. 1: NEAR DESERT SAND
EL ANGLE: –.6° AZ ANGLE: 300° MAG

PLOT NO. 2: NEAR DESERT SAGE BRUSH
EL ANGLE: –.6° AZ ANGLE: 301° MAG

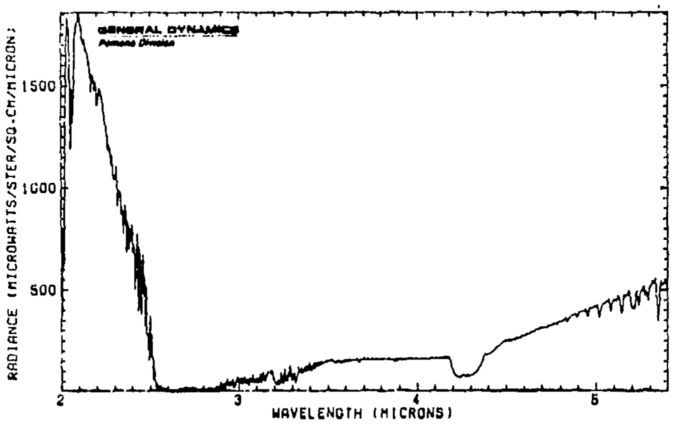


PHOTOGRAPH 0.7 – 0.9 MICRONS

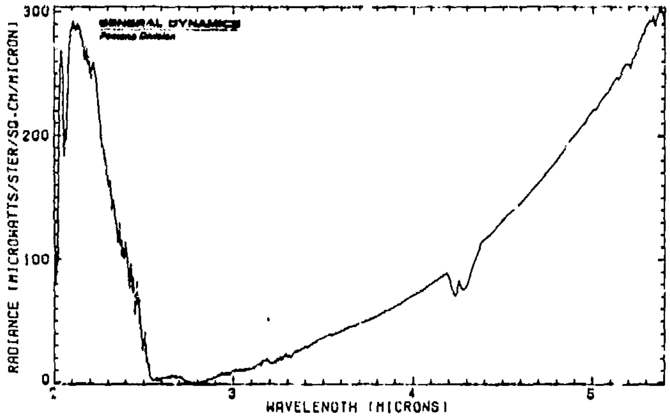


THERMAL IMAGE 2–5 MICRONS

PLOT NO. 1 – NEAR DESERT SAND

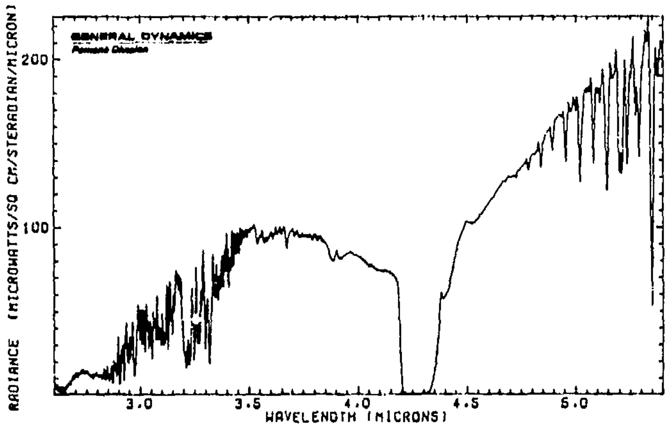


PLOT NO. 2 – NEAR DESERT SAGE BRUSH



INFRARED BACKGROUND SITE NO. 17
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



A63905-1

Figure 4-17.

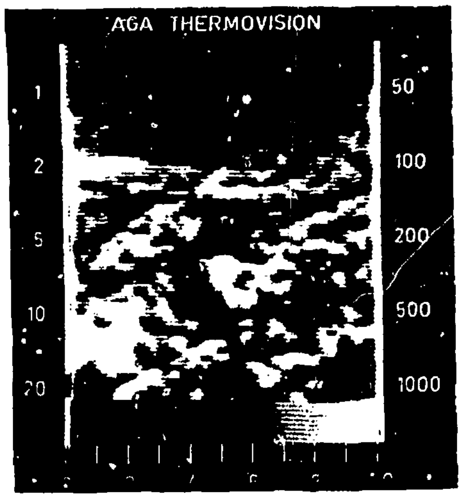
INFRARED BACKGROUND SITE NO. 18

LOCATION: SAN ONOFRE
DATE: MAY 14, 1970
TIME: 15:45 PST
ELEVATION: 110 FEET
TEMPERATURE: 72°F
RELATIVE HUMIDITY: 60%
SUN ANGLE: 27° EL 240° AZ MAG

PLOT NO. 1: BRIGHT DIRT
EL ANGLE: 6° AZ ANGLE: 320° MAG

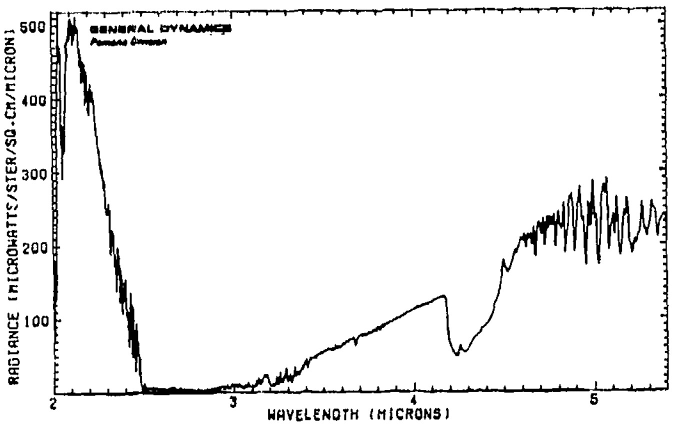
PLOT NO. 2: GREEN BUSH
EL ANGLE: 6.2° AZ ANGLE: 320° MAG

PHOTOGRAPH 0.7 – 0.9 MICRONS

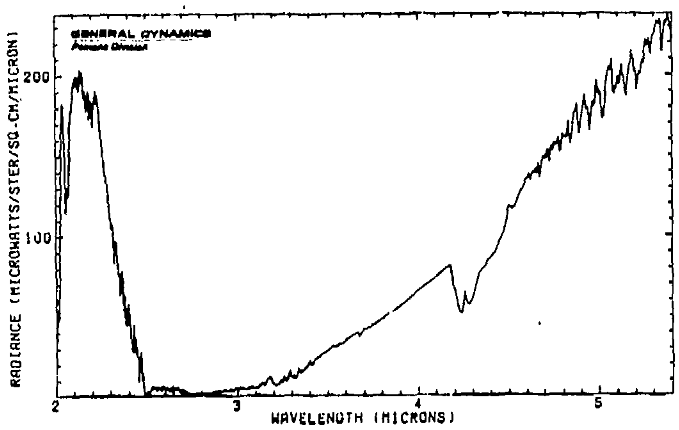


THERMAL IMAGE 2 – 5 MICRONS

PLOT NO. 1 – BRIGHT DIRT

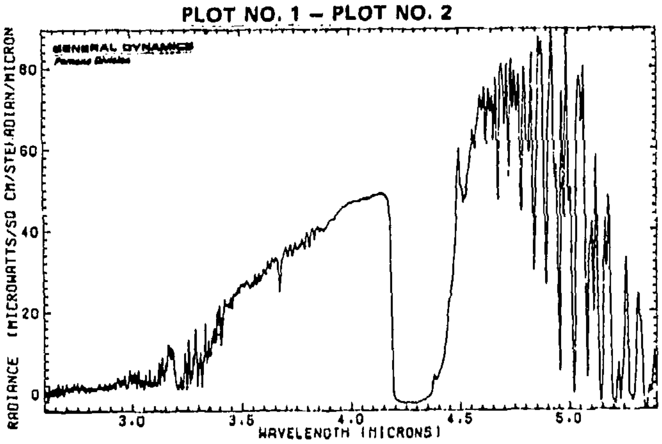


PLOT NO. 2 – GREEN BUSH



INFRARED BACKGROUND SITE NO. 18
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



A63978-1

Figure 4-18.

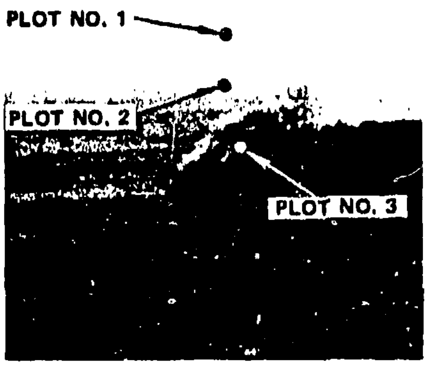
INFRARED BACKGROUND SITE NO. 19

LOCATION: SAN ONOFRE
DATE: MAY 14, 1970
TIME: 14:59 PST
ELEVATION: 110 FEET
TEMPERATURE: 72°F
RELATIVE HUMIDITY: 60%
SUN ANGLE: 39.5° EL 236° AZ MAG

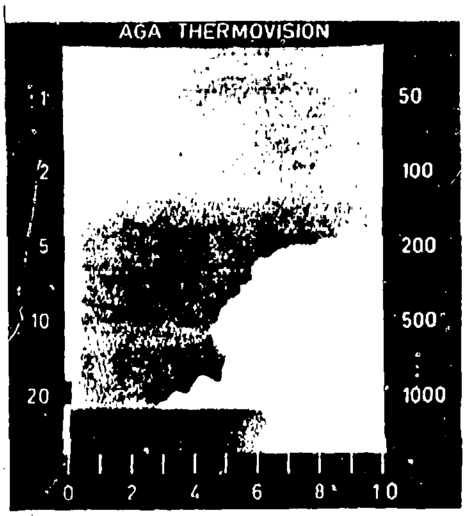
PLOT NO. 1: BLUE SKY
EL ANGLE: +.5° AZ ANGLE: 217° MAG

PLOT NO. 2: WATER
EL ANGLE: -.5° AZ ANGLE: 217° MAG

PLOT NO. 3: BUSH
EL ANGLE: -1° AZ ANGLE: 217° MAG

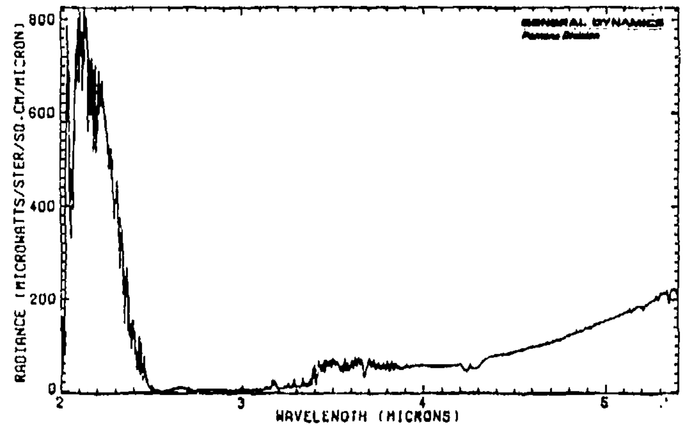


PHOTOGRAPH 0.7 – 0.9 MICRONS

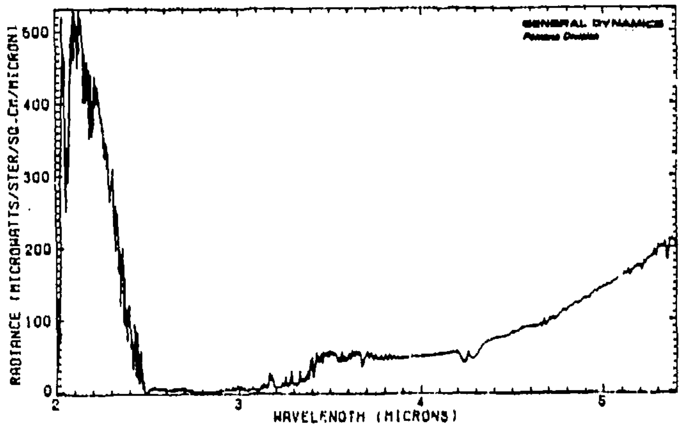


THERMAL IMAGE 2–5 MICRONS

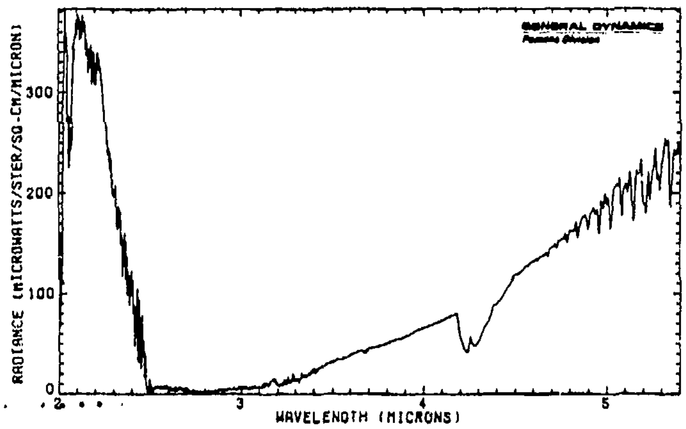
PLOT NO. 1 – BLUE SKY



PLOT NO. 2 – WATER



PLOT NO. 3 – BUSH

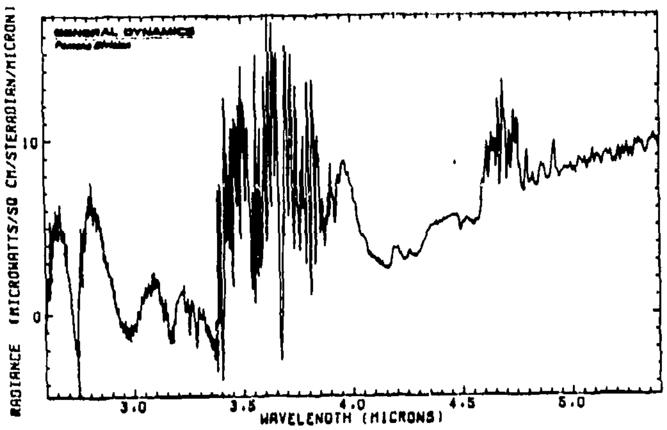


A63976-1

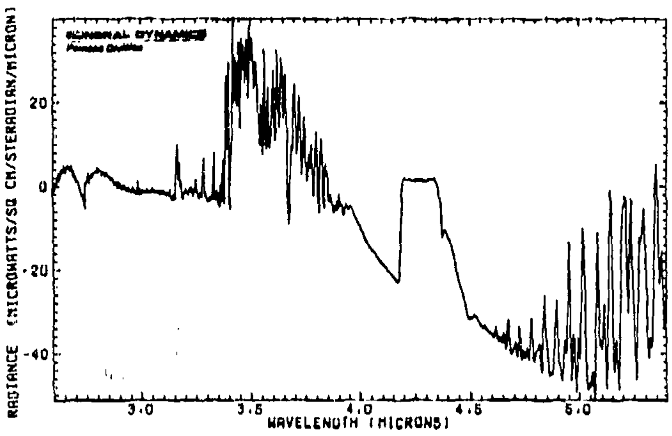
Figure 4-19.

INFRARED BACKGROUND SITE NO. 19
DIFFERENCE PLOTS

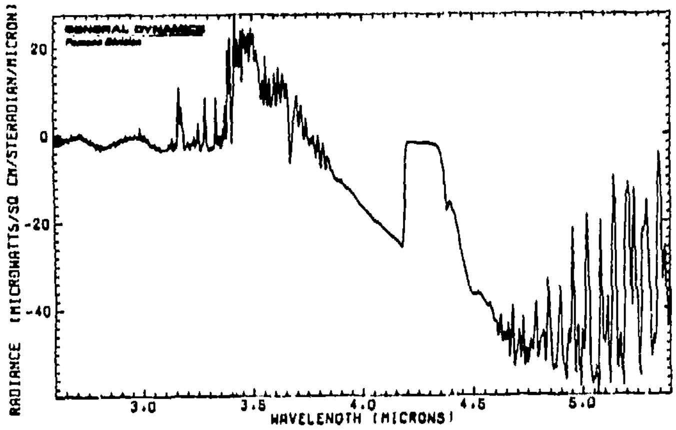
PLOT NO. 1 – PLOT NO. 2



PLOT NO. 1 – PLOT NO. 3



PLOT NO. 2 – PLOT NO. 3



A63977

Figure 4-19 (Continued).

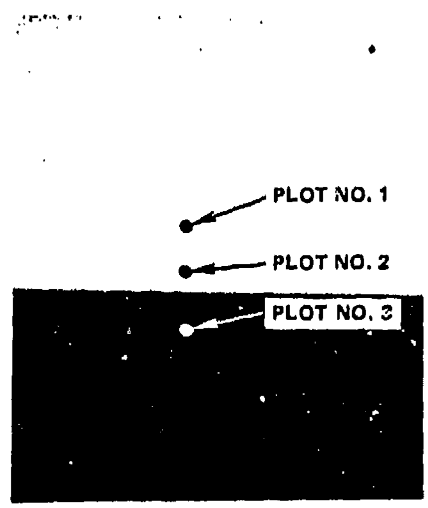
INFRARED BACKGROUND SITE NO. 20

LOCATION: SAN ONOFRE
DATE: APRIL 28, 1970
TIME: 1515 PST
ELEVATION: 110 FEET
TEMPERATURE: 62°F
RELATIVE HUMIDITY: 36%
SUN ANGLE: 34° EL 232° AZ MAG

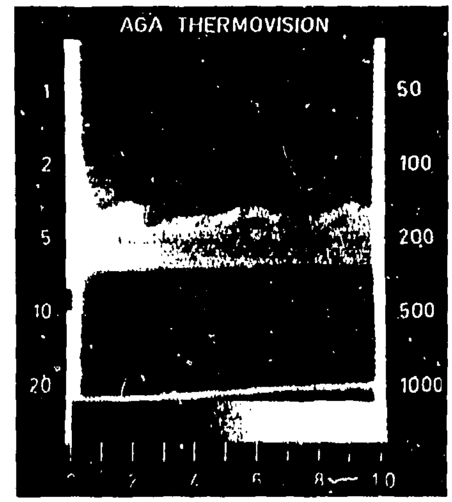
PLOT NO. 1: CLOUD OVER OCEAN
EL ANGLE: +.6° AZ ANGLE: 195° MAG

PLOT NO. 2: ABOVE OCEAN HORIZON
EL ANGLE: +.3° AZ ANGLE: 195° MAG

PLOT NO. 3: BELOW OCEAN HORIZON
EL ANGLE: −.3° AZ ANGLE: 195° MAG

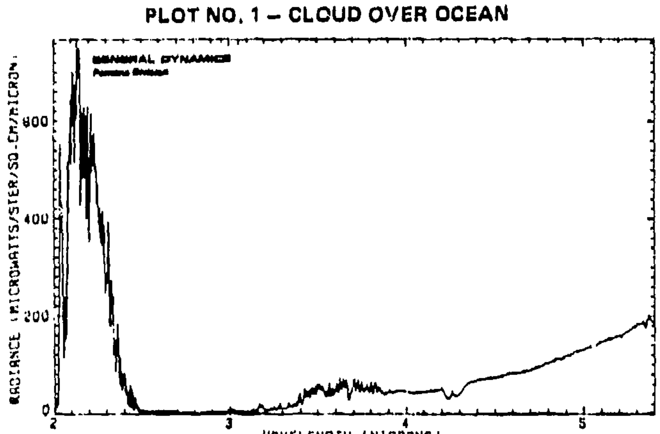


PHOTOGRAPH 0.7 – 0.9 MICRONS

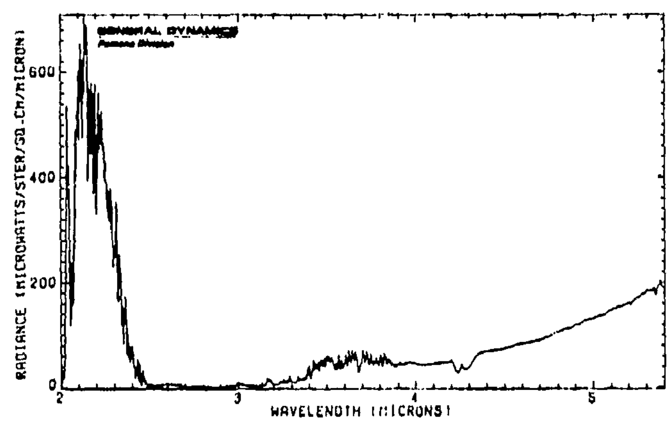


THERMAL IMAGE 2–5 MICRONS

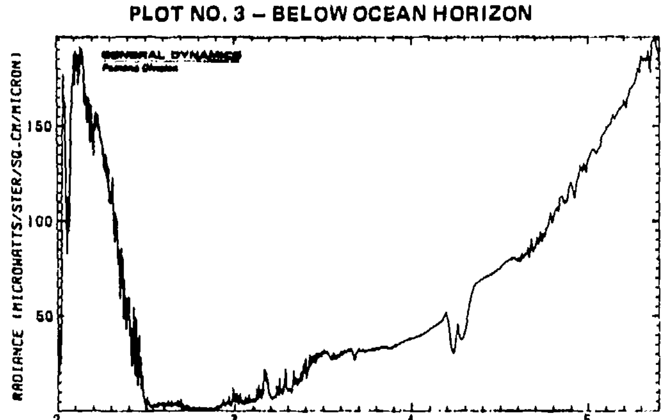
PLOT NO. 1 – CLOUD OVER OCEAN



PLOT NO. 2 – ABOVE OCEAN HORIZON



PLOT NO. 3 – BELOW OCEAN HORIZON

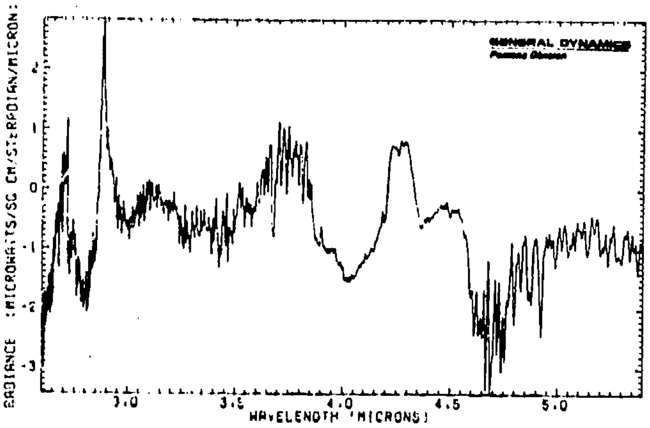


A63884-1

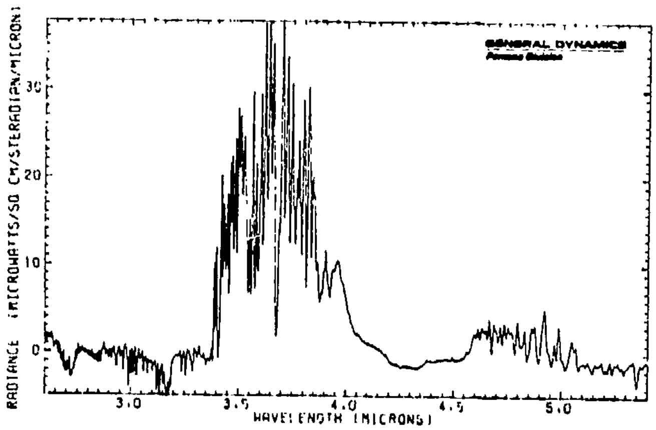
Figure 4-20.

INFRARED BACKGROUND SITE NO. 20
DIFFERENCE PLOTS

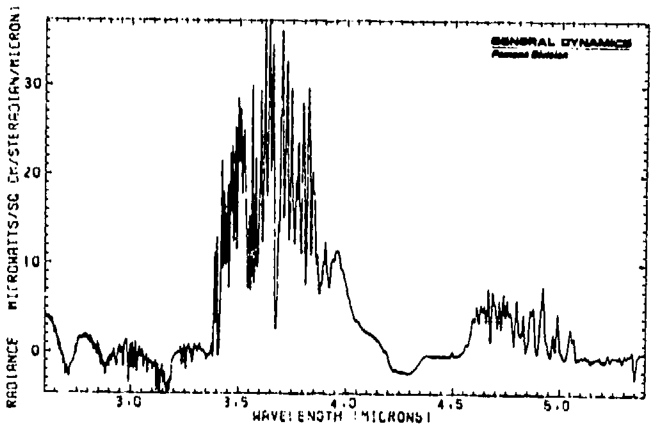
PLOT NO. 1 – PLOT NO. 2



PLOT NO. 1 – PLOT NO. 3



PLOT NO. 2 – PLOT NO. 3



A63885

Figure 4-20 (Continued).

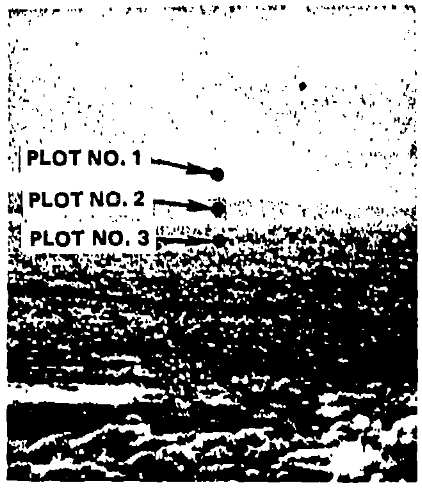
INFRARED BACKGROUND SITE NO. 21

LOCATION: SAN ONOFRE
DATE: APRIL 28, 1970
TIME: 1528 PST
ELEVATION: 110 FEET
TEMPERATURE: 60°F
RELATIVE HUMIDITY: 41%
SUN ANGLE: 31° EL 230° AZ MAG

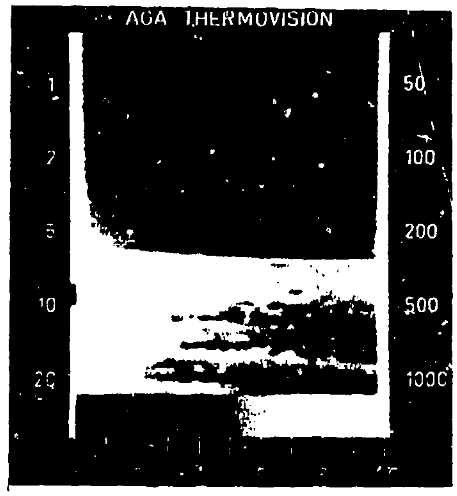
PLOT NO. 1: CLOUD OVER CATALINA
EL ANGLE: + .5° AZ ANGLE: 230° MAG

PLOT NO. 2: CATALINA ISLAND
EL ANGLE: +.2° AZ ANGLE: 230° MAG

PLOT NO. 3: OCEAN BELOW CATALINA
EL ANGLE: −.3° AZ ANGLE: 230° MAG

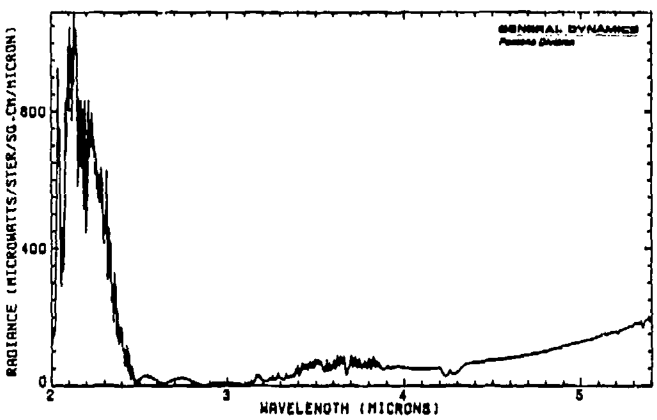


PHOTOGRAPH 0.7 – 0.9 MICRONS

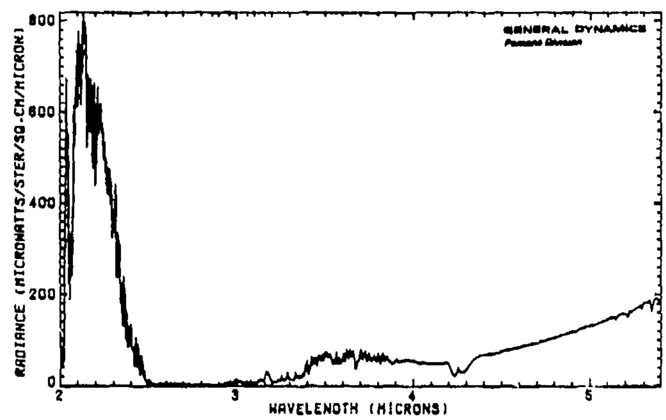


THERMAL IMAGE 2–5 MICRONS

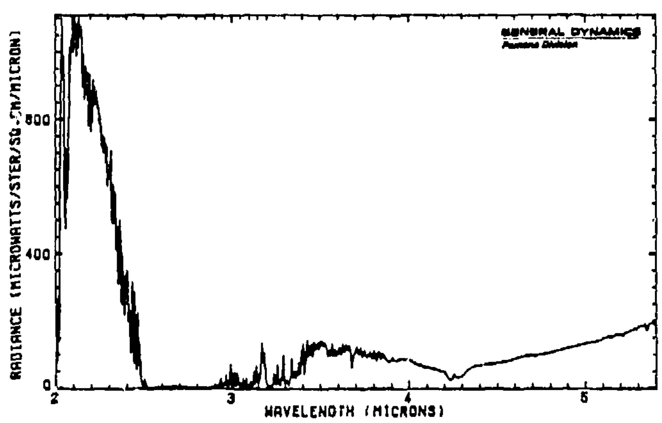
PLOT NO. 1 – CLOUD OVER CATALINA



PLOT NO. 2 – CATALINA ISLAND



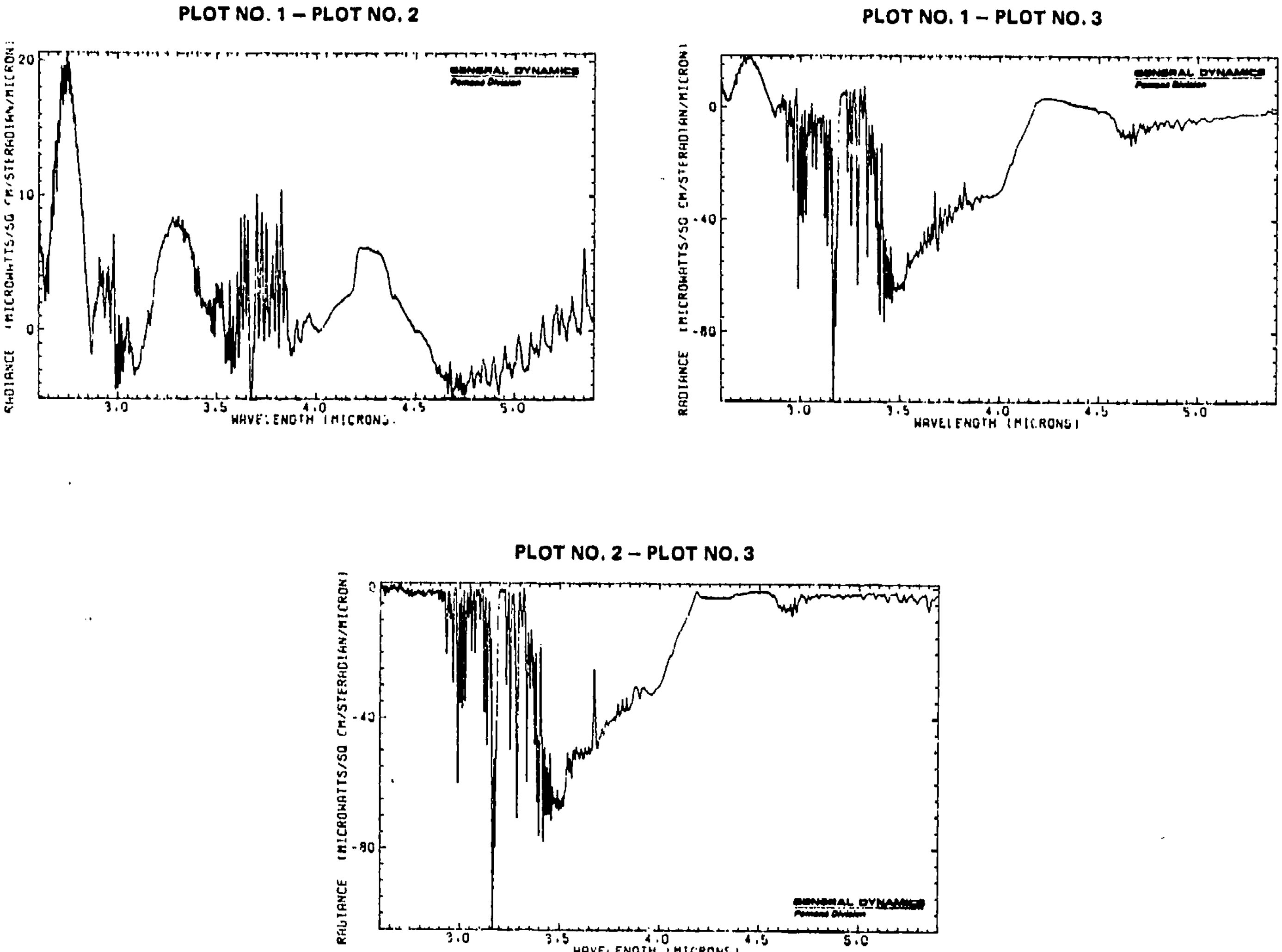
PLOT NO. 3 – OCEAN BELOW CATALINA



A63886-1

Figure 4-21.

