A RAND NOTE

A Unified Lunar Control Network--The Near Side

Merton E. Davies, Tim R. Colvin,
Donald L. Meyer

October 1987

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PREFACE

The most important sources of information useful for positioning features on the surface of the Moon have been telescopic pictures, Lunar Orbiter pictures, Apollo 15, 16, and 17 mapping camera frames, and the Soviet Zond 6 and 8 pictures. This Note describes the effort to combine the Apollo mapping frames, telescopic pictures, and Mariner 10 pictures into a unified control network of the near side of the Moon.

The Note was generated within RAND's Domestic Research Division as part of the Lunar Control Network project for the National Aeronautics and Space Administration. The paper has been accepted for publication in the *Journal of Geophysical Research*, where the Appendix will be published in the microfiche version only.

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SUMMARY

The Lunakhod 2, Apollo 11, 14, and 15 retroreflectors, and the Apollo 15, 16, and 17 ALSEP antenna locations are the most accurately located positions on the Moon. The Apollo 15 retroreflector and the Apollo 15, 16, and 17 ALSEP antennas have been identified on high-resolution Apollo panoramic pictures and their locations transferred to Apollo mapping camera frames. Three Apollo control networks have been computed, two by the Defense Mapping Agency Aerospace Center and one by the National Ocean Survey/U.S. Geological Survey, based on measurements of points on the Apollo mapping camera frames. Transformations involving translation, rotation, and scale were determined that adjusted the coordinates of the points of the three control networks to the center of mass origin and the mean Earth/polar axis coordinate system defined by the lunar ranging retroreflector experiment. The transformed DMA/603 control network was the best fit to the ALSEP coordinates and was selected as a base to transform all points in D. L. Meyer's (DMAAC) telescopic network to the new origin and coordinate system. New coordinates of 1156 of these points are given as are 10 points from a Mariner 10 solution in the north polar region. These coordinates are presented in the Appendix.

ACKNOWLEDGMENTS

The authors would like to thank Robert W. King, MIT, for generously furnishing new and unpublished data regarding LRRR and ALSEP coordinates. We would also like to thank James G. Williams and Jean O. Dickey, JPL, for their recent data on the LRRR coordinates. We are indebted to Frederick J. Doyle, USGS, for a thoughtful review of this Note and for the many suggestions for improving the presentation. The Note was also reviewed by two anonymous scientists who contributed valuable ideas for clarifying particular sections of the paper. We feel that this article (to be published in the *Journal of Geophysical Research*) has been significantly improved by the efforts of these reviewers.

We are indebted to Jeanne Heller for editing and Jean Renner for typing the manuscript. The research was supported by the National Aeronautics and Space Administration through contracts NASW-3899 at RAND and W-16033 at DMAAC.

CONTENTS

PREFACE iii

SUMMARY v

ACKNOWLEDGMENTS vii

Section

I. INTRODUCTION 1

II. DEFINITION OF THE REFERENCE SYSTEM 2

III. THE APOLLO CONTROL NETWORKS 6

IV. THE UNIFIED APOLLO CONTROL NETWORK 12

V. THE UNIFIED TELESCOPIC CONTROL NETWORK 17

VI. THE MARINER 10 CONTROL NETWORK 19

VII. CONCLUSIONS 20

Appendix: COORDINATES OF POINTS FROM A UNIFIED LUNAR CONTROL NETWORK 23

REFERENCES 45

I. INTRODUCTION

The Moon was the first extraterrestrial body to be explored by spacecraft of the United States and the Soviet Union. Using data collected by many missions, maps of almost the entire lunar surface have been produced, with control networks used to position features relative to each other and to the latitude/longitude lines on the maps. The most important sources of positional information have been telescopic pictures, Lunar Orbiter pictures, Apollo 15, 16, and 17 mapping camera frames, and the Soviet Zond 6 and 8 pictures. Each of these data sources has been processed to cover large regions of the Moon, often with little attention paid to overlapping areas. The present effort combines all the data sources into a single consistent unified control network.

The plan is to start with the most accurate data, tie common points and new pictures to them, and expand into new regions, always paying particular attention to overlapping areas to assure that coordinates of common features have the best possible values.

The most accurately located points on the Moon are the lunar retroreflectors, so those are the starting points; the Apollo lander sites are tied to them. The Apollo network is then tied to the lander sites. The near side control based on telescopic pictures is next tied to the Apollo network, requiring a rather large shift as all telescopic networks have their origin at the center-of-figure rather than at the center-of-mass. The present study covers only the near side data from Apollo mapping camera, telescopic data, and Mariner 10 pictures. The Lunar Orbiter and Zond 6 and 8 pictures must eventually be tied to the Apollo and telescopic networks to obtain a farside control network in the same coordinate system.

II. DEFINITION OF THE REFERENCE SYSTEM

The lunar ranging retroreflector (LRRR) experiment involved measuring the round-trip light time of a laser pulse from McDonald Observatory to a retroreflector on the Moon (Bender et al., 1973). (Retroreflectors were placed on the Moon by Apollo 11, 14, and 15 and Lunakhod 2.) Analysis of these data contributed to studies of the lunar gravity field and have resulted in accurate measurements of the coordinates of the retroreflectors on the Moon (Bender et al., 1973; (Ferrari et al., 1980; J. G. Williams and J. O. Dickey, personal communication, 1986; R. W. King, personal communication, 1986). The coordinates are given in a system whose axes are the Moon's principal axes of inertia and also in a system whose axes are the Moon's mean axis of rotation and the mean Earth direction.

The principal axes system is *defined* with respect to the observed mean Earth/polar axis system by the values of the spherical harmonic coefficients of the gravity field. These coefficients are determined dynamically from their effects on orbiting spacecraft and the physical librations (see Ferrari et al., 1980). The effects of uncertainties in these coefficients on the constant terms in the angles p_1, p_2, and τ are much larger than the uncertainties of the mean Earth/polar axis coordinates determined from laser ranging.

The relation between principal axes X_{PA} and mean Earth/polar axis X_{ME} coordinates is given by:

$$X_{PA} = T \cdot X_{ME}$$

where

$$T = \begin{bmatrix} \cos p_1 \cos \tau & \cos p_1 \sin \tau & \sin p_1 \\ -\sin p_1 \sin P_2 \cos \tau - \cos p_2 \sin \tau & -\sin p_1 \sin p_2 \sin \tau + \cos p_2 \cos \tau & \sin p_2 \cos p_1 \\ -\sin p_1 \cos p_2 \cos \tau + \sin p_2 \sin \tau & -\sin p_1 \cos p_2 \sin \tau - \sin p_2 \cos \tau & \cos p_2 \cos p_1 \end{bmatrix}$$

The three angles p_1, p_2, τ are derived from spherical harmonic coefficients and were computed (by King, personal communication, 1977), as $p_1 = -72.45"$, $p_2 = 0.53"$, $\tau = 219.45"$. Ferrari et al. (1980) give $p_1 = -84.956"$, $p_2 = 0.305"$, $\tau = 80.025"$. Recent values are (King, personal communication, 1986) $p_1 = -79.695"$, $p_2 = 0.405"$, $\tau = 43.506"$, and (Williams and Dickey, personal communication, 1986) $p_1 = -78.406"$, $p_2 = 0.292"$, $\tau = 79.816"$. For cartographic purposes the mean Earth/polar axis coordinates are used (Davies et al., 1986); Table 1 gives these coordinates for the four retroreflector sites (Williams and Dickey, personal communication, 1986). These coordinates are updates from those in Ferrari et al. (1980).

Table 1

LUNAKHOD 2 AND APOLLO LANDER SITES MEAN EARTH/POLAR AXIS COORDINATES

	Ranging[a]			Laser Ranging and VLBI[b]		
Site	R(m)	Latitude(°)	Longitude(°)	R(m)	Latitude(°)	Longitude(°)
Lunakhod 2	1734641	25.83228	30.92196			
Apollo 11 LRRR	1735475	0.67339	23.47292			
Apollo 14 LRRR	1736339	-3.64423	-17.47877	1736347	-3.64450	-17.47841
Apollo 15 LRRR	1735480	26.13335	3.62837	1735480	26.13335	3.62837
Apollo 12 ALSEP				1735997	-3.00776	-23.42450
Apollo 14 ALSEP				1736354	-3.64402	-17.47736
Apollo 15 ALSEP				1735480	26.13409	3.62981
Apollo 16 ALSEP				1737439	-8.97545	15.49808
Apollo 17 ALSEP				1734786	20.19214	30.76514

[a] J. G. Williams and J. O. Dickey, personal communication, 1986.

[b] King et al., 1976, and R. W. King, personal communication, 1977. Relative measurements normalized to Apollo 15 LRRR.

King et al. (1976) made very long base interferometry (VLBI) observations of the radio signals transmitted by the ALSEP stations. These stations transmitted data from the Apollo lunar surface experiment packages (ALSEP) at the Apollo 12, 14, 15, 16, and 17 landing sites. The VLBI data were tied to the lunar laser ranging positions by fixing the coordinates of the Apollo 15 ALSEP transmitter with respect to the Apollo 15 retroreflector using a determination by the Defense Mapping Agency Aerospace Center (DMAAC) (L. A. Schimerman, personal communication, 1975) from astronaut photographs. The estimated uncertainty was about 1 m (King et al., 1976). The results presented by King et al. (1976) were transferred from principal axes to mean Earth/polar axis coordinates and added to Table 1 normalized to the Apollo 15 LRRR position. A check for consistency is the true distance between the LRRR and ALSEP points at the Apollo 14 landing site, given as about 30 m in the first science report (Faller et al., 1971) and as 34.8 m in King et al. (1976). King et al. checked the distance and relative coordinates of the Apollo 14 retroreflector and ALSEP antenna with measurements from landing site photographs made by L. Schimerman and reported good agreement.

