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APOLLO 17 PHOTOGRAPH
EVALUATION (APE) DATA BOOK

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JOHNSON SPACE CENTER
HOUSTON, TEXAS



Mathematical Physics Branch
MISSION PLANNING AND ANALYSIS DIVISION
National Aeronautics and Space Administration
LYNDON B. JOHNSON SPACE CENTER
Houston, Texas

JSC-03573

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PROJECT APOLLO

APOLLO 17 PHOTOGRAPH EVALUATION (APE) DATA BOOK

By H. H. Cunningham
TRW systems Group

February 22, 1974

MISSION PLANNING AND ANALYSIS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JOHNSON SPACE CENTER
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APOLLO 17 PHOTOGRAPH EVALUATION (APE) DATA BOOK

By H. H. Cunningham

Analysis and Experiment Support Section
TRW Systems Group

1.0 INTRODUCTION

This is a catalog of the Apollo 17 photographic evaluation data available at the National Aeronautics and Space Administration, Johnson Space Center. Section 2 provides explanation and definition of all the photographic evaluation data elements. Sections 3 and 4 present data summaries for all of the lightside sequences of Apollo 17 3-inch mapping camera photography and Apollo 17 24-inch panoramic camera photography respectively. Each data summary includes a brief description of the trajectory reconstruction, telemetered data used, and the constants employed for the data processing. They also contain a brief resume of the apparent data trends throughout the sequence and the data for the first and last frame of the sequence.

2.0 EXPLANATION OF APOLLO PHOTOGRAPH EVALUATION (APE) DATA

The first and last frame figures appearing in the data book are typical Apollo 17 photo evaluation data groups. The microfilm of data for each Apollo 17 mapping camera photo sequence also contains two frames that contain stellar camera star pattern definitions. These star patterns are companion to identified map camera photos of the sequence.

GMT - Sidereal time of film exposure (year, month, day, hour, minute, second) - (UT1 - USNO).

CTE - Central clock time of film exposure which is recorded on the film (hour, minute, second).

1950 state vector - Mean of 1950 moon centered, inertial, cartesian coordinates of the spacecraft position (km) and velocity (km/sec).

Selenographic state vector - Selenographic, instantaneous inertial cartesian coordinates of vehicle position (km) and velocity (km/sec).

Nadir Point (Longitude, Latitude) - Intersection with the mean lunar surface, of the vector from the moon's center of mass to the spacecraft.

Camera Axis Intersect (Longitude, Latitude) - Position of principal intersection point - Intersection of camera optical axis direction with mean lunar surface.

Spacecraft radius - Vector from moon center of mass to spacecraft.

Spacecraft altitude - Height of spacecraft above mean lunar surface.

Scale Factor - Proportionality constant relating dimensions on the film to dimensions on the mean lunar surface.

Azimuth of Velocity Vector - Angle, measured positive clockwise in the local horizontal plane at nadir, between North and the projection of the vehicle velocity vector onto the local horizontal plane.

Mean altitude rate - Rate of change in spacecraft altitude above the mean lunar surface.

Horizontal velocity - Component of spacecraft velocity parallel to the lunar local horizontal plane at the nadir point.

Tilt azimuth - Angle, measured positive clockwise in the local horizontal plane at the principal intersection point, between North and the projection of a vector along the camera optical axis onto that local horizontal plane.

Tilt - Angle between the camera optical axis direction and the lunar local vertical at the principal intersection point.

- Sun Elevation at Prin Grnd Pnt - Angle between the vector from the sun to the principal intersection point and the lunar local horizontal plane at that point.
- Sun Azimuth at Principal Grnd Pnt - Angle, measured positive clockwise in the lunar local horizontal plane, from North to the projection of the vector from the sun to the principal intersection point onto that plane.
- Subsolar Point (longitude, latitude) - Intersection with the mean lunar surface, of a vector from the moon's center of mass to the sun's center.
- Alpha - Angle between the camera optical axis and the projection of the lunar local vertical at the principal intersection point onto the plane of the phase angle (measure of surface tilt toward or away from the sun).
- Swing - Angle between the camera Y axis and the projection of the line between the vehicle nadir and principal intersection point onto the camera X-Y plane.
- Emission Angle - Angle between the camera optical axis and the lunar local vertical at the principal intersection point.
- Phase Angle - Angle between the camera optical axis and the vector from the sun to the principal intersection point.
- North Deviation Angle - Angle, measured positive clockwise in the camera X-Y plane, from the camera X axis to lunar North.
- Phi, Kappa, Omega - Angles which rotate the camera axes coordinate system into the nadir point centered lunar local horizontal system, where:
- ϕ - primary right-handed rotation about the camera Y axis.
 - ω - secondary right-handed rotation about the intermediate X-axis.
 - κ - final right-handed rotation about the local vertical (local horizontal Z-axis).
- X-tilt - (Lateral tilt) Angle from the local horizontal plane at the nadir point to the camera Y-axis.
- Y-tilt - (Longitudinal tilt) Angle from the local horizontal plane at the nadir point to the camera X-axis.
- Heading - Angle, measured positive clockwise in the lunar local horizontal plane at the nadir point, from North to the projection of the camera X-axis onto that plane.
- Laser slant range - Telemetered laser altimeter readout.

Spacecraft altitude (Laser) - Vertical component of laser altimeter slant range based on the assumption that the laser altimeter was aligned along the 3-inch mapping camera optical axis.

Selenographic direction Cosines - Direction definition of vector from the spacecraft to the principal intersection point in the instantaneous inertial selenographic coordinate system.

Coordinate Transformation Matrices - Selenocentric coordinate system to camera axes coordinate system and local horizontal coordinate system to the camera axes coordinate system.

Photograph Footprint - Latitudes and Longitudes of field of view corner point projections onto the lunar surface (full field of view only for mapping camera, full field of view and inner field of view for panoramic camera).

Sigmas - First order uncertainties in selected camera aiming parameters arising from uncertainties in camera mounting angles, vehicle attitude measurements and film exposure times.

The following data group is substituted when vehicle attitude is unavailable for the APE computations.

IFRAME - Photograph frame number which corresponds to page number of the standard printout.

GMT - Sidereal time of film exposure (year, month, day, hour, minute, second) - (UT1-USNO).

STE - Central clock time of film exposure which is recorded on the film (hour, minute, second).

1950 state vector - Mean of 1950 moon centered, inertial, cartesian coordinates of the spacecraft position (er) and velocity (er/min).

Selenographic state vector - Selenographic, instantaneous inertial cartesian coordinates of vehicle position (er) and velocity (km/sec).

Note: 6378.16 km/er should be used for conversion of these state vectors to the standard APE units of km and km/sec.

3.0 APOLLO 17 3-INCH MAPPING CAMERA DATA

Mission: Apollo 17, Target: Vertical strip photography
Rev: 1/2, Camera: 3 Inch Mapping Frames: 163 Through: 321
Coverage Interval:
From: 19.8 Deg S Lat., 145.8 Deg W Long., To: 18.3 Deg N Lat., 16.7 Deg E Long.
From: 88 Hr 8 Min 30.350 Sec, To: 89 Hr 14 Min 50.198 Sec.
Date Processed: 9/20/73, APE Version Used: 7

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 km

Ephemeris-Universal Time Difference: .721533195 Min

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable ($\times 10^{-14}$ - 64 Min)

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used: -.9271362 -.2076425 .3119342
 .3673256 -.3389995 .8661127
 -.0740963 .9175859 .3905711

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

$\Omega = -95^\circ 55' 32.079''$

$\phi = -0^\circ 1' 30.755''$

$\kappa = 0^\circ 0' 58.194''$

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate

± 5 ms in universal to sidereal time conversion

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 89 H, 9 m, 44.06 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 2. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = <u>1618.8228</u>	$\dot{X}$ = <u>.8698</u>
Y = <u>964.2463</u>	$\dot{Y}$ = <u>-1.2692</u>
Z = <u>675.1559</u>	$\dot{Z}$ = <u>-.0665</u>

• Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 9/20/73 (During APE operation)

Edited Data Tape No. T00412 File No.: 1 Location: TRW

Remarks: There were no gaps in the vehicle attitude data used for this sequence.

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a strip of vertical photography starting at 145.8 deg W Long. and ending at 16.7 deg. E Long. Throughout the sequence tilt was maintained at less than 1 deg.

APOLLO 17 REV 1/2 MAP 4/73H PAGE - 163

STATE VECTON X (KM) Y (KM) Z (KM) XDOT (KM/SEC) YDOT (KM/SEC) ZDOT (KM/SEC)
 1950+0 1/34.7348965 131.100952 -683.7605649 -17597.01 -1.5415464 -5.542237
 SELENOGRAPHIC -1456.6731623 -992.1436696 -636.5132094 -8888314 -1.3009315 .0433325

LONGITUDE OF NAUTIC POINT -145.7411251 DEG
 -145 DEG, 44 MIN, 28.0503845 SEC
 LONG OF CAMERA AXIS INTERSECT -145.8071730 DEG
 -145 DEG, 49 MIN, 1.6228149 SEC
 SPACECRAFT ALTITUDE 1873.8716148 KM
 SCALE FACTOR .0000000 M/KM
 MEAN ALTITUDE RATE -.0719107 KM/SEC
 TILT AZIMUTH 288.3600807 DEG
 SIGMA TILT ANGLE .0118541 DEG
 SUN ELEVATION AT PRIN GRID PNT -5.9898154 DEG
 LONGITUDE OF SUBSOLAR POINT 117.5274220 DEG
 117 DEG, 31 MIN, 38.7192249 SEC
 ALPHA -9680710 DEG
 EMISSION ANGLE 1.0400299 DEG
 PHASE ANGLE 96.9578190 DEG
 SIGMA PHI .9279048 DEG
 KAPPA .0002000 DEG
 SIGMA KAPPA -177.5059814 DEG
 UMEGA .0002000 DEG
 SIGMA OMEGA .2637496 DEG
 SPACECRAFT ALTITUDE (LASER) .0002000 DEG
 132.7521744 KM

LATITUDE OF NAUTIC POINT -14.0572652 DEG
 -19 DEG, 51 MIN, 40.1548424 SEC
 LATI OF CAMERA AXIS INTERSECT -14.8335075 DEG
 -19 DEG, 50 MIN, .6271362 SEC
 SPACECRAFT ALTITUDE 135.7816184 KM
 AZIMUTH OF VELOCITY VECTOR 272.5551667 DEG
 HORIZONTAL VELOCITY 1.0432999 KM/SEC
 TILT ANGLE .9648427 DEG
 SIGMA TILT ANGLE .0002004 DEG
 SUN AZIMUTH AT PRINCIPAL GRID P.T 266.9084071 DEG
 LATITUDE OF SUBSOLAR POINT -7.0773054 DEG
 0 DEG, 0 MIN, 15.7343456 SEC
 SWING ANGLE 265.6681469 DEG
 SIGMA SWING ANGLE .0118541 DEG
 NORTH DEVIATION ANGLE 177.5105434 DEG
 A-TILT .2637496 DEG
 SIGMA A-TILT .0002000 DEG
 Y-TILT -.9278950 DEG
 SIGMA Y-TILT .0002000 DEG
 HEADING -67.5102517 DEG
 SIGMA HEADING .0002000 DEG
 LASER SLANT RANGE 132.7709999 KM

SELENOGRAPHIC DIRECTION COSINES X Y Z MAGNITUDE (KM)
 OF CAMERA AXIS .76676030 .54157925 .34461770 135.802369

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA
 -51836452-01 -.93334750+00 -.35521171+00
 -.36974634+00 -.34634970+00 -.86135936+00
 .42768544+00 .86688472+01 -.36315924+00

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA
 -.99892496+00 .43434933-01 .16194114-01
 -.43514615-01 -.99404217+00 -.76032828-02
 .15978639-01 -.53030236-02 .99985622+00

PHOTOGRAPH FOOTPRINT
 LATITUDE -16.444
 LONGITUDE -142.009
 -23.422 -142.202
 -23.205 -149.683
 -16.031 -149.408

DIRECTION TO STELLAR PHOTO CENTER
 RIGHT ASCENSION -2 HR, 24 MIN, 22.9 SEC DECLINATION 51 DEG, 59 MIN, 44.6 SEC

Mission: Apollo 17, Target: Vertical strip photography

Rev: 13/14, Camera: 3 Inch Mapping Frames: 323 Through: 463

Coverage Interval:

From: 15.0 Deg SLat., 167.4 Deg E Long., To: 18.5 Deg NLat., 6.5 Deg E Long.

From: 111 Hr 29 Min 54.890Sec. To: 112 Hr 23 Min 40.663Sec. CTE

Date Processed: 9/20/73, APE Version Used: 7.

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: .72158319 Min

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable ($\times 10^{-14}$ - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 112 H, 16 m, 4.86469 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 14. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = <u>1494.5024</u>	X = <u>.8184</u>
Y = <u>890.1942</u>	Y = <u>-1.4057</u>
Z = <u>634.0940</u>	Z = <u>.0055</u>

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 9/20/73 (During APE operation)

Edited Data Tape No. T00178 File No.: 1 Location: TRW

Remarks: There were no vehicle attitude data for the intervals 111 H, 19 M - 111 H, 29 M, 44 Sec (FMS 323-344) and 111 H, 50 M - 111 H, 52 M, (FMS 390-393).

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used:	-.9271362	-.2076425	.3119342
	.3673256	-.3389995	.8661127
	-.0740963	.9175859	.3905711

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

$\Omega = -95^\circ 55' 32.079''$
 $\phi = -0^\circ 1' 30.755''$
 $\kappa = 0^\circ 0' 58.194''$

Uncertainties Assumed:

± 1 degree in camera positioning angle
 ± 0.2 mrad in each gimbal angle
 ± 20 ms in onboard clock bias definition
 ± 5 ms in onboard clock drift rate
 ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of vertical strip photography starting at 167.4 deg E Long. and ending at 6.5 deg E Long. Throughout the sequence tilt is maintained less than 1 deg. Vehicle state vector data only are provided for frames 323 through 344 and 390 through 393 for which vehicle attitude data are unavailable for the computations. Star patterns companion to frames 350 and 450 are included in these data.

STATE VECTOR	X (KM)	Y (KM)	Z (KM)	XDUT (KM/S)	YDUT (KM/S)	ZDUT (KM/S)
1950.0	-1636.7413407	286.0068613	803.0830102	.4728466	1.5111011	.3957653
SELENOGRAPHIC	1738.6778416	196.6330121	586.5145215	.2389738	-1.6004117	-2.2126370

LONGITUDE OF NADIR POINT	6.4523596 DEG	LATITUDE OF NADIR POINT	18.5309892 DEG
6 DEG, 27 MIN, 8.4946203 SEC		18 DEG, 31 MIN, 51.5610123 SEC	
LONG OF CAMERA AXIS INTERSECT	6.4677448 DEG	LATI OF CAMERA AXIS INTERSECT	18.5260096 DEG
6 DEG, 28 MIN, 3.8813782 SEC		18 DEG, 31 MIN, 33.8344147 SEC	
SPACECRAFT RADIUS	1845.442452 KM	SPACECRAFT ALTITUDE	107.3542489 KM
SCALE FACTOR	.0007041 M/KM	AZIMUTH OF VELOCITY VECTOR	262.2555559 DEG
MEAN ALTITUDE RATE	-.0129560 KM/SEC	HORIZONTAL VELOCITY	1.0319853 KM/SEC
TILT AZIMUTH	108.8446846 DEG	TILT ANGLE	.2501739 DEG
SIGMA TILT AZIMUTH	.0457850 DEG	SIGMA TILT ANGLE	.0002001 DEG
SUN ELEVATION AT PRIN GRND PNT	-8.5449047 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	87.9266405 DEG
LONGITUDE OF SUBSOLAR POINT	105.2260109 DEG	LATITUDE OF SUBSOLAR POINT	-7.613156 DEG
105 DEG, 13 MIN, 33.6392856 SEC		0 DEG, 45 MIN, 40.7361031 SEC	
ALPHA EMISSION ANGLE	-.2474580 DEG	SWING ANGLE	117.0502919 DEG
PHASE ANGLE	.2849521 DEG	SIGMA SWING ANGLE	.0457853 DEG
PHI	98.7923746 DEG	NORTH DEVIATION ANGLE	188.2056086 DEG
SIGMA PHI	-.2222395 DEG	X-TILT	-.1134821 DEG
KAPPA	.0002000 DEG	Y-TILT	.2222391 DEG
SIGMA KAPPA	.0002000 DEG	SIGMA X-TILT	.0002000 DEG
OMEGA	-.1134821 DEG	HEADING	-98.2056628 DEG
SIGMA OMEGA	.0002000 DEG	SIGMA HEADING	.0002000 DEG
SPACECRAFT ALTITUDE (LASER)	109.4309568 KM	LASER SLANT RANGE	109.4320002 KM

SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)
OF CAMERA AXIS	-.94215596	-.10240356	-.31914833	107.355330

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA	TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA
.28318691+00	-.98975464+00
-.32693632+00	-.14272568+00
-.88508478+00	-.14271883+00
	-.98976127+00
	-.41217930+02
	.14067609+02
	.99999047+00

PHOTOGRAPH FOOTPRINT
LATITUDE
21.650
8.996
16.140
9.750
15.379
4.040
20.831
3.130

RIGHT ASCENSION	-3 HR, 15 MIN, 13.5 SEC	DIRECTION TO STELLAR PHOTO CENTER
		DECLINATION
		65 DEG, 12 MIN, 38.8 SEC

Mission: Apollo 17, Target: Vertical strip photography

Rev: 14/15, Camera: 3 Inch Mapping Frames: 465 Through: 611

Coverage Interval:

From: 19.4 Deg S Lat., 165.2 Deg W Long., To: 19.0 Deg N Lat., 9.8 Deg E Long.

From: 113 Hr 19 Min 54.322 Sec. To: 114 Hr 21 Min 13.920 Sec. CTE

Date Processed: 9/23/73, APE Version Used: 7

INPUT DATA

• Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Kozie11)

Lunar Radius: 1738.09 km

Ephemeris-Universal Time Difference: .72158319 Min

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable ($\times 10^{-14}$ - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 114 H, 14 m, 42.19471 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 15. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X =	<u>1494.3165</u>	$\dot{X}$ =	<u>.8157</u>
Y =	<u>890.0835</u>	$\dot{Y}$ =	<u>-1.4075</u>
Z =	<u>633.5526</u>	$\dot{Z}$ =	<u>.0143</u>

• Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 9/23/73 (During APE operation)

Edited Data Tape No. T00178 File No.: 1 Location: TRW

Remarks: There were no vehicle attitude data available for the interval 113h, 34 M - 113 H, 52 M (FMS 500-542).

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMAT Used:	-.9271362	-.2076425	.3119342
	.3673256	-.3389995	.8661127
	-.0740963	.9175859	.3905711

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

$\Omega = -95^{\circ} 55' 32.079''$
 $\phi = -0^{\circ} 1' 30.755''$
 $\kappa = 0^{\circ} 0' 58.194''$

Uncertainties Assumed:

± 1 degree in camera positioning angle
 ± 0.2 mrad in each gimbal angle
 ± 20 ms in onboard clock bias definition
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 ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of vertical strip photography starting at 165.2 deg W Long. and ending at 9.8 deg E Long. At the start of the sequence tilt is 40 deg. Tilt is quickly reduced to less than 1 deg, then maintained at that level or less from that time (frame 480) forward. State vector data only are provided for frames 500-542, for which vehicle attitude data are unavailable for the computations. Star patterns companion to frames 475 and 600 are included in these data.