INFRARED BACKGROUND SITE NO. 21
DIFERENCE PLOTS



A63887

Figure 4-21 (Continued).

INFRARED BACKGROUND SITE NO. 22

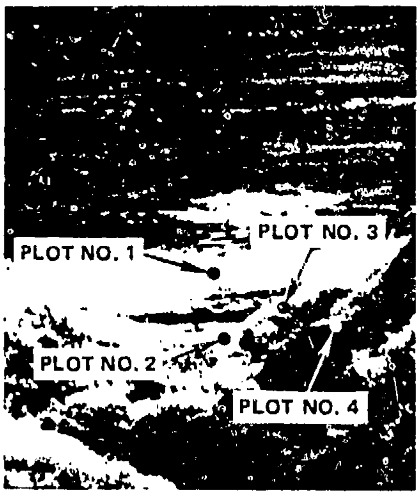
LOCATION: SAN ONOFRE
DATE: MAY 14, 1970
TIME: 15:11 PST
ELEVATION: 110 FEET
TEMPERATURE: 72°F
RELATIVE HUMIDITY: 60%
SUN ANGLE: 35.5° EL 239° AZ MAG

PLOT NO. 1: SURF
EL ANGLE: -9° AZ ANGLE: 210° MAG

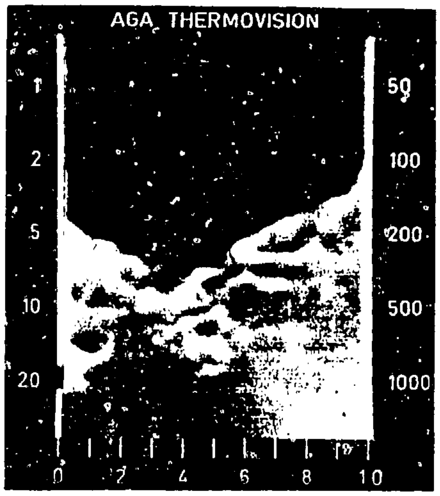
PLOT NO. 2: SAND BEACH
EL ANGLE: -10° AZ ANGLE: 210° MAG

PLOT NO. 3: GREEN BRUSH
EL ANGLE: -9.5° AZ ANGLE: 211° MAG

PLOT NO. 4: SUNLIT EDGE OF HILL
EL ANGLE: -10° AZ ANGLE: 212° MAG

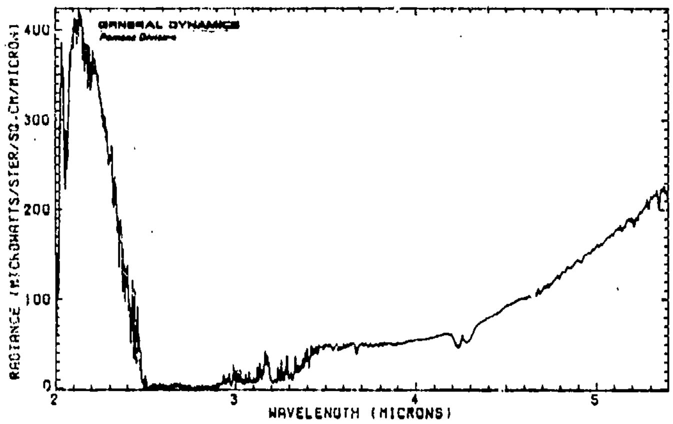


PHOTOGRAPH 0.7 – 0.9 MICRONS

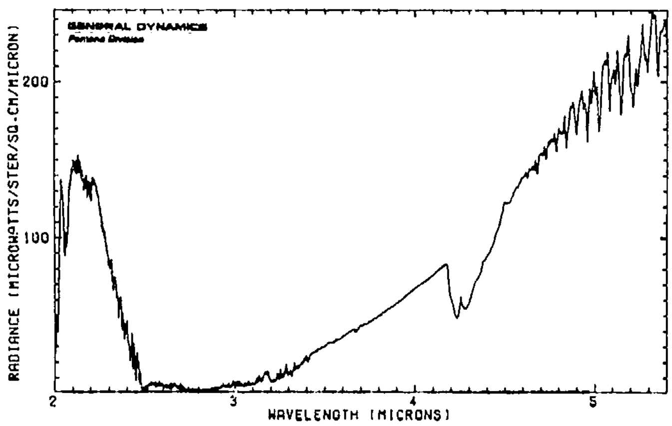


THERMAL IMAGE 2–5 MICRONS

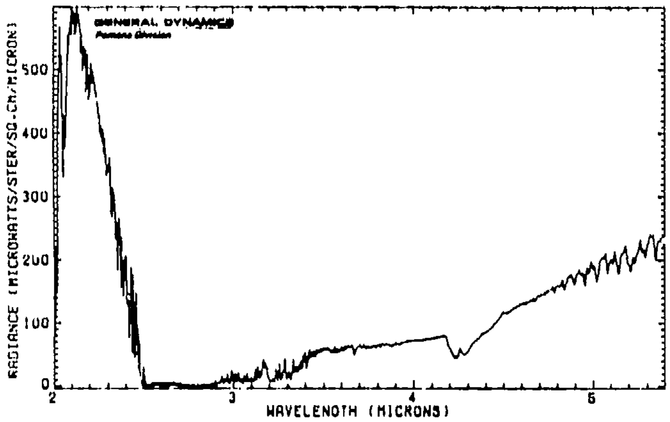
PLOT NO. 1 – SURF



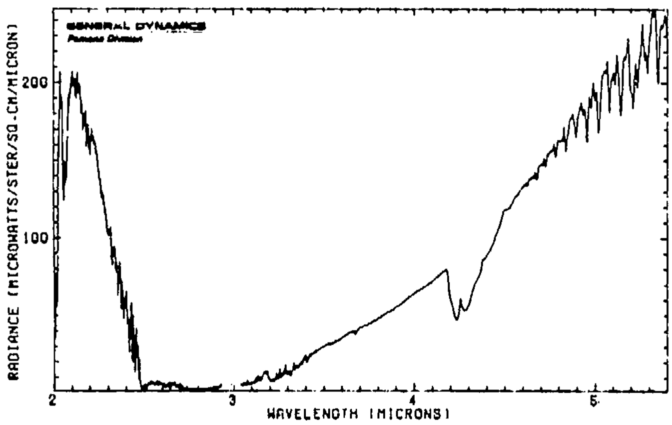
PLOT NO. 3 – GREEN BUSH



PLOT NO. 2 – SAND BEACH



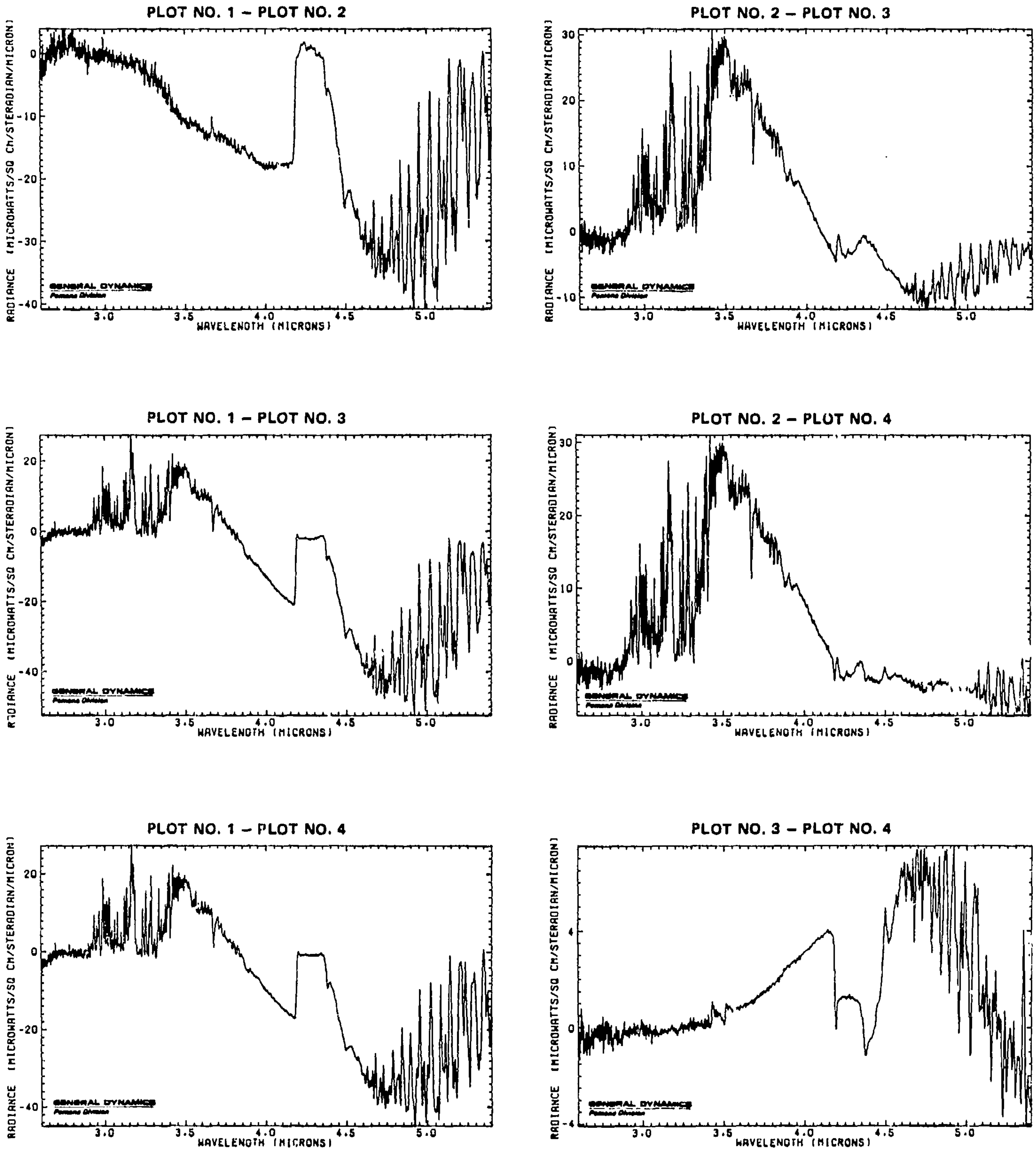
PLOT NO. 4 – SUNLIT EDGE OF HILL



A63974-1

Figure 4-22.

INFRARED BACKGROUND SITE NO. 22
DIFFERENCE PLOTS



A63975

Figure 4-22 (Continued).

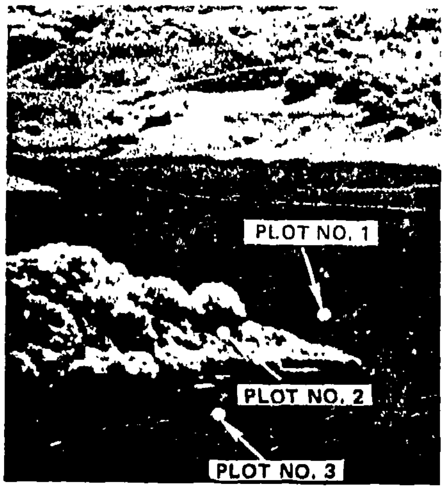
INFRARED BACKGROUND SITE NO. 23

LOCATION: LAKE CASITAS
DATE: MAY 19, 1970
TIME: 9:50 PST
ELEVATION: 700 FEET
TEMPERATURE: 68°F
RELATIVE HUMIDITY: 56%
SUN ANGLE: 58° EL 97° AZ MAG

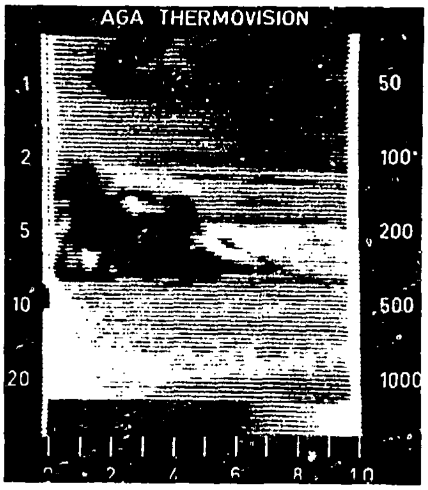
PLOT NO. 1: SUN GLINT OFF WATER
EL ANGLE: -2° AZ ANGLE: 76° MAG

PLOT NO. 2: DARK SIDE OF PENINSULA
EL ANGLE: -2° AZ ANGLE: 75° MAG

PLOT NO. 3: CALM WATER
EL ANGLE: -2.5° AZ ANGLE: 75° MAG

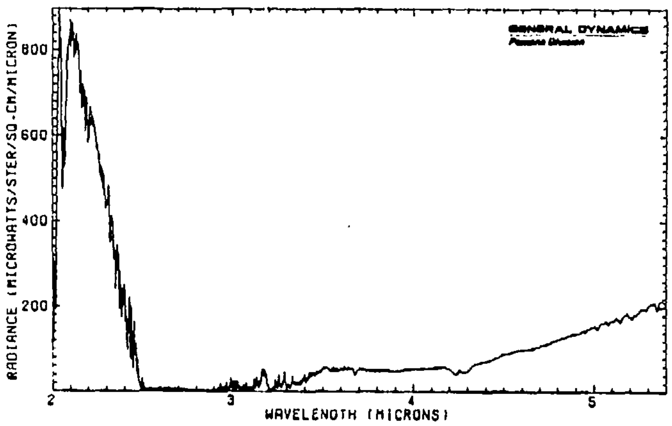


PHOTOGRAPH 0.7 – 0.9 MICRONS

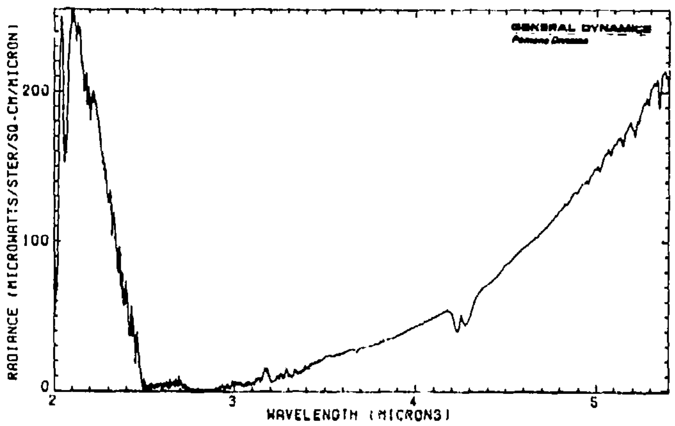


THERMAL IMAGE 2–5 MICRONS

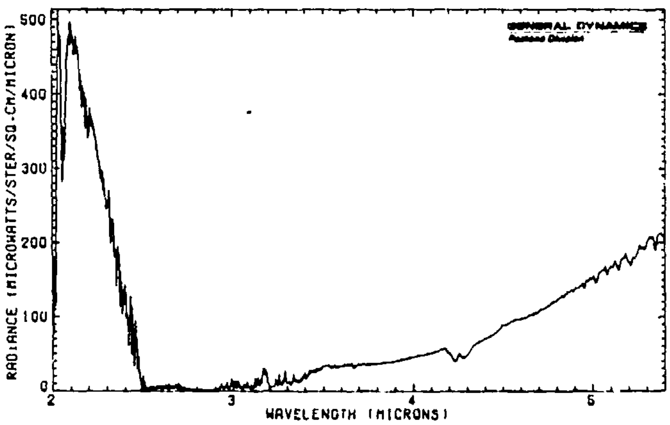
PLOT NO. 1 – SUN GLINT OFF WATER



PLOT NO. 2 – DARK SIDE OF PENINSULA



PLOT NO. 3 – CALM WATER

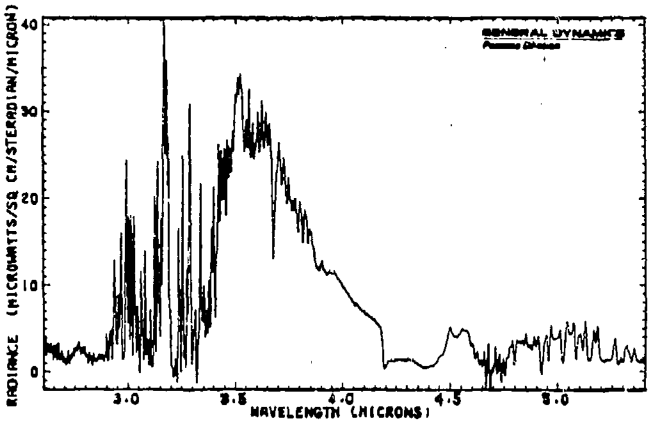


A63944-1

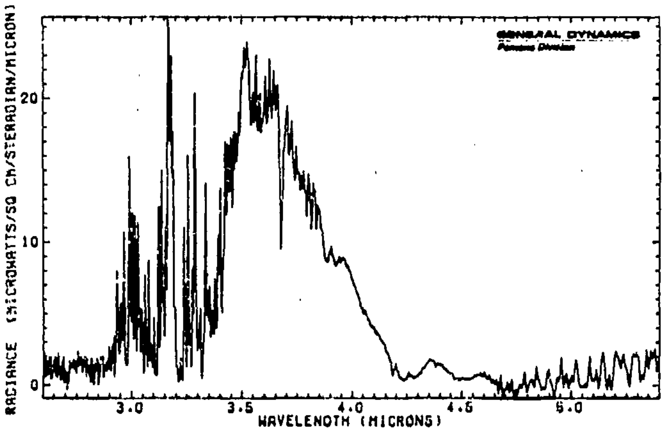
Figure 4-23.

INFRARED BACKGROUND SITE NO. 23
DIFFERENCE PLOTS

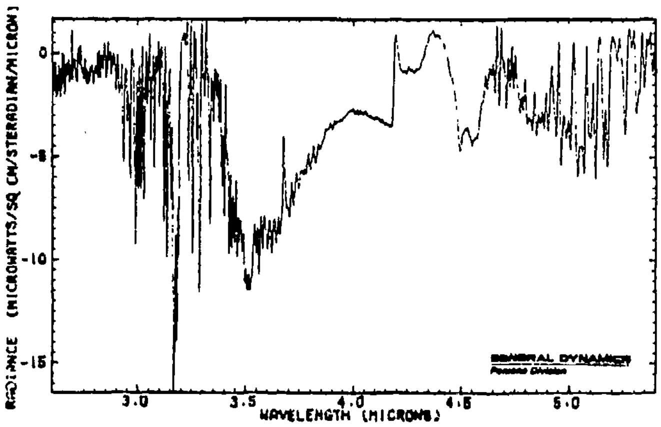
PLOT NO. 1 – PLOT NO. 3



PLOT NO. 1 – PLOT NO. 2



PLOT NO. 2 – PLOT NO. 3



A63945

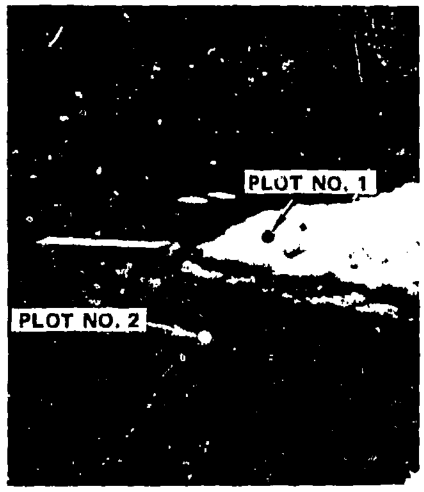
Figure 4-23 (Continued).

INFRARED BACKGROUND SITE NO. 24

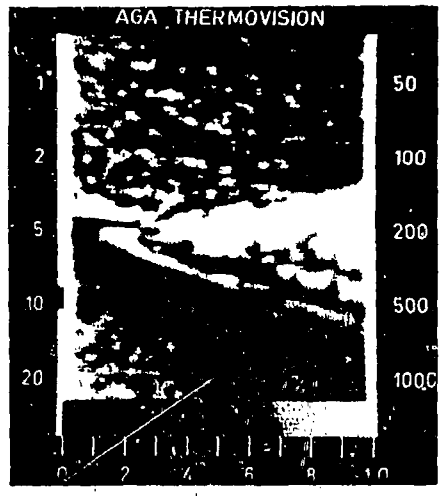
LOCATION: LAKE CASITAS
DATE: MAY 19, 1970
TIME: 10:15 PST
ELEVATION: 700 FEET
TEMPERATURE: 67°F
RELATIVE HUMIDITY: 58%
SUN ANGLE: 63° EL 105° AZ MAG

PLOT NO. 1: DRY GRASS ON PENINSULA
EL ANGLE: -9° AZ ANGLE: 83° MAG

PLOT NO. 2: CALM WATER
EL ANGLE: -10° AZ ANGLE: 82° MAG

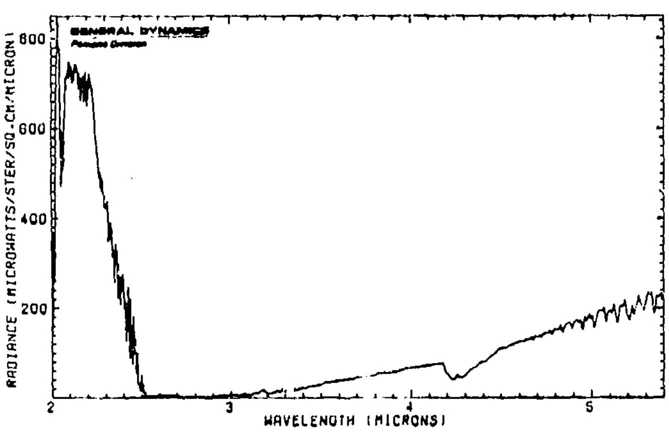


PHOTOGRAPH 0.7 – 0.9 MICRONS

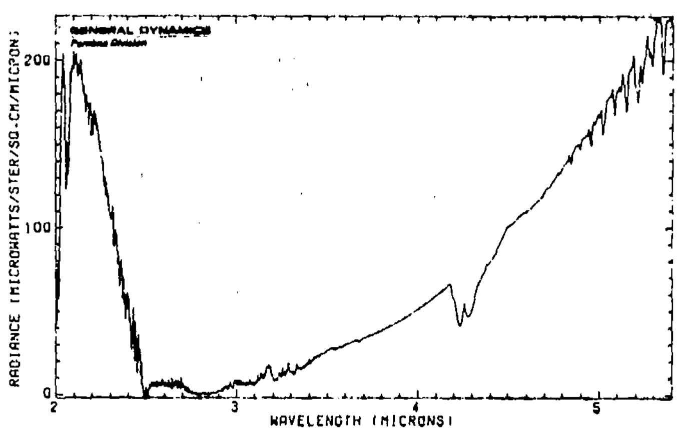


THERMAL IMAGE 2 – 5 MICRONS

PLOT NO. 1 – DRY GRASS ON PENINSULA

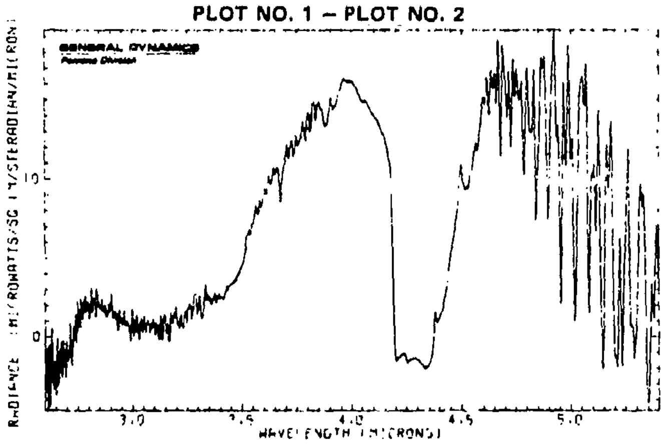


PLOT NO. 2 – CALM WATER



INFRARED BACKGROUND SITE NO. 24
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



A63943-1

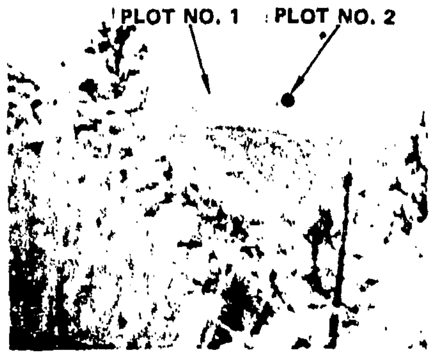
Figure 4-24.

INFRARED BACKGROUND SITE NO. 25

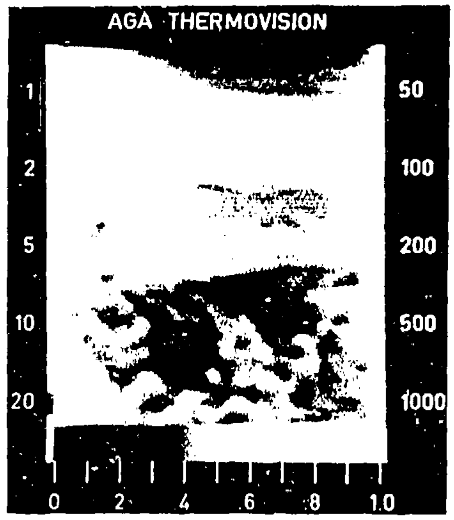
LOCATION: BLUE RIDGE, CALIF.
DATE: JAN 29, 1970
TIME: 13:09 PST
ELEVATION: 7386 FEET
TEMPERATURE: 50°F
RELATIVE HUMIDITY: 13.5%
SUN ANGLE: 35° EL, 180° AZ MAG

PLOT NO. 1: SUN LIT LAKE
EL ANGLE: -2° AZ ANGLE: 175° MAG

PLOT NO. 2: RIGHT OF SUN LIT LAKE
EL ANGLE: -2° AZ ANGLE: 176° MAG

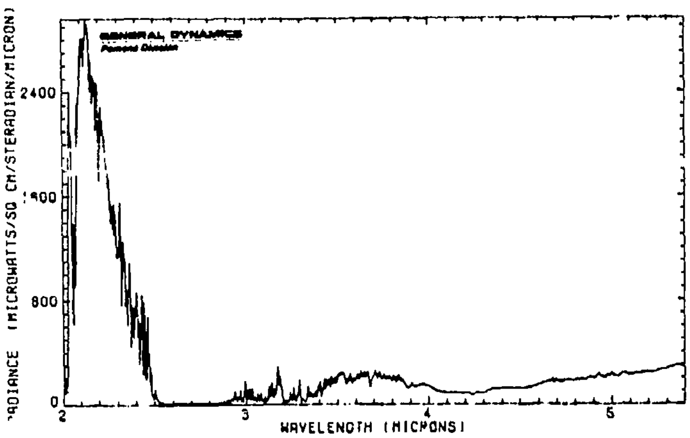


PHOTOGRAPH 0.7 – 0.9 MICRONS

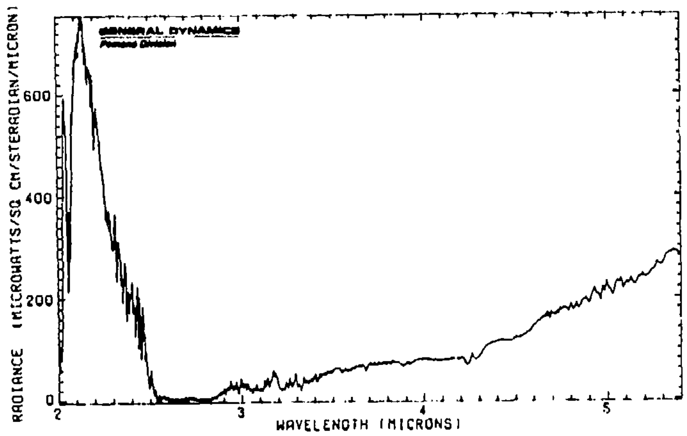


THERMAL IMAGE 2 – 5 MICRONS

PLOT NO. 1 – SUNLIT LAKE

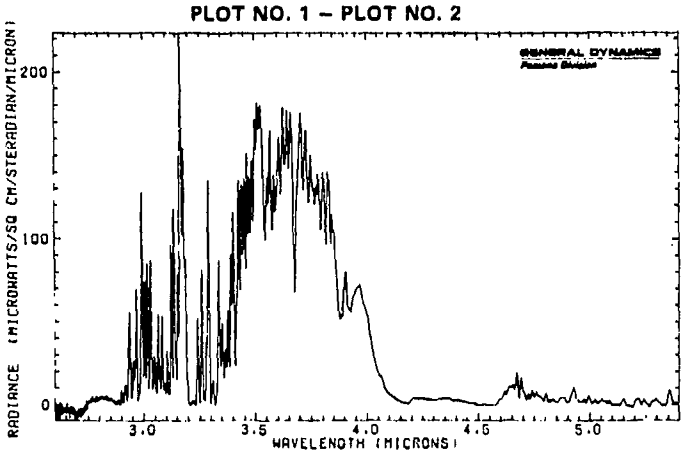


PLOT NO. 2 – RIGHT OF SUNLIT LAKE



INFRARED BACKGROUND SITE NO. 25
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



A63059-1

Figure 4-25.