The uncertainty in the coordinates of the laser retroreflectors is estimated to be about 5 m in each direction (J. G. Williams, personal communication, 1987). The tie between the Apollo 15 LRRR and ALSEP is good to about 1 m and that between the Apollo 14 LRRR and ALSEP is good to about 5 m. The weakest link is the tie between the Apollo 12, 16, and 17 ALSEPs and the Apollo 14 and 15 points, which have uncertainties of 30 m or more in the Earthward direction and about 10 m normal to that direction (King et al., 1976). The locations of the retroreflectors and the ALSEP sites are shown in Fig. 1.

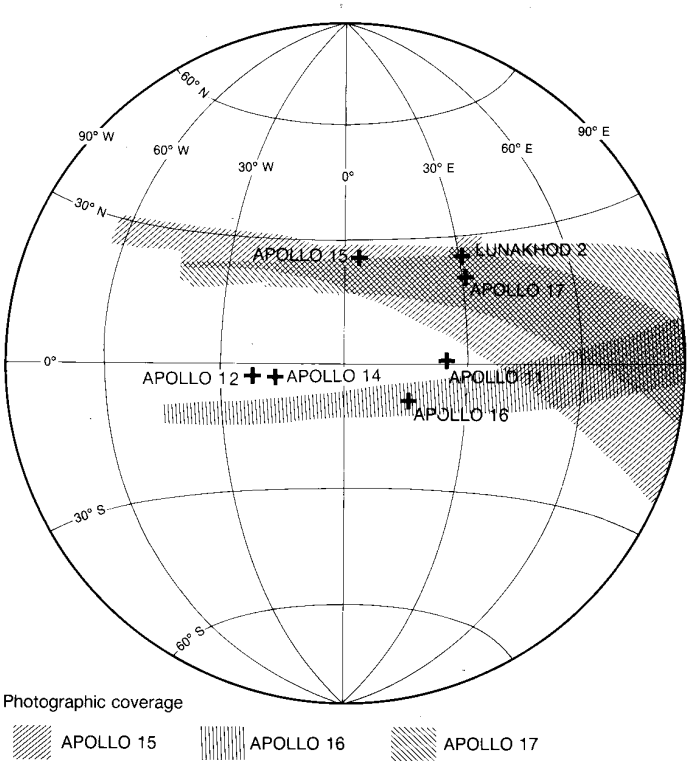

Fig. 1—Locations of laser retroreflectors, ALSEP sites, and mapping coverage of Apollo 15, 16, and 17

III. THE APOLLO CONTROL NETWORKS

The Apollo 15, 16, and 17 missions carried three cameras: a mapping (metric) camera, a stellar camera, and a high-resolution panoramic camera. The characteristics of these camera systems have been described by Light (1972). Pictures taken by the stellar camera determine the orientation of the metric camera when it is shuttered. Also, a laser altimeter was on board to measure the distance to the lunar surface when pictures were taken. The metric camera had a focal length of 76 mm and 114 mm x 114 mm format. At the nominal altitude of 110 km, the expected ground resolution would be between 30 m and 60 m depending upon the solar altitude.

The initial control networks based on the Apollo mapping camera frames were compiled by the Defense Mapping Agency Aerospace Center. The data and procedures have been reported in a series of documents titled *Development of the Apollo Mission 15 Control Network* (1972), *Development of the Apollo 16 Control Network* (1976), and *Development of the Apollo Mission 17 Control Network* (1975). The metric camera was programmed to take pictures on selected revolutions of the spacecraft with 78 percent overlap between successive frames and 57 percent between alternate frames. Each revolution thus produced a strip of photographs. Because stellar exposures were taken simultaneously with the metric exposures, the metric camera orientations could be determined. Also, boresighted laser distance measurements were available. The metric frames were first assembled in strips, normally using alternate frames as they contained sufficient overlap. About 30 points were identified and measured per frame. Independent analytical triangulation computations were performed on each strip, incorporating initial camera positions from the spacecraft orbital ephemeris. Since there were sufficient data to fully constrain the triangulations, the biases can be compared by observing the distances between the coordinates at common points on different strips. The results are summarized in Table 2.

Table 2

MEAN SYSTEMATIC BIASES BETWEEN COMMON SURFACE COORDINATES DERIVED IN INDEPENDENT STRIP SOLUTIONS

Spacecraft	Standard Revolution	Comparison Revolution	Number of Common Coordinates	Mean Bias (m)
Apollo 15	22	16	408	263
	22	27	415	466
	33	27	400	274
	33	38	411	343
	44	38	357	386
	44	50	307	1554
	60	50	133	2077
	60	62	360	335
	63	62	403	193
	63	70	285	529
	63	72	195	697
Apollo 16	47	17	174	548
	47	29	329	730
	47	63	357	452
	17	29	396	212
	17	63	51	255
	29	63	84	370
Apollo 17	2	14	303	94
	2	29	30	438
	29	14	128	682
	29	38	245	360
	29	49	21	278
	38	14	30	514
	38	49	82	505
	38	62	9	113
	38	66	17	135
	62	49	19	490
	66	62	54	175
	74	2	12	929
	74	38	54	168
	74	62	15	165
	74	66 1st part	62	216
	74	66 2nd part	110	308

The mean biases were frequently more than a few hundred meters and give a measure of the inconsistency in the ephemeris. This large error is unfortunate because the coordinate system and its origin (the center of mass) of any photogrammetric triangulation are determined by the spacecraft emphemeris together with the lunar ephemeris, and the assumed lunar libration model.

Work on the Apollo 15 control network was started soon after the photographs were returned to Earth. When the strips were assembled and the ephemeris inconsistencies noted, it was decided to select revolution 44 to provide the absolute positional reference for the total Apollo 15 block solution. In this solution the camera positions of all revolutions would be permitted to vary in order to tie to revolution 44 and to each other. Pictures from revolutions 15 and 62 were deleted because their coverage was redundant. A single block triangulation was computed that included 4933 points and 630 photographs on 12 revolutions. Soon after this control network was completed, an extensive series of 1:250,000 topographic maps was started. A report by Schimerman et al. (1973) compared coordinates of 62 points with five Earth-based telescopic networks (ACIC, Kiev, Manchester, Strutka, Tucson).

The Apollo 17 pictures had large overlapping coverage with the Apollo 15 area, and a block triangulation solution (3945 points, 408 pictures) was readily tied to the Apollo 15 network through 889 common points. The Apollo 16 coverage crossed the Apollo 15/17 coverage so the overlapping area was much smaller than was the case for Apollo 15 and 17 (see Fig. 1). After the individual strips were evaluated independently (see Table 2), revolution 47 was selected to provide absolute positional reference for the entire block. The Apollo 16 block triangulation solution contained 2465 points and 246 pictures, with 321 points common to Apollo 15 and 193 points common to Apollo 17.

The combined Apollo network developed by DMAAC is in this paper referred to as DMA/A15. This designation is used because revolution 44 of Apollo 15 was the fundamental reference for the entire network. Schimerman (1976) presented coordinates of 330 points (named craters) on the near side of the Moon that can be compared with Earth-based telescopic networks. Apollo 15, 16, and 17 lander sites had been located on high-resolution panoramic pictures and their locations

transferred to metric frames. Thus, Schimerman (1976) was able to compare DMA/A15 coordinates of these points with laser ranging/VLBI coordinates (see Table 1). The Lunakhod 2 reflector was also included; however, its location on the pictures was probably misidentified.

Members of the Apollo Orbital Science Photo Team also computed an Apollo control network (Doyle et al., 1977). As the authors were associated with the National Ocean Survey and the U.S. Geological Survey, this network is referred to in this paper as NOS/USGS. Doyle et al. (1977) point out four significant differences between the DMA/A15 and NOS/USGS solutions:

1. DMA/A15 used the orbital constraints provided by the tracking data to force a best fit between tracking and photogrammetry, while NOS/USGS elected to abandon all tracking data for a purely photogrammetric solution.
2. DMA/A15 transferred the camera orientations from the initial reference frame into the selenocentric coordinate system of data using the Koziel model for lunar librations, while NOS/USGS used a model developed more recently by Eckhardt (1973).
3. DMA/A15 first reduced mission 15 and then fit 16 and 17 to those results, while NOS/USGS performed a simultaneous adjustment of all three missions.
4. The computer program used by DMA/A15 did not include a covariance propogation capability.

Corrected image point measurements, camera orientation angles, spacecraft laser ranging measurements, and approximate coordinates of the points and camera locations were supplied by DMA for the NOS/USGS activity. The camera orientation data, which were tied to an inertial reference frame, were transformed into the lunar coordinate system using the Eckhardt (1973) libration model. Then a single, large-block analytical triangulation containing data from all three Apollo missions was computed. It contained 51138 measurements and 519 altimeter observations and solved for 23436 parameters (three exposure station coordinates and three orientation angles for each of 1244 photographs

and three coordinates for each of 5324 lunar surface points). No orbital constraints were placed on the camera positions; however, the coordinates of one point, 22051, were held fixed to provide a location origin for the solution. Finally, a least-squares best-fit to revolution 44 of Apollo 15 involving translation only (no rotation) was carried out on all positions to minimize the discrepancies between DMA/A15 and NOS/USGS versions.

The error analysis demonstrated the strength of the purely photogrammetric solution and confirmed the optimum design of the metric camera. The computation of standard deviations of horizontal position of control points resulted in 70 percent being less than 30 m, 94 percent less than 60 m, and 97 percent less than 90 m. The standard deviations of elevations of the points gave 74 percent less than 30 m, 96 percent less than 60 m, and 98 percent less than 90 m. The 30 m precision of the lunar surface coordinates implies about 20 μm precision in the adjusted image coordinates on the metric camera photographs at scale approximately 1:1,500,000. This is a reasonable photogrammetric result. The best region was a large block of Apollo 15 and 17 coverage, with standard errors increasing toward the eastern and western tails of coverage. The Apollo 16 coverage was poorest everywhere, with standard errors increasing after leaving the overlapping coverage with Apollo 15 and 17.