APOLLO 17 KEY 14/15 MAP 5/13F

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YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
1972	12	11	22	52	52.525
GMT		4	17	19	54.322
STAT VECTOR	X (KM)				
1950.0	-1692.4468835	-45.9903979	-734.3966180		
SELENOGRAPHIC	-1692.4468835	-432.3155712	-615.2401035		
LONGITUDE OF RADII POINT	-165.6712818 DEG				
LONG OF CAMERA AXIS INTERSECT	-165.6712818 DEG				
SPACECRAFT RADIUS	-165.6712818 DEG				
SCALE FACTOR	1852.0158851 KM				
MEAN ALTITUDE RATE	0.000000 KM/SEC				
TILT AZIMUTH	0.035322 KM/SEC				
SIGMA TILT AZIMUTH	7.7126189 DEG				
SUN ELEVATION AT PRINCIPAL GROUND POINT	0.003109 DEG				
LONGITUDE OF SUBSOLAR POINT	104.7507986 DEG				
ALPHA	104 DEG, 45 MIN, 2.8748703 SEC				
EMISSION ANGLE	5.5690440 DEG				
PHASE ANGLE	43.2553008 DEG				
SIGMA PHI	84.1757171 DEG				
KAPPA	0.734826 DEG				
SIGMA KAPPA	0.002604 DEG				
OMEGA	-170.7735329 DEG				
SIGMA OMEGA	0.002807 DEG				
SPACECRAFT ALTITUDE (LASER)	40.0031140 DEG				
	0.002005 DEG				
	0.000000 KM				

SELENOGRAPHIC DIRECTION COSINES
OF CAMERA AXIS

X
0.51606599

Y
0.04274268

Z
0.85547984

MAGNITUDE (KM)
152.580022

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

-0.12168767+00	-0.95943252+00	-0.25432503+00
-0.8777111+00	0.24366089+00	-0.42379110+00
0.46348151+00	0.17165369+00	-0.86932147+00

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-0.98867127+00	0.14953166+00	0.13014333+01
-0.12288119+00	-0.75598831+00	-0.64296293+00
-0.66306151+01	-0.63727696+00	0.76578669+00

PHOTOGRAPH FOOTPRINT

LATITUDE	LONGITUDE
0.000000	0.000000
-19.523	-163.307
-18.833	-168.107
0.000000	0.000000

DIRECTION TO STELLAR PHOTO CENTER

RIGHT ASCENSION
0 HR, 50 MIN, 14.6 SEC

DECLINATION

19 DEG, 22 MIN, 12.4 SEC

STATE VECTOR	X (KM)	Y (KM)	Z (KM)	DDOT (KM/S)	YDDOT (KM/S)	ZDDOT (KM/S)
1950.0	-1671.5295130	158.4737731	766.6777755	1.52265120	-1.5898005	-0.4465010
SELENOGRAPHIC	1719.2655833	298.2128551	602.0143209	0.3227935	-0.3227935	-0.1746951

LONGITUDE OF NADIR POINT	9.8402551 DEG	LATITUDE OF NADIR POINT	19.0347500 DEG
9 DEG, 50 MIN, 24.9185085 SEC		19 DEG, 2 MIN, 5.1317024 SEC	
LONG OF CAMERA AXIS INTERSECT	9.8680418 DEG	LAT OF CAMERA AXIS INTERSECT	19.0496151 DEG
9 DEG, 52 MIN, 4.9503134 SEC		19 DEG, 2 MIN, 58.6145210 SEC	
SPACECRAFT RADIUS	1845.8673559 KM	SPACECRAFT ALTITUDE	107.7773595 KM
SCALE FACTOR	0.0007015 M/KM	AZIMUTH OF VELOCITY VECTOR	263.6569239 DEG
MEAN ALTITUDE RATE	-0.0131644 KM/SEC	HORIZONTAL VELOCITY	1.6315359 KM/SEC
TILT AZIMUTH	60.5028586 DEG	TILT ANGLE	0.002001 DEG
SIGNA TILT AZIMUTH	0.0235106 DEG	SIGNA TILT ANGLE	0.002001 DEG
SUN ELEVATION AT PRIN GRND PNT	-4.3731089 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	89.2924566 DEG
LONGITUDE OF SUBSOLAR POINT	104.2325077 DEG	LATITUDE OF SUBSOLAR POINT	-75.91306 DEG
104 DEG, 13 MIN, 57.0277405 SEC		0 DEG, 45 MIN, 32.8699780 SEC	
ALPHA	-4.4528502 DEG	SWING ANGLE	66.6290342 DEG
EMISSION ANGLE	51.67708 DEG	SIGNA SWING ANGLE	0.235186 DEG
PHASE ANGLE	94.8260002 DEG	NORTH DEVIATION ANGLE	186.1253696 DEG
PHI	-4.4466727 DEG	X-TILT	0.1930212 DEG
SIGNA PHI	0.0020000 DEG	SIGNA X-TILT	0.0020000 DEG
KAPPA	173.8729935 DEG	Y-TILT	0.4466701 DEG
SIGNA KAPPA	0.0020000 DEG	SIGNA Y-TILT	0.0020000 DEG
OMEGA	-1.930212 DEG	HEADING	-94.1255028 DEG
SIGNA OMEGA	0.0020000 DEG	SIGNA HEADING	0.0020000 DEG
SPACECRAFT ALTITUDE (LASER)	108.7160740 KM	LASER SLANT RANGE	108.7200003 KM

SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)
OF CAMERA AXIS	-0.93398480	-0.15450126	-0.32217701	107.781487

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA
LOCAL HORIZONTAL TO CAMERA

224.30712+00	93430517+00	27705611+00	-0.9426029+00	-0.10670340+00	-0.77957851-02
-0.36134791+00	0.34377352+00	-0.86674781+00	0.10673311+00	-0.99428209+00	-0.33688483-02
-0.90505151+00	0.94305742+01	0.41471447+00	-0.73917675-02	-0.41815739-02	0.99996189+00

PHOTOGRAPH FOOTPRINT
LATITUDE
22.122
12.560
16.545
13.075
16.001
7.324
21.480
6.592

DIRECTION TO STELLAR PHOTO CENTER

RIGHT ASCENSION	-3 HR, 25 MIN, 5.4 SEC	DECLINATION	64 DEG, 49 MIN, 49.1 SEC
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Mission: Apollo 17, Target: Vertical strip photography

Rev: 23/24, Camera: 3 Inch Mapping Frames: 668 Through: 813

Coverage Interval:

From: 19.5 Deg S Lat., 172.9 Deg W Long., To: 19.3 Deg N Lat., 3.9 Deg E Long.

From: 131 Hr 9 Min 28.805 Sec, To: 132 Hr 10 Min 21.663 Sec. CTE

Date Processed: 8/23/73, APE Version Used: 7.

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziel)

Lunar Radius: 1738.03 km

Ephemeris-Universal Time Difference: .72161653 Min

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable ($\times 10^{-14}$ - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 132 H, 2 M, 2.05295 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 24. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = 1496.5185 $\dot{X}$ = .7902

Y = 891.3591 $\dot{Y}$ = -1.4203

Z = 622.2548 $\dot{Z}$ = .0931

• Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 8/23/73 (During APE operation)

Edited Data Tape No. T01065 File No.: 1 Location: TRW

Remarks: There were no vehicle attitude data available for the interval
131 H, 26 M, 54 sec - 131 H, 38 M, 32 sec (FMS 710-737).

9 APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMAT Used: -.9271362 -.2076425 .3119342
 .3673256 -.3389995 .8661127
 -.0740963 .9175859 .3905711

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

$\Omega = -95^\circ 55' 32.079''$
 $\phi = -0^\circ 1' 30.755''$
 $\kappa = 0^\circ 0' 58.194''$

Uncertainties Assumed:

± 1 degree in camera positioning angle
 ± 0.2 mrad in each gimbal angle
 ± 20 ms in onboard clock bias definition
 ± 5 ms in onboard clock drift rate
 ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of vertical strip photography starting at 172.9 deg W Long. and ending at 3.9 deg E Long. Throughout the sequence tilt is maintained less than 1 deg. State vector data only are provided for frames 710 through 737 for which vehicle attitude data are unavailable for the computations. Star patterns companion to frames 675 and 800 are included in these data.

APOLLO 17 REV 23/24 MAP 4/73F PAGE - 000

STATE VECTOR
1950.0 1714.2907924
SELENOGRAPHIC -1735.3678543

LONGITUDE OF NAIR POINT
-172.8748131 DEG

LONG OF CAMERA AXIS INTERSECT
-172.8870220 DEG

SPACECRAFT RADIUS
1854.7202454 KM

SCALE FACTOR
0.000000 M/KM

TILT AZIMUTH
270.42247238 DEG

SIGMA TILT AZIMUTH
0.067554 DEG

SUN ELEVATION AT PRIM GRND PNT
-1.0727081 DEG

LONGITUDE OF SUBSOLAR POINT
95.7132155 DEG

ALPHA
95 DEG, 42 MIN, 47.575848 SEC

EMISSION ANGLE
-1.1829604 DEG

PHASE ANGLE
1830145 DEG

PHI
91.2556886 DEG

SIGMA PHI
17.09469 DEG

KAPPA
0.002000 DEG

SIGMA KAPPA
0.003247 DEG

OMEGA
0.002000 DEG

SIGMA OMEGA
-0.0138443 DEG

SPACECRAFT ALTITUDE (LASER)
115.4704742 KM

SELENOGRAPHIC DIRECTION COSINES
A .93510828
Y .1190794
Z .3335854

MAGNITUDE (KM)
116.630807

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

-11043933+00 -94394574+00 -31107781+00
-J6431013+00 -34965540+00 -87097957+00
92470593+00 -17137744-01 -38029609+00

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-99640802+00 -84626089-01 -29835812-02
-84626705-01 -84641251+00 -29162704-03
-29933033-02 -11740405-04 -99999547+00

PHOTOGRAPH FOOTPRINT
LATITUDE
-16.702
LONGITUDE
-22.710
-169.911
-22.204
-176.423
-175.760

DIRECTION TO STELLAR PHOTO CENTER
-2 HR, 22 MIN, .2 SEC

RIGHT ASCENSION
55 DEG, 47 MIN, 4.2 SEC

DECLINATION

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-99640802+00 -84626089-01 -29835812-02
-84626705-01 -84641251+00 -29162704-03
-29933033-02 -11740405-04 -99999547+00

PHOTOGRAPH FOOTPRINT
LATITUDE
-16.702
LONGITUDE
-22.710
-169.911
-22.204
-176.423
-175.760

DIRECTION TO STELLAR PHOTO CENTER
-2 HR, 22 MIN, .2 SEC

RIGHT ASCENSION
55 DEG, 47 MIN, 4.2 SEC

DECLINATION

STATE VECTOR X (KM) -1092.614290 Y (KM) 46.4168333 Z (KM) 727.4264890 YDOT (KM/SEC) 2001 (KM/SEC) 4018951
 SELENOGRAPHIC 1735.5831521 119.9690179 608.1078923 0.2600255 1538124 -1.0202186 -1.1495011
 LONGITUDE OF NADIR POINT 349541765 DEG LATITUDE OF NADIR POINT 17.2666974 DEG
 LONG OF CAMERA AXIS INTERSECT 3 DEG, 57 MIN, 15.0353336 SEC 19 DEG, 16 MIN, 11.06064 SEC
 SPACECRAFT RADIUS 3 DEG, 56 MIN, 3.946852 DEG LAT OF CAMERA AXIS INTERSECT 19 DEG, 16 MIN, 11.06064 SEC
 SCALE FACTOR 164259423898 KM AZIMUTH OF VELOCITY VECTOR 104.8523944 KM
 MEAN ALTITUDE RATE -6007211 M/KM HORIZONTAL VELOCITY 264.5954016 DEG
 TILT AZIMUTH 333.7106094 DEG TILT ANGLE .2569281 DEG
 SIGMA TILT AZIMUTH 104.41990 DEG SIGMA TILT ANGLE .0002003 DEG
 SUN ELEVATION AT PRIN GRND PNT -1.4257393 DEG SUN AZIMUTH AT PRINCIPAL GRND PNT 70.2671647 DEG
 LONGITUDE OF SUBSOLAR POINT 95.1989027 DEG LATITUDE OF SUBSOLAR POINT 0 DEG, 44 MIN, 19.9958324 SEC
 ALPHA 61225412 DEG SWING ANGLE 334.9151566 DEG
 EMISSION ANGLE 2738487 DEG SIGMA SKING ANGLE .0441967 DEG
 PHASE ANGLE 91.3032112 DEG NORTH DEVIATION ANGLE 165.7050404 DEG
 PHI .0908060 DEG X-TILT .2417760 DEG
 SIGMA PHI .0002000 DEG SIGMA A-TILT .0002000 DEG
 KAPPA 174.2953635 DEG Y-TILT -.0908054 DEG
 SIGMA KAPPA .0002000 DEG SIGMA Y-TILT .0002000 DEG
 OMEGA .2417780 DEG HEADING -.95.7050010 DEG
 SIGMA OMEGA .0002000 DEG SIGMA HEADING .0002000 DEG
 SPACECRAFT ALTITUDE (LASER) 106.3359137 KM LASER SLANT RANGE 106.3369994 KM

SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS X -0.94292684 Y -.06717944 Z -.52614734 MAGNITUDE (KM) 104.853523

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA
 .15165443+00 .94367816+00 .29406188+00 -.99504561+00 -.99406473+01 .15848462+02
 -.36067443+00 .32982774+00 -.87234355+00 .99397019+01 -.99503869+00 -.42198094+02
 -.92020132+00 .26175372+01 .39056917+00 .19964373+02 -.40413682+02 .99998979+00

PHOTOGRAPH FOOTPRINT
 LATITUDE 22.227
 LONGITUDE 6.567
 16.848 7.021
 16.313 1.431
 21.686 .746

DIRECTION TO STELLAR PHOTO CENTER
 RIGHT ASCENSION -3 HR, 23 MIN, 37.6 SEC DECLINATION 65 DEG, 14 MIN, 54.7 SEC

Mission: Apollo 17, Target: 40 Deg. N oblique strip

Rev: 26/27, Camera: 3 Inch Mapping Frames: 821 Through: 961

Coverage Interval:

From: 6.5 Deg S Lat., 170.1 Deg W Long., To: 21.0 Deg N Lat., 2.7 Deg W Long.

From: 137 Hr 4 Min 20.277 Sec, To: 138 Hr 8 Min 1.617 Sec CTE

Date Processed: 8/23/73, APE Version Used: 7

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 km

Ephemeris-Universal Time Difference: .72163319 Min

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 137 H, 57 M, 43.60791 sec

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 27. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = 1497.9383 $\dot{X}$ = .7817

Y = 892.2408 $\dot{Y}$ = -1.4326

Z = 615.5754 $\dot{Z}$ = .1191

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 8/23/73 (During APE operation)

Edited Data Tape No. T00948 File No.: 1 Location: TRW

Remarks: There were no vehicle attitude data for the interval 137 H 10 sec - 137 H, 33 M, 18 sec (Fms 876-884).

• APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used:	-.9271362	-.2076425	.3119342
	.3673256	-.3389995	.8661127
	-.0740963	.9175859	.3905711

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

Ω	=	-95° 55' 32.079"
ϕ	=	-0° 1' 30.755"
κ	=	0° 0' 58.194"

Uncertainties Assumed:

- ± 1 degree in camera positioning angle
- ±0.2 mrad in each gimbal angle
- ±20 ms in onboard clock bias definition
- ±5 ms in onboard clock drift rate
- ±5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of 40 deg N oblique strip photography starting at 170.1 deg W Long. and ending at 2.7 deg W Long. Throughout the sequence a tilt of $40.0 \pm .5$ deg was maintained. State vector data only are provided for frames 876-884 for which vehicle attitude data are unavailable for the computations and for frame 866 for which vehicle attitude data was ignored as a consequence of a computer erratic. Star patterns companion to frames 830 and 950 are included in these data.

APOLLO 17 RLV 26/27 MAP 4/7JF PAGE - 821

STATE VECTOR X (KM) 1726.7126154
 1950.0
 SELENOGRAPHIC -1718.8197957

YEAR MONTH DAY HOUR MINUTE SECOND
 GMT 1972 12 12 22 37 18.496
 CTE

Y (KM) 197.4391783
 -298.1417394

4 (KM) 4
 20.277

ADOT (KM/S) -0.0255872
 -0.3145617

YDOT (KM/S) -1.5199837
 1.5920370

ZDOT (KM/S) -0.5716887
 .0655932

LONGITUDE OF NAJIR POINT -170.1595421 DEG
 -170 DEG, 9 MIN, 34.5515015 SEC
 LONG OF CAMERA AXIS INTERSECT -170.0604515 DEG
 -170 DEG, 3 MIN, 37.6254272 SEC
 SPACECRAFT RADIUS 1854.0272355 KM
 SCALE FACTOR .0000000 M/KM
 MEAN ALTITUDE MATE .0133976 KM/SEC
 TILT AZIMUTH 1.6696043 DEG
 SIGMA TILT AZIMUTH .0003125 DEG
 SUN ELEVATION AT PRIN GRND PNT -6.7130804 DEG
 92.7156078 DEG
 LONGITUDE OF SUBSOLAR POINT 92 DEG, 42 MIN, 56.1800875 SEC

ALPHA 7.2245381 DEG
 EMISSION ANGLE 43.0499848 DEG
 PHASE ANGLE 91.9067545 DEG
 PHI .7531729 DEG
 SIGMA PHI .0002602 DEG
 KAPPA -177.1534157 DEG
 SIGMA KAPPA .0002602 DEG
 OMEGA 39.7818599 DEG
 SIGMA OMEGA .0002000 DEG
 SPACECRAFT ALTITUDE (LASER) .0000000 KM

LATITUDE OF NAJIR POINT -19 DEG, 47 MIN, 37.9842567 SEC
 LATI OF CAMERA AXIS INTERSECT -16.5330672 DEG
 -16 DEG, 31 MIN, 59.0420151 SEC
 SPACECRAFT ALTITUDE 115.9372392 KM
 AZIMUTH OF VELOCITY VECTOR 272.6303911 DEG
 HORIZONTAL VELOCITY 1.6240559 KM/SEC
 TILT ANGLE 39.7878113 DEG
 SIGMA TILT ANGLE .0002000 DEG
 SUN AZIMUTH AT PRINCIPAL GRND PNT 267.2269440 DEG
 -7332024 DEG
 LATITUDE OF SUBSOLAR POINT 0 DEG, 43 MIN, 59.5287037 SEC
 SWING ANGLE 359.0955329 DEG
 SIGMA SWING ANGLE .0003125 DEG
 NORTH DEVIATION ANGLE 176.9231814 DEG
 X-TILT 39.7818601 DEG
 SIGMA X-TILT .0002000 DEG
 Y-TILT -5787961 DEG
 SIGMA Y-TILT .0002000 DEG
 HEADING -87.6353607 DEG
 SIGMA HEADING .0002000 DEG
 LASER SLANT RANGE .0000000 KM

SELENOGRAPHIC DIRECTION COSINES X Y Z MAGNITUDE (KM)
 OF CAMERA AXIS .50213748 .06817551 .86209631 154.542140

TRANSFORMATION MATRIX FROM
 SELENOCENTRIC TO CAMERA
 TRANSFORMATION MATRIX FROM
 LOCAL HORIZONTAL TO CAMERA

-.15722474-J1 -.93410015+J0 -.35666466+J0
 -.87527606+J0 .18530070+J0 -.44671623+J0
 .48336789+J0 .30515653+J0 -.82050893+J0

PHOTOGRAPH FOOTPRINT
 LATITUDE .000
 LONGITUDE .000
 -19.685
 -167.734
 -172.682
 .000

DIRECTION TO STELLAN PHOTO CENTER

RIGHT ASCENSION J HR, 37 MIN, 48.1 SEC DECLINATION 21 DEG, 4 MIN, 2.6 SEC

STATE VECTOR	X (KM)	Y (KM)	Z (KM)	XDOT (KM/S)	YDOT (KM/S)	ZDOT (KM/S)
1950.0	-1674.1984181	138.5612017	752.5035740	.3408103	1.5366138	.4457211
SELENOGRAPHIC	1739.8500929	-73.9833798	596.5310489	-.0201779	-1.6257789	-.1801019

LONGITUDE OF NAJIK POINT	-2.4349128 DEG	LATITUDE OF NAJIK POINT	18.9090965 DEG
-2 DEG. 26 MIN.	5.6859684 SEC	18 DEG. 54 MIN.	32.7473259 SEC
LONG OF CAMERA AXIS INTERSECT	-2.7015491 DEG	LATI OF CAMERA AXIS INTERSECT	21.0229475 DEG
-2 DEG. 42 MIN.	5.5769062 SEC	21 DEG. 1 MIN.	22.6111794 SEC
SPACECRAFT RADIUS	1640.7610325 KM	SPACECRAFT ALTITUDE	102.6710361 KM
SCALE FACTOR	.0005729 M/KM	AZIMUTH OF VELOCITY VECTOR	263.4628228 DEG
MEAN ALTITUDE RATE	-.0120939 KM/SEC	HORIZONTAL VELOCITY	1.6357742 KM/SEC
TILT ALTITUDE	353.2833241 DEG	TILT ANGLE	31.8601842 DEG
SIGMA TILT ALTITUDE	.0003789 DEG	SIGMA TILT ANGLE	.0002000 DEG
SUN ELEVATION AT PRIM GRND PNT	-4.8168001 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	88.9312716 DEG
LONGITUDE OF SUBSOLAR POINT	92.1778498 DEG	LATITUDE OF SUBSOLAR POINT	-.7319638 DEG
92 DEG. 10 MIN.	39.5392513 SEC	0 DEG. 43 MIN.	55.0496850 SEC
ALPHA	4.9924670 DEG	SWING ANGLE	359.7858924 DEG
EMISSION ANGLE	33.9888328 DEG	SIGMA SWING ANGLE	.0003789 DEG
PHASE ANGLE	90.7978773 DEG	NORTH DEVIATION ANGLE	187.8794079 DEG
PHI	.1330633 DEG	X-TILT	31.8599292 DEG
SIGMA PHI	.002355 DEG	SIGMA X-TILT	.0002000 DEG
KAPPA	173.5360088 DEG	Y-TILT	-.1130161 DEG
SIGMA KAPPA	.002355 DEG	SIGMA Y-TILT	.0002000 DEG
OMEGA	31.8599291 DEG	HEADING	-96.5342292 DEG
SIGMA OMEGA	.0002000 DEG	SIGMA HEADING	.0002000 DEG
SPACECRAFT ALTITUDE (LASER)	.0000000 KM	LASER SLANT RANGE	.0000000 KM

SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)
OF CAMERA AXIS	-.97513172	-.02032192	.22069242	122.295400

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA	TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA
.19985254+00	-.99350208+00
.17156318+00	.95617753-01
-.76468903+00	.61731510-01
.94004751+00	-.11379654+00
.24411055+00	-.84394160+00
.23816100+00	-.52422601+00
	.84933870+00

PHOTOGRAPH FOOTPRINT

LATITUDE	LONGITUDE
18.825	.000
18.354	-.236
	-4.573
	.000

DIRECTION TO STELLAR PHOTO CENTER	DECLINATION
-9 HR. 24 MIN. 29.5 SEC	69 DEG. 41 MIN. 42.3 SEC

Mission: Apollo 17, Target: Vertical strip photography

Rev: 28, Camera: 3 Inch Mapping Frames: 1094 Through: 1243

Coverage Interval:

From: 19.6 Deg S Lat., 174.0 Deg W Long., To: 19.0 Deg N Lat., 3.0 Deg W Long.

From: 139 Hr 4 Min 5.490 Sec, To: 140 Hr 6 Min 45.050 Sec CTE

Date Processed: 8/23/73, APE Version Used: 7.

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziel)

Lunar Radius: 1738.09 km

Ephemeris-Universal Time Difference: .72163319 Min

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable ($\times 10^{-14}$ - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 139 H, 56 M, 16.12701 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 28. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = 1498.5950 $\dot{X}$ = .7790

Y = 892.6319 $\dot{Y}$ = -1.4244

Z = 613.0724 $\dot{Z}$ = .1278

• Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 8/23/73 (During APE operation)

Edited Data Tape No. T01307 File No.: 1 Location: TRW

Remarks: There were no vehicle attitude data available for the interval
139 H, 25 M, 50 sec - 139 H, 32 M, 45 sec (FMS 1146-1162).

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used:	-.9271362	-.2076425	.3119342
	.3673256	-.3389995	.8661127
	-.0740963	.9175859	.3905711

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

Ω = -95° 55' 32.079"
 ϕ = -0° 1' 30.755"
 κ = 0° 0' 58.194"

Uncertainties Assumed:

± 1 degree in camera positioning angle
 ±0.2 mrad in each gimbal angle
 ±20 ms in onboard clock bias definition
 ±5 ms in onboard clock drift rate
 ±5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of vertical photography starting at 174.0 Deg W Long. and ending at 3.0 Deg W Long. Throughout the sequence tilt was maintained less than 1 Deg. Vehicle state vector data only are provided for frames 1146-1162 for which vehicle attitude are not available for the computations.