SECTION 5

PHASE-II UV MEASUREMENT DATA
(0.30–0.44μ)

Section 5
PHASE-II UV MEASUREMENT DATA (0.30 – 0.44 μ)

Figures 5-1 through 5-24 show the ultraviolet spectra of various natural backgrounds. Again, the near-IR photographs illustrate the spatial relationships between the data plots. The UV photographs were taken with a boresighted camera to illustrate the integrated image which exists in the 350 to 400 millimicron region. The various sites include and are arranged in the following approximate sequence: clouds, sky, snow, terrain and water.

The spectrometer was calibrated at each measurement location with collimated, full-field xenon and mercury vapor sources to establish the radiance and wavelength scales. The xenon source has also been referenced to an NBS traceable ribbon filament tungsten lamp to establish absolute radiance levels.

The spectral data were taken over the range of 200 to 440 millimicrons; however, the shorter wavelength data was excluded from the final plots since the radiance levels in the region were extremely low due to absorption by atmospheric ozone. The ordinate scale values are selected by the computer program to fit the data between the maximum and minimum values. The UV data presented in this section represent a single spectral scan which required about 20 seconds to cover the 300 to 440 millimicron region.

The UV spectral plots (see Figure 5-1 for example) generally show characteristics of a rapid rise in radiance level over the wavelength region of 300 to 330 millimicrons followed by variations about a gradually increasing average radiance value to the limits of the plot of 440 millimicrons. The actual peak in the radiance curve will generally occur at some wavelength beyond 440 millimicrons depending on the particular background and measurement conditions.

The difference plots, again obtained by spectral subtraction, are less dramatic than exhibited in the IR spectral region due to the lack of strong atmospheric absorption bands or effects of self-emission of backgrounds in the UV region. In addition, most terrain features are very non-reflective in the UV region and any observed radiance is generally due to the same effects which give rise to sky radiance. Plot number 1 - plot number 2 of site number 1 is typical of cloud/sky backgrounds; the spectral difference produces a generally rising characteristic from 300 to 440 millimicrons.

Figure 5-17 shows spectra obtained from terrain (pine trees) and blue sky. There is a striking similarity between the spectral shapes of these two plots. This spectral similarity is due to the spectrally flat, non-reflective nature of the terrain which also gives rise to a reduced magnitude of the ordinate scale. The difference plot is quite similar in spectral shape to that of the sky, and typical of most other difference plots involving terrain backgrounds.

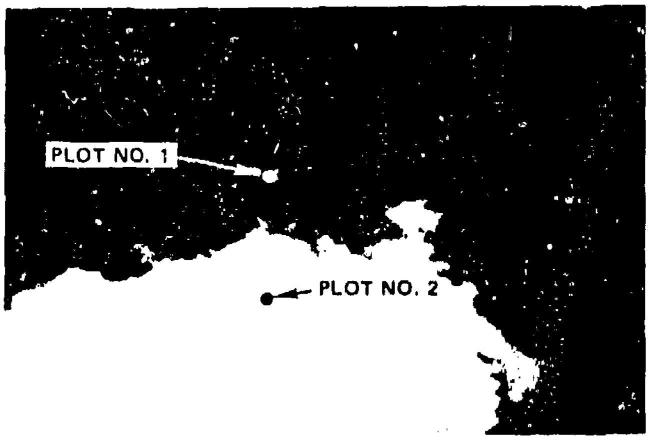
The differences that exist in blue sky radiance as a function of elevation angle are demonstrated in Figure 5-12. Spectral measurements were made at three elevation angles; 3 degrees, slightly above the horizon; at 44 degrees, in a portion of deep blue sky; and at 69 degrees elevation. The major difference between the 3 degree spectral plot and the data taken at the higher elevation angles is a reduction in the longer wavelength radiance at the higher angles due to reduced Mie scattering. The radiance level at 340 millimicrons is reasonably constant at 0.009 watts per square centimeter-steradian-micron from 3 degree elevation up to at least 69 degrees (the limit of the UV instrumentation) for this particular site.

ULTRAVIOLET BACKGROUND SITE NO. 1

LOCATION: BLUE RIDGE, CALIF
DATE: MARCH 31, 1970
TIME: 13:08 PST
ELEVATION: 7386 FEET
TEMPERATIVE: 39°F
RELATIVE HUMIDITY: 28%
SUN ANGLE: 55° EL AV 195° MAG

PLOT NO. 1 – DEEP BLUE SKY
EL ANGLE: 22° AZ ANGLE 95° MAG

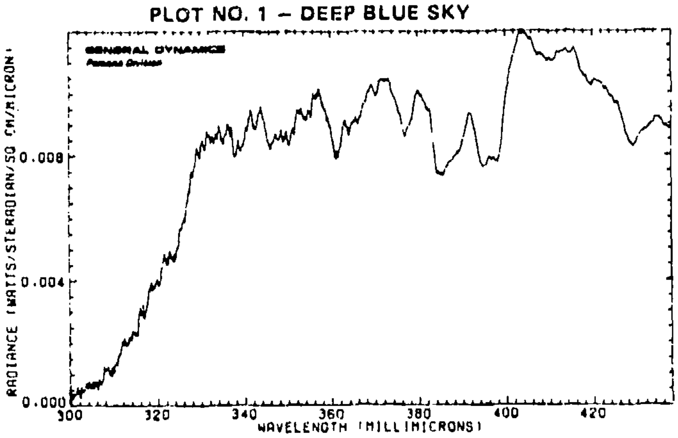
PLOT NO. 2 – BRIGHT CLOUD
EL ANGLE: 21° AZ ANGLE 95° MAG



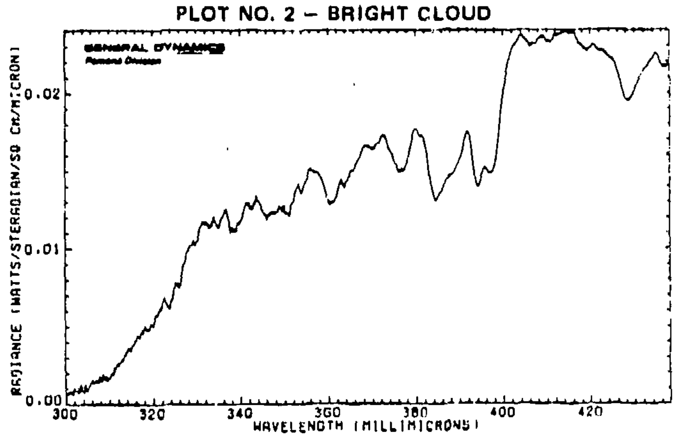
IR PHOTOGRAPH .7 – .9 MICRONS

UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 – DEEP BLUE SKY

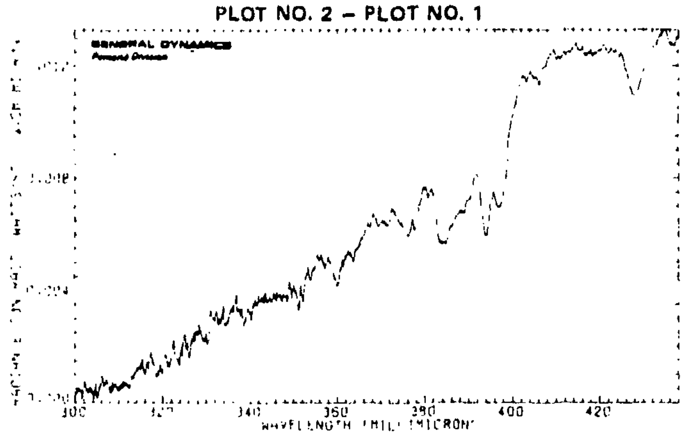


PLOT NO. 2 – BRIGHT CLOUD



ULTRAVIOLET BACKGROUND SITE NO. 26
DIFFERENCE PLOT

PLOT NO. 2 – PLOT NO. 1



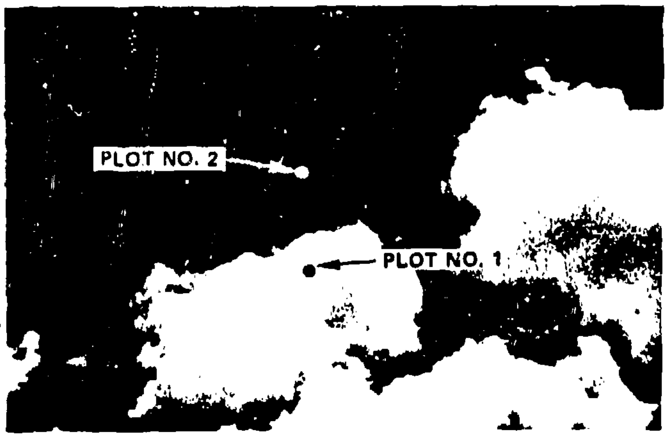
A63445-1

Figure 5-1.

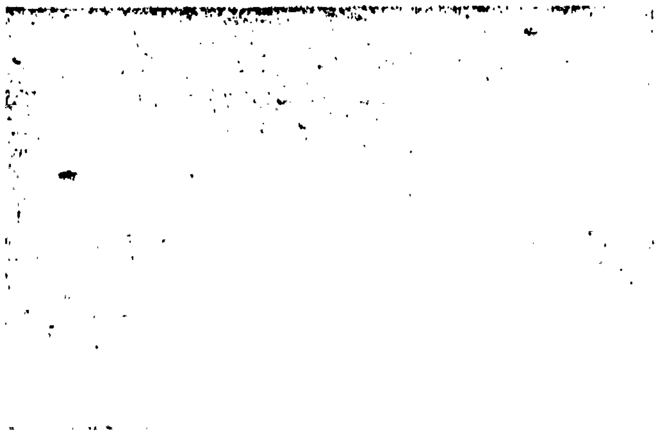
ULTRAVIOLET BACKGROUND SITE NO. 2

LOCATION: BLUE RIDGE, CALIF
DATE: MARCH 31, 1970
TIME: 12:00 PST
ELEVATION: 7386 FEET
TEMPERATIVE: 36°F
RELATIVE HUMIDITY: 37%
SUN ANGLE: 60° EL 165° AZ

PLOT NO. 1 – CLOUD
EL ANGLE: 17.5° AZ ANGLE: 95° MAG
PLOT NO. 2 – BLUE SKY
EL ANGLE: 18° AZ ANGLE: 95° MAG

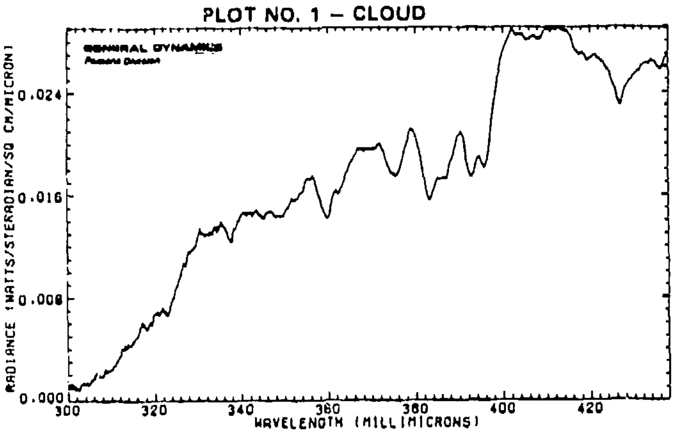


IR PHOTOGRAPH .7 – .9 MICRONS

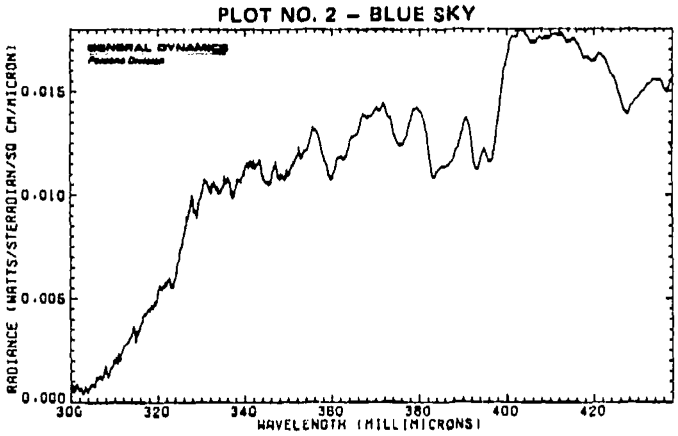


UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 – CLOUD

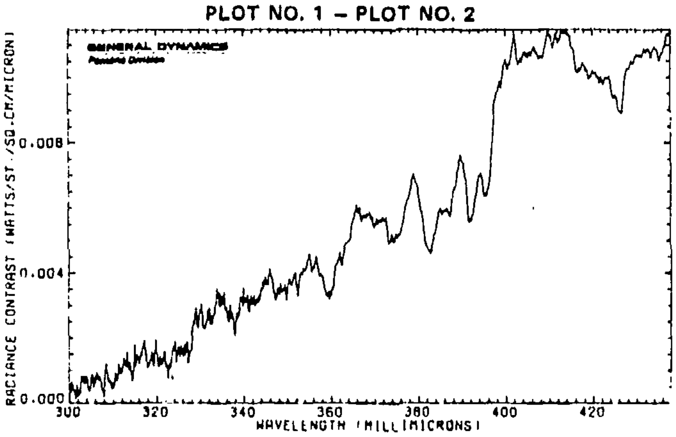


PLOT NO. 2 – BLUE SKY



ULTRAVIOLET BACKGROUND SITE NO. 27
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



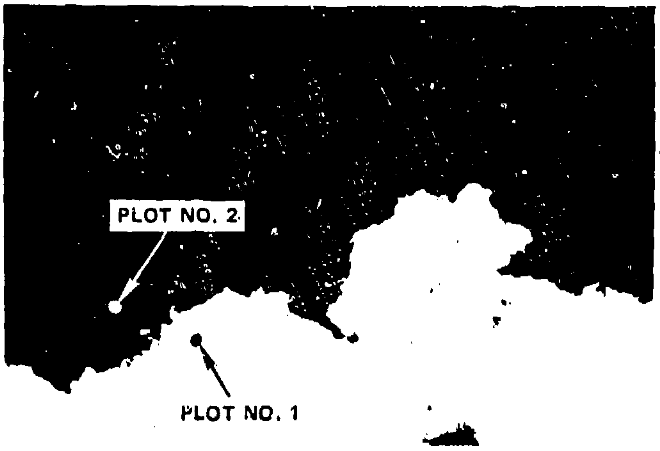
A63448-1

Figure 5-2.

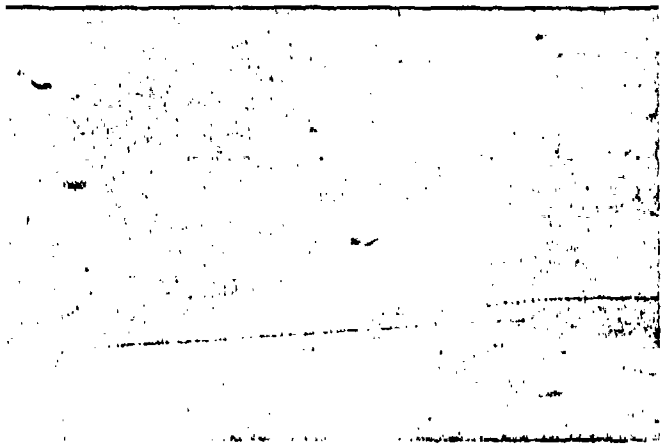
ULTRAVIOLET BACKGROUND SITE NO. 3

LOCATION: BLUE RIDGE
DATE: MARCH,31, 1970
TIME: 11:15 PST
ELEVATION: 7386 FEET
TEMPERATURE: 36°F
RELATIVE HUMIDITY: 37%
SUN ANGLE: 60° EL 160° AZ MAG

PLOT NO. 1 - CLOUD
EL ANGLE: 11° AZ ANGLE: 120° MAG
PLOT NO. 2 - SKY
EL ANGLE: 11.5° AZ ANGLE: 119° MAG

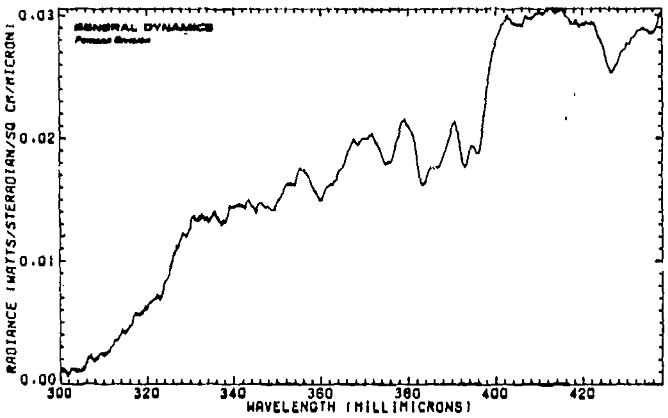


IR PHOTOGRAPH .7 – .9 MICRONS

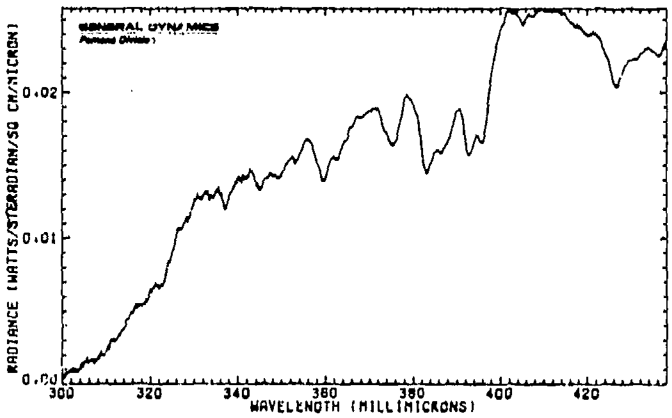


UV PHOTOGRAPH .35 – .40 MICRONS

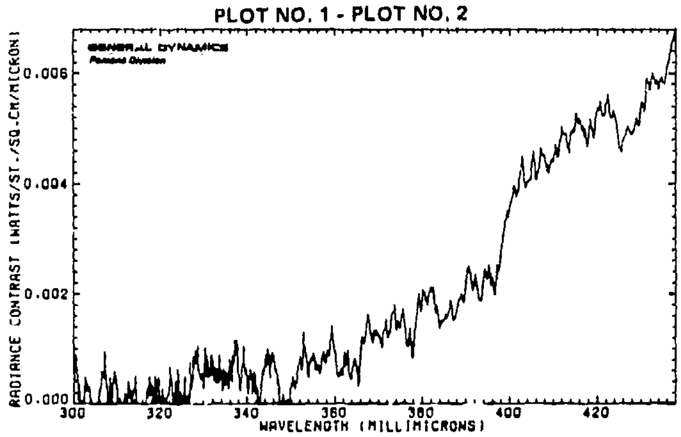
PLOT NO. 1 - CLOUD



PLOT NO. 2 - SKY



ULTRAVIOLET BACKGROUND SITE NO. 28
DIFFERENCE PLOT
PLOT NO. 1 - PLOT NO. 2



A63777-1

Figure 5-3.

ULTRAVIOLET BACKGROUND SITE NO. 4

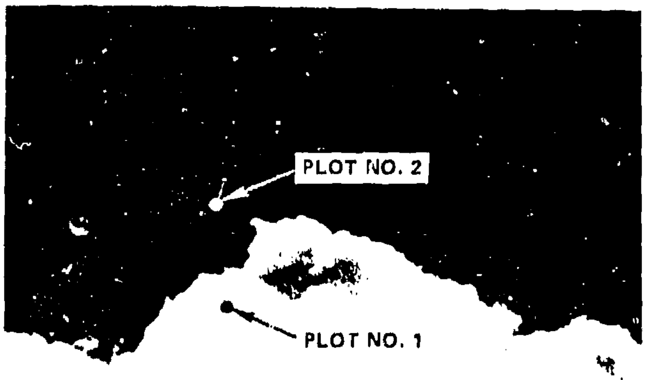
LOCATION: BLUE RIDGE
DATE: MARCH 31, 1970
TIME: 13:59 PST
ELEVATION: 7386 FEET
TEMPERATURE: 40°F
RELATIVE HUMIDITY: 26%
SUN ANGLE: 47° EL 209° AZ MAG

PLOT NO. 1 - BRIGHT CLOUD

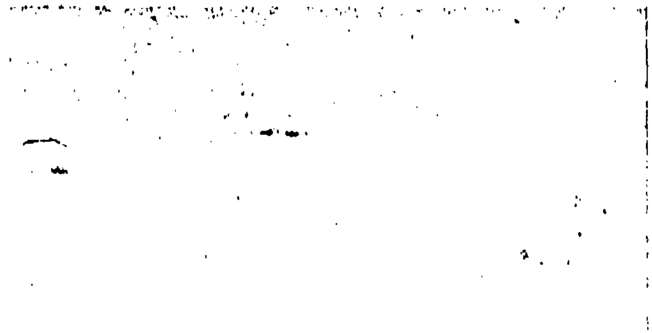
EL ANGLE: 15° AZ ANGLE: 200° MAG

PLOT NO. 2 - BLUE SKY

EL ANGLE: 16° AZ ANGLE: 200° MAG

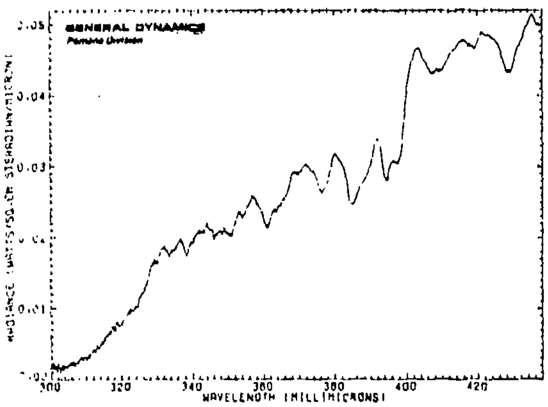


IR PHOTOGRAPH .7 – .9 MICRONS

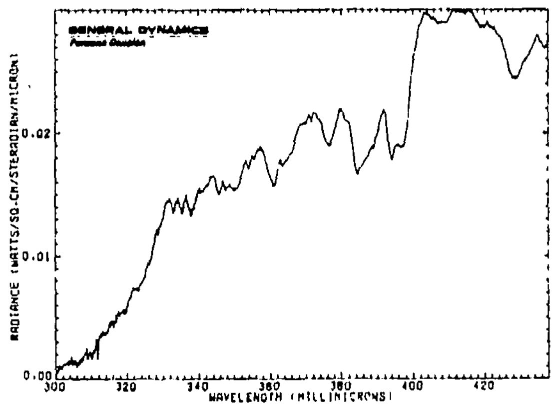


UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 - BRIGHT CLOUD

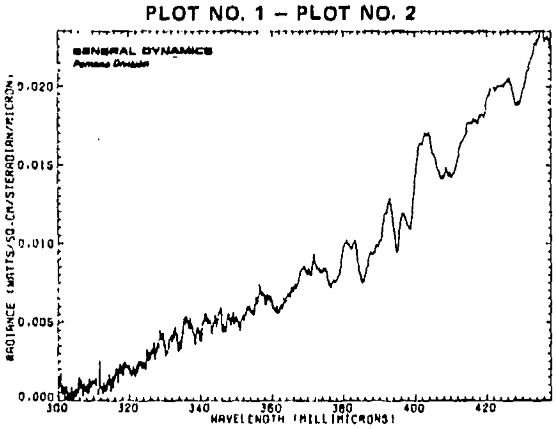


PLOT NO. 2 - BLUE SKY



ULTRAVIOLET BACKGROUND SITE NO. 29
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



A63776-1

Figure 5-4.

ULTRAVIOLET BACKGROUND SITE NO. 5

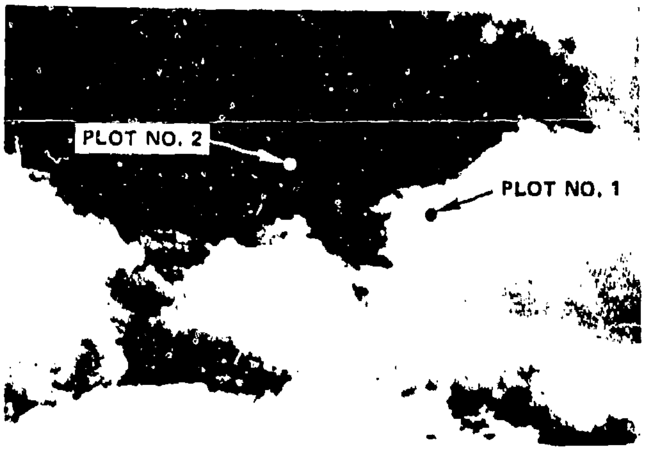
LOCATION: BLUE RIDGE
DATE: MARCH 31, 1970
TIME: 1405 PST
ELEVATION: 7386 FEET
TEMPERATURE: 40°F
RELATIVE HUMIDITY: 26%
SUN ANGLE: 46° EL 210° AZ MAG

PLOT NO. 1 – BRIGHT CLOUD

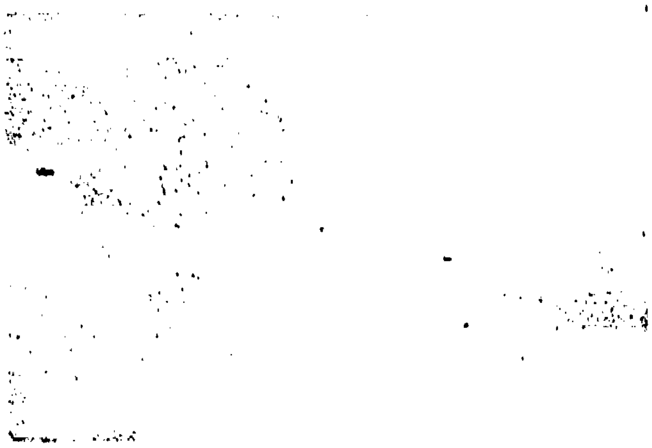
EL ANGLE: 18° AZ ANGLE: 200° MAG

PLOT NO. 2 – BLUE SKY

EL ANGLE: 18.5° AZ ANGLE: 199° MAG

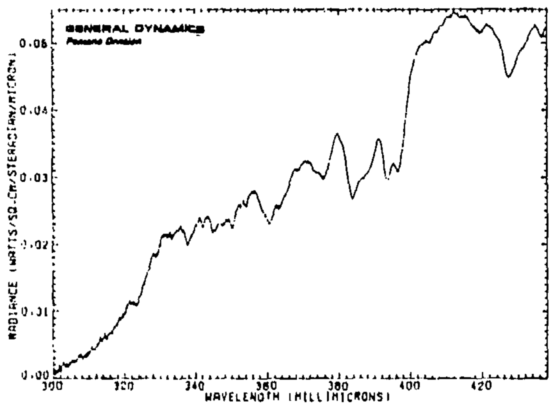


IR PHOTOGRAPH .7 – .9 MICRONS

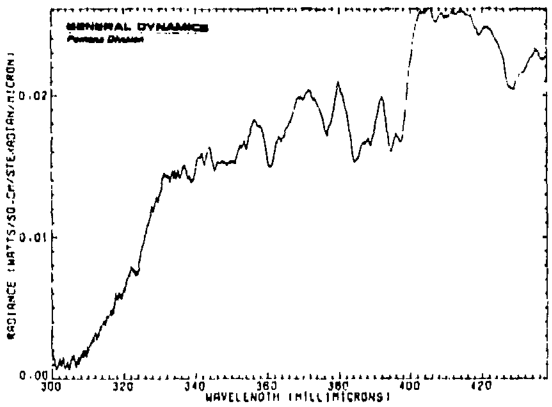


UV PHOTOGRAPH .35 – .40 MICRONS

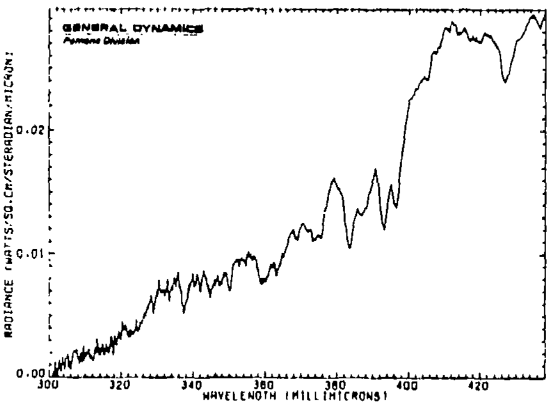
PLOT NO. 1–BRIGHT CLOUD



PLOT NO. 2–BLUE SKY



ULTRAVIOLET BACKGROUND SITE NO. 30
DIFFERENCE PLOT
PLOT NO. 1 – PLOT NO. 2



A63775-1

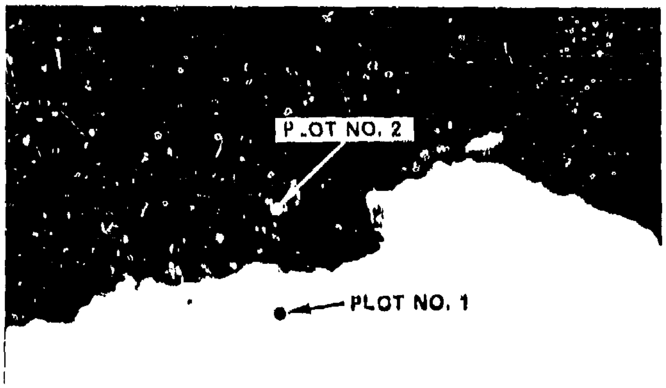
Figure 5-5.