Another Apollo control network was computed by DMAAC and described in *Report on Lunar Control under Contract No. W-14,* 453 (1981); in the current paper this network is called DMA/603. The DMA/603 network was designed to respond to some of the objections to the earlier DMA/A15 network. Thus it is primarily a photogrammetric solution using a single, large-block triangulation and the stellar data were processed using the LURE 2 libration model derived from the lunar laser retroreflector data. A new Apollo ephemeris was incorporated. Nineteen frames from Apollo 16, revolution 60, were added to the data set together with their associated stellar data. Because of limitations of the triangulation program, only 603 frames could be incorporated in the adjustment. Thus, the coverage was not as complete or dense as it was with DMA/A15 and NOS/USGS.

Table 3 lists the number of frames in each revolution used in the computation of the three control networks: DMA/A15, NOS/USGS, and DMA/603.

Table 3

THE NUMBER OF FRAMES BY REVOLUTION
IN THE CONTROL NETWORK COMPUTATIONS

Spacecraft	Revolution	DMA/A15	NOS/USGS	DMA/603
Apollo 15	4	14	13	
	16	67	67	
	22	56	67	
	27	45	62	
	33	63	68	69
	38	46	69	
	44	70	69	70
	50	36	46	
	60	38	69	
	63	70	69	70
	70	67	70	
	72	58	57	
Apollo 16	4	10		
	17	71	58	71
	29	45	37	
	47	49	40	
	60			19
	63	74	56	71
Apollo 17	2	102	57	
	14	52	48	
	29	49	46	49
	38	71	67	71
	49	21		
	62	11	11	11
	66	33	33	33
	74	69	63	69
Total		1287	1242	603

IV. THE UNIFIED APOLLO CONTROL NETWORK

One of the primary weaknesses of all the Apollo control networks was the inability to accurately define the origin of the coordinate system relative to any surface point. At best, the orbital ephemeris was not as accurate as desired (see Table 2).

The Apollo 15, 16, and 17 lander sites were located on panoramic pictures at DMAAC. The locations of the Apollo 15 retroreflector and the Apollo 15, 16, and 17 ALSEP antennas were transferred from the panoramic pictures to the corresponding metric frames. The points on the metric frames were measured, and their coordinates computed in the DMA/A15 system (J. R. Hassell, personal communication, 1981). The coordinates of the points were transformed into the NOS/USGS and DMA/603 systems and are given in Table 4. The transformation was carried out by

Table 4

COORDINATES OF APOLLO LANDER SITES

Spacecraft	DMA/A15	NOS/USGS	DMA/603
Apollo 15 LRRR			
R(m)	1735332	1735330	1735466
Latitude(°)	26.12675	26.15021	26.12826
Longitude(°)	3.62069	3.55673	3.63426
Apollo 15 ALSEP			
R(m)	1735335	1735333	1735469
Latitude(°)	26.12692	26.15038	26.12836
Longitude(°)	3.62094	3.55699	3.63452
Apollo 16 ALSEP			
R(m)	1737458	1737403	1737412
Latitude(°)	-8.98694	-8.97050	-8.98851
Longitude(°)	15.50086	15.42137	15.49410
Apollo 17 ALSEP			
R(m)	1734668	1734677	1734800
Latitude(°)	20.18628	20.20600	20.18169
Longitude(°)	30.75783	30.69748	30.76453

selecting a few nearby points common to both systems and solving for best-fit parameters involving translation, rotation, and scale. This was done independently for each lander site.

The distance between the Apollo 15 LRRR and ALSEP sites is 9.2 m when computed from the photogrammetric coordinates of Table 4. When computed from the laser ranging and VLBI coordinates of Table 1, the distance is 44.6 m. From surface measurements and local maps, the distance is known to be about 43 m (Faller et al., 1972). This check gives an indication of the ability to transfer points from the panoramic pictures to metric pictures and to measure their locations on the pictures.

It is now desirable to transform the coordinate networks (DMA/15, NOS/USGS, and DMA/603) into the origin and coordinate system of the laser ranging and VLBI points in Table 1. If all four points in Table 4 are used to compute the transformation parameters, the Apollo 15 location would have essentially twice the weight of Apollo 16 and 17 since the two Apollo 15 points are so close together. The Apollo 15 laser ranging point was thus deleted because the ALSEP point was a better fit to the data.

Least-squares, best-fit, transformation parameters involving translation, rotation, and scale were computed that transform the ALSEP sites of Table 4 into the ALSEP sites of Table 1.

The transformation equations had the following form:

$$\begin{bmatrix} X_T \\ Y_T \\ Z_T \end{bmatrix} = S \cdot P \cdot \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} + \begin{bmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{bmatrix}$$

where X, Y, Z are Cartesian coordinates of the point, P the rotation matrix, S the scale factor, ΔX, ΔY, ΔZ the translation terms, and X_T, Y_T, Z_T the transformed coordinates of the point. The rotation matrix has the form:

$$P = \begin{bmatrix} \cos\beta\cos\gamma & \cos\beta\sin\gamma & -\sin\beta \\ \sin\alpha\sin\beta\cos\gamma-\cos\alpha\sin\gamma & \sin\alpha\sin\beta\sin\gamma+\cos\alpha\cos\gamma & \sin\alpha\cos\beta \\ \cos\alpha\sin\beta\cos\gamma+\sin\alpha\sin\gamma & \cos\alpha\sin\beta\sin\gamma-\sin\alpha\cos\gamma & \cos\alpha\cos\beta \end{bmatrix}$$

The values of the parameters are presented in Table 5 with the rotation angles multiplied by 1736 km to give an indication of the distances on the surface of the Moon. The RMS of the residuals indicates the goodness of the fit and the mean, maximum, and minimum shifts indicate the coordinate changes due to the transformations. Coordinate shifts are given for the three ALSEP points defining the transformation. Also given are the coordinate shifts due to the transformation of all points in the control network.

Table 5

PARAMETERS TO TRANSFORM DMA/15, NOS/USGS, AND DMA/603 COORDINATES INTO MEAN EARTH/POLAR AXIS COORDINATES

Parameter		DMA/A15	NOS/USGS	DMA/603
Translation	Earthward, Δx	190 m	424 m	178 m
	East, Δy	-66 m	94 m	-43 m
	North, Δz	280 m	194 m	-68 m
Rotation measured at surface	Pole direction, α	446 m	-103 m	-395 m
	Pole direction, β	137 m	-510 m	294 m
	Equatorial E-W shift,	-160 m	-2283 m	-167 m
	Scale	0.9999290	0.9998940	0.9999314
RMS residuals of transformation		73 m	76 m	58 m
Three ALSEP points	Mean shift	333 m	2110 m	308 m
	Maximum shift	353 m	2307 m	411 m
	Minimum shift	294 m	1971 m	206 m
		12305 points	5318 points	5346 points
All control points	Mean shift	334 m	2052 m	355 m
	Maximum shift	737 m	2668 m	522 m
	Minimum shift	32 m	1636 m	36 m

Table 6 compares the coordinates of the points of the three control networks before and after their transformations into mean Earth/polar

Table 6

DIFFERENCES IN THE COORDINATES OF POINTS
BEFORE AND AFTER TRANSFORMATION

	DMA/A15 and NOS/USGS	DMA/A15 and DMA/603	NOS/USGS and DMA/603
Number of common points	3791	4284	2624
Before transformation			
Mean difference	1995 m	340 m	2140 m
Maximum difference	2896 m	2546 m	2832 m
Minimum difference	1586 m	24 m	1769 m
After transformation			
Mean difference	334 m	300 m	274 m
Maximum difference	3955 m	2365 m	4295 m
Minimum difference	7 m	14 m	4 m

axis coordinates. DMA/A15 and NOS/USGS contained 3794 points in common; the true distance between three of the points was greater than 3 km, so these were deleted from the set as gross errors. The mean difference between the coordinates of 3791 points before transformation was 1995 m and after transformation to the new origin was 334 m. DMA/A15 and DMA/603 contained 4288 points in common with four gross errors. The mean difference between the coordinates of 4284 points before transformation was 340 m and after transformation to the new origin was 300 m. NOS/USGS and DMA/603 contained 2631 points in common with seven gross errors. The mean difference between the coordinates of 2624 points before transformation was 2140 m and after transformation to the new origin was 274 m.

It is difficult to argue that one control network is better than another when they are all transformed into the same coordinate system. And perhaps the difference in the coordinates of points represents the accuracy that should be expected from the data set. Also, the ALSEP sites are too close together to obtain more accurate transformations. However, they are what we have and the RMS of the residuals is the best clue we have of the accuracy of the photogrammetry. On this basis the DMA/603 is the best solution. It is not practical to average coordinates of points from the three networks as there are too few in common and they are not well distributed. Thus, the transformed DMA/603 shall represent the Unified Control Network in the Apollo region.

V. THE UNIFIED TELESCOPIC CONTROL NETWORK

Many control networks of the Moon based on telescopic pictures have been computed. The most comprehensive and recent was published by Meyer (1980). This network was based on measurements of points identified on ten plates taken with the 155-cm astrometric reflector of the U.S. Naval Observatory at Flagstaff, Arizona. The plates were taken at near full phase over an eleven year period and recorded near maximum librations in all quadrants. Sixty well-dispersed primary control points were chosen to determine plate constants (rotation, translation, and scale) and to incorporate an improved determination of the coordinates of Mosting A (Koziel, 1967). The LURE 2 libration model derived from lunar laser ranging was used in the solution. However, like all telescopic networks, the origin of the coordinate system was the center of figure (not the center of mass). Coordinates of 1156 points were computed (Meyer, 1980).

130 points were selected that were common to the Meyer (1980) network and the vertical Apollo metric camera coverage. Their locations on the photographs were measured and Apollo DMA/A15 coordinates computed. These points were transformed from DMA/A15 to DMA/603 coordinates and then transformed to the mean Earth/polar axis coordinates. Values of the transformation parameters which convert from Meyer (1980) coordinates to mean Earth/polar axis coordinates are given in Table 7. The RMS of the residuals is 808 m and the mean shift of the coordinates of the 130 points is 1352 m. With these values of the parameters, the coordinates of all 1156 points were transformed into mean Earth/polar axis coordinates. Coordinates of these points are given in the Appendix. The 130 Apollo points are in set 1 and the remaining 1026 points are in set 2. The set number followed by an * indicates that the radius was derived from Apollo altimetry.