APOLLO 17 REV 28 MAP 4/73F PAGE - 1094

STATE VECTOR	X (KM)	Y (KM)	Z (KM)	XDOT (KM/S)	YDOT (KM/S)	ZDOT (KM/S)
1950.0	1723.981048	118.1647634	-674.4621714	-0.942712	-1.524408	-0.5441006
SELENOGRAPHIC	-1737.5493769	-182.0020347	-623.5145024	-2.150628	1.0083553	0.017159

LONGITUDE OF NAJIK POINT	-174.0202789 DEG	LATITUDE OF NAJIK POINT	-19.0412039 DEG
-174 DEG, 1 MIN, 13.0041504 SEC		-19 DEG, 38 MIN, 28.3339691 SEC	
LONG OF CAMERA AXIS INTERSECT	-174.0417557 DEG	LATI OF CAMERA AXIS INTERSECT	-19.6355450 DEG
-174 DEG, 2 MIN, 30.3204346 SEC		-19 DEG, 38 MIN, 7.9620552 SEC	
SPACECRAFT RADIUS	1854.9859602 KM	SPACECRAFT ALTITUDE	116.8959639 KM
SCALE FACTOR	0.000000 M/KM	AZIMUTH OF VELOCITY VECTOR	273.8036185 DEG
MEAN ALTITUDE RATE	0.130112 KM/SEC	HORIZONTAL VELOCITY	1.6231993 KM/SEC
TILT AZIMUTH	285.6257019 DEG	TILT ANGLE	0.128585 DEG
SIGMA TILT AZIMUTH	0.367443 DEG	SIGMA TILT ANGLE	0.001994 DEG
SUN ELEVATION AT PRIM GRND PNT	-3.7598562 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	267.8784828 DEG
LONGITUDE OF SUBSOLAR POINT	91.7041042 DEG	LATITUDE OF SUBSOLAR POINT	-7.3087114 DEG
91 DEG, 42 MIN, 14.7750950 SEC		0 DEG, 43 MIN, 51.1370659 SEC	
ALPHA	-3.3174070 DEG	SWING ANGLE	282.1705500 DEG
EMISSION ANGLE	0.332931 DEG	SIGMA SWING ANGLE	0.367442 DEG
PHASE ANGLE	94.00772686 DEG	NORTH DEVIATION ANGLE	174.5452059 DEG
PHI	0.3052706 DEG	X-TILT	0.658373 DEG
SIGMA PHI	0.002000 DEG	SIGMA X-TILT	0.002000 DEG
KAPPA	-176.5448112 DEG	Y-TILT	-0.3052704 DEG
SIGMA KAPPA	0.002000 DEG	SIGMA Y-TILT	0.002000 DEG
OMEGA	0.658373 DEG	HEADING	-86.5451605 DEG
SIGMA OMEGA	0.002000 DEG	SIGMA HEADING	0.002000 DEG
SPACECRAFT ALTITUDE (LASER)	117.7162447 KM	LASER SLANT RANGE	117.7180004 KM

SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)
OF CAMERA AXIS	0.93563987	0.10328262	0.33750663	116.897817

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA	TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA
-0.61525048-01	-0.99814840+00
-0.36116676+00	-0.0260935-01
0.92929292+00	-0.0267821-01
	0.52469993-02
	-0.14680837-02
	0.99998509+00

PHOTOGRAPH FOOTPRINT
LATITUDE
LONGITUDE
-16.777
-170.709
-22.795
-170.982
-22.450
-177.522
-16.389
-177.017

DIRECTION TO STELLAR PHOTO CENTER	55 DEG, 45 MIN, 52.1 SEC
RIGHT ASCENSION	-2 HR, 21 MIN, 55.2 SEC
DECLINATION	

STATE VECTOR X (KM) 124.6032684 Y (KM) 747.7700216 Z (KM) 597.5430070
 1950.0 -1677.1871435 1738.4269613
 SELENOGRAPHIC LONGITUDE OF NADIR POINT -3.0280518 DEG
 -3 DEG, 1 MIN, 40.984569 SEC
 LONG OF CAMERA AXIS INTERSECT -3.063997 DEG
 -3 DEG, 3 MIN, 47.8787613 SEC
 SPACECRAFT RADIUS 1840.5549962 KM
 SCALE FACTOR .0007380 M/KM
 MEAN ALTITUDE RATE 291.0808723 DEG
 TILT AZIMUTH .0188447 DEG
 SUN ELEVATION AT PRIN GRND PNT -4.2452259 DEG
 LONGITUDE OF SUBSOLAR POINT 91.1748689 DEG
 91 DEG, 10 MIN, 29.5280457 SEC
 ALPHA .5940958 DEG
 EMISSION ANGLE .6418833 DEG
 PHASE ANGLE 93.6492167 DEG
 PHI .5375377 DEG
 SIGMA PHI .0002000 DEG
 KAPPA 173.5906582 DEG
 SIGMA KAPPA .0002000 DEG
 OMEGA .2797143 DEG
 SIGMA OMEGA .0002000 DEG
 SPACECRAFT ALTITUDE (LASER) 101.9502926 KM

LATITUDE OF NADIR POINT 18.9445863 DEG
 18 DEG, 56 MIN, 40.546461 SEC
 LATI OF CAMERA AXIS INTERSECT 18.9574432 DEG
 18 DEG, 57 MIN, 26.7958543 SEC
 SPACECRAFT ALTITUDE 102.4649998 KM
 AZIMUTH OF VELOCITY VECTOR 263.5857842 DEG
 HORIZONTAL VELOCITY 1.6359378 KM/SEC
 TILT ANGLE .6062336 DEG
 SIGMA TILT ANGLE .0002000 DEG
 SUN AZIMUTH AT PRINCIPAL GRND PNT 89.3126422 DEG
 LATITUDE OF SUBSOLAR POINT 0 DEG, 43 MIN, 46.7336367 SEC
 SWING ANGLE 297.4912998 DEG
 SIGMA SWING ANGLE .0188446 DEG
 NORTH DEVIATION ANGLE 186.4117300 DEG
 X-TILT .2797144 DEG
 SIGMA X-TILT .0002000 DEG
 Y-TILT -.5375377 DEG
 SIGMA Y-TILT .0002000 DEG
 HEADING -96.4119669 DEG
 SIGMA HEADING .0002000 DEG
 LASER SLANT RANGE 101.9560003 KM

SELENOGRAPHIC DIRECTION COSINES X Y Z MAGNITUDE (KM)
 OF CAMERA AXIS -.94621405 .04017178 -.32103769 102.471068

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA
 .18542105+00 .94129467+00 .28210511+00 .93815532-02
 -.35888058+00 .33212051+00 -.87239626+00 -.48819170-02
 -.71478066+00 .60500054-01 .39939452+00 .99994402+00

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA
 -.99370084+00 -.11167157+00 .93815532-02
 .11162960+00 -.99373788+00 -.48819170-02
 .96679510-02 -.38039058-02 .99994402+00

PHOTOGRAPH FOOTPRINT
 LATITUDE 21.847
 LONGITUDE -5.568
 16.635
 -5.057
 16.014
 -5.494
 21.287
 -6.235

DIRECTION TO STELLAR PHOTO CENTER

RIGHT ASCENSION -3 HR, 23 MIN, 47.4 SEC DECLINATION 65 DEG, 21 MIN, 58.9 SEC

Mission: Apollo 17, Target: Vertical strip photography

Rev: 29, Camera: 3 Inch Mapping Frames: 1376 Through: 1524

Coverage Interval:

From: 19.6 Deg S Lat., 174.8 Deg W Long., To: 19.0 Deg NLat., 3.1 Deg W Long.

From: 141 Hr 2 Min 52.975 Sec, To: 142 Hr 5 Min 18.266 Sec. CTE

Date Processed: 8/23/73, APE Version Used: 7.

INPUT DATA

• Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Kozie11)

Lunar Radius: 1738.09 km

Ephemeris-Universal Time Difference: .72163319 Min

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable ($\times 10^{-14}$ - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 14 H, 54 M, 48.39248 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 29. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = <u>1429.2959</u>	$\dot{X}$ = <u>.7762</u>
Y = <u>893.0494</u>	$\dot{Y}$ = <u>-1.4252</u>
Z = <u>610.4121</u>	$\dot{Z}$ = <u>.1364</u>

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 8/23/73 (During APE operation)

Edited Data Tape No. T01307 File No.: 1 Location: TRW

Remarks: There were no vehicle attitude data available for the interval 141 H, 20 M, 41 sec - 141 H, 29 M, 57 sec (FMS 1418-1440).

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used: $\begin{matrix} -.9271362 & -.2076425 & .3119342 \\ .3673256 & -.3389995 & .8661127 \\ -.0740963 & .9175859 & .3905711 \end{matrix}$

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

$\Omega = -95^\circ 55' 32.079''$
 $\phi = -0^\circ 1' 30.755''$
 $\kappa = 0^\circ 0' 58.194''$

Uncertainties Assumed:

± 1 degree in camera positioning angle
 ± 0.2 mrad in each gimbal angle
 ± 20 ms in onboard clock bias definition
 ± 5 ms in onboard clock drift rate
 ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of vertical strip photography starting at 174.8 deg W Long. and ending at 3.1 deg W Long. Throughout the sequence tilt is maintained less than 1 deg. Vehicle state vector data only are provided for frames 1418-1440 for which vehicle attitude data are not available for the computations. Star patterns companion to frames 1395 and 1515 are included in these data.

STATE VECTOR X (KM) 1724.8879989 Y (KM) 1261.4210222 Z (KM) -671.2427228
 1950.0 SELENOGRAPHIC -1740.0555518 -157.8840130 -623.7523478
 LONGITUDE OF NADIR POINT -174.8154602 DEG
 LONG OF CAMERA AXIS INTERSECT -174.8523502 DEG
 -174 DEG, 51 MIN, 8.4608459 SEC
 SPACECRAFT RADIUS 1855.2055618 KM
 SCALE FACTOR .0000000 M/KM
 MEAN ALTITUDE RATE .0128779 KM/SEC
 TILT AZIMUTH 304.9547882 DEG
 SIGMA TILT AZIMUTH .0182949 DEG
 SUN ELEVATION AT PRIM GRND PNT -3.9425430 DEG
 LONGITUDE OF SUBSOLAR POINT 90.7007757 DEG
 90 DEG, 42 MIN, 2.7924728 SEC
 ALPHA .5350263 DEG
 EMISSION ANGLE .6715135 DEG
 PHASE ANGLE 94.4776678 DEG
 PHI .5369378 DEG
 SIGMA PHI .0002000 DEG
 KAPPA .0002000 DEG
 SIGMA KAPPA .0002000 DEG
 OMEGA .3278577 DEG
 SIGMA OMEGA .0002000 DEG
 SPACECRAFT ALTITUDE (LASER) 117.5449066 KM
 LONGITUDE OF NADIR POINT -174.8154602 DEG
 -19 DEG, 48 MIN, 47.6982307 SEC
 LONG OF CAMERA AXIS INTERSECT -174.8523502 DEG
 -19 DEG, 51 MIN, 8.4608459 SEC
 SPACECRAFT ALTITUDE 1855.2055618 KM
 AZIMUTH OF VELOCITY VECTOR 273.5475575 DEG
 HORIZONTAL VELOCITY 1.0229932 KM/SEC
 TILT ANGLE .6294015 DEG
 SIGMA TILT ANGLE .0001990 DEG
 SUN AZIMUTH AT PRINCIPAL GRND PNT 267.8103603 DEG
 LONGITUDE OF SUBSOLAR POINT 90.7007757 DEG
 90 DEG, 42 MIN, 2.7924728 SEC
 SWING ANGLE .0182949 DEG
 SIGMA SWING ANGLE 176.4560930 DEG
 NORTH DEVIATION ANGLE .3278577 DEG
 X-TILT .0002000 DEG
 SIGMA X-TILT .0002000 DEG
 Y-TILT .0002000 DEG
 SIGMA Y-TILT .0002000 DEG
 HEADING .0002000 DEG
 SIGMA HEADING .0002000 DEG
 LASER SLANT RANGE 117.5520000 KM

SELENOGRAPHIC DIRECTION COSINES X .93495525 Y .09386939 Z .34212163
 OF CAMERA AXIS MAGNITUDE (KM) 117.123102

TRANSFORMATION MATRIX FROM
 SELENOCENTRIC TO CAMERA

-0.52119934-01 -0.94010795+00 -0.33686843+00
 -0.36843541+00 -0.33163215+00 -0.86849032+00
 .92819112+00 .78848659-01 -0.36365372+00

TRANSFORMATION MATRIX FROM
 LOCAL HORIZONTAL TO CAMERA

-0.99804377+00 .61812190-01 .93710421-02
 -0.61867374-01 -0.99806796+00 -0.57421658-02
 .89992162-02 -0.62907422-02 .99993966+00

PHOTOGRAPH FOOTPRINT
 LATITUDE LONGITUDE

-16.761 -171.507
 -22.769 -171.816
 -22.435 -178.343
 -16.338 -177.851

DIRECTION TO STELLAR PHOTO CENTER

RIGHT ASCENSION -2 HR, 19 MIN, 29.0 SEC DECLINATION 55 DEG, 42 MIN, 22.3 SEC

STATE VECTOR X (KM) -16831365294
 1950.0 1737.3133775
 SELENOGRAPHIC 1737.3133775

LONGITUDE OF NADIR POINT -3.0852840 DEG
 -3 DEG, 5 MIN, 7.0223808 SEC
 LONG OF CAMERA AXIS INTERSECT -3.0971646 DEG
 -3 DEG, 5 MIN, 49.7925639 SEC
 SPACECRAFT RADIUS 1840.4646700 KM
 SCALE FACTOR .0007386 M/KM
 TILT ALTITUDE RATE -0118850 KM/SEC
 TILT AZIMUTH 202.5407162 DEG
 SIGMA TILT AZIMUTH .0230543 DEG
 SUN ELEVATION AT PRIN GRND PNT -3.3292303 DEG
 LONGITUDE OF SUBSOLAR POINT 90.1735744 DEG
 90 DEG, 10 MIN, 24.8679829 SEC
 ALPHA .2053255 DEG
 EMISSION ANGLE .5267399 DEG
 PHASE ANGLE 93.1240234 DEG
 PHI .2352723 DEG
 SIGMA PHI .0002000 DEG
 KAPPA 174.3134308 DEG
 SIGMA KAPPA .0002000 DEG
 OMEGA -4382835 DEG
 SIGMA OMEGA .0002000 DEG
 SPACECRAFT ALTITUDE (LASER) 101.7921572 KM

LATITUDE OF NADIR POINT 19 DEG, 2 MIN, 19.0342324 DEG
 LATI OF CAMERA AXIS INTERSECT 19.0071678 DEG
 19 DEG, 0 MIN, 45.8041382 SEC
 SPACECRAFT ALTITUDE 102.3746737 KM
 AZIMUTH OF VELOCITY VECTOR 263.8030001 DEG
 HORIZONTAL VELOCITY .4977767 DEG
 TILT ANGLE .0001997 DEG
 SIGMA TILT ANGLE .0001997 DEG
 SUN AZIMUTH AT PRINCIPAL GRND PNT 89.6224422 DEG
 LONGITUDE OF SUBSOLAR POINT -72/3273 DEG
 0 DEG, 43 MIN, 38.3784199 SEC
 SWING ANGLE 208.2265394 DEG
 SIGMA SWING ANGLE .0230543 DEG
 NORTH DEVIATION ANGLE 185.6649066 DEG
 X-TILT -.4382835 DEG
 SIGMA X TILT .0002000 DEG
 Y-TILT -.2352654 DEG
 SIGMA Y TILT .0002000 DEG
 HEADING -95.6847714 DEG
 SIGMA HEADING .0002000 DEG
 LASER SLANT RANGE 101.7959995 KM

SELENOGRAPHIC DIRECTION COSINES X Y Z MAGNITUDE (KM)
 OF CAMERA AXIS -.94148588 .04741362 -.33370088 102.378759

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

17716217+00 .93961923+00 .29279545+00 .91061435+04
 -.36883303+00 .33920728+00 -.86539042+00 .76494153+02
 -.91245583+00 .45321832+01 .40665732+00 .99496226+00

PHOTOGRAPH FOOTPRINT
 LATITUDE 21.845
 LONGITUDE -5.79
 16.613
 -0.078
 16.075
 -5.580
 21.335
 -6.185

DIRECTION TO STELLAR PHOTO CENTER

RIGHT ASCENSION -3 HR, 22 MIN, 29.3 SEC 64 DEG, 32 MIN, 19.9 SEC
 DECLINATION

Mission: Apollo 17, Target: 40 Deg S. oblique
strip photography

Rev: 36, Camera: 3 Inch Mapping Frames: 1547 Through: 1686

Coverage Interval:

From: 22.8 Deg S Lat., 176.1 Deg E Long., To: 15.5 Deg N Lat., 15.3 Deg W Long.

From: 154 Hr 55 Min 26.200 Sec, To: 155 Hr 58 Min 49.753 Sec. CTE

Date Processed: 8/24/73, APE Version Used: 7.

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziel)

Lunar Radius: 1738.09 km

Ephemeris-Universal Time Difference: .72166653 Min

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable ($\times 10^{-14}$ - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 155 H, 44 M, 31.95470 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 36. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X =	<u>1505.8475</u>	$\dot{X}$ =	<u>.7583</u>
Y =	<u>896.9519</u>	$\dot{Y}$ =	<u>-1.4280</u>
Z =	<u>587.5814</u>	$\dot{Z}$ =	<u>.1960</u>

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 8/24/73 (During APE operation)

Edited Data Tape No. T00319 File No.: 1 Location: TRW

Remarks: There were no vehicle attitude data available for the interval
155 H, 20 M, 0 sec - 155 H, 27 M, 55 sec (FMS 1601-1618).

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMAT Used:	-.9271362	-.2076425	.3119342
	.3673256	-.3389995	.8661127
	-.0740963	.9175859	.3905711

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

$\Omega = -95^\circ 55' 32.079''$

$\phi = -0^\circ 1' 30.755''$

$\kappa = 0^\circ 0' 58.194''$

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of 40 Deg. S oblique strip photography starting at 176.1 deg E Long. and ending at 15.3 deg W Long. Throughout all except the final six frames of the sequence tilt is maintained at $40.0 \pm .5$ deg. Tilt is approximately a degree higher for those last few frames. Vehicle state vector data only are provided for frames 1601-1618 for which vehicle attitude data are not available for the computations. Star patterns companion to frames 1555 and 1675 are included in these data.

FILED: 17 NOV 52 NAT 4173F PAGE - 1086

[illegible]

Mission: Apollo 17, Target: Vertical strip photography

Rev: 38, Camera: 3 Inch Mapping Frames: 1688 Through: 1833

Coverage Interval:

From: 19.4 Deg S Lat., 172.8 Deg E Long., To: 19.0 Deg N Lat., 11.1 Deg W Long.

From: 158 Hr 53 Min 34.591 Sec, To: 159 Hr 54 Min 31.327 Sec. CTE

Date Processed: 8/24/73, APE Version Used: 7.

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.03 km

Ephemeris-Universal Time Difference: .72166653 Min

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable ($\times 10^{-14}$ - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 159 H, 41 M, 31.75961 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 38. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = <u>1508.0142</u>	X = <u>.7535</u>
Y = <u>898.2424</u>	Y = <u>-1.4281</u>
Z = <u>579.6272</u>	Z = <u>.2127</u>

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 8/24/73 (During APE operation)

Edited Data Tape No. T00319 File No.: 1 Location: TRW

Remarks: There were no vehicle attitude data available for the interval
159 H, 15 M, 04 sec - 159 H, 16 M, 43 sec (FMS 1740-1743).

• APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used: -.9271362 -.2076425 .3119342
 .3673256 -.3389995 .8661127
 -.0740963 .9175859 .3905711

• Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

$\Omega = -95^{\circ} 55' 32.079''$

$\phi = -0^{\circ} 1' 30.755''$

$\kappa = 0^{\circ} 0' 58.194''$

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of vertical strip photography starting at 172.8 deg E Long. and ending at 11.1 deg W Long. Throughout the sequence tilt is maintained less than 1 degree. Vehicle state vector data only are provided for frames 1740-1743 for which vehicle attitude data are unavailable for the computations.