ULTRAVIOLET BACKGROUND SITE NO. 6

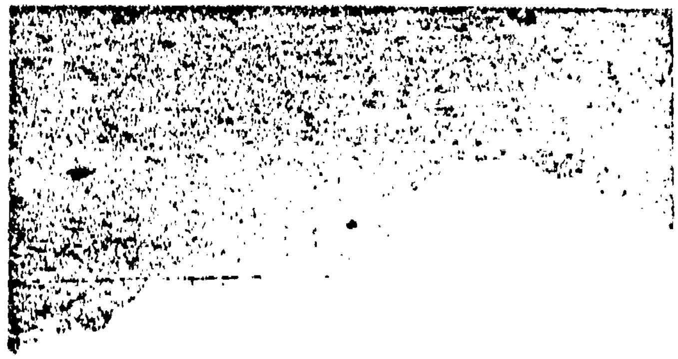
LOCATION: BLUE RIDGE, CALIF
DATE: MARCH 31, 1970
TIME: 12:35 PST
ELEVATION: 7386 FEET
TEMPERATIVE: 36°F
RELATIVE HUMIDITY: 37%
SUN ANGLE: 58% EL 182° AZ MAG

PLOT NO. 1 – BRIGHT CLOUD
EL ANGLE: 11° AZ ANGLE: 165° MAG

PLOT NO. 2 – BLUE SKY
EL ANGLE: 12° AZ ANGLE: 165° MAG

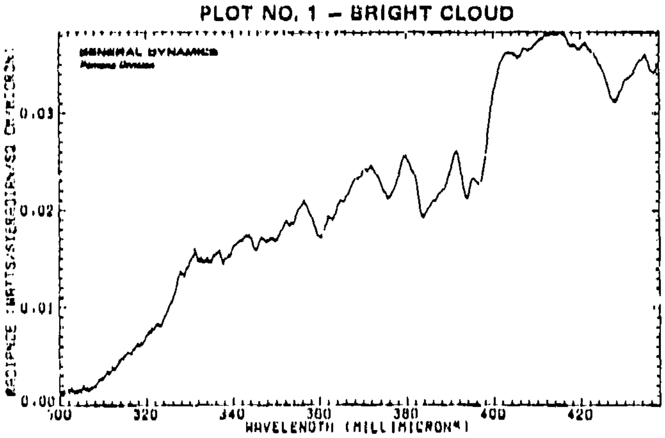


IR PHOTOGRAPH .7 – .9 MICRONS

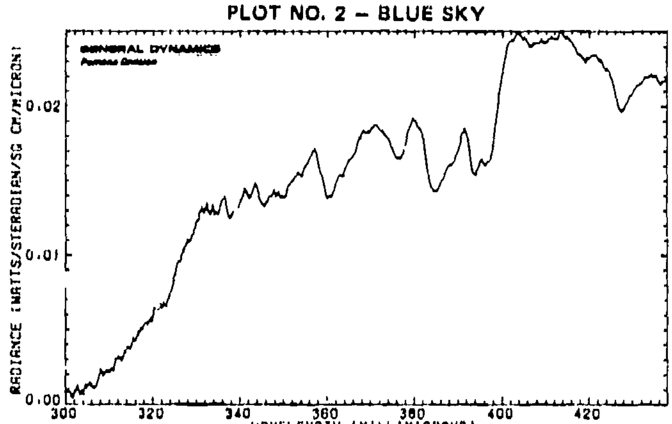


UV PHOTOGRAPH .35 – .40 MICRONS

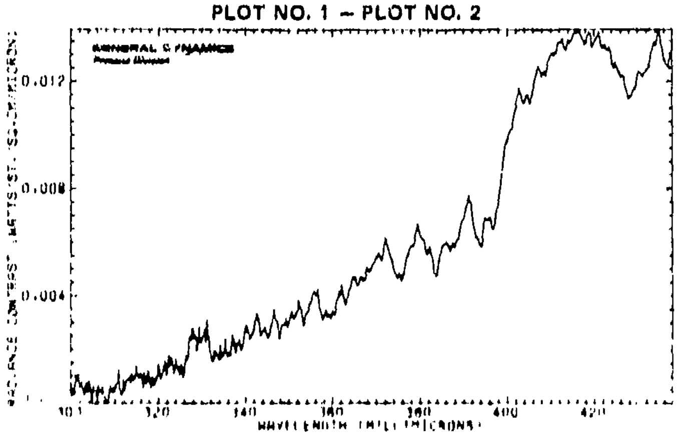
PLOT NO. 1 – BRIGHT CLOUD



PLOT NO. 2 – BLUE SKY



ULTRAVIOLET BACKGROUND SITE NO. 31
DIFFERENCE PLOT
PLOT NO. 1 – PLOT NO. 2

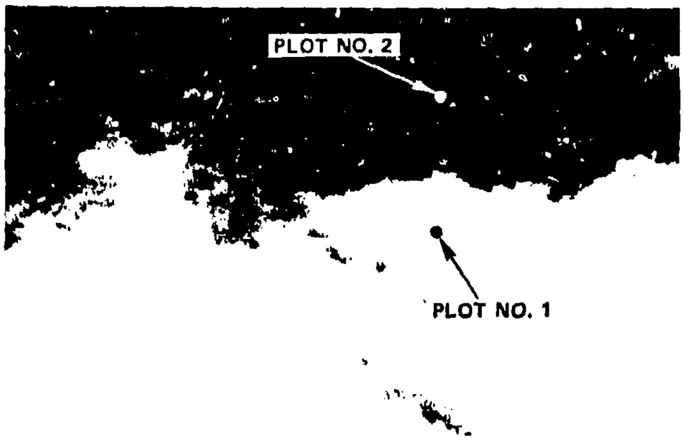


A63453-1

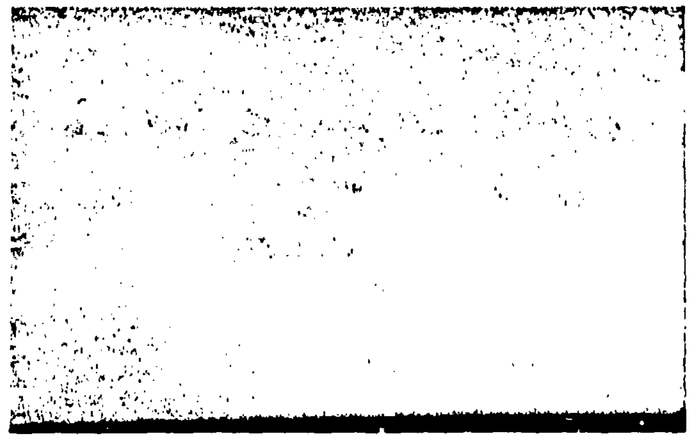
ULTRAVIOLET BACKGROUND SITE NO. 7

LOCATION: POMONA, CALIF
DATE: MAY 6, 1970
TIME: 13:53 PST
ELEVATION: 795 FEET
TEMPERATIVE: 68°F
RELATIVE HUMIDITY: 34%
SUN ANGLE: 55.5° EL 223° EL MAG

PLOT NO. 1 – BRIGHT CLOUD
EL ANGLE: 34° AZ ANGLE: 210° MAG
PLOT NO. 2 – BLUE SKY
EL ANGLE: 35° AZ ANGLE: 210° MAG

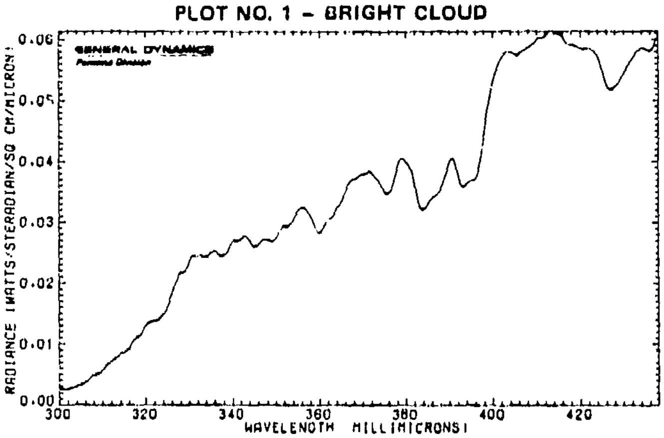


IR PHOTOGRAPH .7 – .9 MICRONS

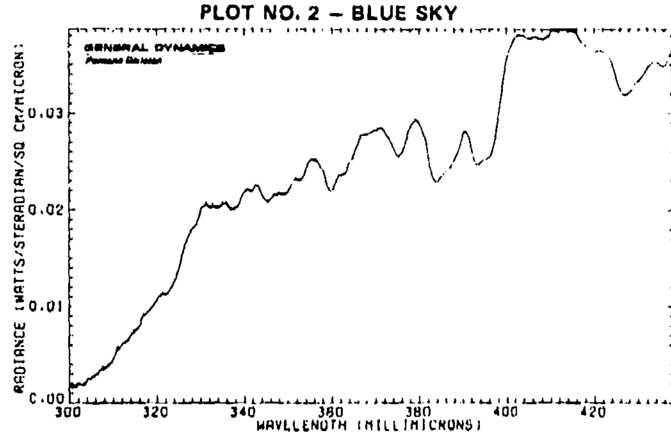


UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 – BRIGHT CLOUD

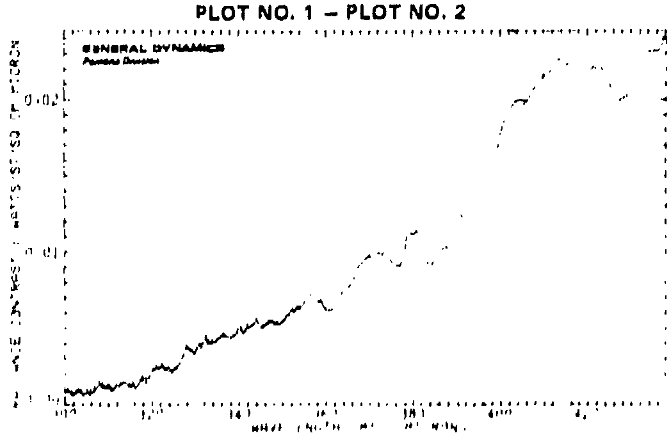


PLOT NO. 2 – BLUE SKY



ULTRAVIOLET BACKGROUND SITE NO. 32
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



A63458-1

ULTRAVIOLET BACKGROUND SITE NO. 8

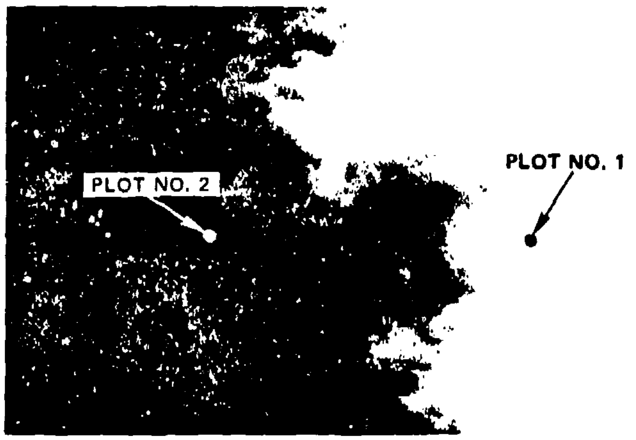
LOCATION: POMONA, CALIF
DATE: MAY 6, 1970
TIME: 14:07 PST
ELEVATION: 795 FEET
TEMPERATIVE: 68°F
RELATIVE HUMIDITY: 34%
SUN ANGLE: 51.5° EL 225° AZ MAG

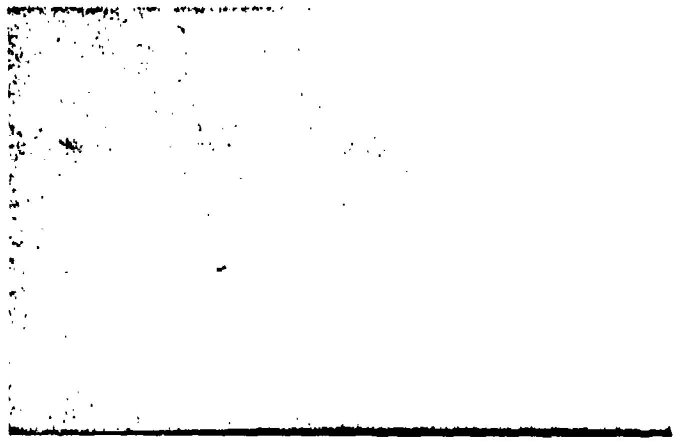
PLOT NO. 1 – BRIGHT CLOUD

EL ANGLE: – 26° AZ ANGLE: 275° MAC

PLOT NO. 2 -- BLUE SKY

EL ANGLE: – 26° AZ ANGLE: 223° MAG

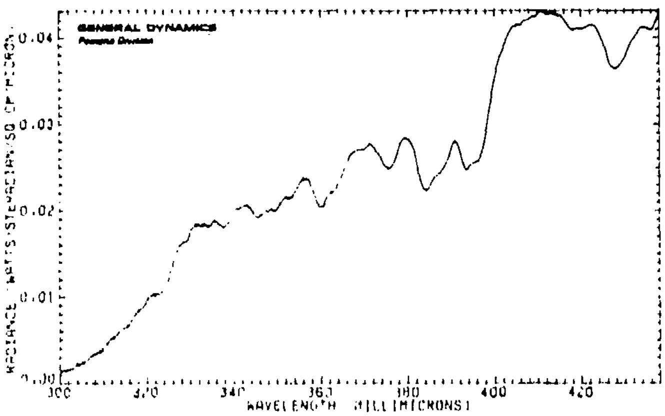




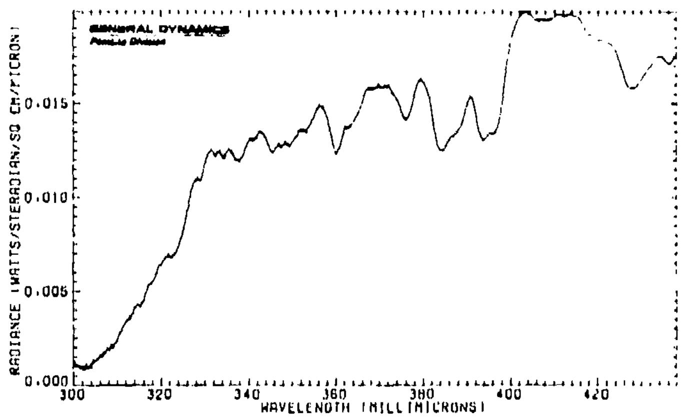
IR PHOTOGRAPH .7 – .9 MICRONS

UV PHOTOGRAPH .35 – .40 MICRONS

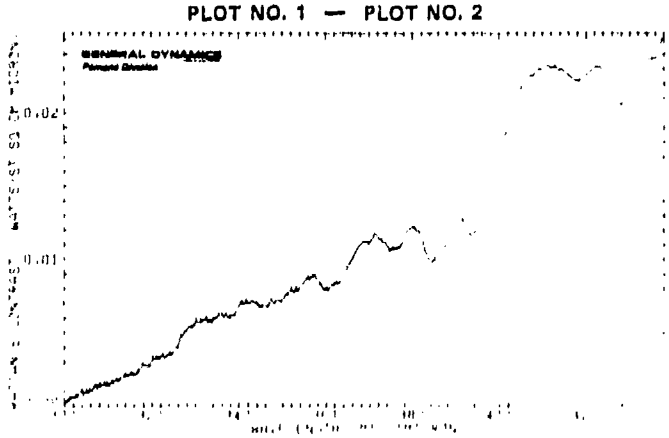
PLOT NO. 1 – BRIGHT CLOUD



PLOT NO. 2 – BLUE SKY



ULTRAVIOLET BACKGROUND SITE NO. 33
DIFFERENCE PLOT
PLOT NO. 1 — PLOT NO. 2



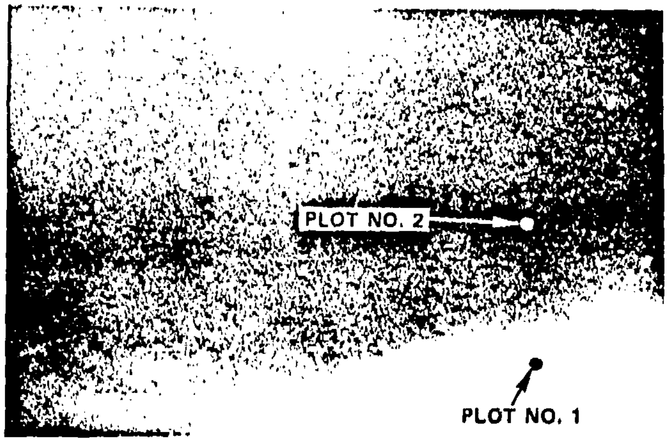
A63457-1

Figure 5-8.

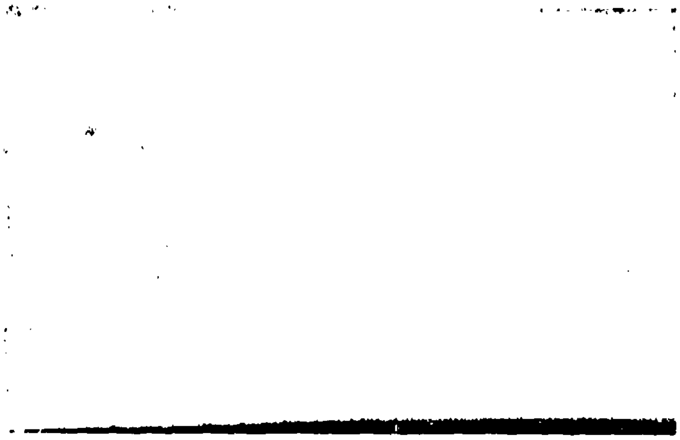
ULTRAVIOLET BACKGROUND SITE NO. 9

LOCATION: POMONA, CALIF
DATE: MAY 6, 1970
TIME: 4:13 PST
ELEVATION: 795 FEET
TEMPERATIVE: 68°F
RELATIVE HUMIDITY: 34%
SUN ANGLE: 50° EL 227° AZ MAG

PLOT NO. 1 – BRIGHT CLOUD
EL ANGLE: 11° AZ ANGLE: 320° MAG
PLOT NO. 2 – DARK PART OF CLOUD
EL ANGLE: 12° AZ ANGLE: 320° MAG

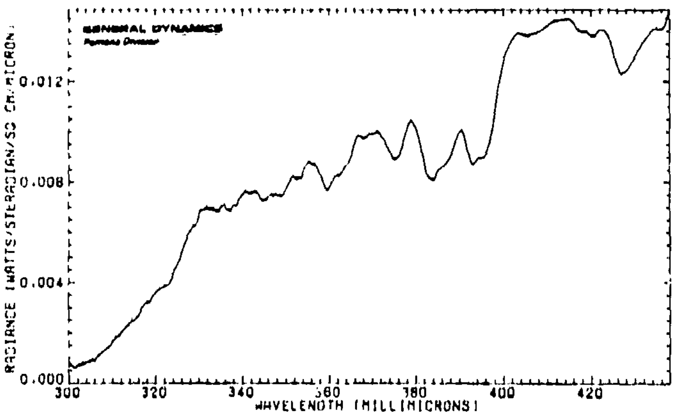


IR PHOTOGRAPH .7 – .9 MICRONS

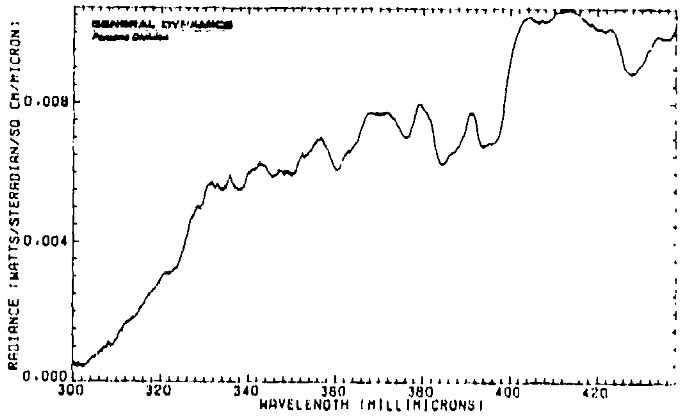


UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 – BRIGHT CLOUD

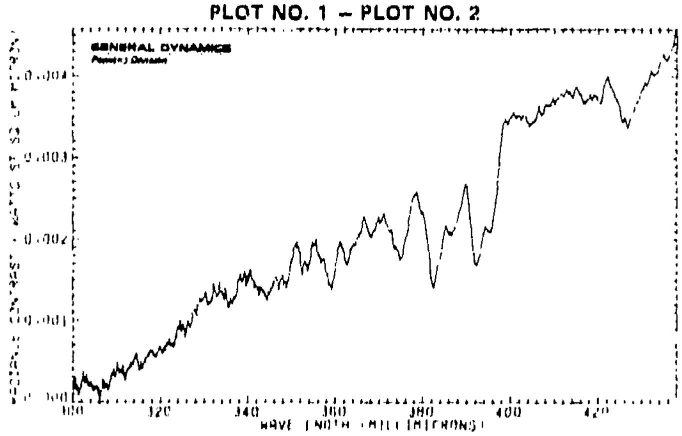


PLOT NO. 2 – DARK PART OF CLOUD



ULTRAVIOLET BACKGROUND SITE NO. 34
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



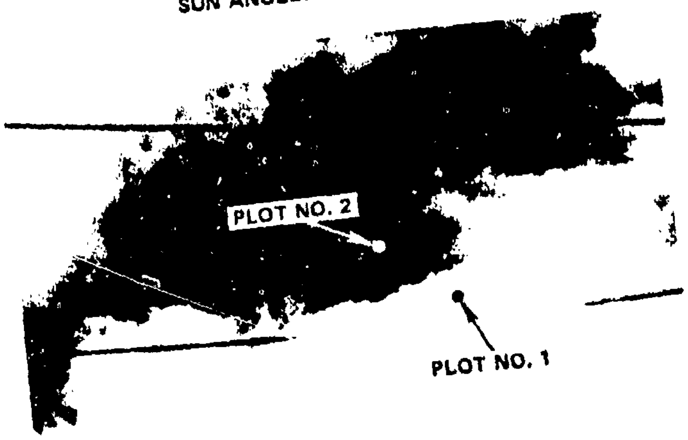
A03459-1

Figure 5-9.

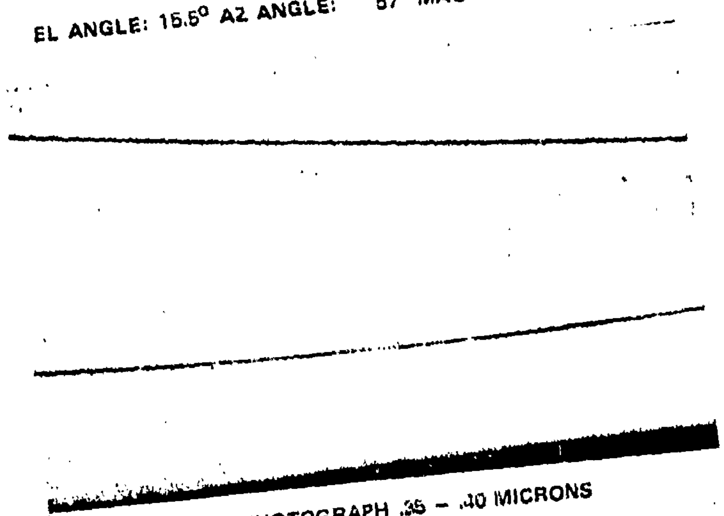
ULTRAVIOLET BACKGROUND SITE NO. 10

LOCATION: POMONA, CALIF
DATE: MAY 6, 1970
TIME: 14:18 PST
ELEVATION: 795 FEET
TEMPERATIVE: 68°F
RELATIVE HUMIDITY: 34%
SUN ANGLE: 49° EL 229° AZ MAG

PLOT NO. 1 – CLOUD EDGE
EL ANGLE: 15° AZ ANGLE: 58° MAG
PLOT NO. 2 – BLUE SKY
EL ANGLE: 15.5° AZ ANGLE: 57° MAG

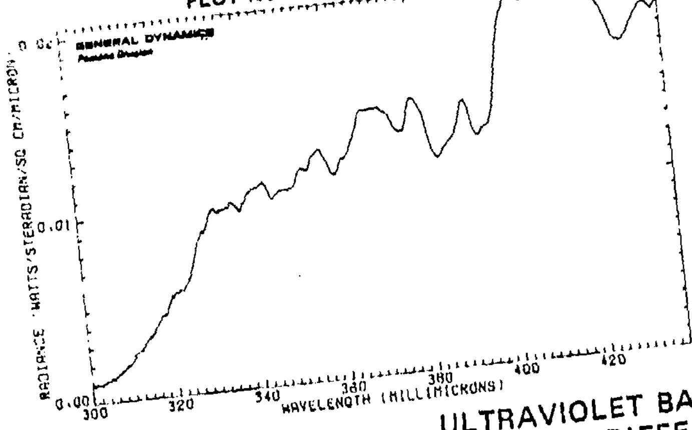


IR PHOTOGRAPH .7 – .9 MICRONS

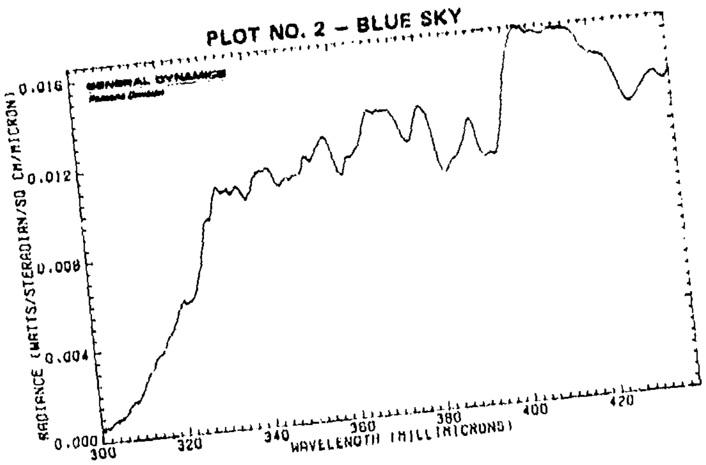


UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 – CLOUD EDGE



PLOT NO. 2 – BLUE SKY



ULTRAVIOLET BACKGROUND SITE NO. 35
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2

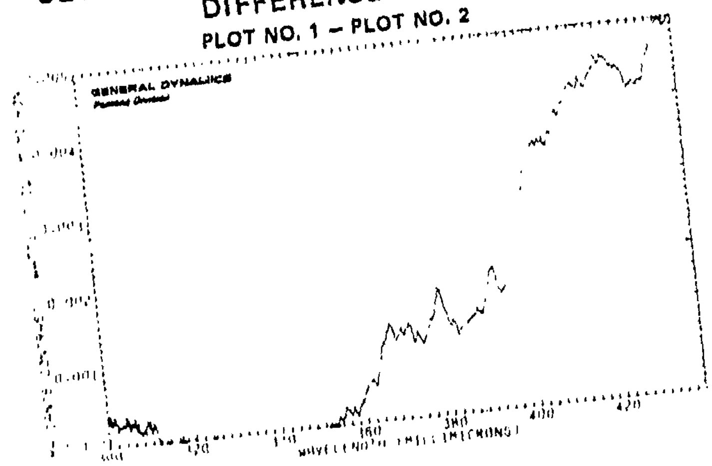


Figure 5-10.

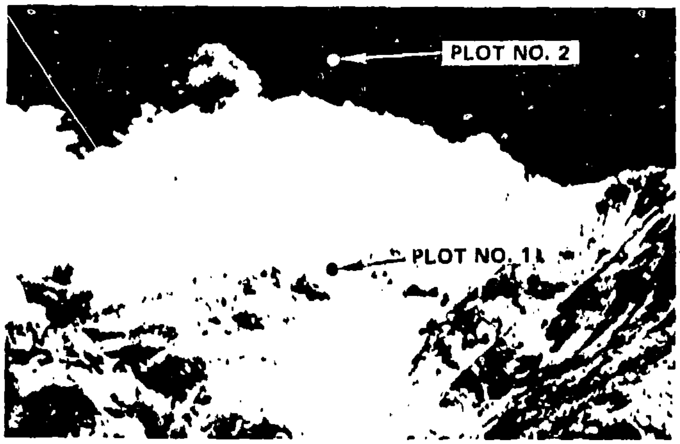
A63456-1

ULTRAVIOLET BACKGROUND SITE NO. 11

LOCATION: BLUE RIDGE, CALIF
DATE: MARCH 31, 1970
TIME: 12:25 PST
ELEVATION: 7386 FEET
TEMPERATIVE: 36°F
RELATIVE HUMIDITY: 37%
SUN ANGLE: 58.6° EL 177° AZ MAG

PLOT NO. 1 – SNOW COVERED MOUNTAIN
EL ANGLE: 7° AZ ANGLE: 222° MAG

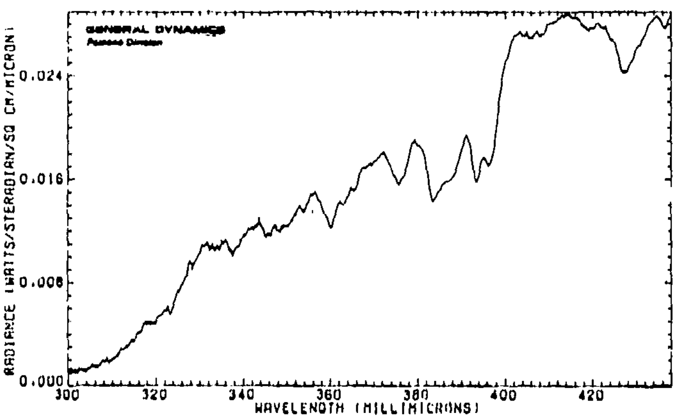
PLOT NO. 2 – BLUE SKY
EL ANGLE: 9° AZ ANGLE: 222° MAG



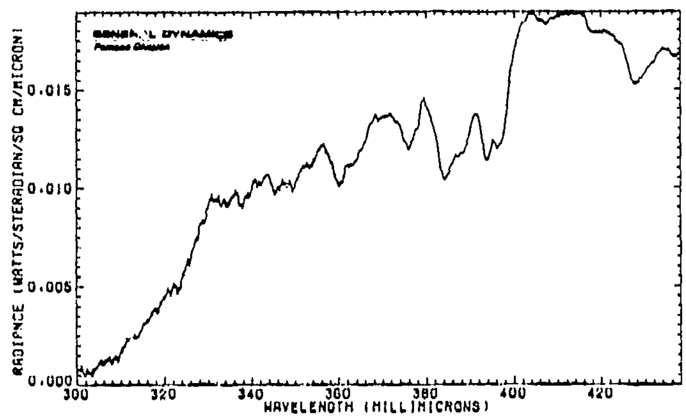
IR PHOTOGRAPH .7 – .9 MICRONS

UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 – SNOW COVERED MOUNTAIN

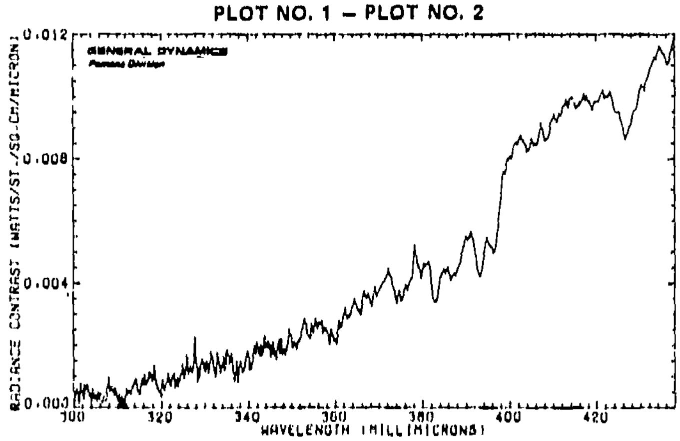


PLOT NO. 2 – BLUE SKY



ULTRAVIOLET BACKGROUND SITE NO. 36
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



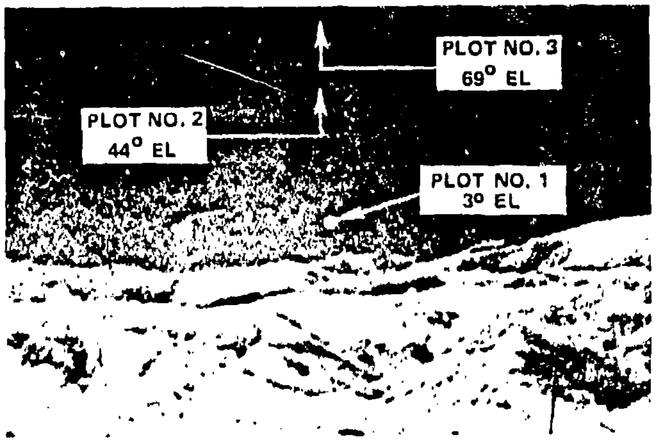
A63484-1

Figure 5-11.