Table 7

PARAMETERS TO TRANSFORM MEYER (1980) COORDINATES
INTO MEAN EARTH/POLAR AXIS COORDINATES

Parameter		130 Meyer (1980) Points
Translation	Earthward, Δx	-1130 m
	East, Δy	895 m
	North, Δz	-354 m
Rotation measured at surface	Pole direction, α	317 m
	Pole direction, β	-566 m
	Equatorial E-W shift,	2082 m
	Scale	1.0001689
RMS residuals of transformation		808 m
The 130 common points	Mean shift	1352 m
	Maximum shift	2336 m
	Minimum shift	803 m
All 1156 points	Mean shift	1571 m
	Maximum shift	3079 m
	Minimum shift	421 m

VI. THE MARINER 10 CONTROL NETWORK

Mariner 10 was launched November 3, 1973, bound for Venus and Mercury. At the time of launch, it was planned to take a few mosaics of the Earth and Moon to verify the performance of the vidicon cameras. The eastern hemisphere of the Moon was illuminated at the time and pictures of the near side and north polar region were taken. With these pictures, a control network has been computed that extends beyond the near side in the northern region.

On 29 pictures, 172 points were identified and an analytical triangulation computed in a manner similar to that performed at Mercury (Davies and Batson, 1975). The computation contained 1126 measurements and resulted in a standard error of measurement of 11.62 μm. Six common points with Meyer (1980) were in the set and their coordinates were fixed at values contained in the Appendix. The coordinates of ten points (1157-1166) from these data may be found in the Appendix.

The transformed coordinates of Apollo points are in set 1 of the Appendix. The transformed coordinates of Meyer's control are set 2, and the Mariner 10 points are set 3. Again, an * indicates that the radius was derived from Apollo altimetry.

VII. CONCLUSIONS

The unified lunar control network employs mean Earth/polar axis coordinates (not principal axes coordinates) with its center-of-mass origin defined by the laser retroreflector experiment. The Apollo 15, 16, and 17 ALSEP antennas have been located relative to the laser retroreflectors (King et al., 1976) and these ALSEP stations were located on the Apollo panoramic pictures. The antenna locations were transferred to mapping camera frames and their coordinates determined in the control network solutions (Schimerman, 1976).

Three Apollo control networks have been computed and are designated DMA/A15, NOS/USGS, and DMA/603. Transformation parameters involving translation, rotation, and scale were computed to transform each of these networks into mean Earth/polar axis coordinates based on the locations of the three ALSEP stations. The RMS of the residuals of the transformation were 58 m for DMA/603, 73 m for DMA/A15, and 76 m for NOS/USGS. The mean shift of the ALSEP coordinates was 308 m for DMA/603, 333 m for DMA/A15, and 2110 m for NOS/USGS.

All three control networks were computed from the same measurements of essentially the same points; however, the coordinates of the points frequently differed greatly. After transformation, the coordinates were much closer. DMA/A15 and NOS/USGS had 3791 points in common. The mean difference before transformation was 1995 m and after transformation was 334 m. DMA/A15 and DMA/603 had 4284 points in common, the mean difference before transformation was 340 m and after transformation was 300 m. NOS/USGS and DMA/603 had 2624 points in common; the mean difference before transformation was 2140 m and after transformation was 274 m.

The Apollo points measured on the metric frames were either very small craters or pug marks. Thus these points cannot be described and exist only on the one set of pictures. (Currently, these pictures are held by Sherman Wu, USGS, Flagstaff.) However, 130 points from the Meyer (1980) telescopic network were measured and coordinates computed in the Apollo network. These 130 points are the centers of named

craters that can be identified on Lunar Orbiter pictures and other data sources.

The transformed DMA/603 was selected to represent the Unified Control Network in the Apollo region. The Meyer (1980) telescopic network contained coordinates for 1156 points. Transformation parameters were determined to map the 130 Meyer coordinates into the 130 unified control network coordinates. The RMS of the residuals was 808 m and the mean shift of the 130 points was 1352 m. Using these transformation parameters, the 1026 remaining Meyer coordinates were transformed into the unified control network coordinates.

The Mariner 10 spacecraft took a few pictures of the north polar region of the Moon shortly after launch. These pictures have been combined into a local network with six common points tied to values from the unified control network. From this data set, coordinates of ten new points have been added in the north polar area.

Coordinates of all of the control points currently in the unified control network are presented in the Appendix. The 130 derived from the Apollo control are in set 1, the 1026 derived from the telescopic network are in set 2, and the 10 derived from the Mariner 10 network are in set 3. The radii of all points were checked for consistency with the Apollo altimetry radii measurements, and those with an * list radii derived from altimetry. Many thousand Apollo points covering both the near and far side of the Moon are identified on one set of pictures and coordinates of these points are available but not published. The next phase of this work will tie points from the far side of the Moon into this same coordinate system; the Apollo points will be important to this effort.

Doyle et al. (1977) carried out a detailed analysis of the internal precision of their block adjustment. No analysis of this type is available for any of the other control networks discussed in this paper. The analysis indicated that the standard deviation of horizontal positions of most of the points was less than 30 m in the Apollo 15, 17 region and only exceeded 30 m toward the limits of coverage. The Apollo 16 region was much poorer, with the standard deviation of horizontal positions in the most western areas rising to 1800 m from the 30 m in areas common with Apollo 15, 17. These results indicate those large

regions where the Apollo coordinates are very reliable and suggest small areas where they may have significant errors.

This Note is concerned with the coordinates of points in the mean Earth/polar axis system as defined by the laser retroreflector experiment. Three ALSEP stations were used to transform Apollo mapping coordinates into this coordinate system (see Table 5). It is difficult to estimate the accuracy of the coordinates of the points listed in the Appendix. In the Apollo region, set 1, the best clues are the RMS residuals of transformation given in Table 5 and the error analysis in Doyle et al. (1977). Considering that all of the RMS residuals of transformation are less than 80 m and allowing for a measurement error of about 60 m, it would seem that points near and between the three ALSEP sites would have positional errors of less than 150 m. Departing from the ALSEP sites in the Apollo area, the estimated positional error would increase to about 300 m over most of the coverage. The extremities of coverage might exceed the 300 m and in some cases exceed 1 km.

In the telescopic region, set 2, the RMS residuals of transformation are about 800 m, suggesting that many points would have positional errors less than 1 km and that most would be less than 2 km.

In the decade following the Apollo landings, many maps were produced covering the area explored by the Apollo photography. All of these products used the DMA/A15 system for control. We believe that the unified control network described here is an improvement over prior networks and should be used in future mapping projects. At this time we are in the process of extending the system onto the far side of the Moon.

Appendix

COORDINATES OF POINTS FROM A UNIFIED LUNAR CONTROL NETWORK

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
1	2	Reiner A	5.136	-51.522	1734.702
2	2	Herodotus A	21.534	-52.167	1734.285
3	1	Brayley D	20.023	-32.878	1736.371
4	2	Draper C	17.062	-21.511	1736.172
5	2	Hortensius C	5.926	-26.741	1736.355
6	2	Lansberg A	0.171	-31.146	1736.538
7	2	Gambart G	1.945	-12.054	1737.301
8	2	Mosting A	-3.212	-5.211	1737.527
9	2	Bruce	1.164	0.359	1737.479
10	2	Manilius D	13.233	6.966	1737.151
11	1	Aratus	23.576	4.507	1737.928
12	2	Eratosthenes B	18.698	-8.714	* 1735.499
13	2	Landsteiner(Timocharis F)	31.300	-14.800	1734.866
14	2	Carlini A	35.359	-26.624	1735.248
15	2	Mairan E	37.818	-37.244	1734.972
16	2	Sharp A	47.649	-42.714	1734.949
17	2	Maupertuis L	51.372	-29.276	1735.144
18	2	Plato G	52.158	-6.266	1736.311
19	2	Piton B	39.359	-0.166	1734.883
20	2	Egede A	51.582	10.516	1734.830
21	2	Baily K	51.515	30.568	1734.773
22	2	Plana D	41.754	26.162	1736.709
23	2	Cepheus A	41.038	46.530	1736.339
24	2	Posidonius A	31.686	29.495	1735.356
25	2	Linne B	30.544	14.165	1734.420
26	1	Sarabhai(Bessel A)	24.772	20.973	1735.766
27	2	Silberschlag A	6.928	13.193	1737.219
28	2	Horrocks M	-4.066	7.595	1737.936
29	2	Abulfeda Q	-12.853	12.209	1738.125
30	2	Argelanger D	-17.635	4.427	1737.920
31	2	Alpetragius H	-18.011	-6.103	1735.867
32	2	Opelt K	-13.617	-17.104	1735.761
33	1	Eppinger(Euclides D)	-9.395	-25.800	1735.908
34	2	Wichmann B	-7.137	-39.211	1735.673
35	2	Flamsteed D	-3.188	-44.934	1735.362
36	2	Damoiseau E	-5.228	-58.427	1735.012
37	2	Zupus A	-17.226	-53.549	1736.595
38	2	de Gasparis B	-27.052	-52.631	1737.200
39	2	Doppelmayer J	-24.528	-41.189	1735.298
40	2	Ramsden A	-33.482	-31.410	1737.276
41	2	Lehmann H	-41.006	-58.717	1737.250
42	2	Schiller A	-47.181	-37.627	1736.734
43	2	Longomontanus R	-52.417	-26.277	1737.408
44	2	Lippershey T	-25.306	-11.144	1735.379
45	2	Aliacenis D	-33.175	6.825	1737.527
46	2	Cuvier C	-49.987	11.762	1737.745
47	2	Nicolai A	-42.463	23.608	1737.666
48	2	Janssen K	-46.183	42.309	1735.333
49	2	Rheita P	-37.953	44.468	1738.074
50	2	Cook B	-17.317	51.686	1736.810
51	1	Messier A	-2.033	46.960	1735.847
52	1	Farenheit(Picard X)	13.116	61.700	1733.730