STATE VECTOR	X (KM)	Y (KM)	Z (KM)	UOT (KM/S)	ZOOT (KM/S)
1950+0	1721.2490810	51.7136096	-693.5233680	-1.5311882	-5112240
SELENOGRAPHIC	-1737.8857316	217.8666521	-615.3500355	1.471875	1.1229497
LONGITUDE OF NAIR POINT	172.8545017 DEG				
LONG OF CAMERA AXIS	172 DEG, 51 MIN, 16.2062073 SEC				
SPACECRAFT RADIUS	172 DEG, 50 MIN, 43.5424805 SEC				
SCALE FACTOR	1856.4397004 KM				
MEAN ALTITUDE RATE	.0000000 M/KM				
SIGMA TILT AZIMUTH	.0104537 KM/SEC				
SUN ELEVATION AT PRIN GRND PNT	196.1444149 DEG				
LONGITUDE OF SUBSOLAR POINT	.0252135 DEG				
ALPHA	81 DEG, 39 MIN, 35.1334190 SEC				
EMISSION ANGLE	.1427817 DEG				
PHASE ANGLE	.4828210 DEG				
PHI	91.0263548 DEG				
SIGMA PHI	.0840702 DEG				
KAPPA	.0001999 DEG				
SIGMA KAPPA	-174.57338297 DEG				
OMEGA	.0002000 DEG				
SIGMA OMEGA	-.4441523 DEG				
SPACECRAFT ALTITUDE (LASER)	.0002001 DEG				
	.0000000 KM				

SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)
OF CAMERA AXIS	.93887528	-.11548935	.32430760	118.353638

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

-91849778-01	-94859423+00	-99551669+00	94574245-01	14672579-02
-35564459+00	31534915+00	-94560182-01	-99548895+00	77518426-02
93009700+00	26904733-01	21937408-02	75783397-02	99996882+00

PHOTOGRAPH FOOTPRINT

LONGITUDE	176.305
ALTITUDE	175.855
SLANT RANGE	169.207
SLANT RANGE	169.988

DIRECTION TO STELLAR PHOTO CENTER

RIGHT ASCENSION	-2 HR, 18 MIN, 45.9 SEC
DECLINATION	56 DEG, 50 MIN, 29.4 SEC

STATE VECTOR	X (KM)	Y (KM)	Z (KM)	YDOT (KM/S)	ZDOT (KM/S)
1950.0	-1692.7042760	45.9759944	718.3275519	1.5464401	0.4726435
SELENOGRAPHIC	1706.0662496	-334.3817386	600.7352450	-1.6064809	-0.1615087

LONGITUDE OF NADIR POINT	-11.0891612 DEG	LATITUDE OF NADIR POINT	19.0622237 DEG
LONG OF CAMERA AXIS INTERSECT	-11 DEG, 5 MIN, 20.9801674 SEC	19 DEG, 3 MIN, 44.0035057 SEC	
SPACECRAFT RADIUS	1839.3901244 KM	19 DEG, 2 MIN, 10.4300308 SEC	
SCALE FACTOR	.0007468 M/KM	SPACECRAFT ALTITUDE	101.3001281 KM
MEAN ALTITUDE RATE	-0.0098875 KM/SEC	AZIMUTH OF VELOCITY VECTOR	264.1275590 DEG
TILT AZIMUTH	139.3518753 DEG	HORIZONTAL VELOCITY	1.6367179 KM/SEC
SIGMA TILT AZIMUTH	.0177973 DEG	TILT ANGLE	.6380991 DEG
SUN ELEVATION AT PRIN GRND PNT	-2.3158550 DEG	SIGMA TILT ANGLE	.0002018 DEG
LONGITUDE OF SUBSOLAR POINT	81.1452510 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	89.9479418 DEG
81 DEG, 8 MIN, 42.9036999 SEC		LATITUDE OF SUBSOLAR POINT	-7059952 DEG
ALPHA EMISSION ANGLE	-48.20059 DEG	0 DEG, 42 MIN, 21.5826702 SEC	
PHASE ANGLE	.8750113 DEG	SWING ANGLE	140.327037 DEG
PHI	-40.62982 DEG	SIGMA SWING ANGLE	77974 DEG
SIGMA PHI	.0002000 DEG	NORTH DEVIATION ANGLE	186.0825254 DEG
KAPPA	173.9209938 DEG	X-TILT	-4916851 DEG
SIGMA KAPPA	.0002000 DEG	SIGMA X-TILT	.0002000 DEG
OMEGA	-4916851 DEG	Y-TILT	.4062832 DEG
SIGMA OMEGA	.0002000 DEG	SIGMA Y-TILT	.0002000 DEG
SPACECRAFT ALTITUDE (LASER)	103.8815565 KM	HEADING	-96.0824942 DEG
		SIGMA HEADING	.0002000 DEG
		LASER SLANT RANGE	103.8879995 KM

SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS	X	Y	Z	MAGNITUDE (KM)
	-0.92343476	0.18910082	-0.33392983	101.306771

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA	TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA
.154411521+00	-0.99434533+00
-0.37017944+00	-0.10595759+00
-0.91603658+00	0.10589581+00
	-0.779600779-02
	0.77819976-02
	-0.70909205-02
	0.85814187-02
	0.99993799+00

PHOTOGRAPH FOOTPRINT
LATITUDE
LONGITUDE
21.884
-8.567
16.662
-8.025
16.147
-13.475
21.297
-14.098

DIRECTION TO STELLAR PHOTO CENTER	DECLINATION
-3 HR, 17 MIN, 4.4 SEC	65 DEG, 11 MIN, 59.7 SEC

Mission: Apollo 17, Target: Vertical strip photography

Rev: 49; Camera: 3 Inch Mapping Frames: 1979 Through: 2133

Coverage Interval:

From: 22.2 Deg S Lat., 165.3 Deg E Long., To: 19.4 Deg N Lat., 32.6 Deg W Long.

From: 180 Hr 39 Min 47.074 Sec, To: 181 Hr 44 Min 44.470 Sec. CTE

Date Processed: 8/24/73, APE Version Used: 7.

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 km

Ephemeris-Universal Time Difference: .72171653 Min

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable ($\times 10^{-14}$ - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 181 H, 25 M, 11.1075 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 49. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = <u>1488.5866</u>	$\dot{X}$ = <u>.7256</u>
Y = <u>886.6705</u>	$\dot{Y}$ = <u>-1.4287</u>
Z = <u>649.3576</u>	$\dot{Z}$ = <u>.2875</u>

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 8/24/73 (During APE operation)

Edited Data Tape No. T00114 File No.: 1 Location: TRW

Remarks: There were no gaps in the vehicle attitude data used for this sequence.

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used:	-.6493783	-.7570575	.0719149
	.4029205	-.2623184	.8768376
	-.6449519	.5983752	.4753779

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

$\Omega = -95^{\circ} 55' 32.079''$
 $\phi = -0^{\circ} 1' 30.755''$
 $\kappa = 0^{\circ} 0' 58.194''$

Uncertainties Assumed:

± 1 degree in camera positioning angle
 ± 0.2 mrad in each gimbal angle
 ± 20 ms in onboard clock bias definition
 ± 5 ms in onboard clock drift rate
 ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of vertical strip photography starting at 165.3 deg E Long. and ending at 32.6 deg W Long. Throughout the sequence tilt is maintained less than 1 deg. Vehicle state vector data only are provided for frame 2100 for which vehicle attitude data were ignored as consequence of a computer erratic. The star pattern companion to frame 2125 is included in these data.

STATE VECTOR X (KM) 1693.1073459 Y (KM) 209.3832557 Z (KM) 716.9678588
 1950.0 GMT 1972 12 14 18 12 39
 SELENOGRAPHIC -1657.3263715 CTE 434.8030830
 LONGITUDE OF NADIR POINT 165.2996216 DEG
 165 DEG, 17 MIN, 58.6376953 SEC
 LONG OF CAMERA AXIS INTERSECT 165.3029995 DEG
 165 DEG, 18 MIN, 10.7981873 SEC
 SPACECRAFT RADIUS 18505395816 KM
 SCALE FACTOR .0000000 M/KM
 MEAN ALTITUDE RATE .0000555 KM/SEC
 TILT AZIMUTH 172.8970825 DEG
 SIGMA TILT AZIMUTH .0301278 DEG
 SUN ELEVATION AT PRIN GRND PNT -4.0519659 DEG
 LONGITUDE OF SUBSOLAR POINT 70.6355166 DEG
 70 DEG, 38 MIN, 7.8598309 SEC
 ALPHA .0348008 DEG
 EMISSION ANGLE .4046730 DEG
 PHASE ANGLE 94.0272655 DEG
 PHI -.0911268 DEG
 SIGMA PHI .0002000 DEG
 KAPPA -173.4306679 DEG
 SIGMA KAPPA .0002000 DEG
 OMEGA -.3689959 DEG
 SIGMA OMEGA .0003000 DEG
 SPACECRAFT ALTITUDE (LASER) 112.2405336 KM
 LATITUDE OF NADIR POINT -22.1956625 DEG
 -22 DEG, 11 MIN, 44.3849945 SEC
 LATI OF CAMERA AXIS INTERSECT -22.2200553 DEG
 -22 DEG, 13 MIN, 12.1992302 SEC
 SPACECRAFT ALTITUDE 112.4495853 KM
 AZIMUTH OF VELOCITY VECTOR 276.6610285 DEG
 HORIZONTAL VELOCITY 1.6278257 KM/SEC
 TILT ANGLE .3797618 DEG
 SIGMA TILT ANGLE .0002003 DEG
 SUN AZIMUTH AT PRINCIPAL GRND PNT 267.6005974 DEG
 LATITUDE OF SUBSOLAR POINT -.6402004 DEG
 U DEG, 40 MIN, 48.7215042 SEC
 SWING ANGLE 166.1280569 DEG
 SIGMA SWING ANGLE .0301278 DEG
 NORTH DEVIATION ANGLE 173.4311252 DEG
 X-TILT -.3689959 DEG
 SIGMA X-TILT .0002000 DEG
 Y-TILT .0911249 DEG
 SIGMA Y-TILT .0002000 DEG
 HEADING -.93.4312592 DEG
 SIGMA HEADING .0002000 DEG
 LASER SLANT RANGE 112.2430000 KM

SELENOGRAPHIC DIRECTION COSINES X .89776148 Y -.23640139 Z .37167015 MAGNITUDE (KM) 112.452220
 OF CAMERA AXIS

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA
 -.60260117-02 -.95712189+00 -.28962264+00
 -.39769539+00 .26803157+00 -.87749502+00
 .91749775+00 .10989381+00 -.38225816+00
 TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA
 -.99343402+00 .11439502+00 -.15904292-02
 -.11440303+00 -.99341357+00 .64401483-02
 -.84323197-03 .65797978-02 .99997803+00

PHOTOGRAPH FOOTPRINT
 LATITUDE 168.707
 LONGITUDE -19.641
 -25.439
 -24.748
 -19.001
 172.620

DIRECTION TO STELLAR PHOTO CENTER
 RIGHT ASCENSION -1 HR, 50 MIN, 9.9 SEC
 DECLINATION 56 DEG, 25 MIN, 49.9 SEC

STATE VECTOR	X (KM)	Y (KM)	Z (KM)	ADOT (KM/S)	YDOT (KM/S)	ZDOT (KM/S)
1950.0	-1621.6841132	300.9579261	838.7784538	.4275944	1.5470566	.2718145
SELENOGRAPHIC	1469.8540744	-941.5086665	613.9721306	-.7545063	-1.4012817	-.3423946

LONGITUDE OF NAIR POINT	-32.6430755 DEG	LATITUDE OF NAIR POINT	19.3783612 DEG
-32 DEG, 38 MIN, 35.0716782 SEC		19 DEG, 22 MIN, 42.1004105 SEC	
LONG OF CAMERA AXIS INTERSECT	-32.6436749 DEG	LATI OF CAMERA AXIS INTERSECT	19.3607845 DEG
-32 DEG, 38 MIN, 37.2294617 SEC		19 DEG, 21 MIN, 38.8243103 SEC	
SPACECRAFT RADIUS	1850.4011271 KM	SPACECRAFT ALTITUDE	112.3111307 KM
SCALE FACTOR	.0006753 M/KM	AZIMUTH OF VELOCITY VECTOR	257.1160050 DEG
MEAN ALTITUDE RATE	.0000908 KM/SEC	HORIZONTAL VELOCITY	1.6278844 KM/SEC
TILT AZIMUTH	181.8427219 DEG	TILT ANGLE	.2717740 DEG
SIGMA TILT AZIMUTH	.0421414 DEG	SIGMA TILT ANGLE	.0002001 DEG
SUN ELEVATION AT PRIN GRND PNT	-12.2294283 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	86.3700495 DEG
LONGITUDE OF SUBSOLAR POINT	70.0874484 DEG	LATITUDE OF SUBSOLAR POINT	-.6788257 DEG
70 DEG, 5 MIN, 14.8144162 SEC		0 DEG, 40 MIN, 43.7723923 SEC	
ALPHA	.0279438 DEG	SWING ANGLE	194.9585043 DEG
EMISSION ANGLE	.2897148 DEG	SIGMA SWING ANGLE	.0421417 DEG
PHASE ANGLE	102.2016420 DEG	NORTH DEVIATION ANGLE	193.1162568 DEG
PHI	.0702417 DEG	X-TILT	-.2629050 DEG
SIGMA PHI	.0002000 DEG	SIGMA X-TILT	.0002000 DEG
KAPPA	166.8835564 DEG	Y-TILT	-.0702409 DEG
SIGMA KAPPA	.0002000 DEG	SIGMA Y-TILT	.0002000 DEG
OMEGA	-.2629050 DEG	HEADING	-103.1161172 DEG
SIGMA OMEGA	.0002000 DEG	SIGMA HEADING	.0002000 DEG
SPACECRAFT ALTITUDE (LASER)	114.2597141 KM	LASER SLANT RANGE	114.2609997 KM

SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)
OF CAMERA AXIS	-.79309059	.50786175	-.33627928	112.312479

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA	TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA
.26000904+00 .95158556+00 .16395162+00	-.97391140+00 -.22692509+00 .12259350-02
-.40870410+00 .26228615+00 -.87416645+00	.22692842+00 -.97390066+00 .45885420-02
-.87484645+00 .16028343+00 .45711373+00	.15272583-03 .47470731-02 .99998875+00

PHOTOGRAPH FOOTPRINT
LATITUDE
22.814
LONGITUDE
-30.304
17.149
-28.985
15.842
-34.908
21.484
-36.379

DIRECTION TO STELLAR PHOTO CENTER

RIGHT ASCENSION	-2 HR, 30 MIN, 32.8 SEC	DECLINATION	66 DEG, 27 MIN, 24.2 SEC
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Mission: Apollo 17, Target: Roll to vertical and Vertical strip photography
Rev: 62, Camera: 3 Inch Mapping Frames: 2151 Through: 2298
Coverage Interval:
From: 22.1 Deg S Lat., 152.0 Deg E Long., To: 21.2 Deg N Lat., 35.8 Deg W Long.
From: 206 Hr 28 Min 44.160 Sec, To: 207 Hr 30 Min 36.102 Sec. CTE
Date Processed: 8/26/73, APE Version Used: 7.

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 km

Ephemeris-Universal Time Difference: .72178319 Min.

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 207 H, 9 M, 58.94921 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 62. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = 1513.7465 $\dot{X}$ = .6941

Y = 901.6569 $\dot{Y}$ = -1.4169

Z = 566.6613 $\dot{Z}$ = .4033

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 8/26/73 (During APE operation)

Edited Data Tape No. T00293 File No.: 1 Location: TRW

Remarks: There were no gaps in the vehicle attitude data used for this sequence.

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMAT Used:	-.6493783	-.7570575	.0719149
	.4029205	-.2623184	.8768376
	-.6449519	.5983752	.4753779

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

$\Omega = -95^\circ 55' 32.079''$
 $\phi = -0^\circ 1' 30.755''$
 $\kappa = 0^\circ 0' 58.194''$

Uncertainties Assumed:

± 1 degree in camera positioning angle
 ± 0.2 mrad in each gimbal angle
 ± 20 ms in onboard clock bias definition
 ± 5 ms in onboard clock drift rate
 ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of strip photography that starts at 152.0 E Long. and ends at 35.8 W Long. The initial 56 frames were taken during a "Roll to Vertical" spacecraft maneuver. During the maneuver tilt is increased from its initial value of 3.7 deg to a maximum of 52.4 deg at frame 2192 (95 deg E Long.). From that point to 76.22 deg E Long. (frame 2212), tilt is steadily reduced to less than 1 deg. The remainder of the sequence is vertical strip photography with tilt maintained less than 1 deg. Star patterns companion to frames 2160 and 2290 are included in these data.

STATE VECTOR	X (KM)	Y (KM)	Z (KM)	ADUT (KM/SEC)	YOUT (KM/SEC)	ZOUT (KM/SEC)
1950.0	1696.6347399	240.0795348	-705.3147570	.0248561	-1.5583227	-.4659212
SELENOGRAPHIC	-1517.9272475	799.4488751	-700.2677705	.6895112	1.4623139	.1196728

LONGITUDE OF NADIR POINT	152.2240273 DEG	LATITUDE OF NADIR POINT	-22.2040710 DEG
152 DEG, 13 MIN, 26.4994812 SEC		-22 DEG, 12 MIN, 14.6557617 SEC	
LONG OF CAMERA AXIS INTERSECT	151.9761944 DEG	LATI OF CAMERA AXIS INTERSECT	-22.1137617 DEG
151 DEG, 58 MIN, 34.2977742 SEC		-22 DEG, 6 MIN, 49.5419884 SEC	
SPACECRAFT RADIUS	1853.0182218 KM		114.9282255 KM
SCALE FACTOR	.0000000 M/KM	SPACECRAFT ALTITUDE	276.8257545 DEG
MEAN ALTITUDE RATE	-.0017962 KM/SEC	AZIMUTH OF VELOCITY VECTOR	1.6266439 KM/SEC
TILT AZIMUTH	291.4307022 DEG	HORIZONTAL VELOCITY	3.7241552 DEG
SIGMA TILT AZIMUTH	.0031735 DEG	TILT ANGLE	.0001937 DEG
SUN ELEVATION AT PRIM GRND PNT	-3.8369484 DEG	SIGMA TILT ANGLE	267.7384796 DEG
LONGITUDE OF SUBSOLAR POINT	57.5703224 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	-.6466035 DEG
57 DEG, 34 MIN, 13.1607914 SEC		LATITUDE OF SUBSOLAR POINT	47.7725024 SEC
ALPHA	-3.6300576 DEG	0 DEG, 36 MIN, 274.2050927 DEG	
EMISSION ANGLE	3.9708436 DEG	SWING ANGLE	.0031736 DEG
PHASE ANGLE	97.4685249 DEG	SIGMA SWING ANGLE	162.8155656 DEG
PHI	3.7141902 DEG	NORTH DEVIATION ANGLE	.2728917 DEG
SIGMA PHI	.0001964 DEG	X-TILT	.0002035 DEG
KAPPA	-1.62.7655506 DEG	SIGMA X-TILT	-3.7141482 DEG
SIGMA KAPPA	.0002000 DEG	Y-TILT	.0001964 DEG
OMEGA	.2728917 DEG	SIGMA Y-TILT	-72.7832682 DEG
SIGMA OMEGA	.0002035 DEG	HEADING	.0002004 DEG
SPACECRAFT ALTITUDE (LASER)	117.4494591 KM	SIGMA HEADING	117.6980000 KM
		LASER SLANT RANGE	

SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)
OF CAMERA AXIS	.83767624	-.37287103	.39906109	115.187572

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA	TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA
.14760255+00	-.953165+00
-.97791395+00	.24536531+00
.78551019+01	-.29627899+00
.19368513+00	-.95508960+00
	.60462697+01
	-.23732456+01
	.64778724+01
	-.47628410+02
	.99768832+00

PHOTOGRAPH FOOTPRINT
LATITUDE
LONGITUDE
-20.209
155.753
-25.620
154.020
-24.117
147.637
-18.114
149.762

DIRECTION TO STELLAR PHOTO CENTER	60 DEG, 33 MIN, 29.9 SEC
NIGHT ASCENSION	0 HR, 27 MIN, 22.3 SEC
DECLINATION	

STATE VECTOR	X (KM)	Y (KM)	Z (KM)	YDOT (KM/S)	ZDOT (KM/S)
1950.0	-1687.4275553	-21.4985092	764.7234369	1.5724407	.3878234
SELENOGRAPHIC	1400.7752573	-1010.8028052	669.9121156	-1.3592213	-.2525927

YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
GMT1972	12	15	21	3	34.371
CTE			15	30	36.102

LONGITUDE OF NAIR POINT	-35.8143072 DEG	LATITUDE OF NAIR POINT	21.1971090 DEG
LONG OF CAMERA AXIS INTERSECT	-35.8285885 DEG	LATI OF CAMERA AXIS INTERSECT	21.2082715 DEG
SPACECRAFT RADIUS	1852.7481953 KM	SPACECRAFT ALTITUDE	114.6581989 KM
SCALE FACTOR	.0006617 M/KM	AZIMUTH OF VELOCITY VECTOR	260.3871893 DEG
MEAN ALTITUDE RATE	.0019086 KM/SEC	HORIZONTAL VELOCITY	1.6268000 KM/S, C
TILT AZIMUTH	309.9777832 DEG	TILT ANGLE	.2629124 DEG
SIGMA TILT AZIMUTH	.0432132 DEG	SIG A TILT ANGLE	.0002017 DEG
SUN ELEVATION AT PRIN GRND PNT	-2.9157534 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	89.5605707 DEG
LONGITUDE OF SUBSOLAR POINT	57.0486642 DEG	LATITUDE OF SUBSOLAR POINT	-.6452260 DEG
ALPHA	57 DEG, 2 MIN, 55.1909781 SEC	SWING ANGLE	0 DEG, 38 MIN, 42.8136635 SEC
EMISSION ANGLE	.2137794 DEG	SIGMA SWING ANGLE	319.8896706 DEG
PHASE ANGLE	.2807326 DEG	NORTH DEVIATION ANGLE	.0432132 DEG
PHI	92.7019882 DEG	X-TILT	189.9118219 DEG
SIGMA PHI	.1696722 DEG	SIGMA X-TILT	.2014174 DEG
KAPPA	.0002000 DEG	Y-TILT	.0002000 DEG
SIGMA KAPPA	170.0867699 DEG	SIGMA Y-TILT	-.1696711 DEG
OMEGA	.0002000 DEG	HEADING	.0002000 DEG
SIGMA OMEGA	.2014174 DEG	SIGMA HEADING	-.99.9118228 DEG
SPACECRAFT ALTITUDE (LASER)	.0002000 DEG	LASER SLANT RANGE	.0002000 DEG
	116.6517715 KM		116.6529979 KM

SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)
OF CAMERA AXIS	-.75897167	.54333228	-.35882034	114.659490

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA

.90715829-01	.96786515+00	.23453694+00
-.39900655+00	.25110259+00	-.68189643+00
-.91244971+00	-.13579836-01	.40896355+00

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

-.98506946+00	-.17213161+00	.29613156-02
.17212111+00	-.98506955+00	-.35153889-02
.35222288-02	-.29531742-02	.99998947+00

PHOTOGRAPH FOOTPRINT

LATITUDE	24.623
LONGITUDE	-33.177
	18.773
	17.759
	23.592

DIRECTION TO STELLAR PHOTO CENTER

RIGHT ASCENSION	-2 HR, 38 MIN, 32.3 SEC	DECLINATION	66 DEG, 51 MIN, 15.0 SEC
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Mission: Apollo 17, Target: N&S 40° Oblique
strip photography
Rev: 65, Camera: 3 Inch Mapping Frames: 2354 Through: 2460

Coverage Interval:

From: 7.1 Deg S Lat., 102.5 Deg E Long., To: 19.1 Deg N Lat., 44.8 Deg W Long.

From: 212 Hr 42 Min 3.963 Sec, To: 213 Hr 30 Min 20.836 Sec. CTE

Date Processed: 8/24/73, APE Version Used: 7

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziel)

Lunar Radius: 1738.09 km

Ephemeris-Universal Time Difference: .72178319 Min

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable ($\times 10^{-14}$ - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 213 H, 6 M, 41.13411 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 65. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = 1520.1005 $\dot{X}$ = .6897

Y = 905.4417 $\dot{Y}$ = -1.4117

Z = 543.3302 $\dot{Z}$ = .4284

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High and Low

Date Edited: 8/24/73 (During APE operation)

Edited Data Tape No. T01247 File No.: 1 Location: TRW

Remarks: High bit rate in 212 H, 42 M - 212 H, 45 M and 212 H, 49 M - 213 H, 30 M. Low bit rate in 212 H, 45 M - 212 H, 49 M. There were no attitude data for the interval 212 H, 45 M - 212 H, 47 M, 10 sec (FMS 2362-2365).