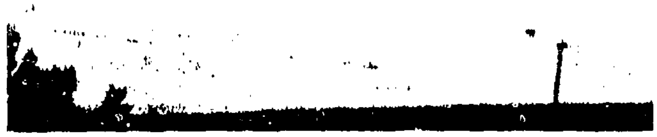
ULTRAVIOLET BACKGROUND SITE NO. 12

LOCATION: DESERT HOT SPRINGS
DATE: APRIL 23, 1970
TIME: 13:54 PST
ELEVATION: 1087 FEET
TEMPERATURE: 79°F
RELATIVE HUMIDITY: 8.5%
SUN ANGLE: 53.6° EL 218° AZ MAG

PLOT NO. 1 - BLUE SKY
EL ANGLE: 3° AZ ANGLE: 345° MAG
PLOT NO. 2 - BLUE SKY
EL ANGLE: 44° AZ ANGLE: 345° MAG
PLOT NO. 3 - BLUE SKY
EL ANGLE: 69° AZ ANGLE: 345° MAG

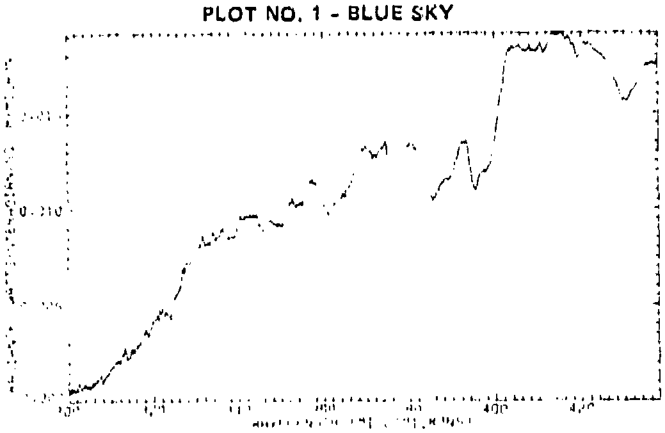


IR PHOTOGRAPH .7 – .9 MICRONS

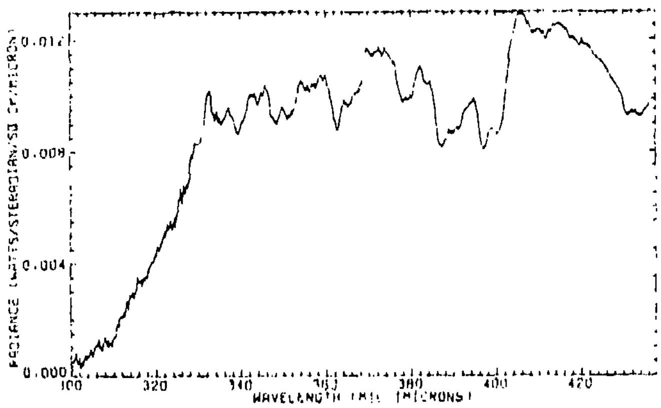


UV PHOTOGRAPH .35 – .40 MICRONS

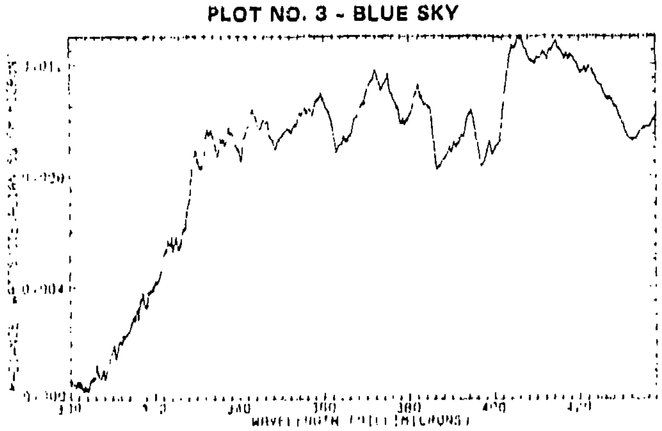
PLOT NO. 1 - BLUE SKY



PLOT NO. 2 - BLUE SKY



PLOT NO. 3 - BLUE SKY

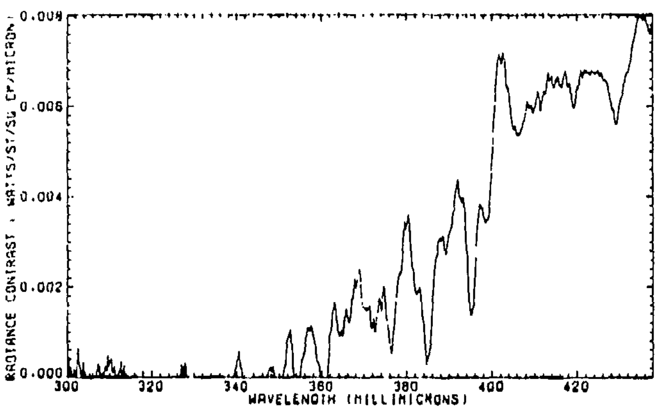


A63374-1

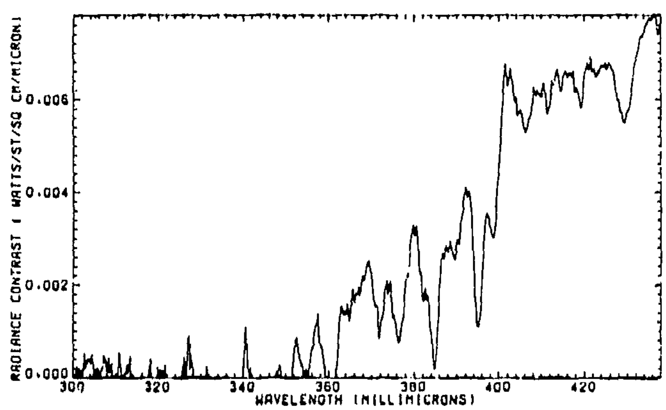
Figure 5-12.

ULTRAVIOLET BACKGROUND SITE NO. 12
DIFFERENCE PLOTS

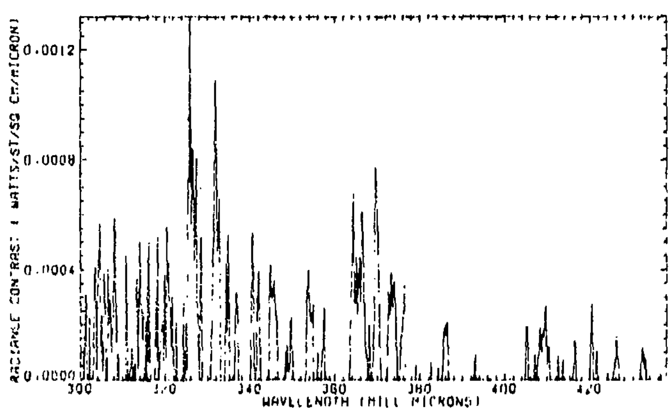
PLOT NO. 1 - PLOT NO. 2



PLOT NO. 1 - PLOT NO. 3



PLOT NO. 2 - PLOT NO. 3



A63675

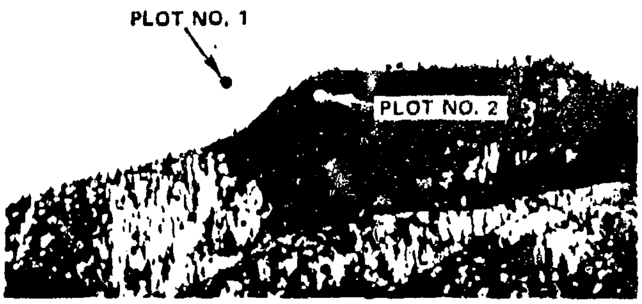
Figure 5-12 (Continued).

ULTRAVIOLET BACKGROUND SITE NO. 13

LOCATION: BLUE RIDGE, CALIF
DATE: MARCH 31, 1970
TIME: 13:02 PST
ELEVATION: 7386 FEET
TEMPERATIVE: $38^{\circ}F$
RELATIVE HUMIDITY: 30%
SUN ANGLE: 55.8° EL 194° AZ MAG

PLOT NO. 1 – CLOUD NEXT TO MOUNTAIN
EL ANGLE: 0° AZ ANGLE: 195° MAG

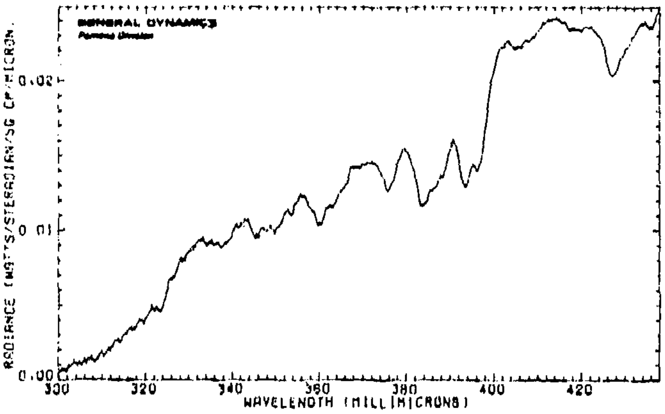
PLOT NO. 2 – MOUNTAIN
EL ANGLE: 0° AZ ANGLE: 196° MAG



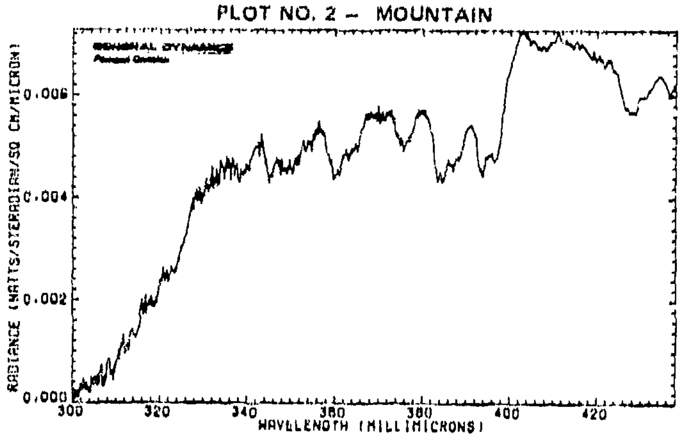
IR PHOTOGRAPH .7 – .9 MICRONS

UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 – CLOUD NEXT TO MOUNTAIN

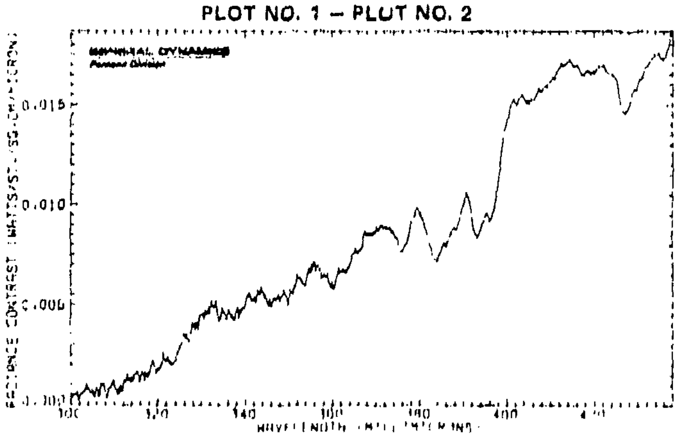


PLOT NO. 2 – MOUNTAIN



ULTRAVIOLET BACKGROUND SITE NO. 38
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



A63444-1

Figure 5-13.

ULTRAVIOLET BACKGROUND SITE NO. 14

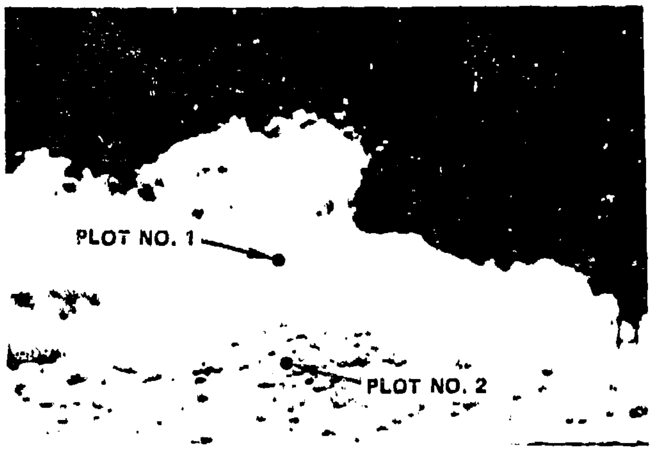
LOCATION: SAN ONOFRE, CALIFORNIA
DATE: APRIL 28, 1970
TIME: 12:50 PST
ELEVATION: 110 FEET
TEMPERATURE: 59°F
RELATIVE HUMIDITY: 42%
SUN ANGLE: 64° EL 198° AZ MAG

PLOT NO. 1 – CLOUD

EL ANGLE: 9° AZ ANGLE: 20° MAG

PLOT NO. 2 – HILL HORIZON

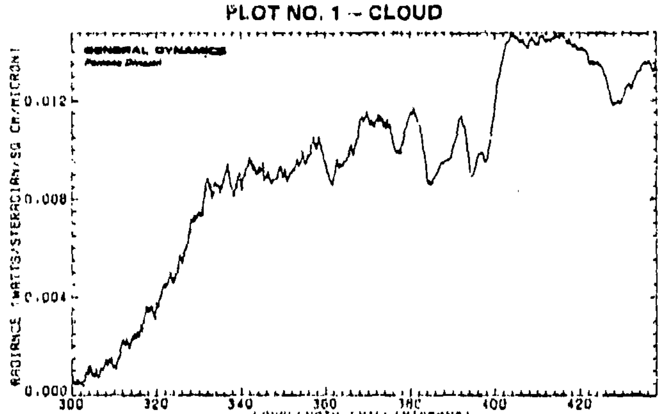
EL ANGLE: 8° AZ ANGLE: 20° MAG



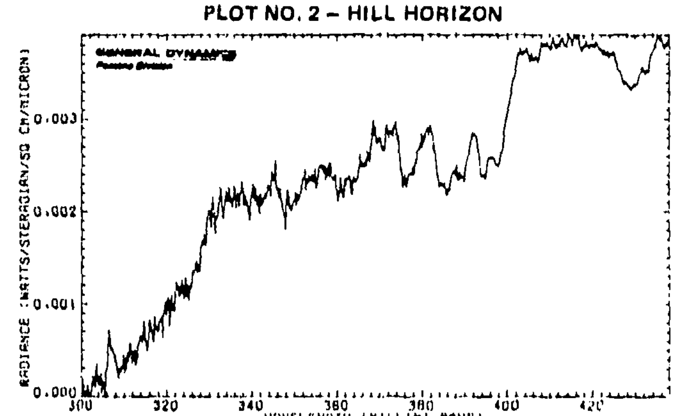
IR PHOTOGRAPH .7 – .9 MICRONS

UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 – CLOUD

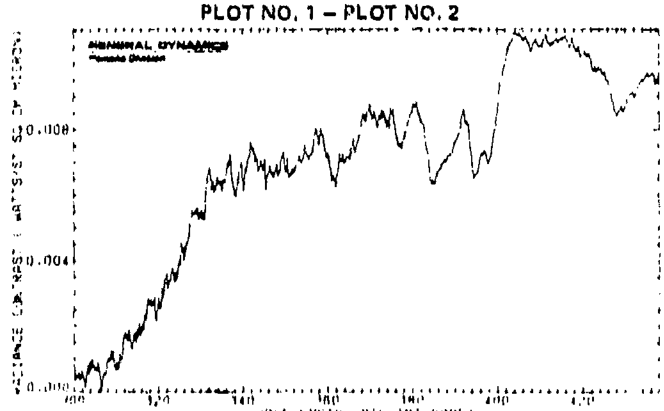


PLOT NO. 2 – HILL HORIZON



ULTRAVIOLET BACKGROUND SITE NO. 39
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



A03673-1

Figure 5-14.

ULTRAVIOLET BACKGROUND SITE NO. 15

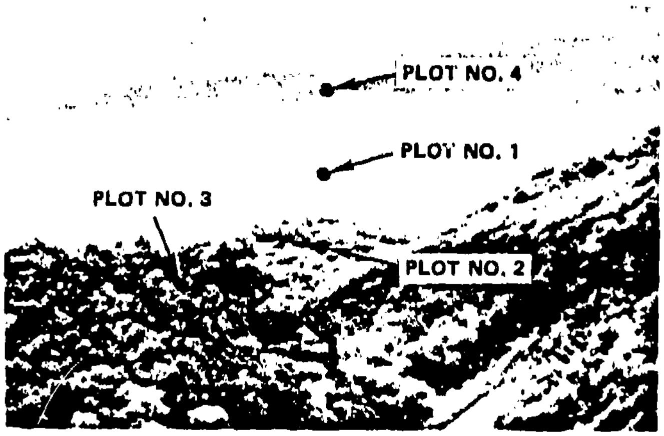
LOCATION: SAN MARCOS PASS
DATE: MAY 18, 1970
TIME: 14:09 PST
ELEVATION: 1850 FEET
TEMPERATURE: 76°F
RELATIVE HUMIDITY: 43%
SUN ANGLE: 51.5° EL 230° AZ MAG

PLOT NO. 1 – LIGHT HAZA CLOUD
EL ANGLE: 6.7° AZ ANGLE : 302° MAG

PLOT NO. 2 – DISTANT HILL
EL ANGLE: 6.2° AZ ANGLE: 301° MAG

PLOT NO. 3 – CLOSE HILL
EL ANGLE: 6° AZ ANGLE: 300° MAG

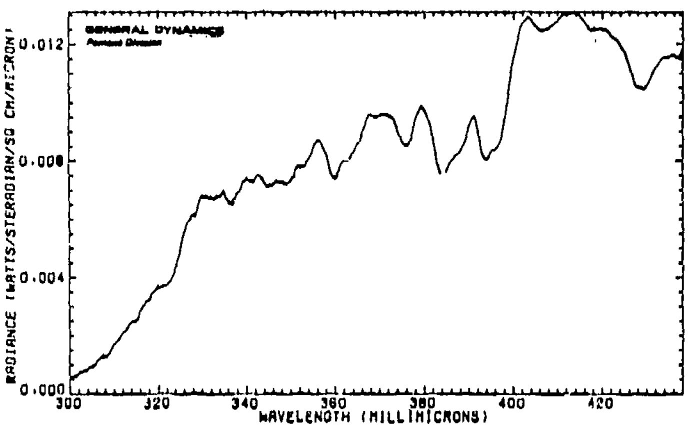
PLOT NO. 4 – BLUE SKY
EL ANGLE: 7° AZ ANGLE: 302° MAG



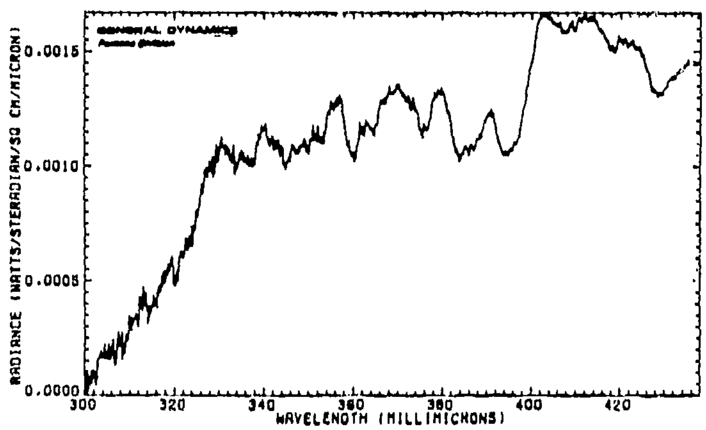
IR PHOTOGRAPH .7 – .9 MICRONS

UV PHOTOGRAPH .35 – .40 MICRONS

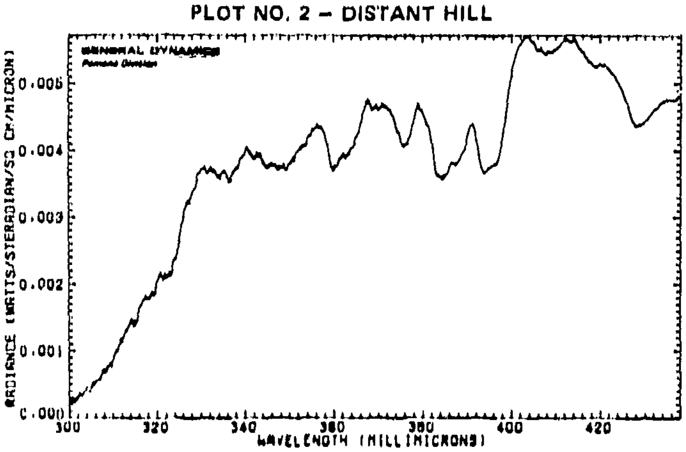
PLOT NO. 1 – LIGHT HAZY CLOUD



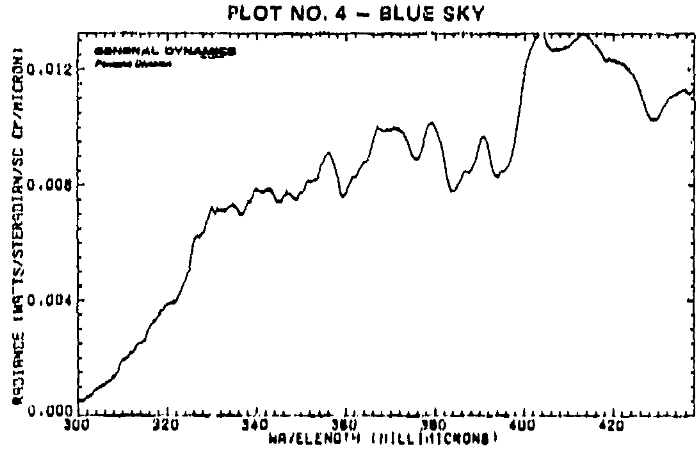
PLOT NO. 3 – CLOSE HILL



PLOT NO. 2 – DISTANT HILL



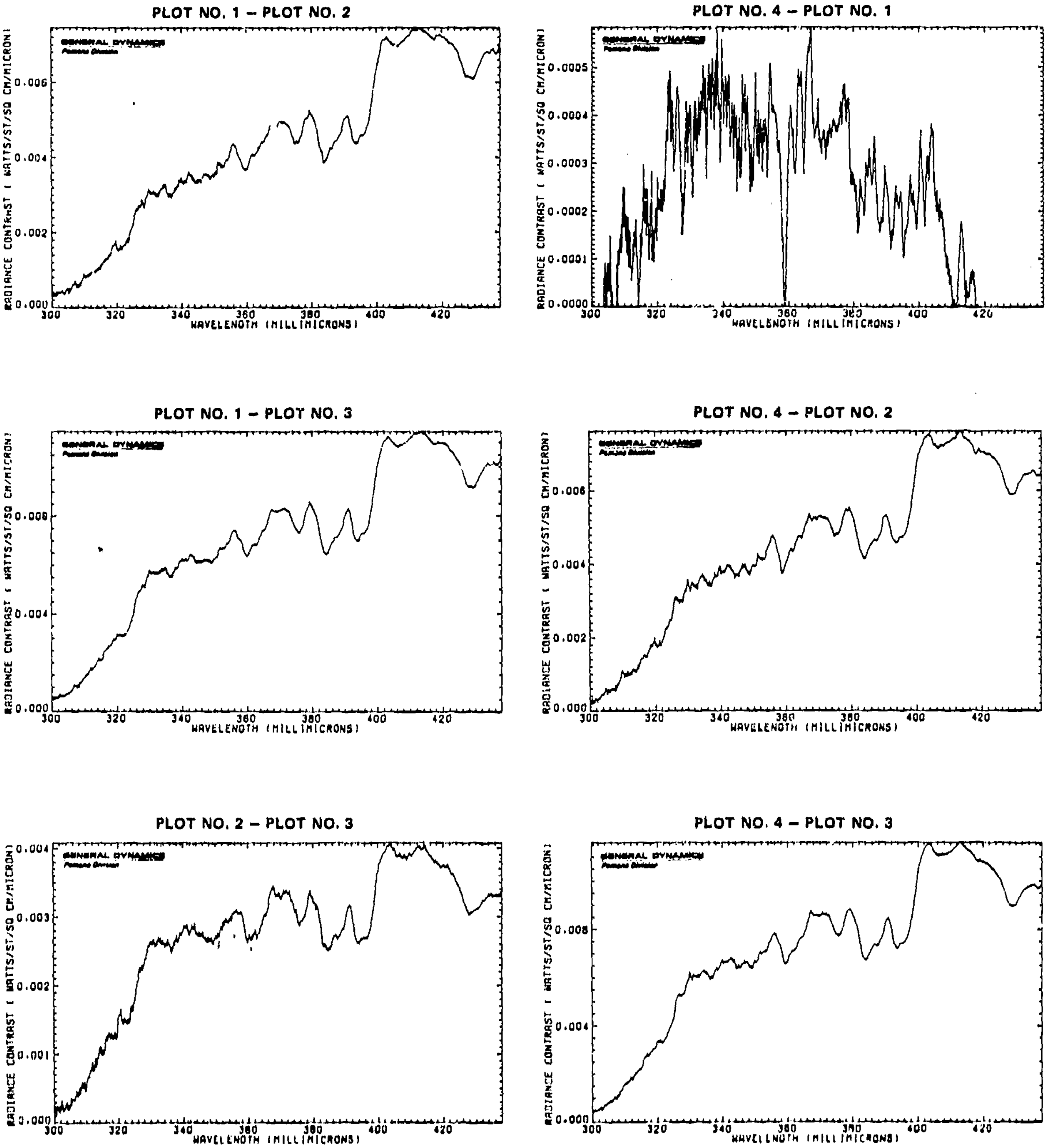
PLOT NO. 4 – BLUE SKY



A63946-1

Figure 5-15.

ULTRAVIOLET BACKGROUND SITE NO. 15
DIFFERENCE PLOTS



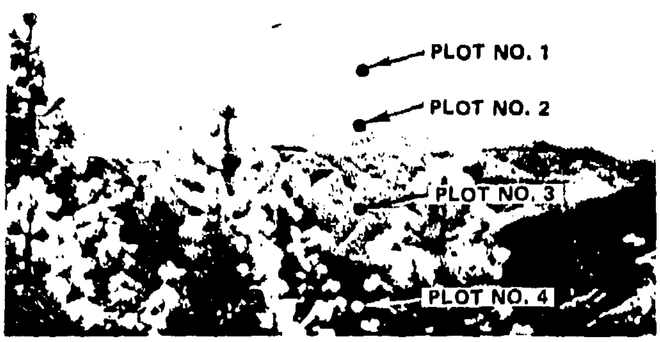
A63947

Figure 5-15 (Continued).

ULTRAVIOLET BACKGROUND SITE NO. 16

LOCATION: BLUE RIDGE, CALIF
DATE: MARCH 31, 1970
TIME: 12:46 PST
ELEVATION: 7386 FEET
TEMPERATURE: 37°F
RELATIVE HUMIDITY: 34%
SUN ANGLE: 57° EL, 186° AZ MAG

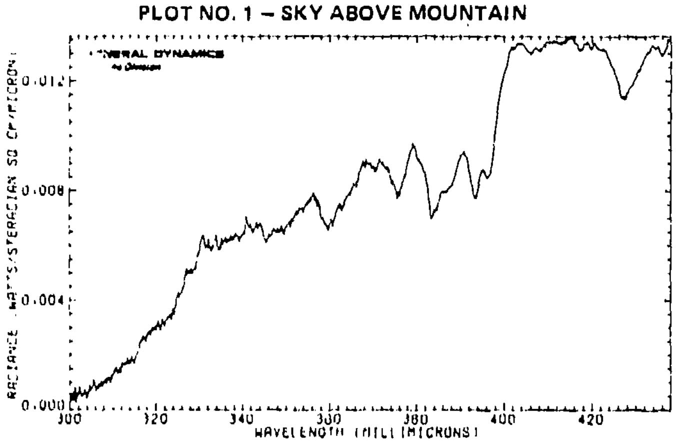
PLOT NO. 1 – SKY ABOVE MOUNTAIN
EL ANGLE: -2° AZ ANGLE: 175° MAG
PLOT NO. 2 – DISTANT MOUNTAIN
EL ANGLE: -3° AZ ANGLE: 175° MAG
PLOT NO. 3 – MIDDLE MOUNTAIN
EL ANGLE: -4° AZ ANGLE: 175° MAG
PLOT NO. 4 – NEAR MOUNTAIN
EL ANGLE: -5° AZ ANGLE: 175° MAG



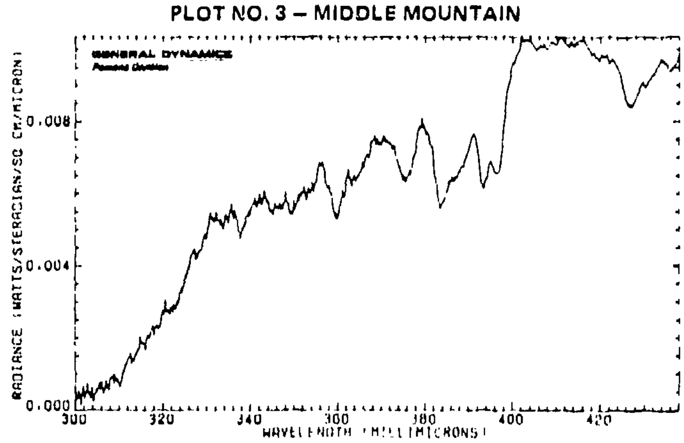
IR PHOTOGRAPH .7 – .9 MICRONS

UV PHOTOGRAPH .35 – .40 MICRONS

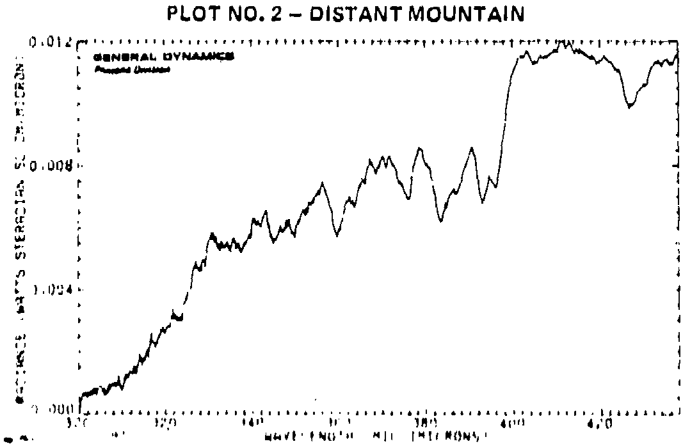
PLOT NO. 1 – SKY ABOVE MOUNTAIN



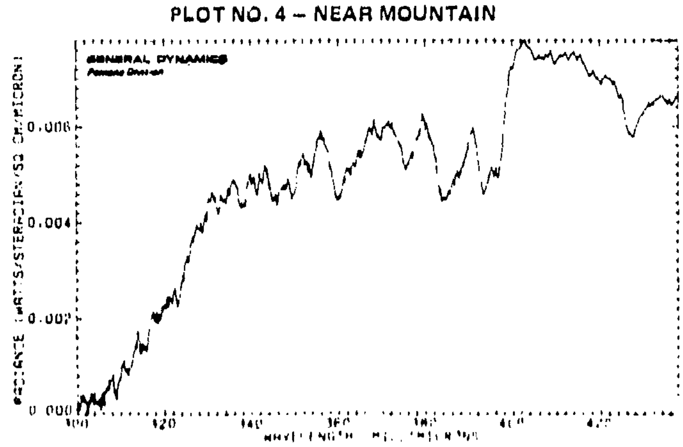
PLOT NO. 3 – MIDDLE MOUNTAIN



PLOT NO. 2 – DISTANT MOUNTAIN



PLOT NO. 4 – NEAR MOUNTAIN

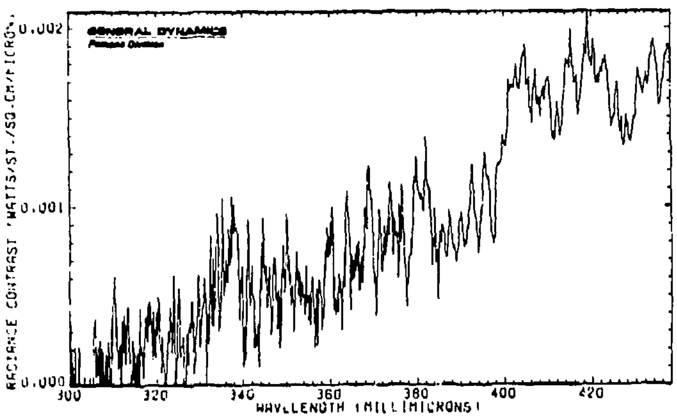


A63442-1

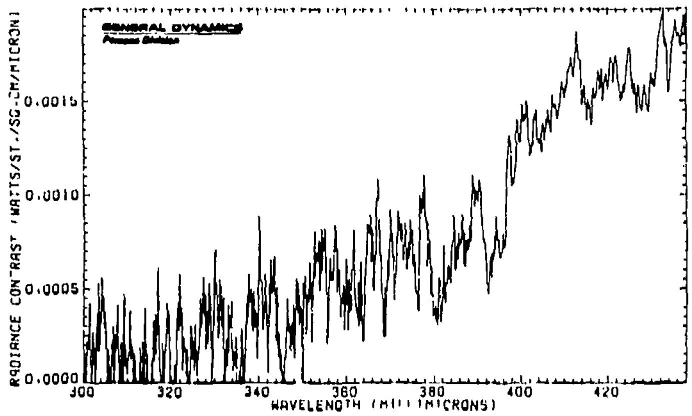
Figure 5-16.