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
53	2	Tralles B	27.256	50.666	1736.659
54	1	Lucian(Maraldi B)	14.343	36.779	1736.620
55	1	Wallach(Maskelyne H)	4.889	32.264	1736.584
56	2	Moltke	-0.591	24.155	1736.162
57	2	White Spot in Daguerre	-11.777	33.105	1734.912
58	2	Beaumont G	-20.370	27.121	1737.612
59	2	Sacrobosco C	-22.998	15.815	1736.941
60	2	Rothmann K	-28.854	24.349	1738.689
61	2	Blagg	1.215	1.448	1737.027
62	2	Rhaeticus A	1.722	5.164	1737.504
63	2	Rhaeticus B	1.603	6.784	1738.822
64	2	Godin A	2.678	9.637	1737.611
65	2	Triesnecker D	3.477	5.928	1737.857
66	2	Triesnecker J	3.258	2.434	1737.078
67	2	Chladni	3.989	1.097	1737.595
68	2	Hyginus B	7.600	5.049	1737.160
69	2	Hyginus C	7.684	8.306	1736.348
70	2	Ukert Y	10.120	0.318	1737.035
71	2	Hyginus D	11.398	4.317	1736.328
72	2	White Spot in Mare Vaporum	14.074	3.268	1736.164
73	1	Conon W	18.720	3.079	1737.019
74	1	Manilius H	17.797	8.631	1736.212
75	1	Sulpicius Gallus G	19.788	6.311	1736.638
76	2	Sulpicius Gallus A	22.085	8.942	1735.726
77	1	Aratus C	24.081	9.460	1734.851
78	1	Aratus D	24.379	8.613	1734.814
79	1	Joy(Hadley A)	25.011	6.568	1736.938
80	2	N of Conon	22.614	2.283	1739.257
81	2	W of Hadley C (Peak)	25.473	1.676	1735.534
82	2	S of Autolycus α	29.242	1.049	1735.361
83	2	Point Fresnel ϕ	28.606	6.991	1735.446
84	2	N of Point Fresnel ϕ	30.064	7.141	1734.397
85	2	Autolycus K	31.222	5.430	1734.551
86	2	N of Montes Caucasus V	33.034	7.518	1734.990
87	2	Aristillus A	33.649	4.540	1734.782
88	2	Cassini A	40.512	4.759	1736.065
89	2	Cassini M	41.369	3.749	1735.229
90	2	Cassini C	41.736	7.783	1735.799
91	2	Cassini L	44.014	4.410	1734.640
92	2	Trouvelot	49.357	5.792	1734.815
93	2	Egede B	50.587	8.908	1734.562
94	2	Protagoras B	56.447	5.702	1734.719
95	2	Archytas W	61.328	5.230	1734.850
96	2	W. Bond G	63.072	6.902	1735.494
97	2	W. Bond B	65.086	7.582	1735.746
98	2	S of Archytas U	61.633	9.131	1736.124
99	2	Theon Senior B	0.168	14.090	1737.921
100	2	Schmidt	0.949	18.737	1738.120
101	2	E of Godin E	1.558	11.847	1737.609
102	2	Cayley	3.940	15.071	1738.023
103	2	Ariadaeus D	4.908	17.043	1735.948
104	2	Silberschlag	6.198	12.510	1737.993

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
105	2	Julius Caesar C	7.309	15.319	1737.000
106	2	Sosigenes C	7.218	18.957	1736.264
107	2	Sosigenes	8.700	17.572	1737.143
108	2	Boscovich A	9.466	12.617	1736.889
109	1	Ross C	11.610	18.935	1736.090
110	2	SW of Menelaus D	13.043	15.845	1738.219
111	2	Julius Caesar PA	11.118	14.392	1737.261
112	2	Tacquet	16.640	19.188	1734.597
113	2	Menelaus A	17.076	13.382	1735.357
114	2	White Spot NW of Manilius Z	16.920	10.701	1737.220
115	1	Bobillier(Bessel E)	19.629	15.431	1734.703
116	2	Bessel G	21.144	14.716	1735.187
117	2	Bessel	21.732	17.917	1734.630
118	1	Banting(Linne E)	26.577	16.426	1735.026
119	2	Artaus CC	23.034	12.934	1734.194
120	1	Bessel D	27.342	19.851	1734.923
121	2	Linne D	28.745	17.100	1734.385
122	2	Linne A	28.987	14.364	1734.760
123	1	Linne	27.744	11.794	1734.846
124	2	Linneβ	30.437	10.754	1735.210
125	2	Posidonius W	31.647	20.115	1735.032
126	2	Linne F	32.333	13.938	1734.992
127	2	Linne H	33.779	13.776	1734.023
128	2	Linne G	35.907	13.308	1734.599
129	2	Calippus B	36.090	10.098	1735.736
130	2	Calippus E	38.946	11.890	1737.820
131	2	Alexander B	40.282	15.168	1735.659
132	2	S of Eudoxus	42.360	16.335	1736.344
133	2	Eudoxus D	43.343	13.226	1736.470
134	2	Eudoxus G	45.412	18.778	1735.652
135	2	Egede F	52.031	12.556	1733.978
136	2	Egede C	50.213	12.985	1735.212
137	2	N of Egede A	53.923	11.270	1734.582
138	2	Sheepshanks C	57.030	18.108	1735.194
139	2	Sheepshanks A	60.001	18.995	1735.537
140	2	C. Mayer F	62.120	19.701	1735.291
141	2	E of Meton W	67.204	19.354	1736.360
142	2	Inside Meton C	70.177	21.042	1736.209
143	2	Arago B	3.435	20.797	1735.292
144	2	Arago CA	3.086	22.730	1735.513
145	2	Maskelyne G	2.293	26.685	1735.095
146	2	Maskelyne B	1.974	28.938	1735.399
147	2	Maskelyne MA	6.462	26.959	1736.361
148	1	Maskelyne N	5.355	30.363	1736.272
149	2	Arago D	6.910	22.389	1735.323
150	1	Arago E	8.510	22.695	1735.549
151	1	Jansen G	9.305	26.018	1735.664
152	2	Carrel(Jansen B)	10.667	26.676	1736.084
153	2	Maskelyne K	3.229	29.687	1735.787
154	2	Ross G	10.687	24.858	1735.413
155	1	Jansen K	11.500	29.661	1736.541
156	1	Jansen E	14.465	27.833	1735.964

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
157	2	Plinius A	12.983	24.144	1736.002
158	2	Ross H	10.250	21.805	1734.739
159	2	Tacquet C	13.465	21.069	1735.544
160	2	Al-Bakri(Tacquet A)	14.323	20.217	1736.846
161	2	Plinus β	15.335	23.595	1734.714
162	1	Jansen D	15.718	28.444	1735.555
163	2	Beketov(Jansen C)	16.231	29.171	* 1735.591
164	2	Fabbroni(Vitruvius E)	18.646	29.264	1735.295
165	1	Clerke(Littrow B)	21.679	29.787	1735.230
166	1	Borel(LeMonnier C)	22.374	26.421	1734.625
167	2	SE of Deseilligny	19.691	22.515	1734.291
168	1	Deseilligny	21.135	20.590	1734.907
169	1	LeMonnier LA	23.242	29.133	1734.807
170	1	Very(LeMonnier B)	25.626	25.348	1734.888
171	2	Posidonius N	29.709	21.037	1734.617
172	2	Posidonius γ	30.032	24.892	1735.183
173	2	Posidonius F	32.805	27.106	1735.447
174	2	Luther	33.215	24.152	1734.758
175	2	Luther H	36.031	22.780	1735.971
176	2	W of Plana G	38.126	20.578	1735.829
177	2	Plana F	39.827	24.001	1735.790
178	2	Burg B	42.722	23.503	1735.783
179	2	Eudoxus A	45.832	20.101	1736.426
180	2	Daniell D	37.058	25.868	1735.133
181	2	S of Mason B	39.490	29.686	1735.225
182	2	Mason B	41.817	29.638	1736.792
183	2	NE of Burg	46.877	30.970	1735.418
184	2	Galle A	53.994	22.300	1734.731
185	2	Aristoteles N	52.901	26.844	1735.055
186	2	Aristoteles M	53.505	27.276	1734.925
187	2	Galle C	57.798	24.522	1735.440
188	2	Kane G	59.231	25.354	1735.990
189	2	Moigno A	64.790	29.751	1737.229
190	2	Moigno C	66.020	29.233	1735.834
191	2	Neison A	67.416	26.911	1736.316
192	2	Maskelyne T	-0.044	36.592	1737.286
193	1	SE of Maskelyne F	3.412	36.941	1736.727
194	2	NE of Maskelyne D	3.493	33.070	1737.380
195	1	Sinas K	6.819	33.078	1736.762
196	2	Cauchy M	7.621	35.040	1736.722
197	1	Sinas	8.859	31.593	1736.664
198	1	Sinas J	10.313	33.700	1736.688
199	2	E of Cauchy F	9.479	37.303	1737.594
200	2	S of Cauchy C	7.540	38.543	1736.975
201	2	Jansen L	14.686	30.073	* 1736.012
202	2	Vitruvius G	13.887	34.592	1736.657
203	1	Lyell B	14.354	38.460	1736.183
204	2	Lyell C	15.136	39.382	1736.698
205	2	Maraldi A	20.000	36.277	1736.627
206	2	Romer J	22.375	37.942	1736.119
207	1	Brewster(Romer L)	23.267	34.691	1736.445
208	2	Littrow D	23.672	32.788	1736.667