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMAT Used:	- .6493783	- .7570575	.0719149
	.4029205	- .2623184	.8768376
	- .6449519	.5983752	.4753779

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

$\Omega = -95^\circ 55' 32.079''$
 $\phi = -0^\circ 1' 30.755''$
 $\kappa = 0^\circ 0' 58.194''$

Uncertainties Assumed:

- ± 1 degree in camera positioning angle
- ±0.2 mrad in each gimbal angle
- ±20 ms in onboard clock bias definition
- ±5 ms in onboard clock drift rate
- ±5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of strip photography which begins as 40 deg N oblique and ends as 40 deg S oblique. The photography starts as 102.5 deg E Long. and ends at 44.8 deg W Long. The sequence is N oblique from its start to 80.7 deg E Long. (frame 2371). Over the next 7 frames, the photography was taken during the roll maneuver executed to switch to 40 deg S oblique. From that point, 69 deg E Long. (frame 2378) the photography is 40 deg S oblique. State vector data only are provided over the interval where vehicle attitude data are unavailable for the computations (frames 2362-2365). The star pattern companion to frame 2365 is included in these data.

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STATE VECTOR	X (KM)	Y (KM)	Z (KM)	DOT (KM/SEC)	DOT (KM/SEC)	DOT (KM/SEC)
1450.0	-1661.7377431	164.3033056	603.167278	3342772	1.5761677	3.130354
STEREOGRAPHIC	1224.373694	-1238.5104732	633.2075631	-1.07408331	-1.02016743	-0.152445

LONGITUDE OF NAUTIC POINT	-75.03200946 DEG	LATITUDE OF NAUTIC POINT	20.0410702 DEG
LONG OF CAMERA AXIS INTERSECT	-75 DEG 19 MIN 44.0200116 SEC	LAT OF CAMERA AXIS INTERSECT	20 DEG 2 MIN 27.3024023 SEC
SPACECRAFT RADIUS	44 DEGS 48 MIN 31.071431 SEC	SPACECRAFT ALTITUDE	17.3386514 DEG
SCALE FACTOR	1853.8117572 KM	ALTITUDE OF VELOCITY VECTOR	15.7219008 KM
MEAN ALTITUDE RATE	0.003190 K/KH	HORIZONTAL VELOCITY	258.0516036 DEG
TILT AZIMUTH	0.002794 K1/SEC	TILT ANGLE	1.6258423 KM/SEC
SIGMA TILT AZIMUTH	107.0318496 DEG	SIGMA TILT ANGLE	30.3073321 DEG
SUN ELEVATION AT PNT. GRID PNT	-6.5735642 DEG	SUN ALTITUDE AT PRINCIPAL GRID PNT	0.002000 DEG
LONGITUDE OF SUBSOLAR POINT	54 DEG 50 MIN 54.0150012 DEG	LATITUDE OF SUBSOLAR POINT	87.3900309 DEG
ALPHA EMISSION ANGLE	54 DEG 0 MIN 55.8042712 SEC	ALPHA EMISSION ANGLE	-0.371521 DEG
PHASE ANGLE	-2.66250733 DEG	SIGMA EMISSION ANGLE	179.4775500 DEG
SIGMA PHI	12.08476753 DEG	LONGT. DEVIATION ANGLE	0.003962 DEG
KAPPA	-0.3031707 DEG	X-TILT	174.0349233 DEG
SIGMA KAPPA	0.002316 DEG	SIGMA X-TILT	-32.3179442 DEG
OMEGA	167.9250498 DEG	Y-TILT	0.002000 DEG
SIGMA OMEGA	0.002317 DEG	SIGMA Y-TILT	0.002000 DEG
SPACECRAFT ALTITUDE (KASST)	-30.307441 DEG	SLANT RANGE	-102.2270556 DEG
	0.002000 DEG		0.002000 DEG
	0.002000 KM		0.002000 KM

SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MASSIVE (KM)
OF CAMERA AXIS	-0.37276571	0.3466171	-0.75837407	145.605202

TRANSFORMATION MATRIX FROM			
STEREOGRAPHIC TO CAMERA			
	1	2	3
	0.77729317+00	-0.2181335+00	-0.43016877-02
	0.18039939+00	-0.84422435+00	0.30464733+00
	0.11077842+00	0.47235499+00	0.33331335+00

TRANSFORMATION MATRIX FROM			
LOCAL HORIZONTAL TO CAMERA			
	1	2	3
	0.77729317+00	-0.2181335+00	-0.43016877-02
	0.18039939+00	-0.84422435+00	0.30464733+00
	0.11077842+00	0.47235499+00	0.33331335+00

ELEVATION AT PRINCIPAL POINT
LONGITUDE OF SUBSOLAR POINT

54 DEG. 0 MIN.

-6.5735022 DEG
54.9150012 DEG

301.4619141 AT PRINCIPAL POINT
LATITUDE OF SUBSOLAR POINT

0 DEG. 38 MIN.

37.4400309 DEG
-0.371521 DEG

ALPHA
MISSION ANGLE
PHASE ANGLE

-2.6250073 DEG
32.5500503 DEG
102.8427675 DEG

SWING ANGLE
SIGMA SWING ANGLE
MOUTH DEVIATION ANGLE

179.4775560 DEG
0.003962 DEG
194.0349233 DEG

PHI
SIGMA PHI

-0.3531767 DEG
0.002316 DEG

X-TILT
SIGMA X-TILT

-33.3079442 DEG
0.002200 DEG

KAPPA
SIGMA KAPPA

167.92500408 DEG
0.002317 DEG

Y-TILT
SIGMA Y-TILT

0.002200 DEG
0.002200 DEG

OMEGA
SIGMA OMEGA

-30.3079441 DEG
0.002200 DEG

SLANT ANGLE
LASER SLANT RANGE

-102.4270456 DEG
0.002200 DEG
0.0000000 KM

SELENOGRAPHIC DIRECTION COSINES
OF CAMERA AXIS

-0.37276571

0.3460171

-0.75837609

MAGNITUDE (KM)
135.605202

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

0.19030627+00 0.76422225+00 0.16551000+00
-0.75921117+00 0.26193844+00 -0.54797114+00
-0.37010000+00 -0.45260729+00 0.42032691+00

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

0.77727817+00 -0.2181335+00 -0.45016877+02
0.18039999+00 -0.84422435+00 0.30464733+00
0.11077842+00 0.47235989+00 0.3331335+00

PHOTOGRAPH FOOTPRINT
LATITUDE

-42.971

0.0000000
0.0000000
19.974

DIRECTION TO SILENT PHOTO CENTER

DECLINATION

10 DEG 11 MIN 24.4 SEC

RIGHT ASCENSION

01 HR 17 MIN 10.2 SEC

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Mission: Apollo 17, Target: Vertical strip photography

Rev: 66, Camera: 3 Inch Mapping Frames: 2591 Through: 2734

Coverage Interval:

From: 22.2 Deg Slat., 147.8 Deg E Long., To: 21.8 Deg N Lat., 35.4 Deg W Long.

From: 214 Hr 25 Min 47.917 Sec, To: 215 Hr 26 Min 9.042 Sec CTE

Date Processed: 8/25/73, APE Version Used: 7

INPUT DATA

0 Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.03 km

Ephemeris-Universal Time Difference: .72179986 Min.

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable ($\times 10^{-14}$ - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 115 H, 5 M, 35.15633 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 66. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = <u>1522.2772</u>	$\dot{X}$ = <u>.6884</u>
Y = <u>906.7382</u>	$\dot{Y}$ = <u>-1.4098</u>
Z = <u>535.1852</u>	$\dot{Z}$ = <u>.4365</u>

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 8/25/73 (During APE operation)

Edited Data Tape No. T01639 File No.: 1 Location: TRW

Remarks: There were no gaps in the vehicle attitude data used for this sequence.

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMAT Used:	-.6493783	-.7570575	.0719149
	.4029205	-.2623184	.8768376
	-.6449519	.5983752	.4753779

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

$\Omega = -95^{\circ} 55' 32.079''$

$\phi = -0^{\circ} 1' 30.755''$

$\kappa = 0^{\circ} 0' 58.194''$

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of vertical strip photography starting at 147.8 deg E Long. and ending at 35.4 deg W Long. Throughout the sequence tilt is maintained less than 1 deg. State vector data only are provided for frame 2621 for which vehicle attitude data were ignored as the result of a computer erratic. Star patterns companion to frames 2600 and 2725 are included in these data.

YEAR MONTH DAY HOUR MINUTE SECOND
 GMT1972 12 16 3 58 46.191
 CTE

STATE VECTOR X (KM) Y (KM) Z (KM) ADUT (KM/S) YOUT (KM/S) ADUT (KM/S)
 1950.0 1696.0486038 238.44330730 -704.4615308 0255265 1.4061393
 SELENOGRAPHIC -1451.5268326 913.4346662 -698.8626323 7985111 -1.5607277 -1.4610881
 LONGITUDE OF NADIR POINT 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 LONG OF CAMERA AXIS INTERSECT 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SPACECRAFT RADIUS 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SCALE FACTOR 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 MEAN ALTITUDE RATE 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 TILT AZIMUTH 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SIGMA TILT AZIMUTH 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SUN ELEVATION AT PRIN GRND PNT 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 LONGITUDE OF SUBSOLAR POINT 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 ALPHA 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 EMISSION ANGLE 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 PHASE ANGLE 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 PHI 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SIGMA PHI 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 KAPPA 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SIGMA KAPPA 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 OMEGA 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SIGMA OMEGA 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SPACECRAFT ALTITUDE (LASER) 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG

LATITUDE OF NADIR POINT 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 LONG OF CAMERA AXIS INTERSECT 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SPACECRAFT ALTITUDE 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 AZIMUTH OF VELOCITY VECTOR 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 HORIZONTAL VELOCITY 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 TILT ANGLE 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SIGMA TILT ANGLE 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SUN AZIMUTH AT PRINCIPAL GRND PNT 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 LATITUDE OF SUBSOLAR POINT 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SWING ANGLE 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SIGMA SWING ANGLE 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 NORTH DEVIATION ANGLE 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 X-TILT 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SIGMA X-TILT 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 Y-TILT 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SIGMA Y-TILT 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 HEADING 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 SIGMA HEADING 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG
 LASER SLANT RANGE 147.8181076 DEG 147.8181076 DEG 147.8181076 DEG

SELENOGRAPHIC DIRECTION COSINES X Y Z
 OF CAMERA AXIS .783563346 .49099458 .38072645
 MAGNITUDE (KM) 113.856462

TRANSFORMATION MATRIX FROM
 SELENOCENTRIC TO CAMERA

.14413376-01 -.95557014+00 -.29441104+00
 -.40451916+00 .26369746+00 -.87568713+00
 .91441597+00 .13171652+00 -.38274569+00

PHOTOGRAPH FOOTPRINT
 LATITUDE LONGITUDE
 -19.519 151.266
 -25.370 150.672
 -24.713 144.233
 -18.863 145.052

TRANSFORMATION MATRIX FROM
 LOCAL HORIZONTAL TO CAMERA

-.99379313+00 .11122237+00 .21667532-02
 -.11122939+00 -.99378893+00 -.34114237-02
 .17738661-02 -.36312695-02 .99999187+00

DIRECTION TO STELLAR PHOTO CENTER

RIGHT ASCENSION -1 HR, 46 MIN, 31.7 SEC 56 DEG, 14 MIN, 21.2 SEC
 DECLINATION

YEAR MONTH DAY HOUR MINUTE SECOND
GMT1972 12 16 4 57 7.317
CTL 8 23 26 9.042

STATE VECTOR
1950.0
SELENOGRAPHIC
X (KM)
-1697.4263825
1402.5076406
Y (KM)
-161.0725849
-926.7411141

YDOT (KM/S)
2001 (KM/S)
1.5664779
-1.3625914

LONGITUDE OF NADIR POINT

-35.4008360 DEG
-35 DEG, 24 MIN, 3.0095673 SEC
LONG OF CAMERA AXIS INTERSECT
-35.4457064 DEG
-35 DEG, 26 MIN, 44.5429230 SEC
SPACECRAFT RADIUS
1853.6705804 KM

SCALE FACTOR
MEAN ALTITUDE RATE
TILT AZIMUTH
SIGMA TILT AZIMUTH
SUN ELEVATION AT PRIM GRND PNT
LONGITUDE OF SUBSOLAR POINT
53 DEG, 2 MIN, 21.1366510 SEC
ALPHA
EMISSION ANGLE
PHASE ANGLE
PHI
SIGMA PHI
KAPPA
SIGMA KAPPA
OMEGA
SIGMA OMEGA
SPACECRAFT ALTITUDE (LASER)

LATITUDE OF NADIR POINT
21.8407917 DEG
LATI OF CAMERA AXIS INTERSECT
21 DEG, 50 MIN, 26.8501282 SEC
21.8557463 DEG
21 DEG, 51 MIN, 20.8865672 SEC
SPACECRAFT ALTITUDE
115.5805841 KM
AZIMUTH OF VELOCITY VLLTUM
261.9569980 DEG
HORIZONTAL VELOCITY
1.6259887 KM/SEC
TILT ANGLE
SIGMA TILT ANGLE
SUN AZIMUTH AT PRINCIPAL GRND PNT
91.1531668 DEG
LATITUDE OF SUBSOLAR POINT
0 DEG, 38 MIN, 4.3684101 SEC
SWING ANGLE
297.6321711 DEG
SIGMA SWING ANGLE
0.0171594 DEG
NORTH DEVIATION ANGLE
167.8731002 DEG
X-TILT
3085852 DEG
SIGMA X-TILT
0.002000 DEG
Y-TILT
-5894703 DEG
SIGMA Y-TILT
0.002000 DEG
HEADING
-97.8734590 DEG
SIGMA HEADING
0.002000 DEG
LASER SLANT RANGE
117.5389996 KM

SELENOGRAPHIC DIRECTION COSINES

OF CAMERA AXIS

X
-76408151

Y
52961376

Z
-36835949

MAGNITUDE (KM)
115.588896

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

.14601661-01 .96181579+00 .27330765+00
-.39618138+00 .25653045+00 -.88160790+00
-.91805619+00 -.95406477-01 .38479932+00

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.99052055+00 -.13697844+00 .10288016-01
.13692888+00 -.99056626+00 -.53858022-02
.10928704-01 -.39260053+02 .99999261+00

PHOTOGRAPH FOOTPRINT

LATITUDE
LONGITUDE
25.192
-32.640
19.301
-31.921
18.446
-38.149
24.402
-39.204

DIRECTION TO STELLAR PHOTO CENTER

RIGHT ASCENSION

-2 HR, 45 MIN, 54.7 SEC

DECLINATION

66 DEG, 27 MIN, 16.1 SEC

Mission: Apollo 17, Target: Vertical strip photography

Rev: 74, Camera: 3 Inch Mapping Frames: 2790 Through: 2942

Coverage Interval:

From: 22.2 Deg S Lat., 140.2 Deg E Long., To: 19.8 Deg N Lat., 55.6 Deg W Long.

From: 230 Hr 19 Min 34.445 Sec, To: 231 Hr 23 Min 51.425 Sec CTE

Date Processed: 8/25/73, APE Version Used: 7

INPUT DATA

● Trajectory Type:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 km

Ephemeris-Universal Time Difference: .72183319 Min.

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 230 H, 56 M, 45.08191 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 74. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = <u>1539.6136</u>	X = <u>.6839</u>
Y = <u>917.0646</u>	Y = <u>-1.3913</u>
Z = <u>463.1958</u>	Z = <u>.4984</u>

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 8/25/73 (During APE operation)

Edited Data Tape No. T01532 File No.: 1 Location: TRW

Remarks: There were no gaps in the vehicle attitude data used for this sequence.

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used:	-.6493783	-.7570575	.0719149
	.4029205	-.2623184	.8768376
	-.6449519	.5983752	.4753779

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Stellar camera Interlock Angles Used:

$\Omega = -95^\circ 55' 32.079''$

$\phi = -0^\circ 1' 30.755''$

$\kappa = 0^\circ 0' 58.194''$

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of vertical strip photography starting at 140.2 deg E Long. and ending at 55.6 deg W Long. Throughout the sequence tilt is maintained less than 1 deg. Vehicle state vector data only are provided for frame 2839 for which vehicle attitude data were ignored as the result of a computer erratic. Star patterns companion to frames 2800 and 2940 are included in these data.

STATE VECTOR
1950.0
1693.2654350
SELENOGRAPHIC -1315.1130427
LONGITUDE OF NADIR POINT
140 DEG, 12 MIN, 35.7975769 DEG
LONG OF CAMERA AXIS INTERSECT
140 DEG, 10 MIN, 20.4254150 DEG
SPACECRAFT RADIUS
SCALE FACTOR
MEAN ALTITUDE RATE
TILT AZIMUTH
SIGMA TILT AZIMUTH
SUN ELEVATION AT PRIN GRND PNT
LONGITUDE OF SUBSOLAR POINT
45 DEG, 30 MIN, 30.5757666 DEG
ALPHA
EMISSION ANGLE
PHASE ANGLE
PHI
SIGMA PHI
KAPPA
SIGMA KAPPA
OMEGA
SIGMA OMEGA
SPACECRAFT ALTITUDE (LASER)
140.2099438 DEG
35.7975769 DEG
140.1723404 DEG
20.4254150 DEG
1849.1091100 KM
2000000 M/KM
2030624 KM/SEC
252.4723110 DEG
2199184 DEG
4.3823402 DEG
45.5084933 DEG
30.5757666 DEG
5865860 DEG
6078103 DEG
94.6689415 DEG
5197695 DEG
2002000 DEG
2028210 DEG
2002000 DEG
2371529 DEG
2002000 DEG
0C02000 DEG
109.8045454 KM

Y (KM)
269.7651620
1095.3242113

Z (KM)
-692.3029863
-699.9621832

YDOT (KM/S)
-1.5617179
1.2893548

XDOT (KM/S)
.0557865
.9801436

YDOT (KM/S)
-1.5617179
1.2893548

ZDOT (KM/S)
-4.439196
.1838122

LATITUDE OF NADIR POINT
-22 DEG, 14 MIN, 35.8446693 DEG
LATI OF CAMERA AXIS INTERSECT
-22 DEG, 15 MIN, 15.3980255 DEG
SPACECRAFT ALTITUDE
AZIMUTH OF VELOCITY VECTOR
HORIZONTAL VELOCITY
TILT ANGLE
SIGMA TILT ANGLE
SUN AZIMUTH AT PRINCIPAL GRND PNT
LATITUDE OF SUBSOLAR POINT
SWING ANGLE
SIGMA SWING ANGLE
NORTH DEVIATION ANGLE
K-TILT
SIGMA X-TILT
Y-TILT
SIGMA Y-TILT
HEADING
SIGMA HEADING
LASER SLANT RANGE
22 DEG, 14 MIN, 35.8446693 DEG
22 DEG, 15 MIN, 15.3980255 DEG
111.0191137 KM
276.9531307 DEG
1.6300890 KM/SEC
5711024 DEG
3002015 DEG
267.6608772 DEG
6140558 DEG
2 DEG, 36 MIN, 50.6007957 DEG
245.4740029 DEG
0199184 DEG
173.0009309 DEG
2371529 DEG
0002000 DEG
5197651 DEG
0002000 DEG
03.0006726 DEG
0002000 DEG
109.8100004 KM

SELENOGRAPHIC DIRECTION COSINES
OF CAMERA AXIS

X
.71813755

Y
-.58574439

Z
.37574190

MAGNITUDE (KM)
111.024986

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

.44562703-01
-.39638674+00
.91700154+00
-.95660230+00
.24766248+00
.15354223+00
-.28796899+00
-.08409482+00
-.36814812+00

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.99250669+00
-.12181943+00
.95082006-02
.12185267+00
-.99254367+00
.30029767-02
.90714877-02
.41390870-02
.99995032+00

PHOTOGRAPH FOOTPRINT
LATITUDE
LONGITUDE
-19.752
143.529
-25.415
142.927
-24.741
136.610
-19.022
137.519

DIRECTION TO STELLAR PHOTO CENTER

RIGHT ASCENSION

-1 HR, 41 MIN, 6.9 SEC

DECLINATION

57 DEG, 15 MIN, 58.1 SEC

STATE VECTOR X (KM) -1463.9705181
 Y (KM) 120.3207747
 Z (KM) 805.1144249
 SELENOGRAPHIC 987.3687127 -1441.9136598
 LONGITUDE OF MADIH POINT -55.5981127 DEG
 LONG OF CAMERA AXIS INTERSECT -53.1984329 SEC
 SPACECRAFT RADIUS -55 DEG, 36 MIN, 58.3250427 SEC
 SCALE FACTOR 1857.2892739 KM
 MEAN ALTITUDE RATE 0006366 M/KM
 TILT AZIMUTH 315.1171425 DEG
 SIGMA TILT AZIMUTH 0322770 DEG
 SUN ELEVATION AT PRIM GRND PNT -10.1603699 DEG
 LONGITUDE OF SUBSOLAR POINT 44.9667419 DEG
 ALPHA 44 DEG, 58 MIN, 2706814 SEC
 EMISSION ANGLE 2508657 DEG
 PHASE ANGLE 3771048 DEG
 PHI 99.9096289 DEG
 SIGMA PHI 1892914 DEG
 KAPPA 0002000 DEG
 SIGMA KAPPA 167.7555923 DEG
 OMEGA 0002000 DEG
 SIGMA OMEGA 2978411 DEG
 SPACECRAFT ALTITUDE (LASEP) 121.9306898 KM
 LATITUDE OF MADIH POINT 19.7922032 DEG
 LATI OF CAMERA AXIS INTERSECT 19 DEG, 47 MIN, 31.9314766 SEC
 SPACECRAFT ALTITUDE 114.1990776 KM
 AZIMUTH OF VELOCITY VECTOR 257.5397061 DEG
 HORIZONTAL VELOCITY 1.6227601 KM/SEC
 TILT ANGLE 3526029 DEG
 SIGMA TILT ANGLE 0002014 DEG
 SUN AZIMUTH AT PRINCIPAL GRND PNT 86.9613285 DEG
 LATITUDE OF SUBSOLAR POINT 19.7922032 DEG
 SAING ANGLE 45.4177525 SEC
 SIGMA SAING ANGLE 327.5624856 DEG
 NORTH DEVIATION ANGLE 0322770 DEG
 X-TILT 192.2454384 DEG
 SIGMA X-TILT 2978411 DEG
 Y-TILT 0002000 DEG
 SIGMA Y-TILT 1892889 DEG
 HEADING 0002000 DEG
 SIGMA HEADING -1.2.2453877 DEG
 LASER SLANT RANGE 121.9329996 KM

SELENOGRAPHIC DIRECTION COSINES
 OF CAMERA AXIS

X -53601951
 Y 77511567
 Z 33448286

MAGNITUDE (KM)
 119.201494

TRANSFORMATION MATRIX FROM
 SELENOCENTRIC TO CAMERA

19149902+00 96339476+30 18761282+00
 -39474389+00 25060752+00 -88395316+00
 -89861307+00 95217112-31 42828532+00

TRANSFORMATION MATRIX FROM
 LOCAL HORIZONTAL TO CAMERA

-97724280+00 -21209784+00 -33037077-02
 21207941+00 -97723864+00 -51982840-02
 43310895-02 -43793040-02 99998106+00

PHOTOGRAPH FOOTPRINT

LATITUDE 23.472
 LONGITUDE -53.037
 17.424 -51.795
 16.125 -58.072
 22.146 -59.614

DIRECTION TO STELLAR PHOTO CENTER

-2 HR, 34 MIN, 11.9 SEC

DECLINATION 67 DEG, 26 MIN, 50.3 SEC

RIGHT ASCENSION

4.0 APOLLO 17 24-INCH PANORAMIC CAMERA DATA

Mission: Apollo 17, Target: Panoramic strip photography

Rev: 1/2, Camera: 24-Inch Panoramic Frames: 1588 Through: 1880

Coverage Interval:

From: 19.3 Deg S Lat., 154.2 Deg W Long., To: 11.9 Deg N Lat., 95.7 Deg E Long.