ULTRAVIOLET BACKGROUND SITE NO. 16
DIFFERENCE PLOTS

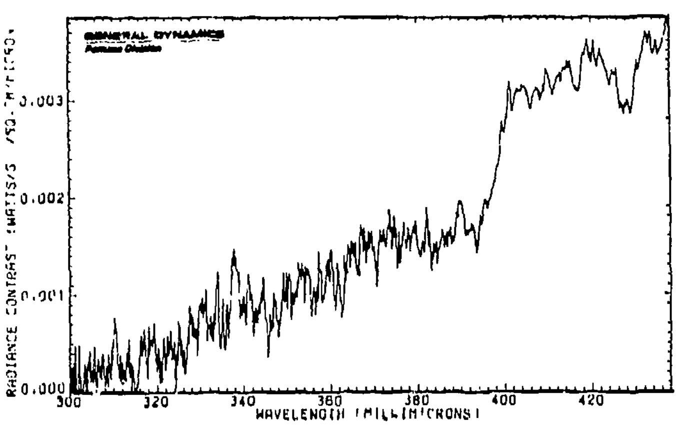
PLOT NO. 1 – PLOT NO. 2



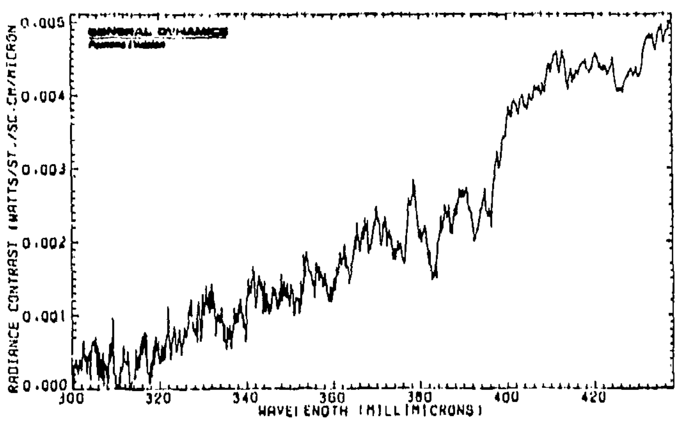
PLOT NO. 2 – PLOT NO. 3



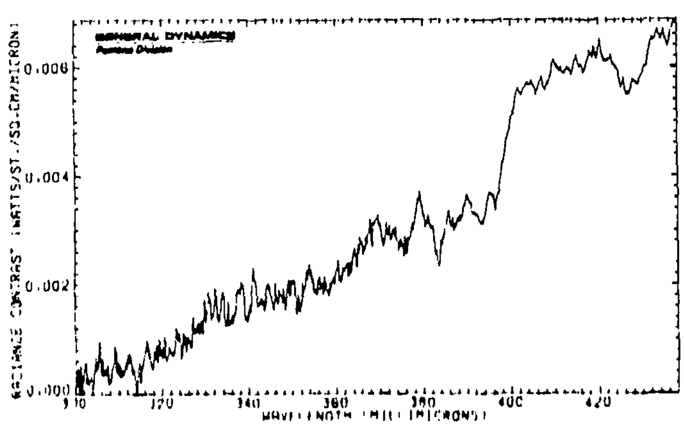
PLOT NO. 1 – PLOT NO. 3



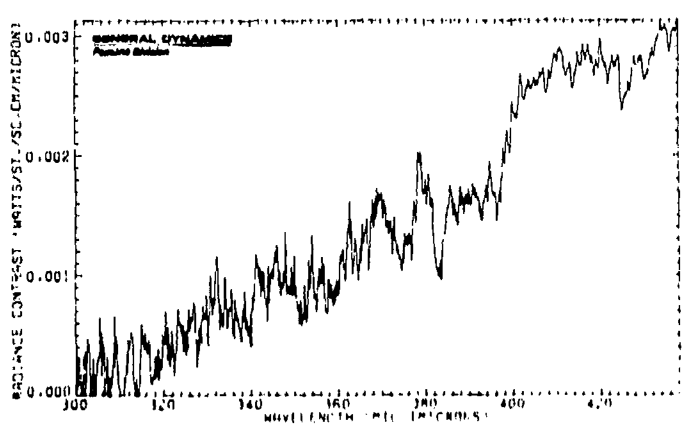
PLOT NO. 2 – PLOT NO. 4



PLOT NO. 1 – PLOT NO. 4



PLOT NO. 3 – PLOT NO. 4



A63443

Figure 5-16 (Continued).

ULTRAVIOLET BACKGROUND SITE NO. 17

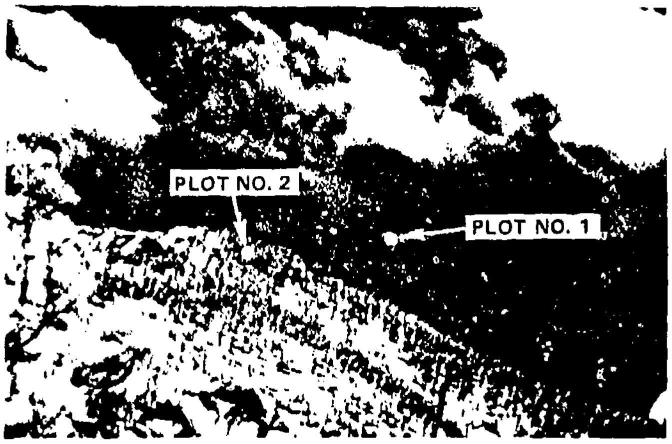
LOCATION: BLUE RIDGE, CALIF
DATE: MARCH 31, 1970
TIME: 12:10 PST
ELEVATION: 7386 FEET
TEMPEATIVE: 30°F
RELATIVE HUMIDITY: 37%
SUN ANGLE: 59.7° EL 170° AZ MAG

PLOT NO. 1 – BLUE SKY

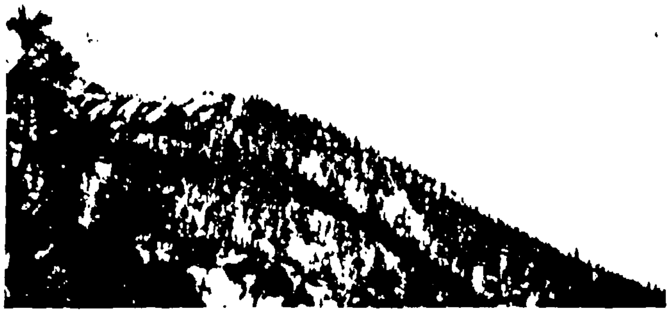
EL ANGLE: 7° AZ ANGLE: 230° MAG

PLOT NO. 2 – PINE TREES

EL ANGLE: 7° AZ ANGLE: 229° MAG

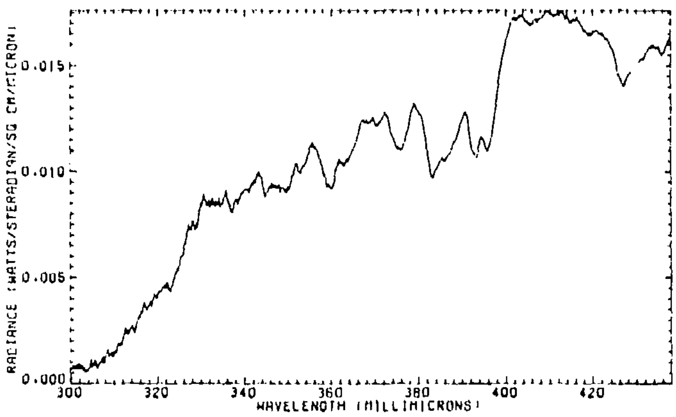


IR PHOTOGRAPH .7 – .9 MICRONS

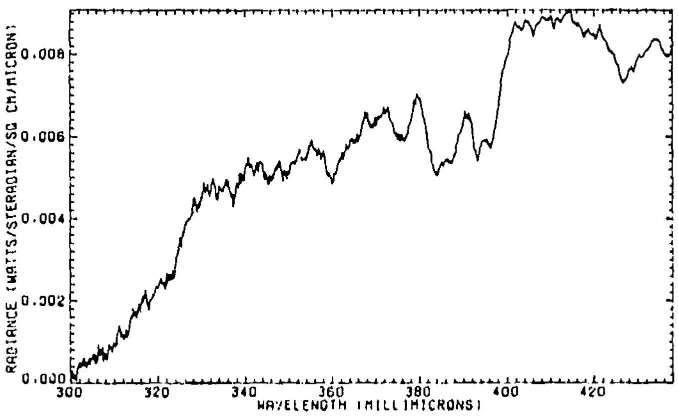


UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 – BLUE SKY

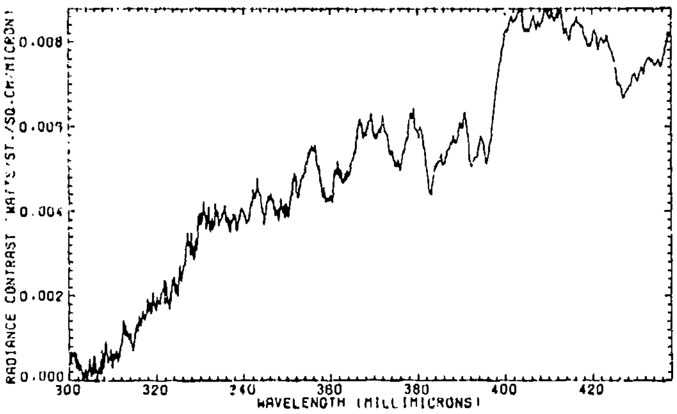


PLOT NO. 2 – PINE TREES



ULTRAVIOLET BACKGROUND SITE NO. 42
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



A63455-1

Figure 5-17.

ULTRAVIOLET BACKGROUND SITE NO. 18

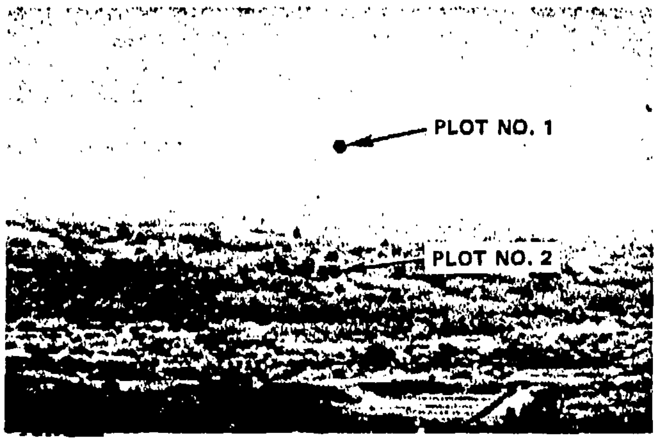
LOCATION: SAN MARCOS PASS
DATE: MAY 18, 1970
TIME: 13:47 PST
ELEVATION: 1850 FEET
TEMPERATURE: 75°F
RELATIVE HUMIDITY: 43%
SUN ANGLE: 57° EL 227° AZ MAG

PLOT NO. 1 – BLUE SKY

EL ANGLE: 3.6° AZ ANGLE: 155° MAG

PLOT NO. 2 – COAST LINE

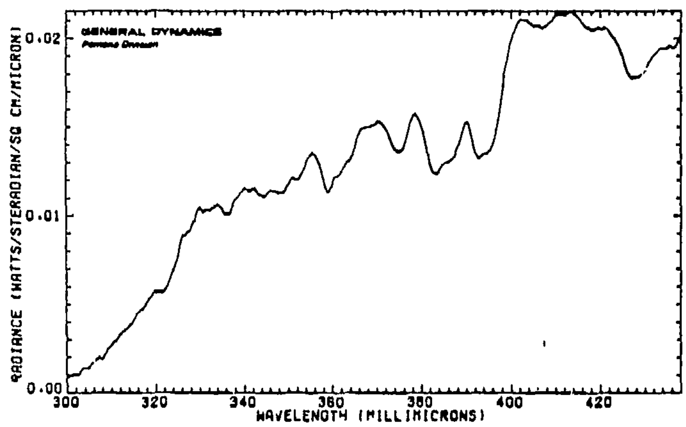
EL ANGLE: 4.5° AZ ANGLE: 155° MAG



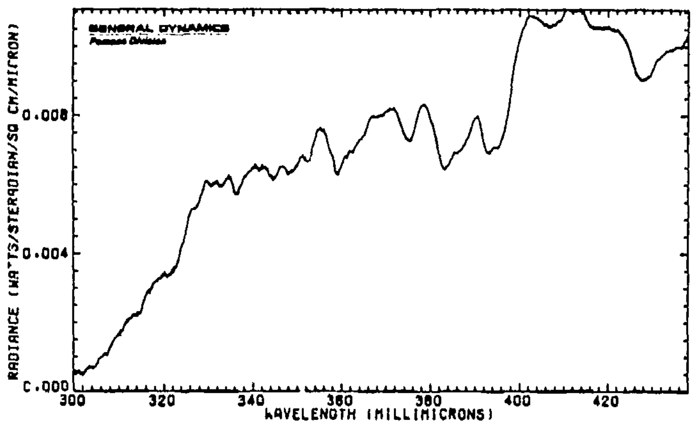
IR PHOTOGRAPH .7 – .9 MICRONS

UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 – BLUE SKY

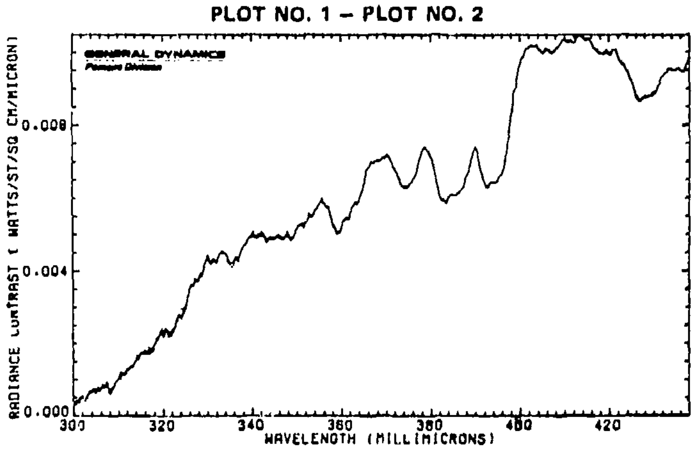


PLOT NO. 2 – COAST LINE



ULTRAVIOLET BACKGROUND SITE NO. 43
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



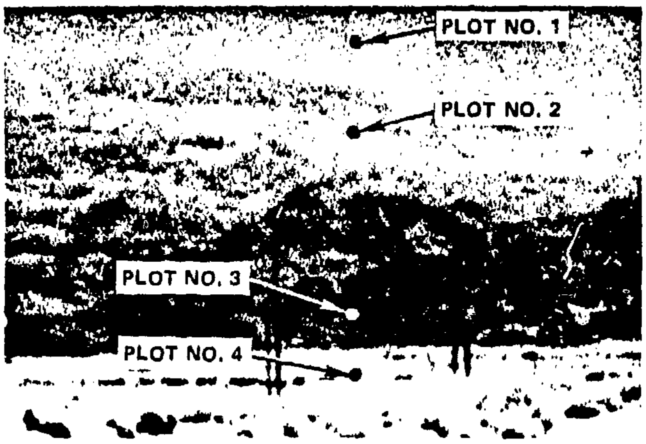
A63979-1

Figure 5-18.

ULTRAVIOLET BACKGROUND SITE NO. 19

LOCATION: DESERT HOT SPRINGS, CALIF.
DATE: APRIL 23, 1970
TIME: 13:35 PST
ELEVATION: 1087 FEET
TEMPERATURE: 78°F
RELATIVE HUMIDITY: 9%
SUN ANGLE: 57.5° EL 214° AZ MAG

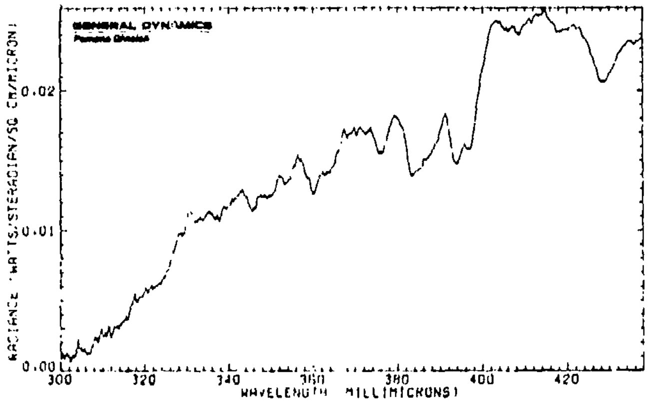
PLOT NO. 1 - BLUE SKY
EL ANGLE: 4° AZ ANGLE: 150° MAG
PLOT NO. 2 - DISTANT MOUNTAIN
EL ANGLE: 3° AZ ANGLE: 150° MAG
PLOT NO. 3 - NEAR MOUNTAIN
EL ANGLE: 1° AZ ANGLE: 150° MAG
PLOT NO. 4 - NEAR DESERT FLOOR
EL ANGLE: 0° AZ ANGLE: 150° MAG



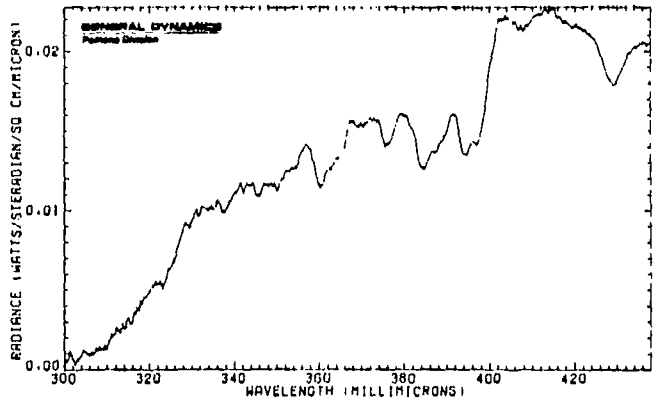
IR PHOTOGRAPH .7 – .9 MICRONS

UV PHOTOGRAPH .35 – .40 MICRONS

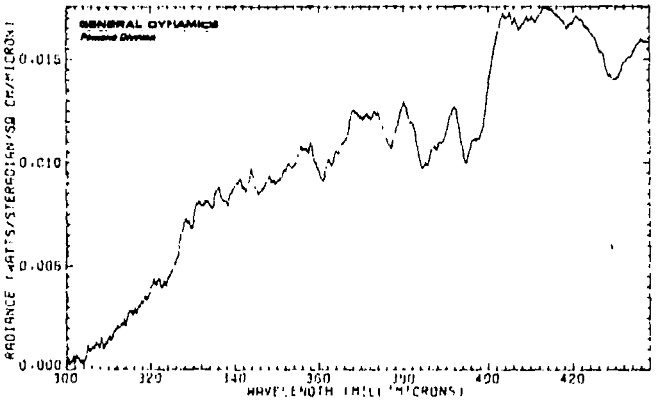
PLOT NO. 1 - BLUE SKY



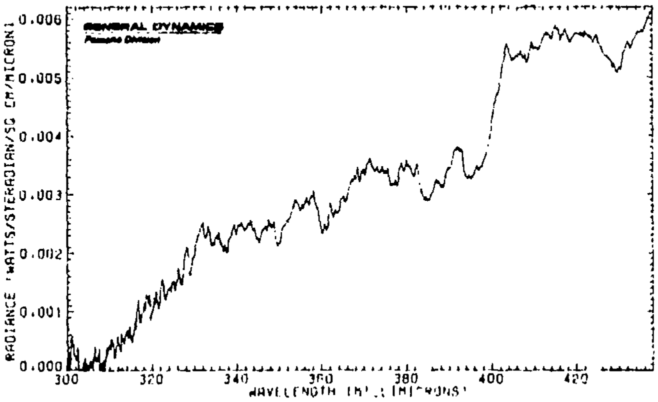
PLOT NO. 2 - DISTANT MOUNTAIN



PLOT NO. 3 - NEAR MOUNTAIN



PLOT NO. 4 - NEAR DESERT FLOOR

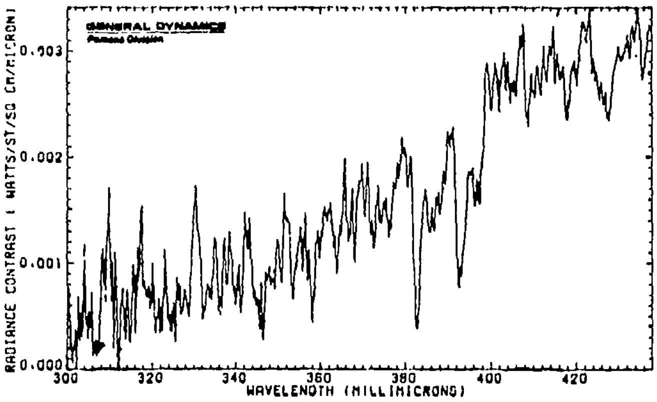


A63671-1

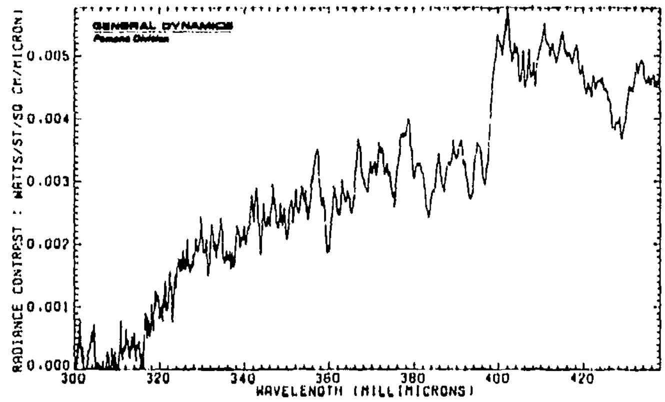
Figure 5-19.

ULTRAVIOLET BACKGROUND SITE NO. 19
DIFFERENCE PLOTS

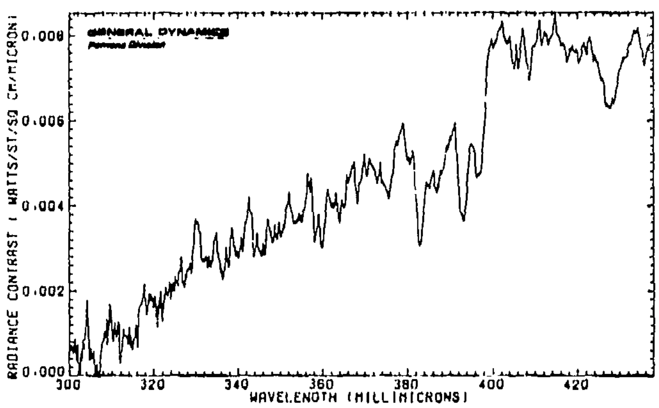
PLOT NO. 1 - PLOT NO. 2



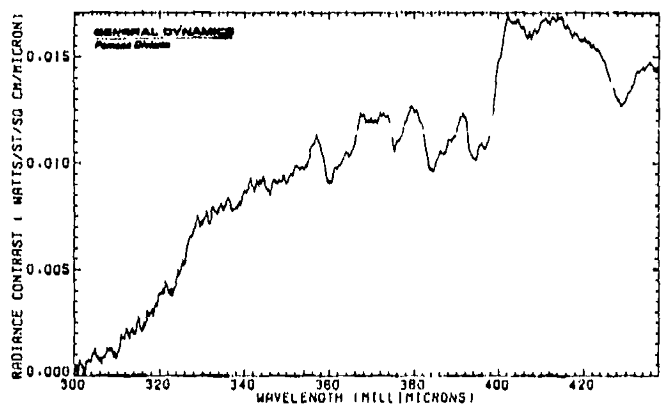
PLOT NO. 2 - PLOT NO. 3



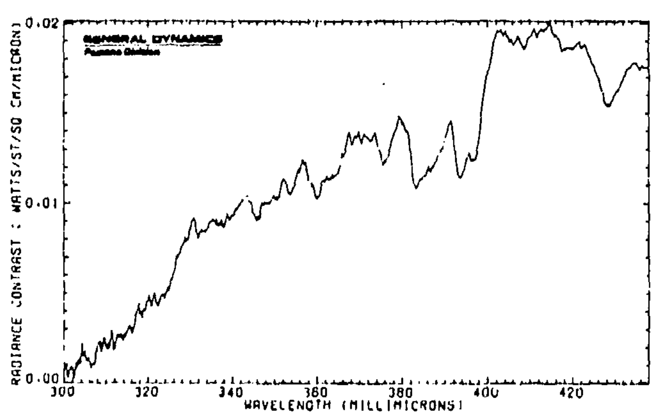
PLOT NO. 1 - PLOT NO. 3



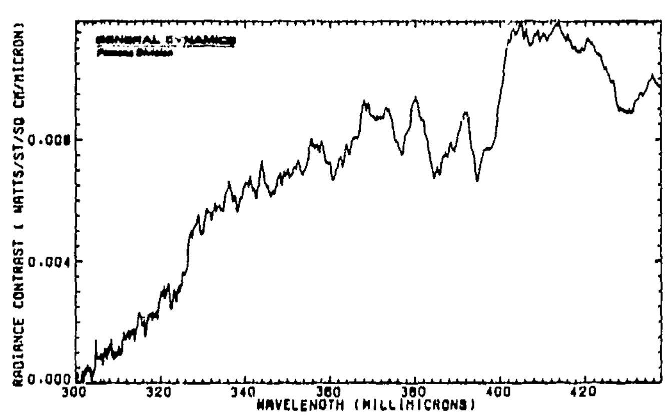
PLOT NO. 2 - PLOT NO. 4



PLOT NO. 1 - PLOT NO. 4



PLOT NO. 3 - PLOT NO. 4



A63672

Figure 5-19 (Continued).