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
209	1	Romer M	25.300	34.620	1736.258
210	2	Romer Y	25.764	36.327	1733.787
211	2	Romer C	27.632	37.031	1736.789
212	2	LeMonnier K	27.752	30.252	1735.947
213	2	Chacornac A	29.818	31.564	1736.193
214	2	G. Bond A	31.580	36.856	1737.849
215	2	Hall J	35.460	36.882	1736.347
216	2	Hall K	35.553	34.238	1735.781
217	2	Posidonius M	34.340	29.988	1735.778
218	2	Daniell X	36.592	31.806	1735.505
219	2	Maury	37.102	39.676	1738.226
220	2	Maury D	38.247	37.755	1736.555
221	2	SE of Grove	38.696	33.989	1736.122
222	2	Mason C	42.895	33.875	1735.733
223	2	Hercules C	42.730	35.348	1736.267
224	2	Williams N	42.097	36.402	1736.407
225	2	Hercules J	44.109	36.420	1736.079
226	2	Hercules D	44.766	39.691	1736.897
227	2	Hercules G	46.445	39.254	1734.625
228	2	Hercules E	45.783	38.778	1735.596
229	2	Burg A	46.862	33.062	1736.015
230	2	Baily B	51.000	35.207	1735.055
231	2	Thales W	58.545	39.888	1736.452
232	2	Gartner D	58.537	34.082	1734.785
233	2	Democritus A	61.603	32.501	1736.117
234	2	Arnold G	67.387	31.560	1736.769
235	2	Democritus D	62.895	31.177	1737.215
236	2	Arnold F	67.544	35.276	1735.674
237	2	W of Arnold M	68.161	41.545	1736.969
238	2	Taruntius H	0.324	49.860	1735.972
239	1	Anville(Taruntius G)	1.846	49.519	1735.371
240	2	Taruntius B	3.298	46.683	1734.921
241	2	SE of Secchi	1.698	44.340	1736.157
242	1	Secchi B	3.661	41.510	1736.496
243	1	Zahringer(Taruntius E)	5.494	40.203	1736.843
244	2	Taruntius MB	7.624	42.940	1736.390
245	2	Cameron(Taruntius C)	6.192	45.963	1735.742
246	1	Asada(Taruntius A)	7.248	49.895	1735.782
247	1	Glaisher	13.177	49.335	1738.049
248	2	Crile(Proclus F)	14.213	45.995	1736.572
249	2	SE of Proclus C	11.792	44.483	1736.365
250	1	Proclus A	13.330	42.233	1737.168
251	2	SE of Proclus E	16.092	41.377	1737.471
252	2	Fredholm(Macrobius D)	18.369	46.556	1736.946
253	1	Hill(Macrobius B)	20.909	40.809	1737.373
254	2	Macrobius Y	23.579	42.128	1737.405
255	1	Macrobius F	22.452	48.520	1736.014
256	2	Tralles A	27.433	47.023	1737.104
257	2	Macrobius V	25.400	43.303	1735.986
258	2	Geminus G	30.807	48.593	1736.075
259	2	Berzelius F	32.825	46.020	1736.711
260	2	Geminus W	34.260	47.415	1736.393

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
261	2	Maury B	35.106	42.036	1736.936
262	2	Franklin H	37.120	43.763	1735.624
263	2	Maury J	39.027	40.090	1737.253
264	2	E of Williams	42.757	40.249	1736.390
265	2	Oersted U	42.404	44.733	1735.741
266	2	NE of Cepheus A	41.790	49.135	1735.745
267	2	Atlas AA	45.486	48.593	1735.501
268	2	Atlas X	45.112	45.113	1736.959
269	2	Inside Atlas	47.379	43.979	1735.334
270	2	Inside Atlas E	48.642	43.692	1736.255
271	2	Hercules H	51.305	41.030	1735.797
272	2	NE of Bailey B	53.845	38.290	1735.090
273	2	NE of Keldysh(Hercules A)	52.428	45.221	1736.116
274	2	Schwabe G	65.470	42.074	1736.526
275	2	Thales G	61.747	45.698	1735.900
276	1	Taruntius O	2.226	54.323	1734.977
277	2	Taruntius K	0.645	51.558	1735.670
278	1	Ameghino(Apollonius C)	3.306	57.040	1735.466
279	2	Abbot(Apollonius K)	5.559	54.772	* 1735.655
280	2	NW of Taruntius X	8.085	52.601	1735.401
281	2	S of Picard Y	10.790	59.075	1734.262
282	1	S of Picard	11.762	55.667	1733.859
283	2	N of Greaves(Lick D)	13.769	52.375	1734.084
284	1	Curtis(Picard Z)	14.571	56.789	1734.006
285	2	Yerkes E	15.881	50.683	1734.472
286	1	Swift(Pierce B)	19.355	53.439	1734.242
287	2	W of Tisserand B	20.328	49.981	1737.653
288	1	Cleomedes FA	22.435	57.634	1733.955
289	2	Cleomedes GA	23.791	57.857	1736.501
290	1	Cleomedes P	24.709	56.271	1737.721
291	2	Cleomedes N	24.722	52.550	1735.126
292	2	Cleomedes B	27.131	55.864	1735.326
293	2	Cleomedes J	26.869	56.950	1734.889
294	2	Cleomedes S	29.460	58.941	1737.793
295	2	Geminus C	33.875	58.702	1737.524
296	2	Berzelius W	38.140	53.131	1735.782
297	2	Hooke D	40.690	55.841	1736.783
298	2	Shuckburgh C	43.538	52.721	1736.181
299	2	Shuckburgh E	44.033	56.998	1736.683
300	2	Chevallier F	46.210	56.657	1735.678
301	2	Endymion K	51.157	52.197	1736.767
302	2	Endymion G	56.410	55.665	1736.851
303	2	W of Atlas D	50.046	47.860	1736.018
304	2	de la Rue J	59.011	53.013	1735.911
305	2	Thales	61.788	50.462	1736.452
306	1	Inside Maclaurin O	-0.284	67.811	1735.694
307	2	Webb E	0.951	61.059	1735.915
308	1	NW of Dubiago R	2.797	65.361	1735.703
309	2	Dubiago Y	4.259	68.237	* 1736.930
310	1	Firmicus F	6.527	61.751	1736.799
311	2	E of Firmicus	7.749	64.830	* 1735.230
312	2	Condorcet E	11.369	68.177	* 1735.517

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
313	2	Firmicus H	7.481	60.261	1736.207
314	2	Picard Y	13.172	60.249	1734.527
315	2	NE of Curtis(Picard Z)	17.174	60.088	1734.159
316	2	SW of Eimmart KA	17.124	64.064	1734.424
317	1	Eimmart KA	19.184	67.284	1733.993
318	2	Eimmart F	23.266	62.065	1735.910
319	2	Eimmart G	25.526	64.835	1736.517
320	2	Eimmart D	22.940	69.272	1735.914
321	2	Hahn A	29.650	69.759	1737.607
322	2	Cleomedes DG	30.731	63.747	1735.719
323	2	Berosus A	33.137	68.112	1737.966
324	2	Bernoulli D	35.788	66.535	1736.525
325	2	Messala B	37.300	59.970	1736.992
326	2	Messala C	40.993	65.866	1736.781
327	2	Zeno P	43.412	66.140	1736.546
328	2	Mercurius L	45.877	64.300	1737.537
329	2	Mercurius H	49.174	63.494	1736.930
330	2	Endymion E	53.580	66.479	1736.181
331	2	Liouville(Dubiago S)	2.741	73.650	1737.094
332	2	Dubiago X	6.529	73.017	1738.291
333	1	Condorcet M	9.072	73.125	1738.081
334	2	Hansen A	13.354	74.657	1737.648
335	2	NE of Alhazen	17.555	73.418	1739.151
336	2	Plutarch C	23.158	70.981	1737.547
337	2	Plutarch L	25.874	71.671	1736.561
338	2	NW of Bruce	2.199	-0.980	1737.240
339	2	Pallas D	2.358	-2.642	1737.237
340	2	E of Schroter	3.750	-4.869	1737.723
341	2	Schroter L	1.758	-7.437	1737.680
342	2	S of Schroter S	5.629	-8.715	1738.094
343	2	Bode G	6.342	-3.579	1737.539
344	2	Bode A	8.987	-1.195	1738.116
345	2	Bode B	8.730	-3.101	1737.468
346	2	Schroter J	8.490	-6.130	1738.088
347	2	Bode H	12.211	-6.539	1736.538
348	2	Marco Polo C	14.012	-5.024	1737.090
349	2	Marco Polo A	14.892	-1.969	1736.581
350	1	Marco Polo B	17.175	-1.872	1738.056
351	2	Marco Polo F	15.734	-4.541	1737.964
352	2	Wolff A	15.778	-7.742	1736.759
353	2	Eratosthenes K	12.672	-9.329	1737.083
354	1	Wallace A	19.176	-5.595	1735.536
355	2	Huygens A	19.805	-1.924	1737.643
356	1	Archimedes L	25.040	-2.615	1736.036
357	1	Macmillan(Archimedes F)	24.190	-7.849	1735.640
358	1	Feuillee	27.383	-9.447	1735.119
359	2	Archimedes X	31.017	-8.026	1735.427
360	1	Bancroft(Archimedes A)	28.058	-6.436	1735.642
361	2	Archimedes T	30.291	-5.038	1734.715
362	2	Archimedes Q	28.509	-2.435	1735.074
363	2	E of Spurr(Archimedes K)	27.824	-0.374	1735.669
364	2	Archimedes C	31.619	-1.540	1735.528