From: 88 Hr 10 Min 48.331 Sec, To: 88 Hr 47 Min 45.531 Sec. CTE

Date Processed: 9/11/73, APE Version Used: 7.

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziel)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: .721533195 Min.

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 89 H, 9 M, 44.06 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 2. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = <u>1618.8228</u>	X = <u>.8698</u>
Y = <u>964.2463</u>	Y = <u>-1.2692</u>
Z = <u>675.1559</u>	Z = <u>-.0665</u>

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 9/11/73 (During APE operation)

Edited Data Tape No. T00412 File No.: 1 Location: TRW

Remarks: There were no gaps in the vehicle attitude data used for this sequence.

• APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used:	-.9271362	-.2076425	.3119342
	.3673256	-.3389995	.8661127
	-.0740963	.9175859	.3905711

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

- ± 1 degree in camera positioning angle
- ±0.2 mrad in each gimbal angle
- ±20 ms in onboard clock bias definition
- ±5 ms in onboard clock drift rate
- ±5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of panoramic stereo strip photography starting at 154.2 deg W Long. and ending at 95.7 deg E Long. Throughout the sequence tilt is maintained within half a degree of its nominal value of 12.5 deg. State vector data only are provided for frame 1724 for which vehicle attitude data were ignored as the result of a computer erratic. There is an 8 M, 24 Sec data gap between frames 1790 and 1791.

APOLLO 17 REV 1/2 PAR 4/7JF PAGE - F 1588
 YEAR MONTH DAY HOUR MINUTE SECOND
 GMT1972 12 10 21 43 48.527
 CTE 3 10 10 48.331
 STATE VECTOR X (KM) Y (KM) Z (KM)
 1703.1230938 -82.0272881 -754.0771129
 SELENOGRAPHIC -1568.9391017 -794.4114533 -619.1279938
 LONGITUDE OF NAUIR POINT -153.1452312 DEG
 LONG OF CAMERA AXIS INTERSECT -153 DEG, 8 MIN, 42.8324899 SEC
 -154.1999321 DEG
 -154 DEG, 11 MIN, 59.7555542 SEC
 SPACECRAFT RADIUS 1864.3977075 KM
 SCALE FACTOR .0000000 M/KM
 MEAN ALTITUDE MATE -0652287 KM/SEC
 TILT AZIMUTH 273.9838867 DEG
 SIGMA TILT AZIMUTH .0008602 DEG
 SUN ELEVATION AT PRIN GRND PNT 1.8722658 DEG
 LONGITUDE OF SUBSOLAR POINT 117.5079762 DEG
 117 DEG, 30 MIN, 28.7142706 SEC
 ALPHA EMISSION ANGLE -14.3991504 DEG
 PHASE ANGLE 14.4441215 DEG
 PHI 102.5265064 DEG
 SIGMA PHI 13.4437351 DEG
 KAPPA .0002000 DEG
 SIGMA KAPPA -174.87799515 DEG
 OMEGA .0002000 DEG
 -0.2716252 DEG
 SIGMA OMEGA .0002000 DEG
 SPACECRAFT ALTITUDE (LASER) .0000000 KM

LONGITUDE OF NAUIR POINT -153.1452312 DEG
 LONG OF CAMERA AXIS INTERSECT -153 DEG, 8 MIN, 42.8324899 SEC
 -154.1999321 DEG
 -154 DEG, 11 MIN, 59.7555542 SEC
 SPACECRAFT RADIUS 1864.3977075 KM
 SCALE FACTOR .0000000 M/KM
 MEAN ALTITUDE MATE -0652287 KM/SEC
 TILT AZIMUTH 273.9838867 DEG
 SIGMA TILT AZIMUTH .0008602 DEG
 SUN ELEVATION AT PRIN GRND PNT 1.8722658 DEG
 LONGITUDE OF SUBSOLAR POINT 117.5079762 DEG
 117 DEG, 30 MIN, 28.7142706 SEC
 ALPHA EMISSION ANGLE -14.3991504 DEG
 PHASE ANGLE 14.4441215 DEG
 PHI 102.5265064 DEG
 SIGMA PHI 13.4437351 DEG
 KAPPA .0002000 DEG
 SIGMA KAPPA -174.87799515 DEG
 OMEGA .0002000 DEG
 -0.2716252 DEG
 SIGMA OMEGA .0002000 DEG
 SPACECRAFT ALTITUDE (LASER) .0000000 KM

SELENOGRAPHIC DIRECTION COSINES X
 OF CAMERA AXIS .70888168
 Y .61894854
 Z .33821513
 MAGNITUDE (KM) 139.138564

TRANSFORMATION MATRIX FROM
 SELENOCENTRIC TO CAMERA
 .39565300-01 -.92201232+00 -.38513347+00
 -.36146629+00 .34612498+00 -.86575954+00
 .93154528+00 .17346679+00 -.31958185+00
 TRANSFORMATION MATRIX FROM
 LOCAL HORIZONTAL TO CAMERA
 -.96861953+00 .87895245-01 .23248775+00
 -.89241795-01 -.99599869+00 .47407371-02
 .23197417+00 -.16155666-01 .97258772+00

PHOTOGRAPH FOOTPRINT
 LATITUDE LONGITUDE
 -13.184 -153.228
 -25.634 -154.482
 -25.923 -155.551
 -12.732 -154.124
 LATITUDE LONGITUDE
 -16.394 -153.492
 -22.348 -154.087
 -22.421 -155.027
 -16.161 -154.360

AFOLLO 17 RELY 1/2 PAN 4/7JF PAGE - A 168C

STATE VECTOR X (KM) Y (KM) Z (KM/S) YDOT (KM/S) ZDOT (KM/S)

1950.0 -1022.5726082 -1576.8572871 -202.3161630 -1.2766595 .7936531

SELENOGRAPHIC -150.3319678 1842.3667900 403.0563696 1.5612403 .1110700 .4533918

LONGITUDE OF NADIR POINT 94.6648359 DEG LATITUDE OF NADIR POINT 12.3005902 DEG

LONG OF CAMERA AXIS INTERSECT 94.4093475 SEC 12 DEG, 18 MIN, 2.1245670 SEC

SPACECRAFT RADIUS 95.7328405 DEG LATI OF CAMERA AXIS INTERSECT 11.9326365 DEG

SCALE FACTOR 56.2259369 SEC 11 DEG, 55 MIN, 57.4913979 SEC

MEAN ALTITUDE RATE 1891.9241269 KM SPACECRAFT ALTITUDE 153.8341306 KM

TILT AZIMUTH .0038690 M/KM AZIMUTH OF VELOCITY VECTOR 285.9209385 DEG

SIGMA TILT AZIMUTH 109.2985096 DEG HORIZONTAL VELOCITY 1.6275023 KM/SEC

SUN ELEVATION AT PRIM GRND PNT .0009391 DEG SIGMA TILT ANGLE 12.2692414 DEG

LONGITUDE OF SUBSOLAR POINT 117.1955057 DEG SUN ALTITUDE AT PRINCIPAL GRND PNT .0002001 DEG

ALPHA 117 DEG, 11 MIN, 43.8203573 SEC LATITUDE OF SUBSOLAR POINT -.7670095 DEG

EMISSION ANGLE -13.3086846 DEG SAING ANGLE 0 DEG, 47 MIN, 13.2340336 SEC

PHASE ANGLE 38.0851259 DEG SIGMA SWING ANGLE 94.1220198 DEG

SIGMA PHI -12.2584008 DEG A-TILT .0009391 DEG

KAPPA .0002000 DEG SIGMA A-TILT .0002000 DEG

OMEGA .0002000 DEG Y-TILT .0002000 DEG

SIGMA OMEGA .0002000 DEG SIGMA Y-TILT .0002000 DEG

SPACECRAFT ALTITUDE (LASER) .0002047 DEG

LASER SLANT RANGE .0000000 KM

SELENOGRAPHIC DIRECTION COSINES X Y Z MAGNITUDE (KM)

OF CAMERA AXIS -.12360098 -.95289380 -.27688757 197.773868

TRANSFORMATION MATRIX FROM Selenocentric to Camera

-.63061879+00 .59995751+00 .49197852+00

-.36525241+00 .32978237+00 -.67053675+00

-.68453068+00 -.72889953+00 .11583245-01

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

-.94355313+00 .25423962+00 -.21229609+00

-.26334758+00 -.96457967+00 .15299584-01

-.20088671+00 .70343662-01 .97708556+00

PHOTOGRAPH FOOTPRINT

LATITUDE LONGITUDE

19.401 94.655

3.545 94.218

4.327 93.212

19.300 97.411

15.420 97.316

8.040 95.253

8.493 94.279

15.533 96.247

Mission: Apollo 17, Target: Panoramic strip photography
Rev: 13/14, Camera: 24-Inch Panoramic Frames: 1881 Through: 2120

Coverage Interval:

From: 15.2 Deg S Lat., 168.4 Deg E Long., To: 6.8 Deg N Lat., 101.1 Deg E Long.

From: 111 Hr 23 Min 30.530 Sec, To: 111 Hr 53 Min 22.987 Sec. CTE

Date Processed: 9/11/73, APE Version Used: 7.

INPUT DATA

• Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: .72158319 Min.

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 112 H, 16 M, 4.86469 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 14. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = 1494.5024

$\dot{X}$ = .8184

Y = 890.1942

$\dot{Y}$ = -1.4057

Z = 634.0940

$\dot{Z}$ = .0055

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 9/11/73 (During APE operation)

Edited Data Tape No. T00178 File No.: 1 Location: TRW

Remarks: There were no vehicle attitude data available for the interval 11 H, 23 M, 30.5 sec - 111 H, 29 M, 44 sec (FMS 1881-1934) and the interval 111 H, 49 M, 59 sec - 111 H, 52 M, 4 sec (FMS 2094-2111).

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min. 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used:	-.9271362	-.2076425	.3119342
	.3673256	-.3389995	.8661127
	-.0740963	.9175859	.3905711

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

- ± 1 degree in camera positioning angle
- ±0.2 mrad in each gimbal angle
- ±20 ms in onboard clock bias definition
- ±5 ms in onboard clock drift rate
- ±5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These data are for a sequence of panoramic stereo strip photography starting at 168.4 deg E Long. and ending at 101.1 deg E Long. Throughout the sequence a tilt of 12.5 ± 0.5 deg is maintained. Vehicle state vector data only are provided for frames 1881-1934 and frames 2094-2111 for which vehicle attitude data are unavailable for the calculations. The footprint for frame 2048 was omitted due to a printer failure.

STATE VECTOR
 1950.0
 SELENOGRAPHIC

X .1649452+004 -.1743205+004	YEAR 1972	MONTH 12	DAY 11	HOUR 20	MINUTE 56	SECOND .287+002
------------------------------------	--------------	-------------	-----------	------------	--------------	--------------------

IF RAME = 1881
 DAY 11
 HOUR 20
 MINUTE 56
 SECOND .287+002

GMT 1972
 CTE

X
 .1649452+004
 -.1743205+004

Y
 -.22716491+003
 -.22718489+003

Z
 -.8010822+003
 -.5901147+003

X DOT
 -.4330824+000
 -.2839711+000

Y DOT
 -.1511509+001
 .1587148+001

Z DOT
 -.4096256+000
 .2008381+000

STATE VECTOR	X (KM)	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
1950.0	-498.2482113	GMT1972	12	11	21	26	21.188
SELENOGRAPHIC	-326.3393871	CTE		4	15	53	22.987
		Y (KM)					
		-1733.4751519					
		1821.6529994					
LONGITUDE OF NADIR POINT							
	100.1564960 DEG						
LONG OF CAMERA AXIS INTERSECT	101.0654993 DEG						
SPACECRAFT RADIUS	1864.6086204 KM						
SCALE FACTOR	.0046982 M/KM						
MEAN ALTITUDE RATE	-0035455 KM/SEC						
TILT AZIMUTH	106.2205858 DEG						
SIGMA TILT AZIMUTH	.0009116 DEG						
SUN ELEVATION AT PRIN GRND PNT	81.2898932 DEG						
LONGITUDE OF SUBSOLAR POINT	105.4820457 DEG						
ALPHA	105 DEG, 28 MIN, 55.3643703 SEC						
EMISSION ANGLE	-13.0501460 DEG						
PHASE ANGLE	13.6190408 DEG						
PHI	20.8296354 DEG						
SIGMA PHI	-12.6707263 DEG						
KAPPA	.0002000 DEG						
SIGMA KAPPA	-161.7334479 DEG						
OMEGA	.0002000 DEG						
SIGMA OMEGA	.4599501 DEG						
SPACECRAFT ALTITUDE (LASER)	.0002000 DEG						

SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)
OF CAMERA AXIS	-.03801833	-.98293310	-.17999203	129.920638

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA		TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA		
-.81408512+00	.34188025+00	-.92593615+00	.30746029+00	-.21934068+00
-.35469543+00	.34736754+00	-.31341092+00	-.94958366+00	-.80275583+02
-.45984396+00	-.87318591+00	-.21075044+00	.61310788-01	.97561526+00

PHOTOGRAPH FOOTPRINT	LATITUDE	LONGITUDE
	12.924	103.796
	.412	99.528
	1.017	98.781
	12.876	102.773

LATITUDE OF NADIR POINT	7 DEG, 0 MIN, 51.5591311 SEC
LATI OF CAMERA AXIS INTERSECT	6 DEG, 45 MIN, 3.1488991 SEC
SPACECRAFT ALTITUDE	126.5186241 KM
AZIMUTH OF VELOCITY VECTOR	288.8128806 DEG
HORIZONTAL VELOCITY	1.6151078 KM/SEC
TILT ANGLE	12.6789443 DEG
SIGMA TILT ANGLE	.0001999 DEG
SUN AZIMUTH AT PRINCIPAL GRND PNT	149.4380741 DEG
LATITUDE OF SUBSOLAR POINT	0 DEG, 45 MIN, 42.7585602 SEC
SWING ANGLE	87.9039911 DEG
SIGMA SWING ANGLE	.0009117 DEG
NORTH DEVIATION ANGLE	.4599502 DEG
X-TILT	.0002000 DEG
SIGMA X-TILT	12.6703108 DEG
Y-TILT	.0002000 DEG
SIGMA Y-TILT	-71.6310756 DEG
HEADING	.0002050 DEG
SIGMA HEADING	.0000000 KM
LASER SLANT RANGE	

Mission: Apollo 17, Target: Panoramic strip photography
Rev: 15, Camera: 24-Inch Panoramic Frames: 2121 Through: 2362

Coverage Interval:

From: 7.5 Deg N Lat., 97.6 Deg E Long., To: 19.4 Deg N Lat., 13.3 Deg E Long.

From: 113 Hr 51 Min 33.304 Sec, To: 114 Hr 20 Min 18.075 Sec. CTE

Date Processed: 9/11/73, APE Version Used: 7

INPUT DATA

• Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Kozie11)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: .72158319 Min.

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 114 H, 14 M, 42.19471 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 15. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = 1494.3165 $\dot{X}$ = .8157

Y = 890.0835 $\dot{Y}$ = -1.4075

Z = 633.5526 $\dot{Z}$ = .0143

• Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 9/11/73 (During APE operation)

Edited Data Tape No. T00178 File No.: 1 Location: TRW

Remarks: There were no vehicle attitude data for the interval 113 H, 51 M, 33 sec - 113 H, 52 M, 29 sec (FMS 2121-2129).

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0
Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used:	-.9271362	-.2076425	.3119342
	.3673256	-.3389995	.8661127
	-.0740963	.9175859	.3905711

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

- ± 1 degree in camera positioning angle
- ± 0.2 mrad in each gimbal angle
- ± 20 ms in onboard clock bias definition
- ± 5 ms in onboard clock drift rate
- ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of panoramic stereo strip photography starting at 97.6 deg E Long. and ending at 13.3 deg E Long. Throughout the sequence tilt is maintained at 12.5 ± 0.5 deg. Vehicle state vector data only are provided for frames 2121-2129 for which vehicle attitude data are unavailable for the computations and for frame 2338 for which vehicle attitude data were ignored as the result of a computer erratic. All camera axis direction associated data for frames 2355-2363 are in error as the consequence of film reader errors. For these frames, the fore and aft designations were reversed.

		IFRAME ■ 2121			
STATE VECTOR	YEAR	MONTH	DAY	HOUR	MINUTE
1950.0	1972	12	11	23	24
SELLNOGRAPHIC	CTE		4	17	51
	X			Z	
	-0.4182449+003			-0.5056718+003	-0.1450565+001
	-0.3648107+003			-0.2038787+003	-0.1504754+001
					X DUT
					33.304
					X DUT
					1575335+000
					2465737+000
					Z DUT
					6755548+000
					5236373+000

STATE VECTOR X (KM) Y (KM) Z (KM) ADUT (KM/SEC) YOUT (KM/SEC) ZOUT (KM/SEC)
 1950.0 -1687.9258782 82.9145182 744.0913242 2994131 1.5311518 .4756057
 SELENOGRAPHIC 1701.6343824 376.6879381 610.0710522 3688816 -1.5767502 -.1513434
 LONGITUDE OF NADIR POINT 12.4821755 DEG 19.2724142 DEG
 12 DEG, 28 MIN, 55.8316898 SEC 19 DEG, 17 MIN, 32.6910782 SEC
 LONG OF CAMERA AXIS INTERSECT 13.2455744 DEG 19.3000000 DEG
 13 DEG, 20 MIN, 13.2455744 SEC 19 DEG, 20 MIN, 30.0000000 SEC
 SPACECRAFT RADIUS 1846.5210641 KM
 SCALE FACTOR .0054843 M/KM
 MEAN ALTITUDE RATE -.0132869 KM/SEC
 ALT ALTITUDE 83.6730946 DEG
 SUN ELEVATION AT PRIN ORHO PAN 1.0051999 DEG
 LONGITUDE OF SUBSOLAR POINT 104.2394680 DEG
 104 DEG, 14 MIN, 22.0847654 SEC
 ALPHA -13.6204675 DEG
 EMISSION ANGLE 13.7100486 DEG
 PHASE ANGLE 104.7159929 DEG
 PHI -12.8882633 DEG
 SIGMA PHI .0002000 DEG
 KAPPA 174.7512894 DEG
 SIGMA KAPPA .0002000 DEG
 UMEGA .2467360 DEG
 SIGMA UMEGA .0002000 DEG
 SPACECRAFT ALTITUDE (LASER) .0000000 KM

LATITUDE OF NADIR POINT 19.2724142 DEG
 19 DEG, 17 MIN, 32.6910782 SEC
 LONG OF CAMERA AXIS INTERSECT 19.3000000 DEG
 19 DEG, 20 MIN, 30.0000000 SEC
 SPACECRAFT ALTITUDE 108.4310677 KM
 AZIMUTH OF VELOCITY VECTOR 264.5221136 DEG
 HORIZONTAL VELOCITY 1.6309511 KM/SEC
 ALT ANGLE 12.4821755 DEG
 SUN ELEVATION AT PRINCIPAL ORHO PAN 1.0051999 DEG
 LONGITUDE OF SUBSOLAR POINT 104.2394680 DEG
 104 DEG, 14 MIN, 22.0847654 SEC
 ALPHA -13.6204675 DEG
 EMISSION ANGLE 13.7100486 DEG
 PHASE ANGLE 104.7159929 DEG
 PHI -12.8882633 DEG
 SIGMA PHI .0002000 DEG
 KAPPA 174.7512894 DEG
 SIGMA KAPPA .0002000 DEG
 UMEGA .2467360 DEG
 SIGMA UMEGA .0002000 DEG
 SPACECRAFT ALTITUDE (LASER) .0000000 KM

SWING ANGLE 0 DEG, 45 MIN, 32.9251957 SEC
 SIGMA SWING ANGLE 88.8939410 DEG
 NORTH DEVIATION ANGLE .0008964 DEG
 X-TILT 185.0626364 DEG
 SIGMA X-TILT .2467360 DEG
 Y-TILT .0002000 DEG
 SIGMA Y-TILT 12.8881412 DEG
 HEADING .0002000 DEG
 SIGMA HEADING -95.1922546 DEG
 LASER SLANT RANGE .0002052 DEG
 .0000000 KM

SELENOGRAPHIC DIRECTION COSINES X Y Z MAGNITUDE (KM)
 OF CAMERA AXIS -.95416527 .01587713 -.29885875 111.416746

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA
 TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

.J7736482+00 .90381328+00 .20178516+00
 -.36056308+00 .34409782+00 -.86694344+00
 -.85298883+00 .25439771+00 .45573212+00

PHOTOGRAPH FOOTPRINT
 LATITUDE LONGITUDE
 25.025 13.325
 13.903 14.299
 14.124 13.488
 24.661 12.501

DATA CARDS ENCOUNTERED BY SYSTEM - IGNORED
 F2364 4 18,20,24.505.

Mission: Apollo 17, Target: Panoramic strip photography
Rev: 28, Camera: 24-Inch Panoramic Frames: 2365 Through: 2594

Coverage Interval:

From: 14.8 Deg S Lat., 153.1 Deg E Long., To: 7.4 Deg N Lat., 85.3 Deg E Long.

From: 139 Hr 14 Min 19.593 Sec, To: 139 Hr 38 Min 37.812 Sec. CTE

Date Processed: 9/12/73, APE Version Used: 7

INPUT DATA

0 Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Kozie11)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: .72163319 Min.