ULTRAVIOLET BACKGROUND SITE NO. 20

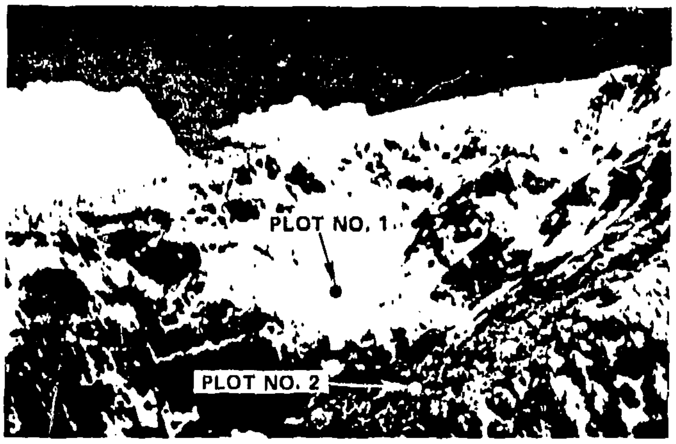
LOCATION: BLUE RIDGE, CALIF.
DATE: MARCH 31, 1970
TIME: 13:14 PST
ELEVATION: 7386 FEET
TEMPERATIVE: 39°F
RELATIVE HUMIDITY: 28%
SUN ANGLE: 54.5° EL 198° AZ MAG

PLOT NO. 1 – SNOW ON MOUNTAIN

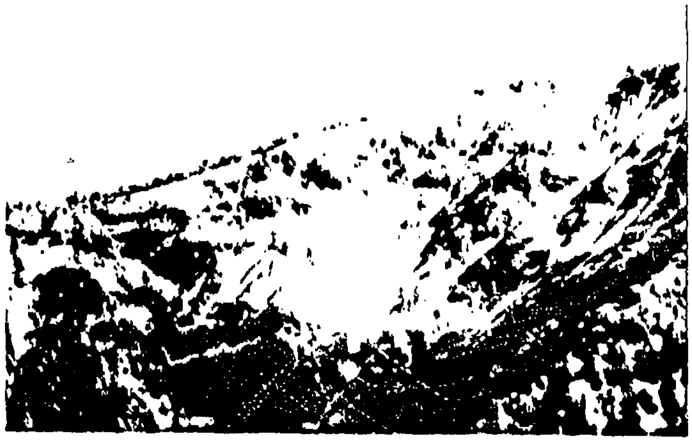
EL ANGLE: 2° AZ ANGLE: 225° MAG

PLOT NO. 2 – PINE COVERED MOUNTAIN

EL ANGLE: 1° AZ ANGLE: 226° MAG

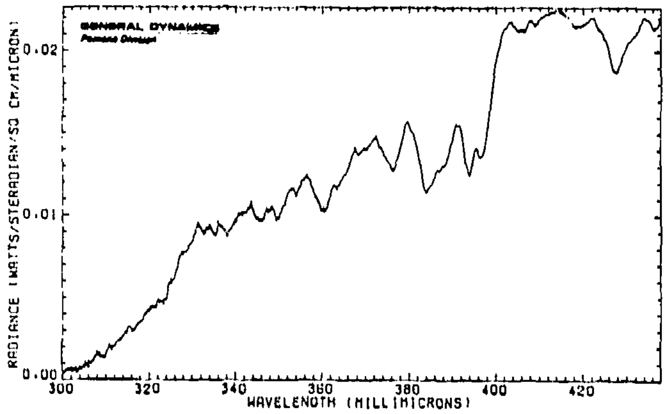


IR PHOTOGRAPH .7 – .9 MICRONS

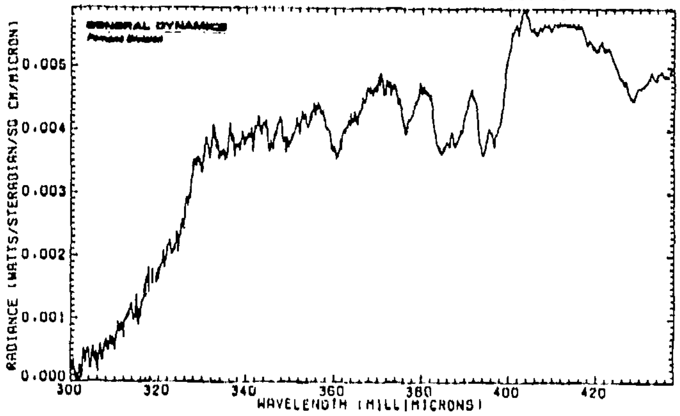


UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 – SNOW ON MOUNTAIN

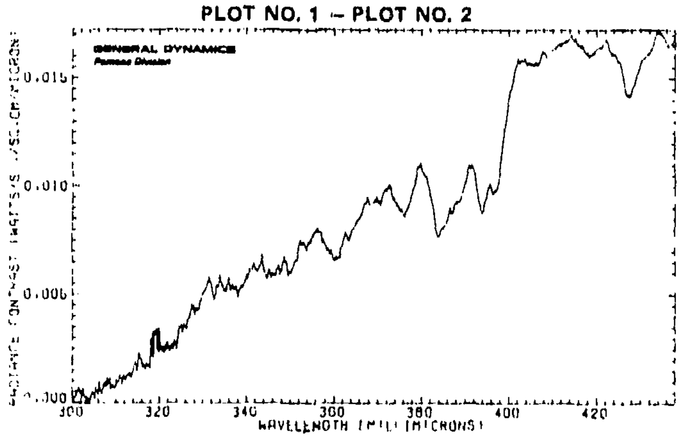


PLOT NO. 2 – PINE COVERED MOUNTAIN



ULTRAVIOLET BACKGROUND SITE NO. 45
DIFFERENCE PLOT

PLOT NO. 1 – PLOT NO. 2



A63460-1

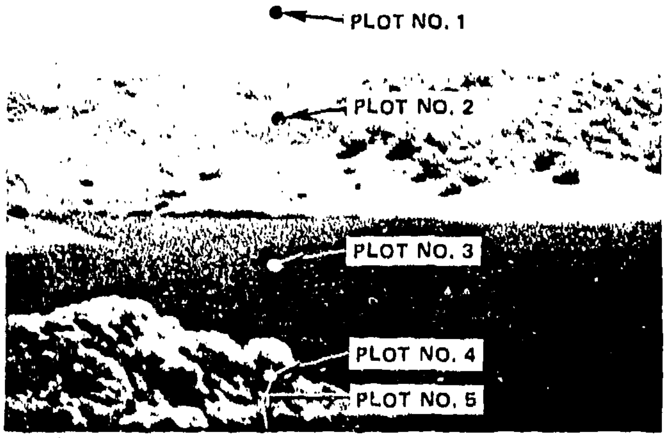
Figure 5-20.

ULTRAVIOLET BACKGROUND SITE NO. 21

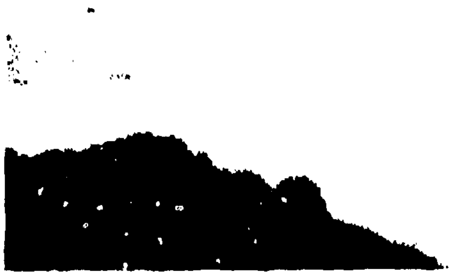
LOCATION: LAKE CASITAS
DATE: MAY 19, 1970
TIME: 11:19 PST
ELEVATION: 700 FEET
TEMPERATURE: 71°F
RELATIVE HUMIDITY: 49%
SUN ANGLE: 72.5°EL 137° AZ MAG

PLOT NO. 1 – BRIGHT HAZY SKY
EL ANGLE: +1° AZ ANGLE: 75° MAG
PLOT NO. 2 – LAND STRIP
EL ANGLE: 0° AZ ANGLE: 75° MAG
PLOT NO. 3 – FAR WATER
EL ANGLE: -1° AZ ANGLE 75° MAG

PLOT NO. 4 – LAND POINT
EL ANGLE: -2° AZ ANGLE: 75° MAG
PLOT NO. 5 – WATER BELOW POINT
EL ANGLE: -2.5° AZ ANGLE: 75° MAG

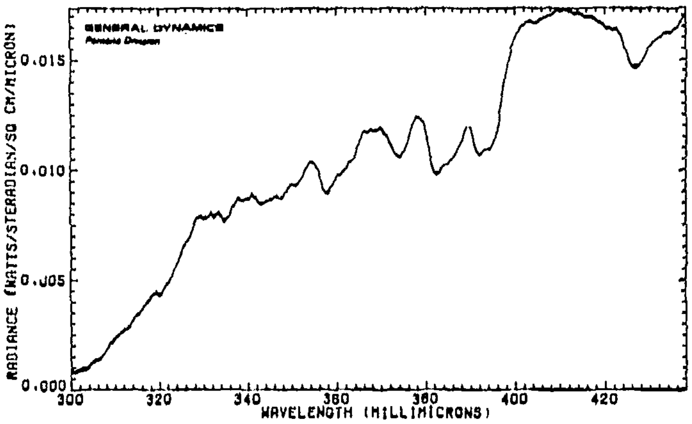


IR PHOTOGRAPH .7 – .9 MICRONS

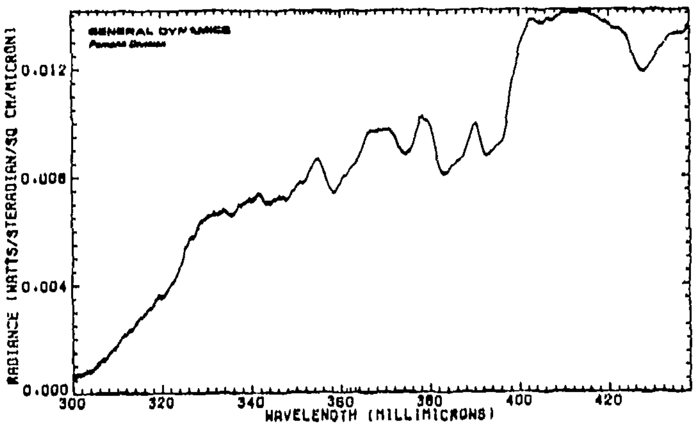


UV PHOTOGRAPH .35 – .40 MICRONS

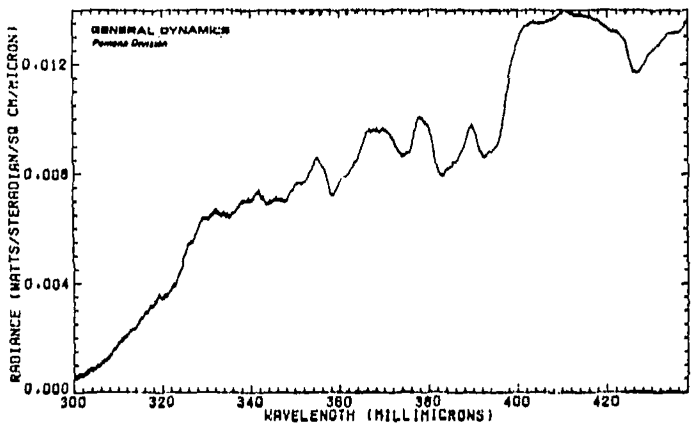
PLOT NO. 1 – BRIGHT HAZY SKY



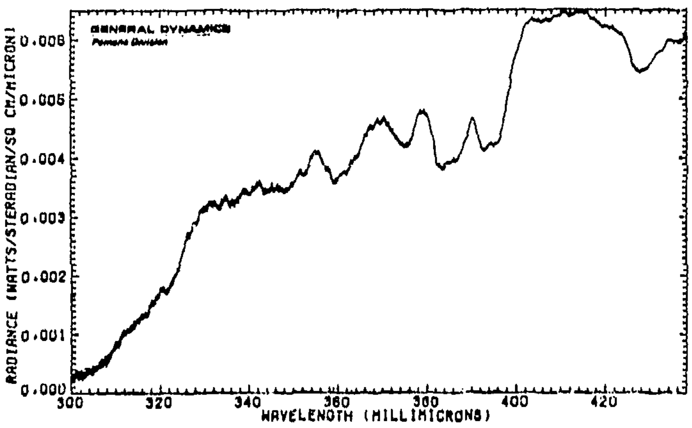
PLOT NO. 3 – FAR WATER



PLOT NO. 2 – LAND STRIP



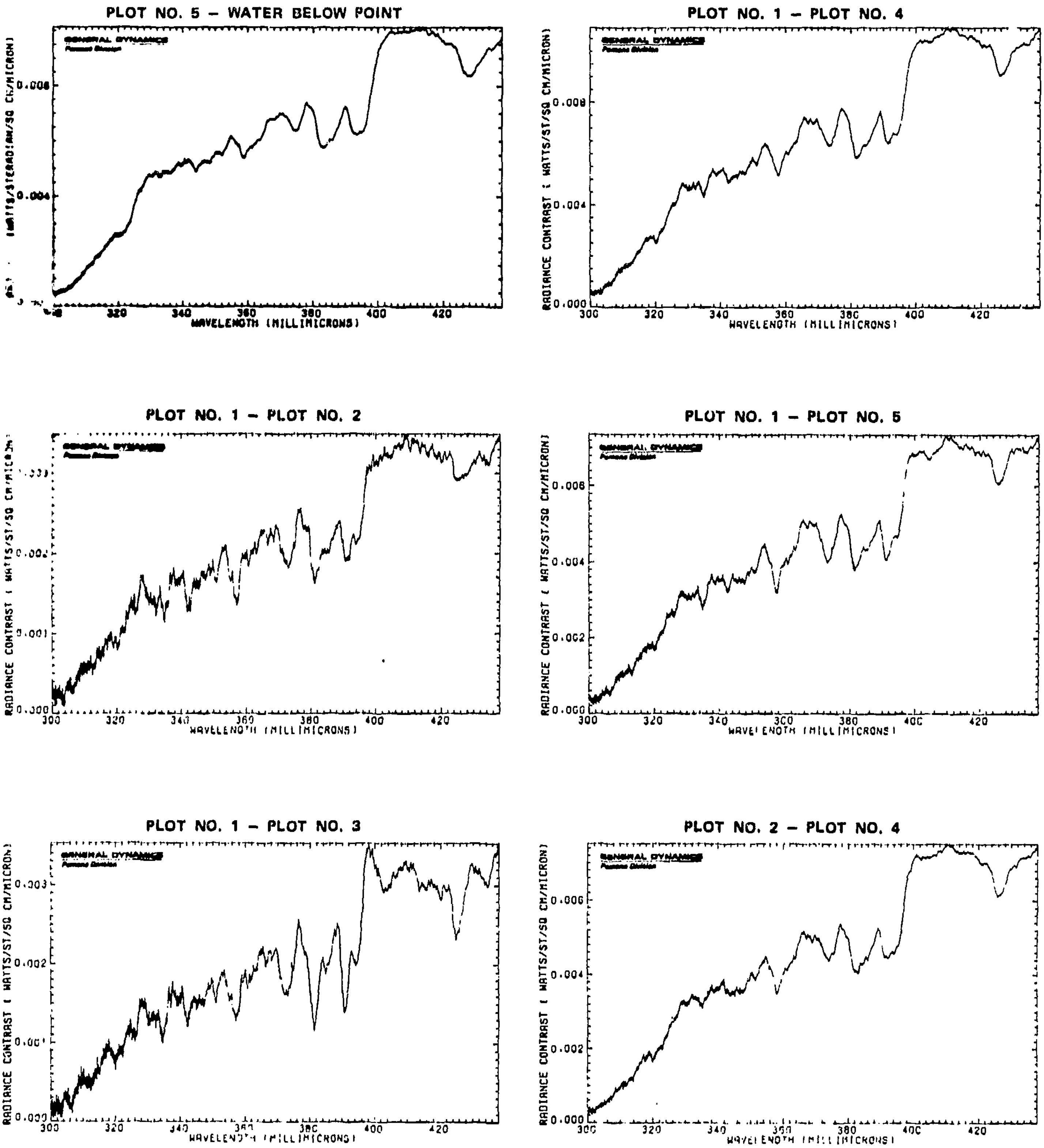
PLOT NO. 4 – LAND POINT



A63948-1

Figure 5-21.

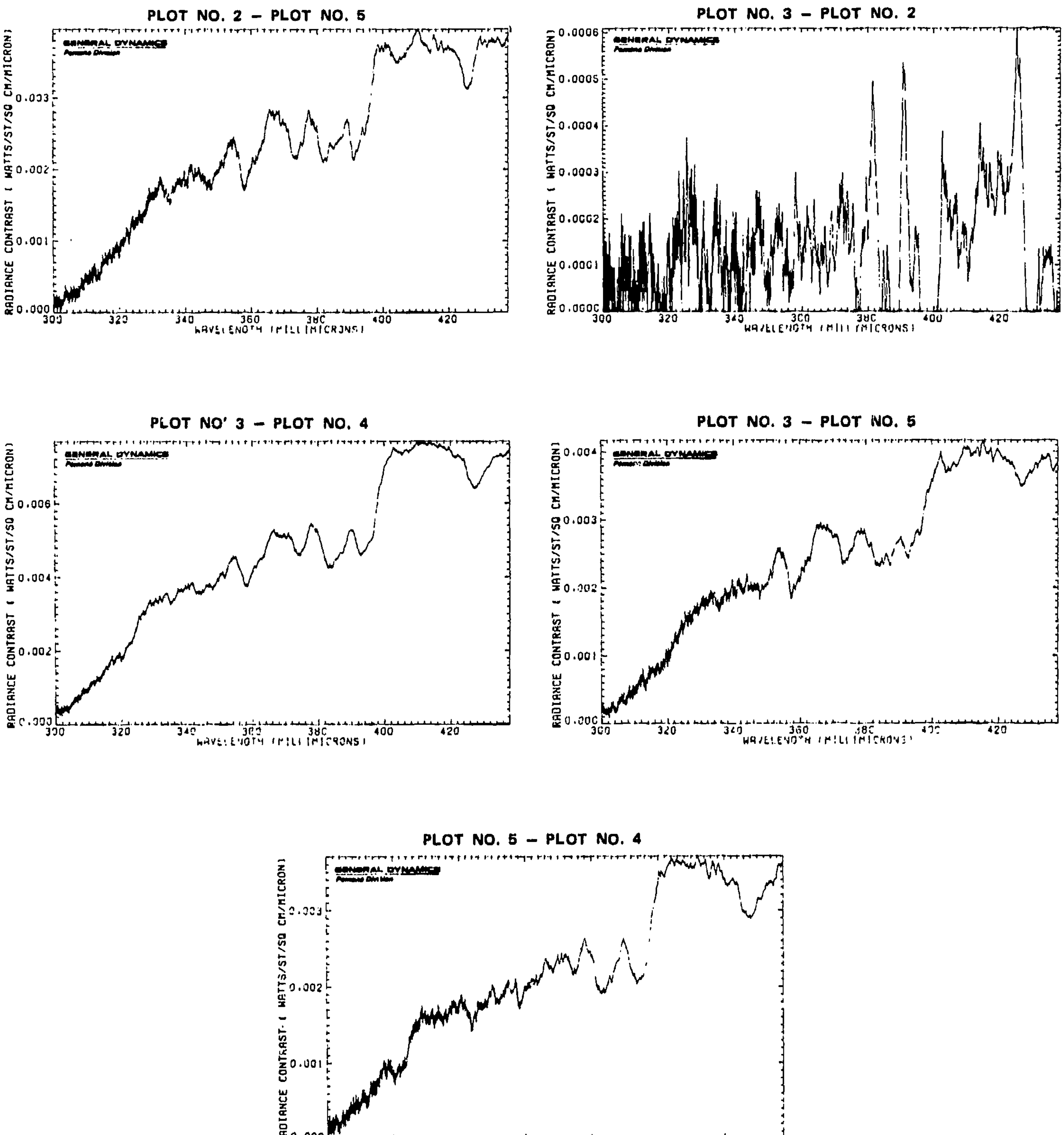
ULTRAVIOLET BACKGROUND SITE NO. 21
DIFFERENCE PLOTS



A63949

Figure 5-21 (Continued).

ULTRAVIOLET BACKGROUND SITE NO. 21
DIFFERENCE PLOTS



A63950

Figure 5-21 (Continued).

ULTRAVIOLET BACKGROUND SITE NO. 22

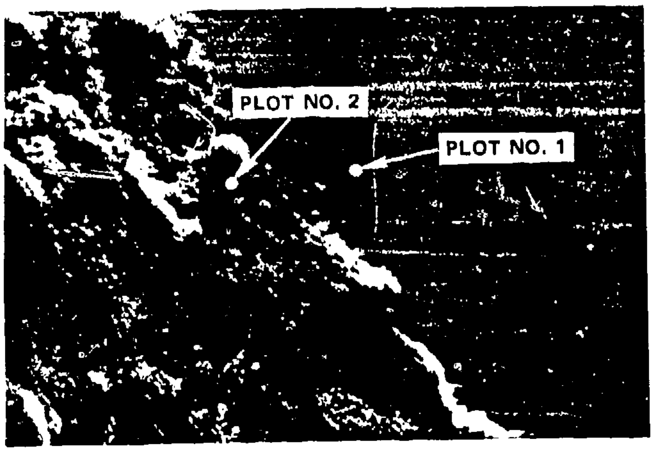
LOCATION: SAN ONOFRE
DATE: MAY 14, 1970
TIME: 14:27 PST
ELEVATION: 110 FEET
TEMPERATURE: 72°F
RELATIVE HUMIDITY: 60%
SUN ANGLE: 45° EL 235° AZ MAG

PLOT NO. 1 - WATER

EL ANGLE: -3° AZ ANGLE: 193° MAG

PLOT NO. 2 - HILLSIDE

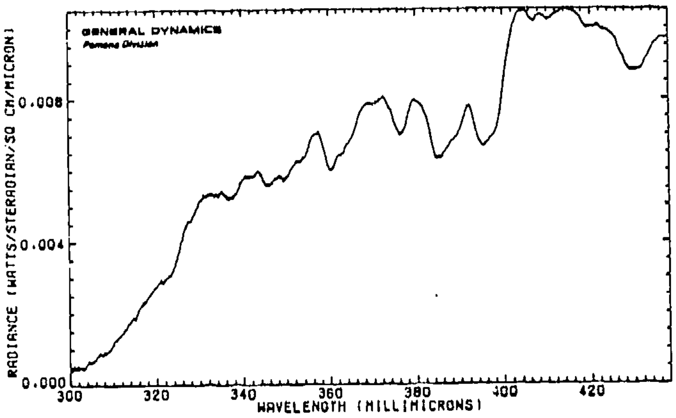
EL ANGLE: -3° AZ ANGLE: 192 MAG



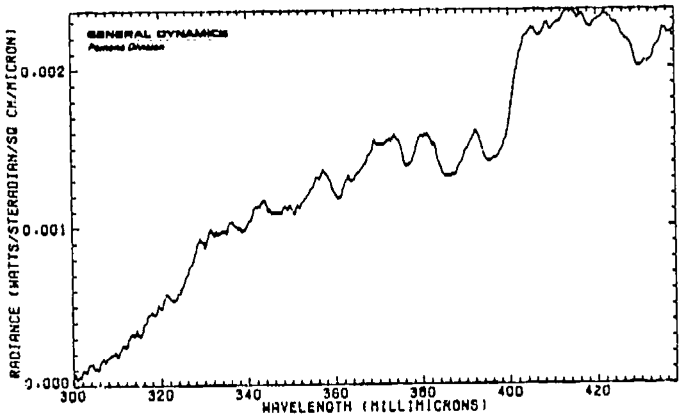
IR PHOTOGRAPH .7 – .9 MICRONS

UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 - WATER

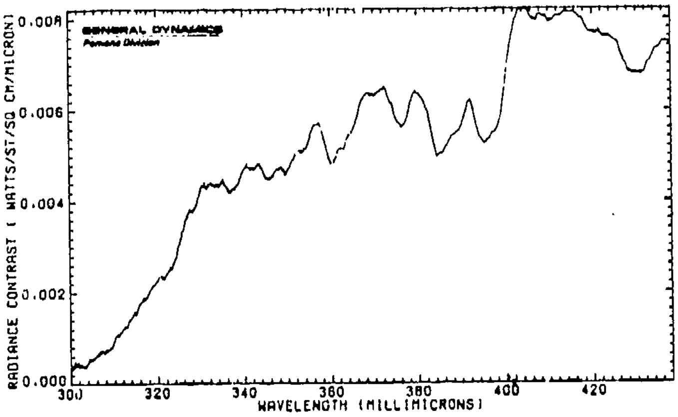


PLOT NO. 2 - HILLSIDE



ULTRAVIOLET BACKGROUND SITE NO. 47
DIFFERENCE PLOT

PLOT NO. 1 - PLOT NO. 2



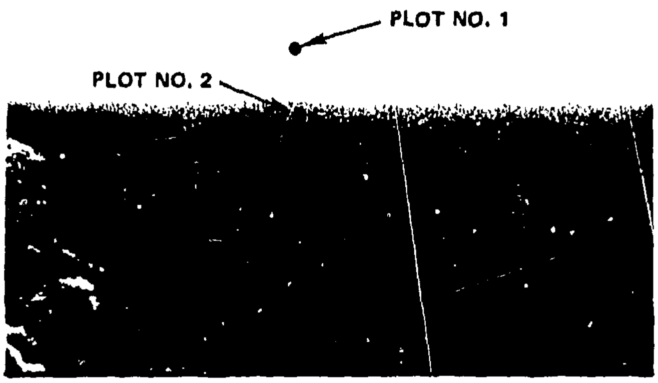
A63779-1

Figure 5-22.

ULTRAVIOLET BACKGROUND SITE NO. 23

LOCATION: SAN ONOFRE
DATE: MAY 14, 1970
TIME: 1417 PST
ELEVATION: 110 FEET
TEMPERATURE: 72°F
RELATIVE HUMIDITY: 60%
SUN ANGLE: 51° EL 230° AZ MAG

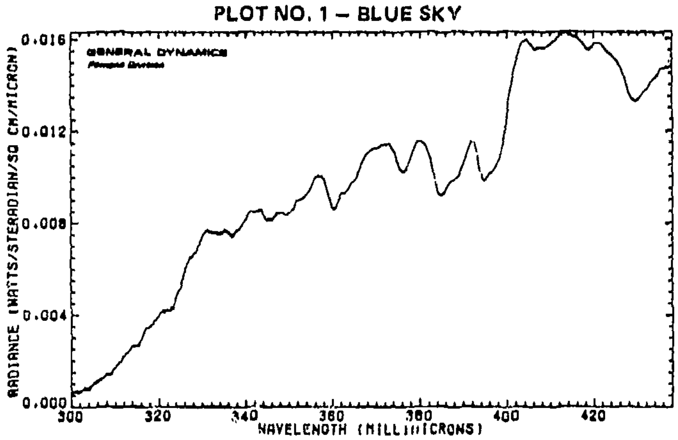
PLOT NO. 1 – BLUE SKY
EL ANGLE: +.2° AZ ANGLE: 195° MAG
PLOT NO. 2 – WATER HORIZON
EL ANGLE: –.2° AZ ANGLE: 195° MAG



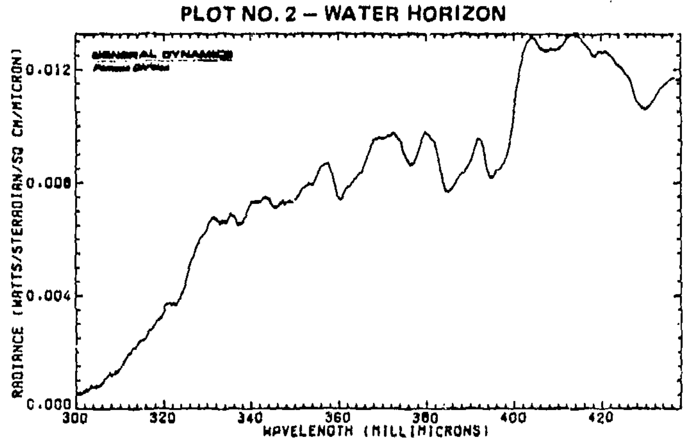
IR PHOTOGRAPH .7 – .9 MICRONS

UV PHOTOGRAPH .35 – .40 MICRONS

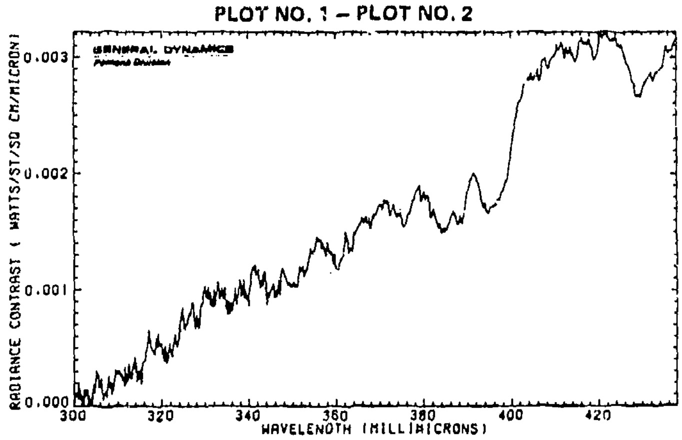
PLOT NO. 1 – BLUE SKY



PLOT NO. 2 – WATER HORIZON



ULTRAVIOLET BACKGROUND SITE NO. 48
DIFFERENCE PLOT
PLOT NO. 1 – PLOT NO. 2



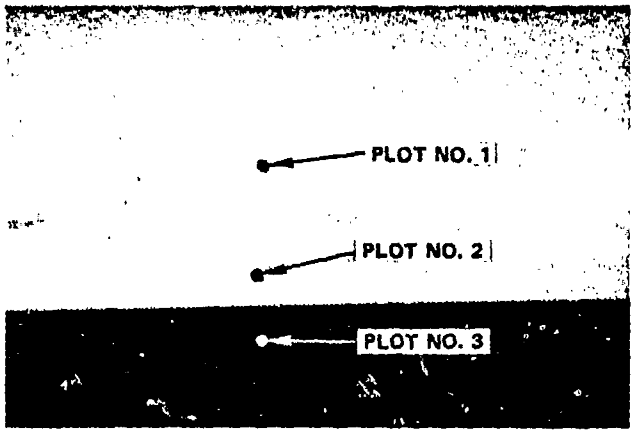
A63778-1

Figure 5-23.

ULTRAVIOLET BACKGROUND SITE NO. 24

LOCATION: SAN ONOFRE, CALIF
DATE: APRIL 28, 1970
TIME: 13:05 PST
ELEVATION:
TEMPERATIVE: 59°F
RELATIVE HUMIDITY: 40%
SUN ANGLE: 62.5° EL 207° AZ MAG

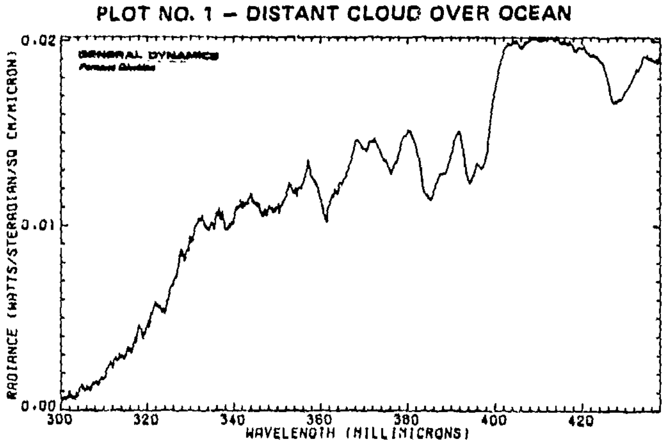
PLOT NO. 1 – DISTANT CLOUD OVER OCEAN
EL ANGLE: 2° AZ ANGLE: 195° MAG
PLOT NO. 2 – SKY NEAR HORIZON
EL ANGLE: 0.5° AZ ANGLE: 195° MAG
PLOT NO. 3 – OCEAN HORIZON
EL ANGLE: –0.5° AZ ANGLE: 195° MAG



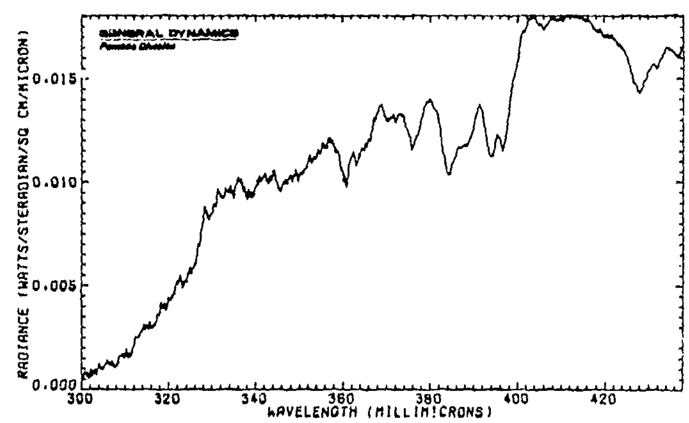
IR PHOTOGRAPH .7 – .9 MICRONS

UV PHOTOGRAPH .35 – .40 MICRONS

PLOT NO. 1 – DISTANT CLOUD OVER OCEAN



PLOT NO. 2 – SKY NEAR HORIZON



PLOT NO. 3 – OCEAN HORIZON

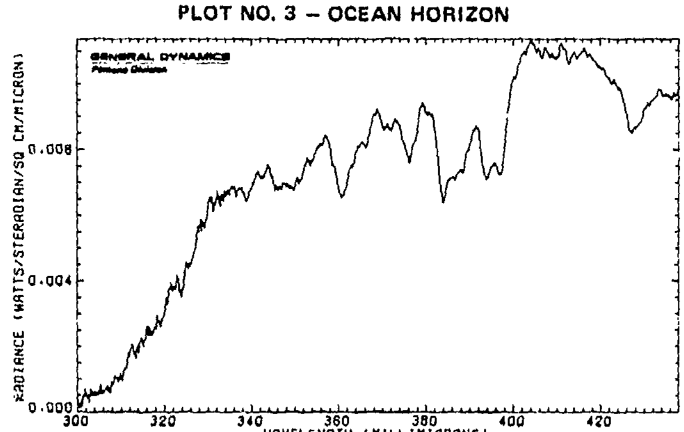


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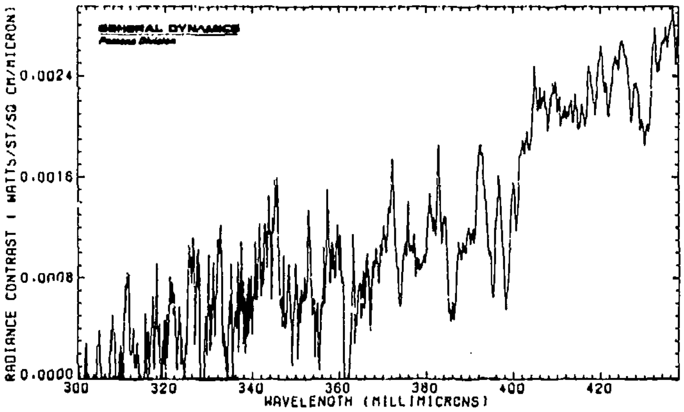
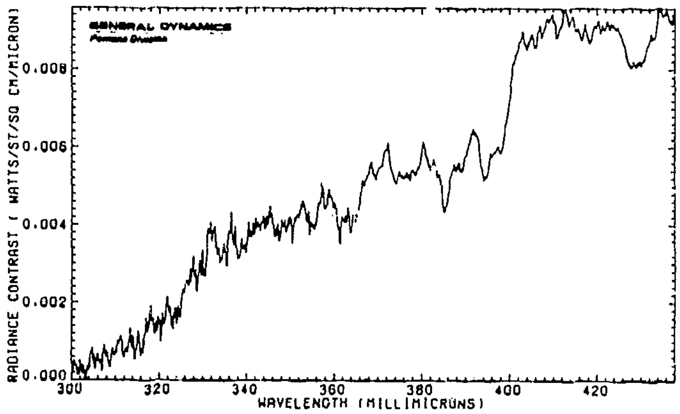
Figure 5-24.