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
365	2	Archimedes D	32.182	-2.708	1735.655
366	2	Archimedes V	32.983	-4.022	1734.449
367	2	Spitzbergen C	32.877	-8.817	1735.292
368	2	Aristillus B	34.805	-1.927	1734.432
369	2	Kirch E	36.515	-6.948	1734.705
370	2	Kirch M	39.605	-9.962	1734.905
371	2	Kirch	39.277	-5.628	1734.972
372	2	Piazzi Smyth B	40.508	-3.372	1735.639
373	2	S of Promontorium Devile	43.486	-0.435	1734.884
374	2	Pico K	44.680	-7.553	1734.763
375	2	Picoβ	43.396	-7.913	1735.830
376	2	Pico C	47.254	-6.655	1734.688
377	2	Plato KA	46.805	-3.610	1734.566
378	2	Plato U	49.604	-7.391	1735.158
379	2	Inside Plato	51.624	-9.080	1734.486
380	2	Alpes A	51.378	-0.273	1735.281
381	2	Plato H	55.179	-2.017	1735.010
382	2	Plato VA	56.983	-9.009	1735.138
383	2	SW of Timaeus	59.957	-6.774	1734.407
384	2	Epigenes A	67.039	-0.344	1736.761
385	2	N of Timaeus	64.202	-0.629	1735.273
386	2	Epigenes F	67.105	-8.066	1736.302
387	2	Goldschmidt D	75.451	-7.669	1737.495
388	2	Gambart A	0.957	-18.773	1736.893
389	2	Gambart L	3.264	-15.293	1736.886
390	2	Gambart C	3.312	-11.830	1736.593
391	2	Copernicus H	6.883	-18.297	1736.897
392	2	Schroter M	6.921	-11.679	1736.535
393	2	SW of Stadius K	9.419	-13.903	1737.590
394	2	Stadius B	11.821	-13.630	1736.708
395	2	SW of Copernicus K	11.875	-17.716	1737.382
396	2	Gay Lussac F	14.013	-19.648	1736.692
397	2	Eratosthenes D	17.430	-10.917	1735.552
398	2	Pytheas H	20.481	-16.525	1735.845
399	2	Timocharis E	24.634	-17.159	* 1735.414
400	1	Heinrich(Timocharis A)	24.837	-15.377	1735.446
401	1	Timocharis C	24.805	-14.216	1735.344
402	1	Timocharis B	27.868	-12.190	1735.361
403	2	Lambertγ	26.473	-18.479	1736.850
404	2	NW of Lambertγ	27.428	-18.876	1735.379
405	2	Carlini D	32.972	-16.026	1735.527
406	2	Le Verrier U	37.246	-13.180	1735.060
407	2	Le Verrier A	38.169	-17.327	1735.376
408	2	Pico D	43.475	-11.305	1734.459
409	2	Le Verrier E	42.420	-17.008	1734.741
410	2	Laplace F	45.554	-19.858	1734.618
411	2	Pico B	46.509	-15.377	1735.156
412	2	Pico BA	46.875	-14.167	1734.879
413	2	Pico G	46.629	-10.430	1734.463
414	2	Plato E	49.793	-16.193	1734.104
415	2	Plato P	51.552	-15.227	1734.594
416	2	Plato T	54.628	-11.281	1734.937

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
417	2	Plato W	57.273	-17.824	1734.188
418	2	N of Fontenelle G	60.350	-18.613	1734.491
419	2	Fontenelle P	64.218	-17.225	1734.916
420	2	Lansberg X	1.194	-27.875	1736.497
421	2	Reinhold NA	1.939	-25.446	1737.002
422	2	Reinhold F	3.356	-21.449	1736.123
423	2	Reinhold A	4.143	-21.920	1737.426
424	2	Copernicus B	7.587	-22.267	1737.718
425	2	Tobias Mayer F	12.866	-28.924	1737.835
426	2	Tobias Mayer D	12.225	-26.813	1736.756
427	2	Tobias Mayer R	11.619	-26.388	1737.300
428	2	S of Gay Lussac H	12.793	-22.984	1738.080
429	2	Tobias Mayer A	15.254	-28.330	1737.784
430	2	N of Gay Lussac H	14.596	-23.401	1738.085
431	2	Tobias Mayer G	17.342	-27.177	1736.075
432	1	Euler L	21.391	-28.969	1736.327
433	1	Pytheas W	21.709	-23.717	1735.930
434	1	Pytheas A	20.461	-21.738	1736.005
435	1	Lambert A	26.452	-21.497	1735.629
436	1	Euler H	25.320	-28.580	1735.995
437	1	La Hire A	28.520	-23.464	1735.548
438	1	McDonald(Carlini B)	30.386	-20.885	1735.701
439	2	Carlini K	31.080	-23.728	1735.253
440	2	Carlini G	32.634	-25.052	1735.365
441	2	Carlini	33.760	-24.106	1734.861
442	2	Carlini C	35.098	-22.894	1735.124
443	2	Helicon B	37.953	-21.296	1735.147
444	2	Helicon E	40.490	-24.172	1734.780
445	2	Laplace A	43.743	-26.925	1734.897
446	2	W of Laplace A	43.589	-28.735	1734.824
447	2	Laplace D	47.251	-25.566	1735.704
448	2	W of Laplace F	45.428	-22.621	1734.226
449	2	Maupertuis A	50.691	-24.750	1735.080
450	2	Laplace L	51.744	-21.062	1734.776
451	2	La Condamine Q	52.666	-23.970	1735.136
452	2	La Condamine A	54.501	-30.246	1734.395
453	2	La Condamine O	55.228	-25.740	1733.978
454	2	La Condamine R	55.020	-21.326	1735.004
455	2	La Condamine S	57.328	-25.185	1734.995
456	2	La Condamine T	59.345	-29.771	1734.340
457	2	Fontenelle X	60.594	-27.871	1734.499
458	2	Fontenelle B	61.963	-22.955	1734.015
459	2	Fontenelle M	63.179	-28.862	1734.540
460	2	Fontenelle F	64.428	-28.212	1735.319
461	2	Anaximenes E	66.562	-31.492	1735.695
462	2	Encke C	0.656	-36.413	1736.727
463	2	Encke M	4.616	-35.828	1737.164
464	2	Hortensius A	4.358	-30.742	1737.096
465	2	Kepler A	7.134	-36.119	1737.091
466	2	Kepler F	8.283	-39.083	1736.528
467	2	Milichius A	9.253	-32.055	1737.103
468	2	Milichius	10.003	-30.220	1737.115

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
469	2	E of Kepler P	12.547	-33.081	1737.192
470	2	Bessarion V	15.063	-34.980	1735.971
471	2	W of Tobias Mayer B	15.595	-32.019	1737.225
472	2	Bessarion A	17.063	-39.821	1736.201
473	1	Brayley E	21.263	-39.817	1736.142
474	2	Brayley	20.901	-36.912	* 1736.205
475	1	Brayley F	21.081	-34.103	1736.253
476	1	Euler E	24.690	-34.063	1736.213
477	2	Brayley S	25.065	-36.751	1735.651
478	2	Artsimovich(Diophantus A)	27.616	-36.606	1735.851
479	1	Diophantus C	27.291	-34.748	1736.242
480	2	Diophantus	27.617	-34.294	1736.074
481	1	Diophantus B	29.073	-32.542	1735.853
482	2	Heis D	31.643	-31.111	1735.787
483	2	C. Herschel E	34.215	-34.693	1734.753
484	2	Gruithuisen B	35.646	-38.730	1735.686
485	2	Mairan H	39.313	-40.066	1735.247
486	2	C. Herschel C	37.234	-32.630	1734.686
487	2	W of Heraclides A	40.896	-36.113	1736.435
488	2	SE of Promontorium Heraclides	39.902	-32.523	1734.607
489	2	Heraclides E	43.014	-32.766	1734.391
490	2	SW of Laplace A	42.758	-30.580	1734.527
491	2	Sharp B	47.000	-45.344	1735.192
492	2	Sharp J	46.986	-38.069	1736.654
493	2	Bianchini G	46.684	-32.771	1734.615
494	2	Bouguer A	52.633	-33.923	1734.234
495	2	La Condamine D	53.508	-30.830	1735.619
496	2	La Condamine F	57.414	-31.052	1734.865
497	2	Horrebow C	56.991	-35.927	1734.788
498	2	J. Herschel N	60.154	-33.068	1734.720
499	2	Horrebow B	58.727	-42.890	1736.572
500	2	J. Herschel C	62.395	-40.168	1734.974
501	2	Encke E	0.341	-40.170	1736.859
502	2	Maestlin G	1.981	-42.167	1736.475
503	2	Suess FB	0.196	-45.646	1736.534
504	2	Reiner E	1.897	-49.657	1734.692
505	2	Suess	4.355	-47.719	1735.424
506	2	Maestlin H	4.632	-43.564	1736.095
507	2	Maestlin	4.889	-40.697	1736.543
508	2	SW of Kepler D	7.141	-42.510	1736.406
509	2	Marius W	9.401	-49.695	1736.315
510	2	Marius DA	10.532	-45.496	1735.681
511	2	Kepler C	10.018	-41.839	1735.867
512	2	Marius A	12.598	-46.036	1735.846
513	2	Bessarion G	14.897	-40.340	1736.087
514	2	Bessarion C	16.019	-42.590	1736.405
515	2	Marius B	16.341	-47.350	1735.011
516	2	Aristarchus S	19.291	-46.295	1734.733
517	1	Bessarion D	19.769	-41.735	1736.235
518	1	Aristarchus D	23.723	-42.882	1736.244
519	2	Vaisala(Aristarchus A)	25.904	-47.908	1736.048
520	1	Toscanelli(Aristarchus C)	27.930	-47.612	1736.035