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 139 H, 56 M, 16.12701 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 28. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = <u>1498.5950</u>	X = <u>.7790</u>
Y = <u>892.6319</u>	Y = <u>-1.4244</u>
Z = <u>613.0724</u>	Z = <u>.1278</u>

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 9/12/73 (During APE operation)

Edited Data Tape No. T01307 File No.: 1 Location: TRW

Remarks: There were no vehicle attitude data for the interval 139 H, 25 M, 50 sec - 139 H, 32 M, 45 sec (FMS 2474-2537).

• APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min. 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used:	-.9271362	-.2076425	.3119342
	.3673256	-.3389995	.8661127
	-.0740963	.9175859	.3905711

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

- ± 1 degree in camera positioning angle
- ± 0.2 mrad in each gimbal angle
- ± 20 ms in onboard clock bias definition
- ± 5 ms in onboard clock drift rate
- ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of panoramic stereo strip photography starting at 153.1 deg E Long. and ending at 85.3 deg E Long. Throughout the sequence a tilt of 12.5 ± 0.7 degrees is maintained with the forward tilt approximately .12 deg higher than the aft tilt. State vector data only are provided for frames 2474-2537 for which vehicle attitude data are unavailable for the computations and for frame 2455 for which vehicle attitude data were ignored as a result of a computer erratic.

STATE VECTOR	X (KM)	Y (KM)	Z (KM)	XDOT (KM/S)	YDOT (KM/S)	ZDOT (KM/S)
1950-0	1425.9948902	-791.5467610	-497.7547351	-8514388	-1.3650973	-1.1641763
SELENOGRAPHIC	-1617.3411810	786.3686213	-481.9490563	.5939803	1.4612582	.3577222

LONGITUDE OF NADIR POINT	154.2790787 DEG	LATITUDE OF NADIR POINT	-15.0032675 DEG
154 DEG, 4 MIN, 44.6832275 SEC		-15 DEG, 0 MIN, 11.7630959 SEC	
LONG OF CAMERA AXIS INTERSECT	153.1165009 DEG	LATI OF CAMERA AXIS INTERSECT	-14.7660322 DEG
153 DEG, 6 MIN, 59.4030762 SEC		-14 DEG, 45 MIN, 57.7159882 SEC	
SPACECRAFT RADIUS	1861.7119181 KM	SPACECRAFT ALTITUDE	123.6219218 KM
SCALE FACTOR	.0000000 M/KM	AZIMUTH OF VELOCITY VECTOR	263.3184511 DEG
MEAN ALTITUDE RATE	.0083667 KM/SEC	HORIZONTAL VELOCITY	1.6173707 KM/S-C
TILT AZIMUTH	284.1824417 DEG	TILT ANGLE	13.2296591 DEG
SIGMA TILT AZIMUTH	.0008740 DEG	SIGMA TILT ANGLE	.0002000 DEG
SUN ELEVATION AT PRIN GRND PNT	27.6862931 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	277.0888138 DEG
LONGITUDE OF SUBSOLAR POINT	91.6176557 DEG	LATITUDE OF SUBSOLAR POINT	-73.06718 DEG
91 DEG, 37 MIN, 3.5604000 SEC		0 DEG, 43 MIN, 50.4183769 SEC	
ALPHA	-14.09703860 DEG	SWING ANGLE	270.7859352 DEG
EMISSION ANGLE	14.1846960 DEG	SIGMA SWING ANGLE	.0008740 DEG
PHASE ANGLE	76.3985443 DEG	NORTH DEVIATION ANGLE	166.9652688 DEG
PHI	13.2284484 DEG	X-TILT	.1798596 DEG
SIGMA PHI	.0002000 DEG	SIGMA X-TILT	.0002000 DEG
KAPPA	-166.5826359 DEG	Y-TILT	-13.2283815 DEG
SIGMA KAPPA	.0002000 DEG	SIGMA Y-TILT	.0002000 DEG
OMEGA	.1798596 DEG	HEADING	-76.6249148 DEG
SIGMA OMEGA	.0002000 DEG	SIGMA HEADING	.0002054 DEG
SPACECRAFT ALTITUDE (LASER)	.0000000 KM	LASER SLANT RANGE	.0000000 KM

SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS	X	Y	Z	MAGNITUDE (KM)
	.92961779	-.20512026	.30616408	127.242826

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA		TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA	
-0.34069453+00	-0.91708113+00	-0.94706189+00	.22518681+00
-0.36663181+00	.33243119+00	-0.23204153+00	-0.97270080+00
.86574144+00	-0.22011735+00	.22187923+00	-0.56071731-01
			.22883310+00
			-0.31391365-02
			.97346057+00

PHOTOGRAPH FOOTPRINT	
LATITUDE	LONGITUDE
-8.877	154.920
-20.742	151.951
-20.868	150.935
-8.315	154.118

YEAR MONTH DAY HOUR MINUTE SECOND
 GMT1972 12 13 1 11 36.034
 CTE
 STATE VECTOR X (KM) Y (KM) Z (KM)
 1950.0 -510.5859244 -1733.2896967 249.5136193
 SELENOGRAPHIC 178.3744647 1836.2248499
 LONGITUDE OF NAIR POINT 84.4515848 DEG
 LONG OF CAMERA AXIS INTERSECT 84 DEG, 27 MIN, 5.7053375 SEC
 85 DEG, 18 MIN, 33.6772156 SEC
 SPACECRAFT RADIUS 1861.6649382 KM
 SCALE FACTOR .0048056 M/KM
 MEAN ALTITUDE RATE -0.0083809 KM/SEC
 TILT ALTITUDE RATE 109.8108168 DEG
 SIGMA TILT ALTITUDE .0009243 DEG
 SUN ELEVATION AT PRIN GRND PNT 79.8472443 DEG
 LONGITUDE OF SUBSOLAR POINT 91.4123806 DEG
 91 DEG, 24 MIN, 44.5703316 SEC
 ALPHA -12.9854064 DEG
 EMISSION ANGLE 13.3957038 DEG
 PHASE ANGLE 22.5858426 DEG
 PHI -12.4844646 DEG
 SIGMA PHI .0002000 DEG
 KAPPA -162.1044807 DEG
 SIGMA KAPPA .0002000 DEG
 OMEGA -42.42263 DEG
 SIGMA OMEGA .0002000 DEG
 SPACECRAFT ALTITUDE (LASER) .0000000 KM
 LATITUDE OF NAIR POINT 7.70233676 DEG
 LATI OF CAMERA AXIS INTERSECT 7 DEG, 42 MIN, 8.5233593 SEC
 7 DEG, 23 MIN, 42.3428249 SEC
 SPACECRAFT ALTITUDE 123.5749419 KM
 AZIMUTH OF VELOCITY VECTOR 268.4759550 DEG
 HORIZONTAL VELOCITY 1.6172162 KM/SEC
 SIGMA TILT ANGLE 12.4915670 DEG
 SUN AZIMUTH AT PRINCIPAL GRND PNT 142.9087296 DEG
 LATITUDE OF SUBSOLAR POINT -7.7301975 DEG
 0 DEG, 43 MIN, 48.7109184 SEC
 SWING ANGLE 91.9616907 DEG
 SIGMA SWING ANGLE .0009243 DEG
 NORTH DEVIATION ANGLE 162.5845264 DEG
 X-TILT -42.42263 DEG
 SIGMA X-TILT .0002000 DEG
 Y-TILT 12.4841164 DEG
 SIGMA Y-TILT .0002000 DEG
 HEADING -72.1984100 DEG
 SIGMA HEADING .0002048 DEG
 LASER SLANT RANGE .0000000 KM
 MAGNITUDE (KM) 126.792769

SELENOGRAPHIC DIRECTION COSINES
OF CAMERA AXIS

X -0.29513764

Y -0.93353196

Z -0.20349902

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

-0.81412220+00 .35255014+00 .46142536+00
 -0.35638035+00 .32402678+00 -0.87635589+00
 -0.45847353+00 -0.87790375+00 -0.13815543+00

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-0.92960889+00 .29849322+00 -0.21616896+00
 -0.30727374+00 -0.95159234+00 .74040777+02
 -0.20349462+00 .73305973+01 .97632785+00

PHOTOGRAPH FOOTPRINT

LATITUDE	LONGITUDE	LATITUDE	LONGITUDE
13.248	87.823	10.147	86.683
1.023	83.829	4.330	84.786
1.629	83.078	4.721	84.034
13.215	86.864	10.273	85.845

Mission: Apollo 17, Target: Test Cycle

Rev: 36, Camera: 24-Inch Panoramic Frames: 2595 Through: 2599

Coverage Interval:

From: 8.1 Deg N Lat., 64.2 Deg E Long., To: 8.7 Deg N Lat., 61.8 Deg E Long.

From: 155 Hr 33 Min 20.192 Sec, To: 155 Hr 34 Min 9.378 Sec. CTE

Date Processed: 9/11/73, APE Version Used: 7.

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: .72166653 Min.

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 155 H, 44 M, 31.954702 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 36. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = <u>1505.8475</u>	$\dot{X}$ = <u>.7583</u>
Y = <u>896.9519</u>	$\dot{Y}$ = <u>-1.4280</u>
Z = <u>587.5814</u>	$\dot{Z}$ = <u>.1960</u>

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 9/11/73 (During APE operation)

Edited Data Tape No. T00319 File No.: 1 Location: TRW

Remarks: There were no gaps in the vehicle attitude data used for this sequence.

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used:	-.9271362	-.2076425	.3119342
	.3673256	-.3389995	.8661127
	-.0740963	.9175859	.3905711

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

- ± 1 degree in camera positioning angle
- ±0.2 mrad in each gimbal angle
- ±20 ms in onboard clock bias definition
- ±5 ms in onboard clock drift rate
- ±5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a short sequence of 40 deg S oblique panoramic photography starting at 64.2 deg E. Long. and ending at 61.8 deg E. Long. Throughout the sequence tilt is maintained at 40 ± 0.5 deg. All photos of this sequence are of the lunar horizon.

YEAR MONTH DAY HOUR MINUTE SECOND
 GMT1972 12 13 17 6 18.423
 CTE 6 11 33 20.192

STATE VECTOR A (KM) -812.7310665 -1515.7596314 1652.3757114
 1950.0 265.1765549
 SELENOGRAPHIC 265.1765549 1652.3757114
 Y (KM) 2 (KM) ADUT (KM/SEC) UDOT (KM/SEC) UDOT (KM/SEC)
 -287.3743873 -1.3246170 .5401027
 363.0965549 1.3680080 -0.7445497 .4504519

LONGITUDE OF RADAR POINT 65.1522388 DEG
 55 DEG, 9 MIN, 5.259450 SEC
 LONG OF CAMERA AXIS INTERSECT 64.2222549 DEG
 64 DEG, 13 MIN, 12.9176331 SEC
 SPACECRAFT RADIUS 1956.7922749 KM
 SCALE FACTOR .0200000
 MEAN ALTITUDE RATE -0.7127195 KM/SEC
 TILT AZIMUTH 155.1748715 DEG
 SIGMA TILT AZIMUTH .0003100 DEG
 SUN ELEVATION AT PRIN PNT 55.9945536 DEG
 LONGITUDE OF SUBSOLAR POINT 83.3502956 DEG
 83 DEG, 21 MIN, 1.0640860 SEC
 ALPHA -39.3669558 DEG
 EMISSION ANGLE 42.8669310 DEG
 PHASE ANGLE 49.4013910 DEG
 PHI -.5566275 DEG
 SIGMA PHI .0002594 DEG
 KAPPA -162.9459372 DEG
 SIGMA KAPPA .0002594 DEG
 OMEGA -39.5576749 DEG
 SIGMA OMEGA .0002000 DEG
 SPACECRAFT ALTITUDE (LASEN) .0000000 KM

LONGITUDE OF RADAR POINT 11.2706007 DEG
 11 DEG, 16 MIN, 36.770680 SEC
 LONG OF CAMERA AXIS INTERSECT 8.0437935 DEG
 8 DEG, 5 MIN, 37.0560410 SEC
 SPACECRAFT ALTITUDE 110.7022786 KM
 SCALE FACTOR 286.5357761 DEG
 MEAN ALTITUDE RATE 1.0213145 KM/SEC
 TILT AZIMUTH 34.5537546 DEG
 SIGMA TILT AZIMUTH .0002000 DEG
 SUN ELEVATION AT PRINCIPAL PNT 113.7127789 DEG
 LONGITUDE OF SUBSOLAR POINT -0.7112738 DEG
 0 DEG, 42 MIN, 40.2657649 SEC
 ALPHA 179.3260140 DEG
 EMISSION ANGLE .0003140 DEG
 PHASE ANGLE 158.7040813 DEG
 PHI -39.5506753 DEG
 SIGMA PHI .0002000 DEG
 KAPPA .4291914 DEG
 SIGMA KAPPA .0002000 DEG
 OMEGA -73.3004420 DEG
 SIGMA OMEGA .0002000 DEG
 SPACECRAFT ALTITUDE (LASEN) .0000000 KM

SELENOGRAPHIC DIRECTION COSINES X Y Z MAGNITUDE (KM)
 OF CAMERA AXIS .010446015 .05218325 .75054663 157.720692

TRANSFORMATION MATRIX FROM
 SELENOCENTRIC TO CAMERA

-0.81662019+00 .33299650+00 .43794682+00
 -.56267500+00 -.30957672+00 -.76578845+00
 -.11013941+00 -.89060017+00 .44112781+00

TRANSFORMATION MATRIX FROM
 LOCAL HORIZONTAL TO CAMERA

-0.42779790+00 .28734506+00 -0.74907332+02
 -.22613149+00 -.73715710+00 .43676044+00
 .17744816+00 .61158170+00 .77102525+00

PHOTOGRAPH FOOTPRINT

LATITUDE	LONGITUDE	LATITUDE	LONGITUDE
12.172	45.698	10.882	65.385
0.000000	.000	0.000000	.000
0.000000	.000	0.000000	.000
12.301	45.259	11.057	64.794

YEAR MONTH DAY HOUR MINUTE SECOND
 1974 12 17 17 7 00
 CTE 11 34 9.375

STATE VECTOR X (KM) -877.355531 Y (KM) -1417.6745529 Z (KM) -243.3371127
 1950.0 Y (KM) 431.9483410
 SELENOGRAPHIC X (KM) -877.355531 Y (KM) -1417.6745529 Z (KM) -243.3371127
 1950.0 Y (KM) 431.9483410

LONGITUDE OF NAUTIC POINT 62.732365 DEG
 62 DEG 43 MIN 57.4912252 SEC
 LONG OF CAMERA AXIS INTERSECT 61.8450278 DEG
 61 DEG 50 MIN 12.1273914 SEC
 SPACECRAFT ALTITUDE 155.2576413 KM
 SCALE FACTOR .2338477 K/KM
 MEAN ALTITUDE RATE -.2110161 K/SEC
 TILT AZIMUTH 175.0074100 DEG
 SIGMA TILT AZIMUTH .0003391 DEG
 SUN ELEVATION AT PRIN CARD POINT 35.6263209 DEG
 LONGITUDE OF SUBSOLAR POINT 33.3933714 DEG
 33 DEG 20 MIN 36.1477375 SEC

ALPHA .39.5083336 DEG
 EMISSION ANGLE 43.6361629 DEG
 PHASE ANGLE 51.2081747 DEG
 PHI -.7253391 DEG
 SIGMA PHI .0002622 DEG
 KAPPA -.03.3693777 DEG
 SIGMA KAPPA .0002622 DEG
 OMEGA -.40.2904515 DEG
 SIGMA OMEGA .0002000 DEG
 SPACECRAFT ALTITUDE (LASER) .0000000 KM

LONGITUDE OF NAUTIC POINT 62.732365 DEG
 62 DEG 43 MIN 57.4912252 SEC
 LONG OF CAMERA AXIS INTERSECT 61.8450278 DEG
 61 DEG 50 MIN 12.1273914 SEC
 SPACECRAFT ALTITUDE 155.2576413 KM
 SCALE FACTOR .2338477 K/KM
 MEAN ALTITUDE RATE -.2110161 K/SEC
 TILT AZIMUTH 175.0074100 DEG
 SIGMA TILT AZIMUTH .0003391 DEG
 SUN ELEVATION AT PRIN CARD POINT 35.6263209 DEG
 LONGITUDE OF SUBSOLAR POINT 33.3933714 DEG
 33 DEG 20 MIN 36.1477375 SEC
 ALPHA .39.5083336 DEG
 EMISSION ANGLE 43.6361629 DEG
 PHASE ANGLE 51.2081747 DEG
 PHI -.7253391 DEG
 SIGMA PHI .0002622 DEG
 KAPPA -.03.3693777 DEG
 SIGMA KAPPA .0002622 DEG
 OMEGA -.40.2904515 DEG
 SIGMA OMEGA .0002000 DEG
 SPACECRAFT ALTITUDE (LASER) .0000000 KM

SELENOGRAPHIC DIRECTION COSINES
 OF CAMERA AXIS

X
 -.13303593

Y
 -.62481196

Z
 -.76925378

MAGNITUDE (KM)
 158.917954

TRANSFORMATION MATRIX FROM
 SELENOCENTRIC TO CAMERA

- .80123075+00 .37567455+00 .16570611+00
 -.58274422+00 -.31332616+00 -.74982384+00
 -.13578559+00 -.37216736+00 .16993053+00

TRANSFORMATION MATRIX FROM
 LOCAL HORIZONTAL TO CAMERA

-.96283040+00 .26993327+00 -.76727870+02
 -.21192444+00 -.73271506+00 .64666267+00
 .16746813+00 .62467643+00 .76271471+00

PHOTOGRAPH FOOTPRINT

LATITUDE LONGITUDE
 12.814 63.254
 .000000 .000
 .000000 .000
 12.914 52.814

LATITUDE LONGITUDE
 11.528 62.967
 .000000 .000
 .000000 .000
 11.641 62.373

Mission: Apollo 17, Target: Panoramic strip photography

Rev: 49, Camera: 24-Inch Panoramic Frames: 2600 Through: 2768

Coverage Interval:

From: 5.9 Deg N Lat., 78.4 Deg E Long., To: 21.5 Deg N Lat., 24.9 Deg E Long.

From: 181 Hr 8 Min 59.654 Sec, To: 181 Hr 26 Min 44.054 Sec. CTF

Date Processed: 9/11/73, APE Version Used: 7.

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: .72171653 Min.

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 181 H, 25 M, 11.1075 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 49. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = 1488.5866 $\dot{X}$ = .7256

Y = 886.6705 $\dot{Y}$ = -1.4287

Z = 649.3576 $\dot{Z}$ = .2875

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 9/11/73 (During APE operation)

Edited Data Tape No. T00114 File No.: 1 Location: TRW

Remarks: There were no gaps in the vehicle attitude data used for this sequence.

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min. 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used:	-.6493783	-.7570575	.0719149
	.4029205	-.2623184	.8768376
	-.6449519	.5983752	.4753779

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

- ± 1 degree in camera positioning angle
- ±0.2 mrad in each gimbal angle
- ±20 ms in onboard clock bias definition
- ±5 ms in onboard clock drift rate
- ±5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of panoramic stereo strip photography starting at 78.4 deg E. Long. and ending at 24.9 deg E. Long. Throughout the sequence tilt is maintained at 12.5 ± 0.5 deg with forward tilt slightly higher than aft tilt.