ULTRAVIOLET BACKGROUND SITE NO. 24
DIFFERENCE PLOTS

PLOT NO. 1 – PLOT NO. 2



PLOT NO. 1 – PLOT NO. 3



PLOT NO. 2 – PLOT NO. 3

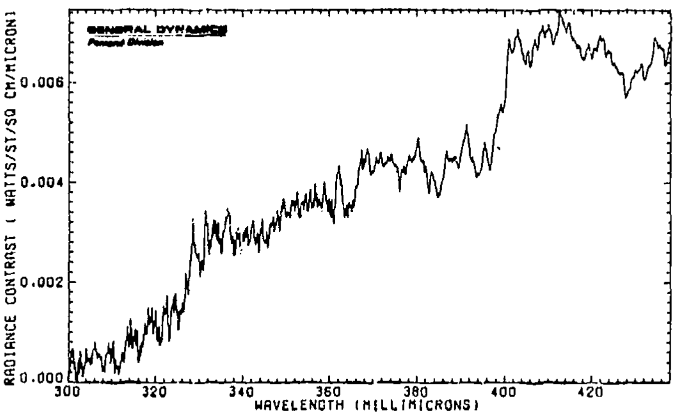


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Figure 5-24 (Continued).

SECTION 6

PHASE-III IR MEASUREMENT DATA
(2.0–12.8μ)

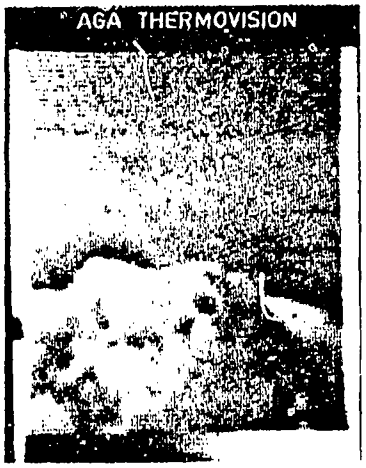
Section 6
PHASE III IR MEASUREMENT DATA (2-12.8μ)

This section presents the spectral radiance data from 8 natural background sites obtained during late 1974. These data were taken at San Clemente, California and represent the first spectral data taken using a new 2-14μ interferometer. The San Clemente measurements were performed to obtain data for typical ocean/terrain background sites.

Background spectral radiance data from each of 8 different sites are presented in Figures 6-1 through 6-8. Each figure contains the absolute spectral radiance (in microwatts per square centimeter per steradian per micron) of two portions of the background for the spectral region from 2 to 12.8μ. These absolute radiance spectra were obtained by referencing the measured interferometric data to a source maintained at liquid nitrogen temperature (77°K) thereby removing instrument radiation components from the data. The data typically represent the coherent average of interferograms recorded over a 10 second time period. In addition to the absolute radiance spectra, a radiance difference spectrum is presented in each figure. This spectrum was derived by taking the difference of the two absolute spectra in the wavelength domain. To complement the spectral data, infrared photographs are provided which illustrate the relative radiation of the measurement site in three spectral bands. For the near-IR band (.75 - .90μ) an infrared photograph is given. Thermal images are provided to describe the spacial radiation geometry in the mid-IR (3.6 - 5.4μ) and in the long wavelength-IR (7.5 - 13μ) spectral regions. Additional information given includes temperature, relative humidity, line-of-sight angles, and sun angles.

The radiance spectra presented in Figures 6-1 through 6-8 display graybody continuum radiation and molecular emission/absorption structure. The graybody radiation components evolve from two different sources and appear in two distinct spectral regions. In the 2 to 3μ spectral region the radiance spectra of certain backgrounds display a high temperature graybody characteristic. This is due to diffuse reflection and scattering of sunlight. In the 3 to 13μ spectral region a definite low temperature graybody continuum can be observed in all the absolute radiance spectra. This component provides the predominant spectral shape in this region and is due to the ambient temperature emission of the constituents of the scene.

The radiance difference spectra shown in the C portion of Figures 6-1 through 6-8 all show a significantly larger contrast in the 8 - 13μ spectral region than in the 2 - 8μ band. The molecular line structure inherent in the absolute radiance spectra become much more pronounced in the contrast spectra. This is because the graybody continuum portion of the absolute spectra are generally quite similar both in amplitude and in spectral shape. Consequently, the major difference between the two absolute spectra is in the molecular line structure.

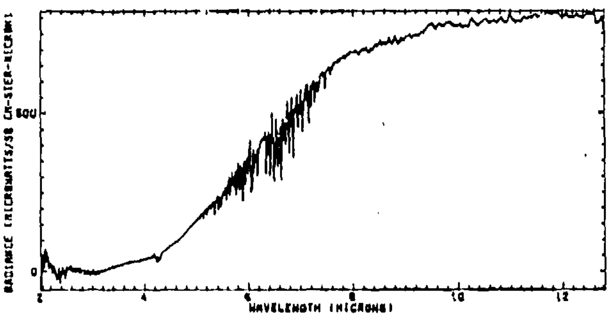


THERMAL IMAGE(2-5.5μ)

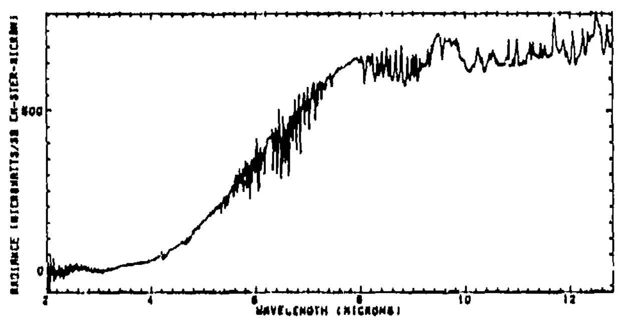
NEAR-IR PHOTO(.75-.90μ)

THERMAL IMAGE(7.5 - 13μ)

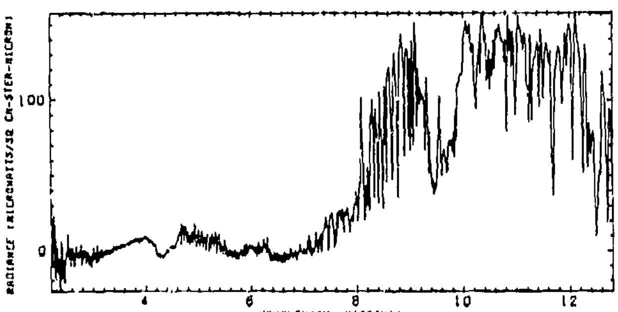
A. Radiance Spectrum of Terrain



B. Radiance Spectrum of Water



C. Terrain/Water Difference Spectrum

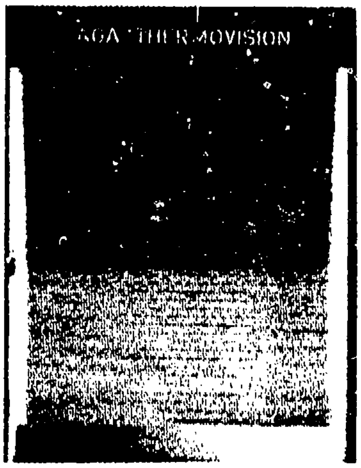


Location: San Clemente, CA
Date: October 16, 1974
Time: 11:21 P.D.T.
Temperature: 78°F
Relative Humidity: 27%
Azimuth: 165° Mag.
Elevation: -5°
Sun Azimuth: 154°
Sun Elevation: 44°

Figure 6-1. Spectral Radiance Data From Background Site No. 2 Terrain/Water

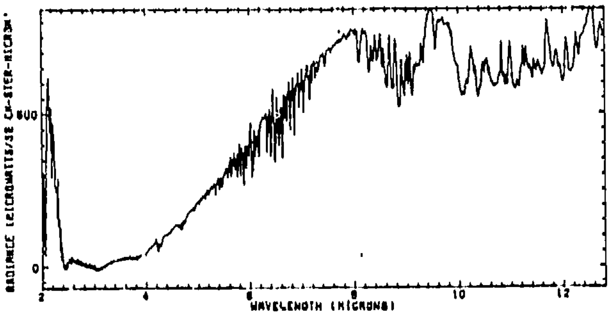
THERMAL IMAGE(2-5.5μ)

NEAR-IR PHOTO(.75-.90μ)

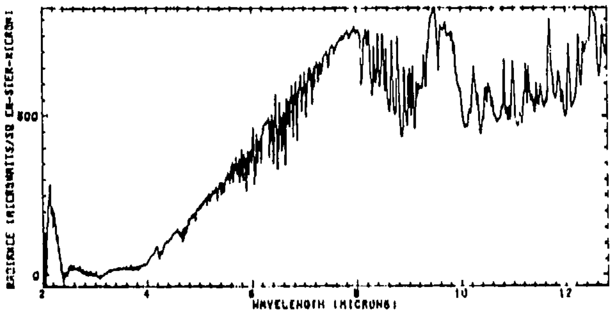


THERMAL IMAGE(7.5 - 13μ)

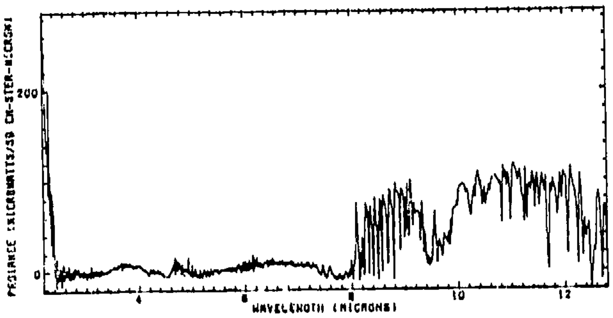
A. Radiance Spectrum of Cloud



B. Radiance Spectrum of Sky



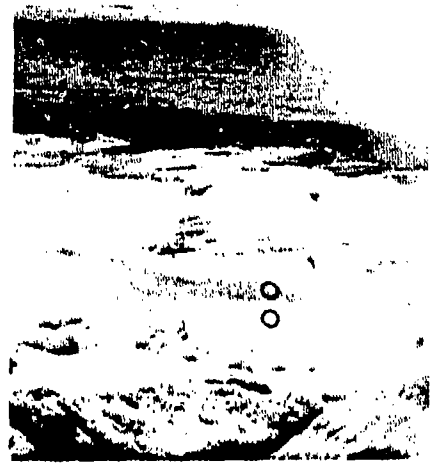
C. Cloud/Sky Difference Spectrum



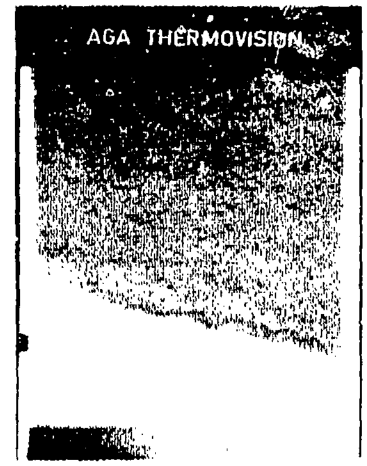
Location: San Clemente, CA
Date: October 16, 1974
Time: 11:35 P.D.T.
Temperature: 78°F
Relative Humidity: 27%
Azimuth: 190° Mag.
Elevation: +4°
Sun Azimuth: 158°
Sun Elevation: 45°

Figure 6-2. Spectral Radiance Data From Background Site No. 3 Cloud/Sky

THERMAL IMAGE(2-5.5μ)

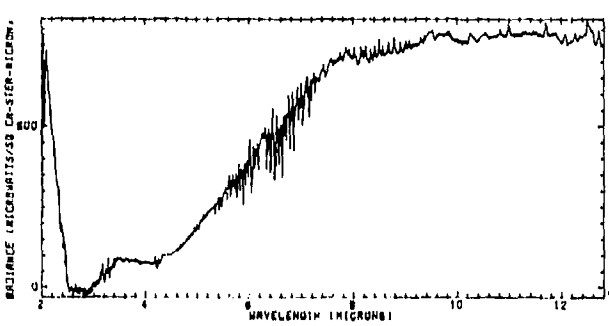


NEAR-IR PHOTO(.75-.90μ)

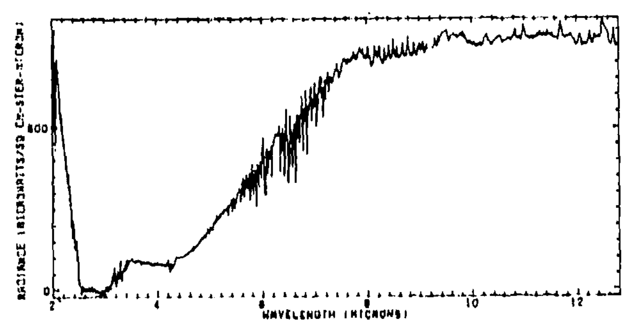


THERMAL IMAGE(7.5 - 13 μ)

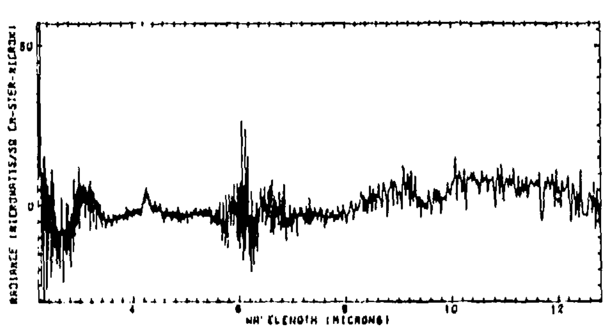
A. Radiance Spectrum of Sand



B. Radiance Spectrum of Surf



C. Sand/Surf Difference Spectrum



Location: San Clemente, CA
Date: October 16, 1974
Time: 11:41 P.D.T.
Temperature: 78°F
Relative Humidity: 27%
Azimuth: 170° Mag.
Elevation: - 7.5°
Sun Azimuth: 161°
Sun Elevation: 46°

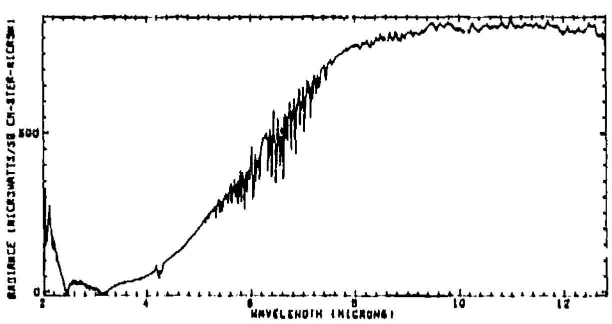
Figure 6-3. Spectral Radiance Data From Background Site No. 4 Sand/Surf

THERMAL IMAGE(2-5.5μ)

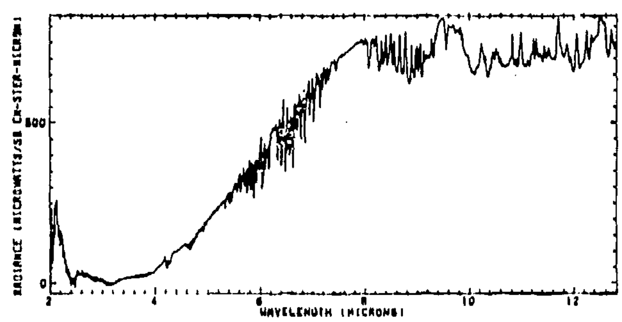
NEAR-IR PHOTO(.75-.90μ)

THERMAL IMAGE(7.5 - 13μ)

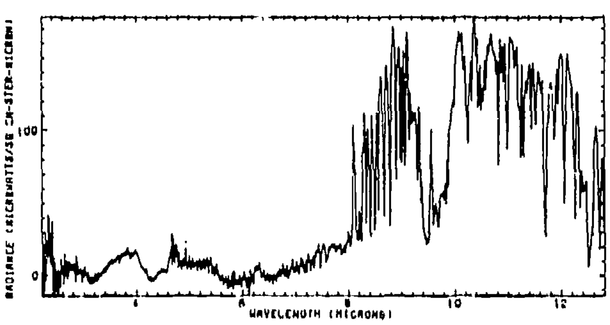
A. Radiance Spectrum of Rock



B. Radiance Spectrum of Water

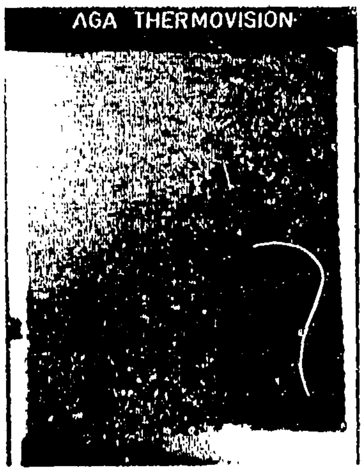


C. Rock/Water Difference Spectrum



Location: San Clemente, CA
Date: October 16, 1974
Time: 11:48 P.D.T.
Temperature: 78°F
Relative Humidity: 27%
Azimuth: 190° Mag.
Elevation: + 2°
Sun Azimuth: 163°
Sun Elevation: 46.5°

Figure 6-4. Spectral Radiance Data From Background Site No. 5 Rock/Water

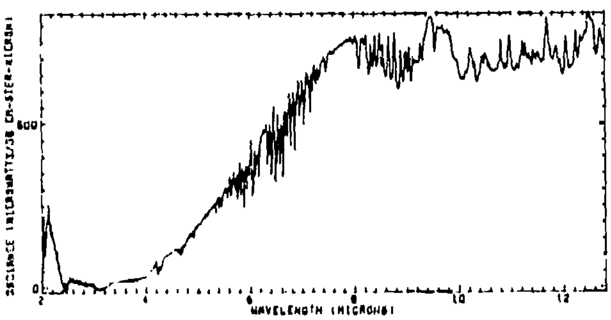


THERMAL IMAGE(2-5.5μ)

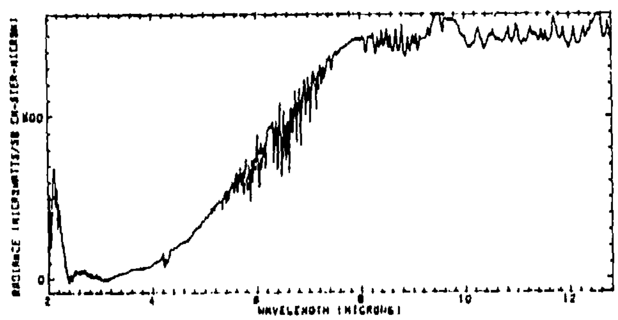
NEAR-IR PHOTO(.75-.90μ)

THERMAL IMAGE(7.5 - 13 μ)

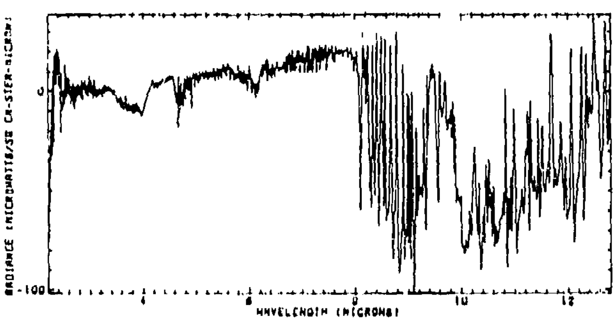
A. Radiance Spectrum of Ocean



B. Radiance Spectrum of Cloud

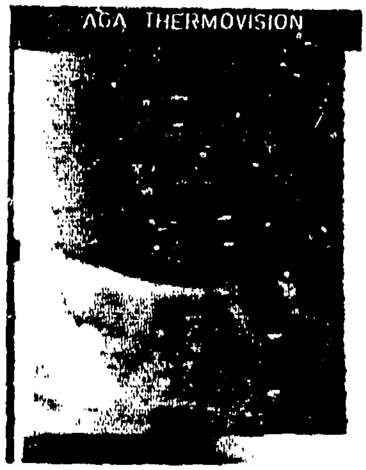


C. Ocean/Cloud Difference Spectrum



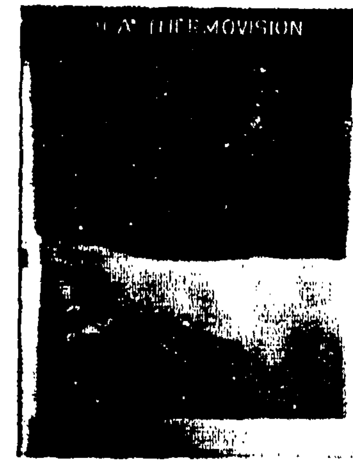
Location: San Clemente, CA
Date: October 16, 1974
Time: 11:54 P.D.T.
Temperature: 78°F
Relative Humidity: 27%
Azimuth: 220° Mag.
Elevation: + 1°
Sun Azimuth: 166°
Sun Elevation: 46.7°

Figure 6-5. Spectral Radiance Data From Background Site No. 6 Ocean/Cloud



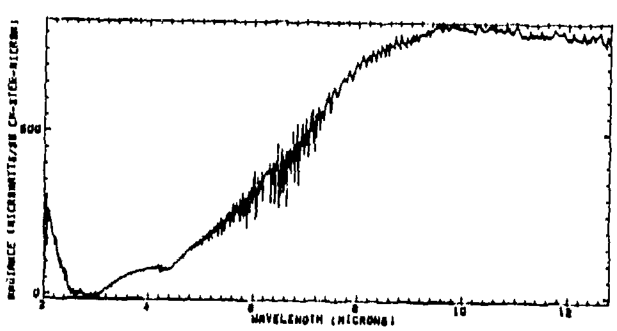
THERMAL IMAGE(2-5.5μ)

NEAR-IR PHOTO(.75-.90μ)

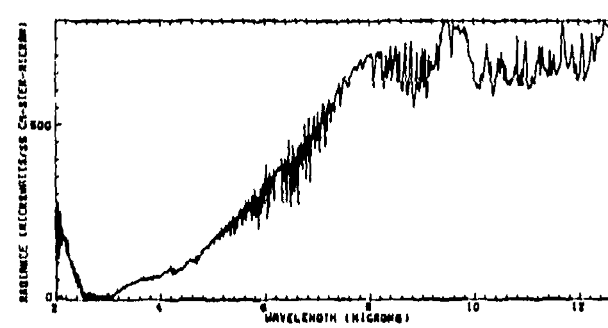


THERMAL IMAGE(7.5 - 13μ)

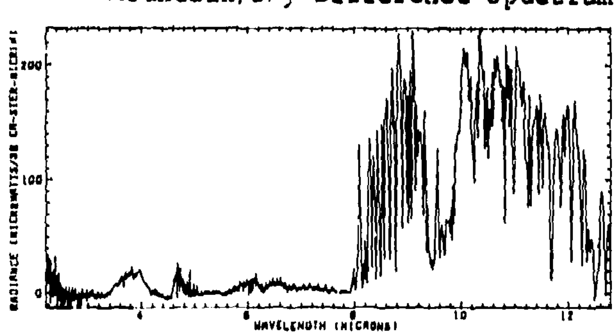
A. Radiance Spectrum of Mountain



B. Radiance Spectrum of Sky



C. Mountain/Sky Difference Spectrum



Location: San Clemente, CA
Date: October 16, 1974
Time: 12:15 P.D.T.
Temperature: 78°F
Relative Humidity: 27%
Azimuth: 105° Mag.
Elevation: + 2°
Sun Azimuth: 172°
Sun Elevation: 47.3°

Figure 6-6. Spectral Radiance Data From Background Site No. 7 Mountain/Sky

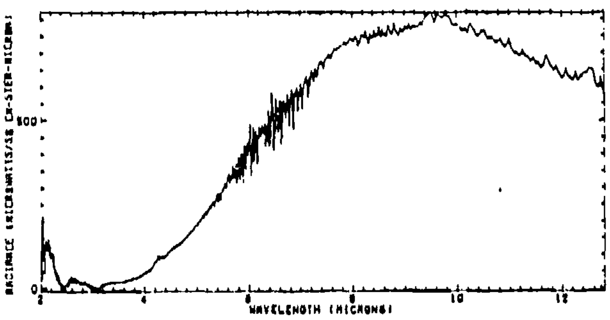
NOT AVAILABLE

THERMAL IMAGE(2-5.5μ)

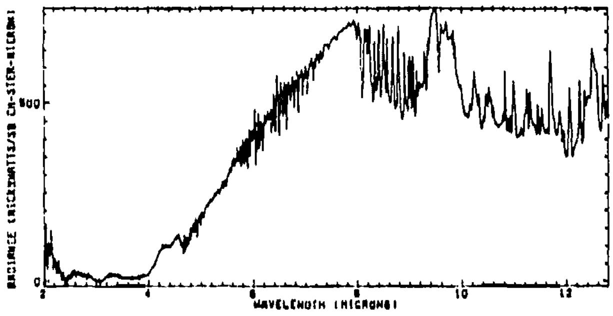
NEAR-IR PHOTO(.75-.90μ)

THERMAL IMAGE(7.5 - 13 μ)

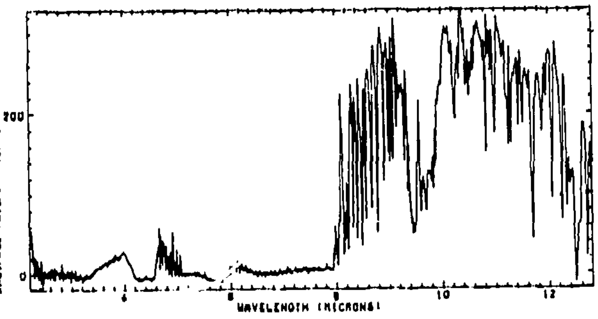
A. Radiance Spectrum of Trees



B. Radiance Spectrum of Sky



C. Trees/Sky Difference Spectrum



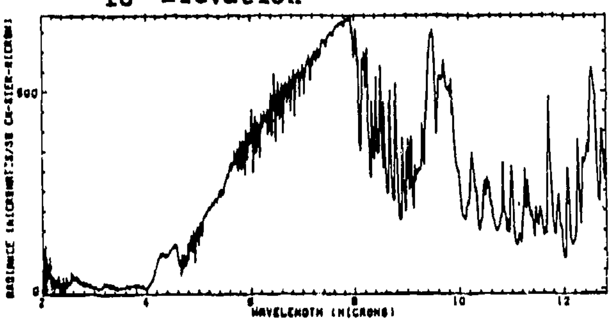
Location: San Clemente, CA
Date: October 16, 1974
Time: 14:20 P.D.T.
Temperature: 80°F
Relative Humidity: 35%
Azimuth: 60° Mag.
Elevation: + 8°
Sun Azimuth: 215°
Sun Elevation: 41.5°

Figure 6-7. Spectral Radiance Data From Background Site No. 8 Trees/Sky

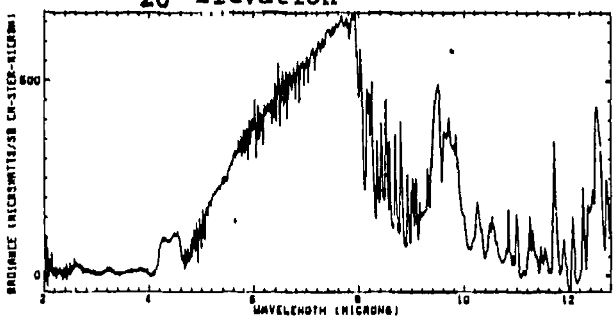
NOT AVAILABLE

THERMAL IMAGE(2-5.5μ)　　NEAR-IR PHOTO(.75-.90μ)　　THERMAL IMAGE(7.5 - 13μ)

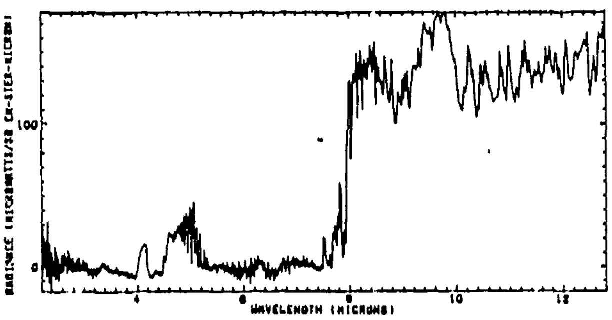
A. Radiance Spectrum of Sky at 10° Elevation



B. Radiance Spectrum of Sky at 20° Elevation



C. 10° Sky/ 20° Sky Difference Spectrum



Location: San Clemente, CA
Date: October 16, 1974
Time: 14:42 P.D.T.
Temperature: 80°F
Relative Humidity: 35%
Azimuth: 115° Mag.
Elevation: 20°/10°
Sun Azimuth: 221°
Sun Elevation: 38.9°

Figure 6-8. Spectral Radiance Data From Background Site No. 9 Sky at 20° and 10° Elevation