DAY MONTH DAY HOUR MINUTE SECOND

0011172 12 10 13 41 57900

011 2 (PM) 54054

STATE VECTOR X (KM) 42.1558756 -1764.7909125 -554.7132756 -1.9686224 -0.2273450 -0.169652

SELENOGRAPHIC 347.0000000 1808.5922642 128.7709352 1.5054044 -0.2433101 -0.199380

LONGITUDE OF RADAR POINT 70.1117611 DEG

70 DEG, 6 MIN, 52.3309353 SEC

LONG OF CAMERA AXIS INTERSECT 70.3470287 DEG

70 DEG, 20 MIN, 40.3034363 SEC

SPACECRAFT RADIUS 1750.1974981 KM

SCALE FACTOR .0000000 NM/SEC

MEAN ALTITUDE RATE .0001566 NM/SEC

TILT AZIMUTH .92.4208491 DEG

SIGMA TILT ANGLE .0005231 DEG

SUN ELEVATION AT PRINCIPAL POINT 79.7122479 DEG

LONGITUDE OF SUBSOLAR POINT 70.3850596 DEG

70 DEG, 23 MIN, 20.6146431 SEC

ALPHA .11.936710 DEG

EMISSION ANGLE 13.3354122 DEG

PHASE ANGLE 20.3215055 DEG

PHI 12.5119516 DEG

SIGMA PHI .0002000 DEG

KAPPA .157.0842896 DEG

SIGMA KAPPA .0002000 DEG

OMEGA .1062151 DEG

SIGMA OMEGA .0002000 DEG

SPACECRAFT ALTITUDE (LASER) .0000000 KM

SELENOGRAPHIC DIRECTION COSINES X Y Z

.0116063

-.49986054

-.01200946

MAGNITUDE (KMI) 115.223440

TRANSFORMATION MATRIX FROM SELENOGRAPHIC TO CAMERA

-.8848/713.00 -.23462337.00 .31183221.00
-.41033459.00 .26271055.00 -.67372264.00
.22048756.00 -.290001377.00 -.37453570.00

-.69404454.00 .38050805.00 .21664286.00
.38937583.00 -.92107706.00 .16847095.02
.20026343.00 -.62657521.01 .47624905.00

PHOTOGRAPH FOOTPRINT

LATITUDE LONGITUDE
10.762 40.610
.655 76.509
.800 75.255
11.005 10.182

LATITUDE LONGITUDE
8.154 79.711
3.276 77.640
3.451 76.647
8.560 79.066

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

original had quality

DATE MONTH DAY HOUR MINUTE SECOND

APR 17 12 10 16 41 57.000

CTE 7 13 8 59.654

STATE VECTOR X (KM) 2 (KM) ADUT (KM/SEC) ADUT (KM/SEC) ADUT (KM/SEC)
 1950.0 -1764.7909125 -554.7132756 -1.7688224 -0.2243450 -0.169652
 SELENOGRAPHIC 047.8749534 1008.5922652 178.7109352 1.4654844 -0.3433161 -0.1949386

LONGITUDE OF NAUTIC POINT 20.1117611 DEG LATITUDE OF NAUTIC POINT 5.5419401 DEG
 79 DEG, 6 MIN, 52.339333 SEC 5 DEG, 32 MIN, 30.469334 SEC
 LONG OF CAMERA AXIS INTERSECT 78.3470287 DEG LATI OF CAMERA AXIS INTERSECT 5.6554341 DEG
 70 DEG, 20 MIN, 49.3034363 SEC 5 DEG, 51 MIN, 17.5626163 SEC
 SPACECRAFT RADIUS 1150.3974981 KM SPACECRAFT ALTITUDE 112.3075018 KM
 SCALE FACTOR .0000000 M/KM AZIMUTH OF VELOCITY VECTOR 292.4970219 DEG
 MEAN ALTITUDE RATE -1.001566 KM/SEC HORIZONTAL VELOCITY 1.0270002 KM/SEC
 TILT AZIMUTH 79.4210491 DEG TILT ANGLE 12.5124257 DEG
 SIGMA TILT ANGLE .000231 DEG SIGMA TILT ANGLE .0004000 DEG
 SUN ELEVATION AT PRIN GRIP PMT 79.7122479 DEG SUN AZIMUTH AT PRINCIPAL GRIP PMT 250.0149733 DEG
 LONGITUDE OF SUBSOLAR POINT 70.3840594 DEG LATITUDE OF SUBSOLAR POINT -0.6795826 DEG
 70 DEG, 23 MIN, 20.6146431 SEC 6 DEG, 40 MIN, 76.4472676 SEC
 ALPHA -11.9366710 DEG SAILING ANGLE 269.5005035 DEG
 EMISSION ANGLE 13.3354122 DEG SIGMA SAILING ANGLE .0009231 DEG
 PHASE ANGLE 20.3215055 DEG NORTH DEVIATION ANGLE 157.5539958 DEG
 PHI 12.5119514 DEG X-TILT -1.1062151 DEG
 SIGMA PHI .0002000 DEG SIGMA X-TILT .0002000 DEG
 KAPPA -157.0842894 DEG Y-TILT -12.5119283 DEG
 SIGMA KAPPA .0002000 DEG SIGMA Y-TILT .0002000 DEG
 OMEGA -1.1062151 DEG HEADING -67.0602756 DEG
 SIGMA OMEGA .0002000 DEG SIGMA HEADING .0002049 DEG
 SPACECRAFT ALTITUDE (LASER) .0000000 KM LASER SLANT RANGE .0000000 KM

SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS

.01160463

-.99986054

-.01200946

MAGNITUDE (MM) 115.223440

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA

-0.88787713-00 -0.34623387-00 .31163221-00
 -0.41033459-00 0.26271055-00 -0.87327254-00
 0.22048756-00 -0.90061377-00 -0.37453970-00

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

-0.69404454-00 0.36050905-00 0.46642864-00
 0.38437583-00 -0.92107706-00 0.16847095-02
 0.20026343-00 -0.62657521-01 0.76624405-00

PHOTOGRAPH FOOTPRINT

LATITUDE LONGITUDE
 10.762 10.810
 .655 76.509
 .650 75.655
 11.345 79.182

LATITUDE LONGITUDE
 8.154 79.711
 3.276 77.640
 3.451 76.897
 8.560 79.564

208 2-44

YEAR MONTH DAY HOUR MINUTE SECOND
 GMT1972 12 14 16 59 44.054
 CTE 7 13 26 45.002

STATE VECTOR A (KM) Y (KPH) Z (KPH) ADUT (KM/S) YDUT (KM/S) ZDUT (KM/S)
 1950.0 -1334.7137CS3 -1254.0219117 237.3478463 -.4105937 1.1102475 .7503306
 SELENOGRAPHIC 1551.1652039 750.6796132 673.3737994 .6158730 -1.4078024 .2348110

LONGITUDE OF NAUTIC POINT 25.024427R DEG LATITUDE OF NAUTIC POINT 21.3577583 DEG
 25 DEG, 49 MIN, 27.9422351 SEC 21 DEG, 21 MIN, 27.9244210 SEC
 LONG OF CAMERA AXIS INTERSECT 24.9335597 DEG LAT OF CAMERA AXIS INTERSECT 21.4647635 DEG
 24 DEG, 56 MIN, .8113289 SEC 21 DEG, 29 MIN, 23.1405939 SEC
 SPACECRAFT RADIUS 1450.3345015 KM SPACECRAFT ALTITUDE 112.2445052 KM
 SCALE FACTOR .0053006 M/KM HORIZONTAL VELOCITY VECTOR 279.1000055 DEG
 MEAN ALTITUDE RATE 279.2066536 DEG TILT ANGLE 12.7644655 DEG
 TILT AZIMUTH 279.2066536 DEG SIGMA TILT ANGLE .0002000 DEG
 SIGMA TILT AZIMUTH .0009052 DEG SUN ELEVATION AT PRIN GRID PNT 40.5449138 DEG SUN AZIMUTH AT PRINCIPAL GRID PNT 110.7046645 DEG
 LONGITUDE OF SUBSOLAR POINT 70.2391338 DEG LATITUDE OF SUBSOLAR POINT -0.6742064 DEG
 70 DEG, 14 MIN, 20.3815908 SEC 0 DEG, 40 MIN, 19.1421442 SEC
 ALPHA 270.2592115 DEG
 EMISSION ANGLE 13.1408600 DEG SIGMA SWING ANGLE .0009052 DEG
 PHASE ANGLE 13.6047146 DEG NORTH DEVIATION ANGLE 171.2763512 DEG
 PHI 36.7197360 DEG X-TILT .0572732 DEG
 SIGMA PHI 12.7644652 DEG SIGMA X-TILT .0002000 DEG
 KAPPA 171.2763512 DEG Y-TILT .0002000 DEG
 SIGMA KAPPA -171.2763512 DEG SIGMA Y-TILT -12.7644639 DEG
 OMEGA .0002000 DEG HEADING .0002000 DEG
 SIGMA OMEGA .0572732 DEG SIGMA HEADING -81.0591302 DEG
 SPACECRAFT ALTITUDE (LASER) .0002000 DEG LASER SLANT RANGE .0000000 KM

SELENOGRAPHIC DIRECTION COSINES X Y Z MAGNITUDE (KM)
 OF CAMERA AXIS -.73417561 -.59760447 -.32226552 115.280349

TRANSFORMATION MATRIX FROM
 SELENOCENTRIC TO CAMERA

-1.70655058+00 .51972438+00 .43026153+00
 -.40144923+00 .20444937+00 -.87685382+00
 -.58273330+00 -.081237026+00 .21824690+01

TRANSFORMATION MATRIX FROM
 LOCAL HORIZONTAL TO CAMERA

-1.96343471+00 .15157401+00 .22094994+00
 -.15563865+00 -.98781358+00 -.99560522+03
 .21810574+00 .735351425+01 .97528464+00

PHOTOGRAPH FOOTPRINT

LATITUDE	LONGITUDE
26.054	25.740
18.822	24.082
18.806	24.077
24.246	24.955

original film poor quality

Mission: Apollo 17, Target: Panoramic strip photography

Rev: 62, Camera: 24-Inch Panoramic Frames: 2769 Through: 2900

Coverage Interval: Roll to Vertical Stereo

From: 18.2 Deg S Lat., 129.7 Deg E Long., To: 4.6 Deg S Lat., 90.6 Deg E Long.

From: 206 Hr 35 Min 3.974 Sec, To: 206 Hr 47 Min 46.834 Sec. CTE

Coverage Interval: Vertical Mono

From: 17.5 Deg N Lat., 32.0 Deg E Long., To: 18.9 Deg N Lat., 26.4 Deg E Long.

From: 207 Hr 9 Min 36.520 Sec, To: 207 Hr 11 Min 36.599 Sec. CTE

Date Processed: 9/11/73, APE Version Used: 7.

INPUT DATA

0 Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: .72178319 Min.

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 207 H. 9 M. 58.94921 sec.

Type: One Revolution Solution

Description. This vector was determined from a solution based on a fit of data from Rev 36. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = <u>1513.7465</u>	$\dot{X}$ = <u>.6941</u>
Y = <u>901.6569</u>	$\dot{Y}$ = <u>-1.4169</u>
Z = <u>566.6613</u>	$\dot{Z}$ = <u>.4033</u>

• Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 9/11/73 (During APE operation)

Edited Data Tape No. T00293
T01247 File No.: 1 Location: TRW

Remarks: There were no gaps in the vehicle attitude data used for this sequence.

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used:	-.6493783	-.7570575	.0719149
	.4029205	-.2623184	.8768376
	-.6449519	.5983752	.4753779

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

- ± 1 degree in camera positioning angle
- ±0.2 mrad in each gimbal angle
- ±20 ms in onboard clock bias definition
- ±5 ms in onboard clock drift rate
- ±5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for two sequences of panoramic strip photography. The first is a sequence of stereo photography taken during a roll maneuver to bring the camera axis to the vertical. This sequence starts at 129.7 deg E Long. (frame 2769) and ends at 90.6 deg E Long. (frame 2889). Throughout this sequence tilt is constantly changing, ranging from a low of 7.3 deg (frame 2770) to a high of 64.7 (frame 2871). Only vehicle state vector data are provided for frame 2850 for which vehicle attitude data were ignored as the result of a computer erratic.

The second sequence is panoramic vertical mono photography starting at 32.0 deg E Long. and ending at 26.4 deg E Long. (frames 2890-2900). During this sequence tilt is maintained less than 0.7 deg.

There is a 21 minute gap between the two sequences.

STATE VECTOR X (KM) Y (KM) Z (KM) XDOT (KM/S) YDOT (KM/S) ZDOT (KM/S)
 1950.0 1612.4243013 -354.1185919 -840.1215264 -1.5414958 -2.2373010
 SELENOGRAPHIC -1175.9238111 1301.8031823 -594.6662500 1.0890392 1.1507476 .3712632

LONGITUDE OF NADIR POINT 132.0916233 DEG LATITUDE OF NADIR POINT -18.7256713 DEG
 LONG OF CAMERA AXIS INTERSECT 129.6543560 DEG LATI OF CAMERA AXIS INTERSECT -18.1552000 DEG
 SPACECRAFT RADIUS 1852.3272615 KM SPACECRAFT ALTITUDE 114.2372652 KM
 SCALE FACTOR .0000000 M/KM AZIMUTH OF VELOCITY VECTOR 283.9173969 DEG
 MEAN ALTITUDE RATE -0.018128 KM/SEC HORIZONTAL VELOCITY 1.6272563 KM/SEC
 TILT AZIMUTH 283.4722176 DEG TILT ANGLE 31.9623168 DEG
 SIGMA TILT AZIMUTH .0003778 DEG SIGMA TILT ANGLE .0002000 DEG
 SUN ELEVATION AT PRIN GRND PNT 17.1552410 DEG SUN AZIMUTH AT PRINCIPAL GRND PNT 275.0945740 DEG
 LONGITUDE OF SUBSOLAR POINT 57.5169446 DEG LATITUDE OF SUBSOLAR POINT -1.6464627 DEG
 57 DEG. 31 MIN. 1.0007143 SEC 0 DEG. 38 MIN. 47.2655582 SEC
 ALPHA -34.0042458 DEG SWING ANGLE 269.6177868 DEG
 EMISSION ANGLE 34.3437474 DEG SIGMA SWING ANGLE .0003778 DEG
 PHASE ANGLE 106.7776928 DEG NORTH DEVIATION ANGLE 168.1290901 DEG
 PHI 31.9617467 DEG X-TILT -20.23278 DEG
 SIGMA PHI .0002000 DEG SIGMA X-TILT .0002000 DEG
 KAPPA -166.2035103 DEG Y-TILT -31.9615249 DEG
 SIGMA KAPPA .0002000 DEG SIGMA Y-TILT .0002000 DEG
 OMEGA -20.23278 DEG HEADING -76.0772748 DEG
 SIGMA OMEGA .0002000 DEG SIGMA HEADING .0002357 DEG
 SPACECRAFT ALTITUDE (LASER) .0000000 KM LASER SLANT RANGE .0000000 KM

SELENOGRAPHIC DIRECTION COSINES X Y Z MAGNITUDE (KM)
 OF CAMERA AXIS .89406868 -.22179018 .36916618 136.419887

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA
 .21958761+00 -.90507717+00 -.36416549+00 .52934967+00
 -.39808344+00 .25766245+00 -.88042018+00 .35312798+02
 .89068003+00 .33829760+00 -.30371678+00 .84839644+00

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA
 -.82347855+00 .20413699+00 .52934967+00
 -.23847246+00 -.97114287+00 .35312798+02
 .51479501+00 -.12332739+00 .84839644+00

PHOTOGRAPH FOOTPRINT
 LATITUDE LONGITUDE
 -12.086 131.579
 -24.445 128.167
 -25.236 126.477
 -10.692 130.637

APOLLO 17 REV 62 PAN VERT 4/73F PAGE - V 2900

STATE VECTOR X (KM) Y (KM) Z (KM) XDOT (KM/S) YDOT (KM/S) ZDOT (KM/S)

1950.0 -1043.3082670 -1528.5083508 31.3340502 -1.1758601 .81/2518 .7755235

SELENOGRAPHIC 1567.9866328 780.0723086 598.9292336 .5937851 -1.4716876 .3654941

LONGITUDE OF NADIR POINT. 26.4503114 DEG LATITUDE OF NADIR POINT 16.8601124 DEG

26 DEG, 27 MIN, 1.211205 SEC 18 DEG, 52 MIN, 48.4046745 SEC

LONG OF CAMERA AXIS INTERSECT 26.4252565 DEG LATI OF CAMERA AXIS INTERSECT 16.8823447 DEG

26 DEG, 25 MIN, 30.9233665 SEC 18 DEG, 52 MIN, 56.4410019 SEC

SPACECRAFT RADIUS 1850.8948488 KM SPACECRAFT ALTITUDE 112.8048525 KM

SCALE FACTOR .0057052 M/KM AZIMUTH OF VELOCITY VECTOR 283.7082540 DEG

MEAN ALTITUDE RATE .0010425 KM/SEC HORIZONTAL VELOCITY 1.6284758 KM/SEC

TILT AZIMUTH 275.3835335 DEG TILT ANGLE .3670210 DEG

SIGMA TILT AZIMUTH .0312980 DEG SIGMA TILT ANGLE .0001995 DEG

SUN ELEVATION AT PRIM GRND PNT 54.0140886 DEG SUN AZIMUTH AT PRINCIPAL GRND PNT 119.4246817 DEG

LONGITUDE OF SUBSOLAR POINT 57.2104915 DEG LATITUDE OF SUBSOLAR POINT .6456536 DEG

57 DEG, 12 MIN, 37.7695298 SEC 0 DEG, 38 MIN, 44.3530369 SEC

ALPHA .3561392 DEG SWING ANGLE 262.0720722 DEG

EMISSION ANGLE .3706686 DEG SIGMA SWING ANGLE .0312975 DEG

PHASE ANGLE 35.6294622 DEG NORTH DEVIATION ANGLE 166.6888333 DEG

PHI .3633559 DEG X-TILT .0506000 DEG

SIGMA PHI .0002000 DEG SIGMA X-TILT .0002000 DEG

KAPPA -166.6888847 DEG Y-TILT .3633557 DEG

SIGMA KAPPA .0002000 DEG SIGMA Y-TILT .0002000 DEG

OMEGA .0002000 DEG HEADING -76.6885628 DEG

SIGMA OMEGA .0002000 DEG SIGMA HEADING .0002000 DEG

SPACECRAFT ALTITUDE (LASER) .0000000 KM LASER SLANT RANGE .0000000 KM

SELENOGRAPHIC DIRECTION COSINES X Y Z MAGNITUDE (KM)

OF CAMERA AXIS -.84446798 -.42724208 -.32301397 112.807315

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA

-.72801981+00 .49889128+00 .47020703+00

-.39725325+00 .25199488+00 -.88243328+00

-.55872808+00 -.82922009+00 .14728926+01

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

-.97311336+00 .23023937+00 .63417110-02

-.23023842+00 -.97313388+00 .88313601-03

.63745729-02 -.60072641-03 .99997948+00

PHOTOGRAPH FOOTPRINT

LATITUDE	LONGITUDE	LATITUDE	LONGITUDE
24.119	28.202	21.372	27.450
13.446	25.501	16.223	26.151
13.607	24.746	16.381	25.427
24.305	27.406	21.542	26.707

Mission: Apollo 17, Target: Panoramic strip photography
Rev: 74, Camera: 24-Inch Panoramic Frames: 2901 Through: 3151

Coverage Interval:

From: 1.1 Deg N Lat., 65.3 Deg E Long., To: 21.6 Deg N Lat., 45.7 Deg W Long.

From: 230 Hr 44 Min 26.952 Sec, To: 231 Hr 20 Min 32.685 Sec. CTF

Date Processed: 9/12/73, APE Version Used: 7.

INPUT DATA

● Trajectory Tape:

HOPE Version Used: B-6.4 (Relocatable)

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: .72183319 Min

Base Time: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 230 H. 56 M. 45.08191 sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 74. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Km, Second, Degree

Components:

X = 1539.6136 $\dot{X}$ = .6839

Y = 917.0646 $\dot{Y}$ = -1.3913

Z = 463.1953 $\dot{Z}$ = .4984

● Telemetered Data Tape

Data Source: Station Tapes

Bit Rate: High

Date Edited: 9/11/73 (During APE operation)

Edited Data Tape No. T01532 File No.: 1 Location: TRW

Remarks: There were no gaps in the vehicle attitude data used for this sequence.

● APE Card Inputs:

Time of Launch: Yr 1973 Month 12 Day 7 Hr 5 Min 33 Sec 0

Range Zero-Clock Zero Time Difference 0.0 Sec

REFSMMAT Used:	-.6493783	-.7570575	.0719149
	.4029205	-.2623184	.8768376
	-.6449519	.5983752	.4753779

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

- ± 1 degree in camera positioning angle
- ±0.2 mrad in each gimbal angle
- ±20 ms in onboard clock bias definition
- ±5 ms in onboard clock drift rate
- ±5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The basic output is a listing of single page tabulations of computed spacecraft state, camera orientation and photograph position and lighting data. Each tabulation presents the computation results for a specified photograph time. The basic data for each map camera sequence is preceded and followed by a star pattern description for a stellar photograph that is companion to a specific map camera photograph of the sequence.

Basic Data Format:

Generally, the format will be as shown in figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the vehicle state vector and the computed value of tilt are substituted for the tabulation.

With the exception of its initial line, all entries of each tabulation are self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. State vector identification
3. Date of data origin
4. Status of data PRE = preliminary, F = final
5. Page number within the sequence

Star Pattern Format:

The star pattern format is a star pattern plot preceded by identification, and field of view direction information. It is followed by a tabulation of the stellar camera diapositive coordinates and identification numbers of the plotted stars. All angular quantities are expressed in radian measure.

OUTPUT Summary: These photo evaluation data are for a sequence of panoramic stereo strip photography starting at 65.3 deg E. Long. and ending at 45.7 deg W Long. Throughout the sequence a tilt of 12.5 ± 0.7 deg is maintained with forward tilt slightly greater than aft tilt.

STATE VECTOR
1950,0
SELENOGRAPHIC
X (KM)
489.1293989
750.4246789
Y (KM)
-1.446.1185909
1689.0355901
Z (KM)
-683.8562297
25.1972916
YEAR
1972
MONTH
12
DAY
16
HOUR
20
MINUTE
17
SECOND
25.238
CTE
9
14
44
XDOT (KM/S)
-1.4300010
1.3665429
YDOT (KM/S)
-.6242514
-.6141987
ZDOT (KM/S)
.4735445
.6435507

LONGITUDE OF NADIR POINT
66 DEG, 2 MIN, 41.3307953 SEC
LONG OF CAMERA AXIS INTERSECT
65 DEG, 16 MIN, 58.0137634 SEC
SPACECRAFT RADIUS
1848.4083226 KM
SCALE FACTOR
.0000000 M/KM
MEAN ALTITUDE RATE
.0023262 KM/SEC
TILT AZIMUTH
291.6098137 DEG
SIGMA TILT AZIMUTH
.0009111 DEG
SUN ELEVATION AT PRIM GRND PNT
69.9451065 DEG
LONGITUDE OF SUBSOLAR POINT
45 DEG, 17 MIN, 55.8754778 SEC
ALPHA
-12.9668232 DEG
EMISSION ANGLE
13.4976618 DEG
PHASE ANGLE
32.6798501 DEG
PHI
12.6712363 DEG
SIGMA PHI
.0002000 DEG
KAPPA
-156.5122528 DEG
SIGMA KAPPA
.0002000 DEG
OMEGA
-4223778 DEG
SIGMA OMEGA
.0002000 DEG
SPACECRAFT ALTITUDE (LASER)
.0000000 KM
LATITUDE OF NADIR POINT
0 DEG, 46 MIN, 51.6653965 SEC
LATI OF CAMERA AXIS INTERSECT
1 DEG, 4 MIN, 58.0948091 SEC
SPACECRAFT ALTITUDE
110.3183262 KM
AZIMUTH OF VELOCITY VECTOR
293.2466513 DEG
HORIZONTAL VELOCITY
1.6305627 KM/SEC
TILT ANGLE
12.6781709 DEG
SIGMA TILT ANGLE
.0002000 DEG
SUN AZIMUTH AT PRINCIPAL GRND PNT
265.2387657 DEG
LATITUDE OF SUBSOLAR POINT
0 DEG, 36 MIN, 46.5189438 SEC
SWING ANGLE
268.0751578 DEG
SIGMA SWING ANGLE
.0009111 DEG
NORTH DEVIATION ANGLE
156.9452539 DEG
X-TILT
-4223778 DEG
SIGMA X-TILT
.0002000 DEG
Y-TILT
-12.6708657 DEG
SIGMA Y-TILT
.0002000 DEG
HEADING
-66.4172918 DEG
SIGMA HEADING
.0002050 DEG
LASER SLANT RANGE
.0000000 KM
MAGNITUDE (KM)
113.257495

SELENOGRAPHIC DIRECTION COSINES
OF CAMERA AXIS

X
-21006080
Y
-97535392
Z
06752183

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

-79564658+00
-40199585+00
45315110+00
-56902292+00
23943147+00
-76669268+00
20774858+00
-88378276+00
-41924771+00

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-69410361+00
-39854210+00
20404826+00
39032915+00
-91712044+00
-80826658+01
21935047+00
73718161+02
97561823+00

PHOTOGRAPH FOOTPRINT

LATITUDE	LONGITUDE	LATITUDE	LONGITUDE
5.827	67.708	3.314	66.634
-4.045	63.393	-1.453	64.555
-4.004	62.541	-1.273	63.823
6.397	67.109	3.720	66.009

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