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
521	1	Krieger C	27.724	-44.705	1735.920
522	1	Angstrom	29.896	-41.658	1735.912
523	2	Angstrom A	30.935	-41.180	1734.191
524	2	Angstrom B	31.751	-44.140	1735.564
525	1	Wollaston	30.601	-46.970	1735.639
526	2	Aristarchus P	29.265	-49.919	1735.363
527	2	Wollaston D	33.164	-48.774	1734.667
528	2	SE of Gruithuisen K	35.069	-41.183	1734.305
529	2	Mairan N	39.208	-45.610	1734.441
530	2	Mairan K	40.841	-41.101	1735.773
531	2	Mairan T	41.788	-48.327	1735.363
532	2	Louville B	44.044	-46.530	1735.037
533	2	Sharp D	44.849	-42.171	1734.914
534	2	Sharp W	50.237	-45.465	1733.944
535	2	Harpalus C	55.604	-45.243	1734.905
536	2	South B	57.544	-45.031	1735.215
537	2	Harpalus B	56.260	-43.756	1734.787
538	2	NW of Robinson	61.056	-49.009	1735.588
539	2	Hermann E	0.190	-51.997	1735.662
540	2	Hermann F	1.289	-55.591	1735.129
541	2	Reiner N	5.368	-57.584	1734.950
542	2	Reiner L	7.968	-54.645	1735.439
543	2	Marius K	9.395	-50.692	1735.766
544	2	Marius X	9.729	-54.968	1735.773
545	2	Marius E	12.135	-52.715	1736.046
546	2	Galilaei M	13.282	-56.915	1735.320
547	2	Marius L	15.877	-55.682	1735.317
548	2	Marius M	17.386	-55.024	1734.393
549	2	Marius P	17.898	-51.340	1734.801
550	2	W of Marius N	19.192	-57.154	* 1735.197
551	2	Herodotus B	22.574	-55.466	1734.727
552	2	NE of Shiaparelli	24.664	-57.872	1735.288
553	2	Herodotus L	26.125	-53.164	1735.851
554	1	Herodotus χ	27.505	-52.926	1737.073
555	2	Zinner(Schiaparelli B)	26.649	-58.864	1734.248
556	1	Golgi(Schiaparelli D)	27.772	-59.952	1735.258
557	2	Lichtenberg A	29.000	-60.155	1734.021
558	1	Humason(Lichtenberg G)	30.722	-56.660	1735.189
559	2	Wollaston V	30.901	-53.950	1735.162
560	2	Nielson(Wollaston C)	31.803	-51.738	1734.943
561	2	Rumker E	38.654	-57.103	1734.647
562	2	Mairan G	40.912	-50.821	1734.435
563	2	Rumker L	43.596	-57.324	1733.989
564	2	Louville K	46.808	-55.237	1734.209
565	2	Louville D	46.862	-52.152	1734.923
566	2	Harpalus E	52.798	-50.963	1734.961
567	2	Harpalus H	53.841	-53.418	1734.296
568	2	South A	57.296	-50.446	1734.448
569	2	Babbage C	59.186	-57.579	1735.778
570	2	Hevelius D	3.043	-60.947	1734.828
571	2	Hevelius A	2.850	-68.307	1734.514
572	2	Cavalerius F	8.110	-65.327	1735.879

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
573	2	Cavalerius C	5.857	-69.300	1735.519
574	2	Galilaei D	8.768	-62.653	1736.059
575	2	Galilaei A	11.699	-63.055	1734.789
576	2	Galilaei E	13.928	-61.967	1734.432
577	2	Galilaei G	12.667	-67.203	1734.870
578	2	Galilaei T	16.177	-61.447	* 1735.397
579	2	Seleucus A	22.049	-60.535	1733.973
580	2	Schiaparelli A	22.985	-62.115	1734.583
581	2	Briggs C	25.046	-66.991	1733.924
582	2	Schiaparelli C	25.847	-62.224	1734.287
583	2	Lichtenberg^{E}	32.113	-69.408	1735.224
584	2	Lichtenberg F	33.207	-65.450	1734.118
585	2	Lichtenberg B	33.275	-61.494	1734.474
586	2	Naumann	35.397	-62.011	1734.657
587	2	Naumann B	37.489	-60.689	1734.519
588	2	Harding H	40.768	-64.398	1734.687
589	2	Rumker T	42.544	-64.758	1733.922
590	2	Harding D	42.877	-67.636	1734.449
591	2	Markov F	50.143	-62.029	1734.342
592	2	Markov E	50.695	-60.179	1735.117
593	2	Riccioli H	1.121	-75.104	1736.480
594	2	Hedin K	2.971	-73.603	1736.554
595	2	Obers B	6.864	-74.397	1734.519
596	2	Cardanus C	11.192	-76.369	* 1734.646
597	2	Cardanus E	12.803	-70.786	* 1735.927
598	2	Krafft D	15.103	-73.365	1734.928
599	2	Krafft C	16.397	-72.450	1733.153
600	2	Inside Eddington	22.426	-71.942	1734.339
601	2	Struve C	22.890	-75.450	1734.999
602	2	Struve D	25.369	-73.884	1735.042
603	2	Repsold R	49.874	-72.478	1734.401
604	2	Dechen	46.155	-68.280	1734.045
605	2	Oppolzer A	-0.487	-0.352	1737.140
606	2	Reaumur X	-2.912	-0.661	1736.849
607	2	Flammarion A	-1.951	-2.511	1736.787
608	2	Herschel C	-5.007	-3.200	1738.879
609	2	Mosting C	-1.806	-8.112	1737.047
610	2	Lalande C	-5.600	-6.920	1737.803
611	2	Lalande A	-6.644	-9.821	1736.654
612	2	Mosting B	-2.735	-7.405	1736.663
613	2	Palisa P	-9.678	-7.379	* 1736.222
614	2	Ptolomaeus JA	-9.594	-5.071	1736.803
615	2	Ptolomaeus L	-8.850	-4.018	1737.580
616	2	Ammonius(Ptolomaeus A)	-8.526	-0.840	1737.267
617	2	Alphonsus G	-12.357	-3.408	1736.124
618	2	SE of Davy A	-12.637	-7.526	1736.446
619	2	Davy A	-12.236	-7.753	1736.375
620	2	Davy K	-10.201	-9.497	1735.719
621	2	Alpetragius B	-15.130	-6.885	1736.560
622	2	Alphonsus H	-15.616	-0.551	1738.644
623	2	Arzachel A	-18.059	-1.512	1735.359
624	2	Arzachel Y	-17.907	-4.414	1736.694

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
625	2	Lassell B	-16.215	-7.698	1736.746
626	2	Thebit D	-19.773	-8.272	1736.304
627	2	Birt	-22.362	-8.591	1736.203
628	2	Thebit E	-23.117	-4.656	1737.531
629	2	Purbach D	-22.885	-1.572	1738.501
630	2	Purbach T	-24.676	-0.908	1736.509
631	2	Purbach A	-26.147	-1.956	1737.367
632	2	Regiomontanus E	-28.246	-6.260	1737.757
633	2	Pitatus L	-29.095	-8.690	1736.819
634	2	Orontius D	-39.408	-6.186	1737.695
635	2	Maginus Y	-51.931	-9.150	1736.572
636	2	Cysatus A	-64.279	-0.813	1737.862
637	2	Turner	-1.392	-13.243	1736.920
638	2	Turner L	-3.446	-12.626	1736.523
639	2	Turner F	-1.624	-14.131	1737.964
640	2	Fra Mauro G	-2.210	-16.339	1736.773
641	2	Fra Mauro J	-2.627	-18.653	1736.458
642	2	Fra Mauro D	-4.819	-17.613	1737.025
643	2	Gambart N	-0.553	-14.948	1735.855
644	2	E. of Bonpland F	-7.457	-19.106	1736.688
645	2	Parry C	-6.867	-12.750	1735.762
646	1	Parry F	-7.654	-14.745	1736.105
647	2	Tolansky(Parry A)	-9.526	-15.986	1736.492
648	1	Bonpland D	-10.157	-18.265	1735.754
649	1	Guericke A	-11.154	-17.282	1735.738
650	1	Guericke D	-11.999	-14.623	1735.856
651	1	Guericke E	-10.022	-12.062	1736.058
652	1	Kundt(Guericke C)	-11.565	-11.565	1736.312
653	2	Lassell H	-14.538	-11.280	1735.347
654	2	Guericke P	-15.066	-14.713	1735.220
655	2	Guericke B	-14.580	-15.306	1736.797
656	2	Opelt E	-17.041	-17.906	1736.789
657	2	Gould A	-19.221	-17.047	1736.285
658	2	Lassell F	-17.149	-12.492	1735.190
659	2	Lassell E	-18.240	-10.232	1735.428
660	2	Nicollet B	-20.145	-13.574	1735.986
661	2	Birt B	-22.288	-10.265	1735.903
662	2	Nicollet	-21.957	-12.502	1735.455
663	2	Wolf A	-22.283	-18.486	1735.639
664	2	Wolf E	-23.959	-16.397	1734.661
665	2	Kies D	-24.939	-18.556	1735.563
666	2	Hesiodus B	-27.153	-17.534	1736.190
667	2	Pitatus J	-26.524	-13.576	1736.209
668	2	Lippershey R	-26.699	-10.181	1736.451
669	2	Pitatus XA	-28.454	-11.945	1737.569
670	2	Hesiodus A	-30.099	-17.048	1738.026
671	2	Weiss A	-30.613	-18.674	1737.640
672	2	Wurzelbauer M	-32.109	-16.046	1737.781
673	2	W of Gauricus N	-32.473	-13.329	1738.455
674	2	Gauricus D	-35.117	-11.453	1739.266
675	2	Wurzelbauer C	-34.998	-15.082	1738.654
676	2	Cichus K	-36.621	-20.034	1736.875

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
677	2	N of Heinsius A	-39.091	-18.118	1734.879
678	2	Heinsius A	-39.735	-17.590	1735.742
679	2	Heinsius G	-38.282	-14.597	1736.825
680	2	Sasserides B	-39.565	-11.235	1738.004
681	2	Street P	-45.688	-11.992	1738.994
682	2	Wilhelm E	-44.167	-17.996	1738.354
683	2	Tycho H	-45.282	-15.925	1737.178
684	2	Maginus H	-52.479	-10.084	1738.526
685	2	Clavius R	-53.223	-15.399	1738.267
686	2	Clavius MC	-54.847	-10.440	1738.354
687	2	Clavius Y	-57.994	-16.190	1735.254
688	2	Clavius J	-58.099	-18.101	1735.357
689	2	Rutherford A	-62.331	-12.121	1737.688
690	2	S of Deluc E	-61.182	-5.037	1738.089
691	2	NW of Gambart R	-0.623	-20.886	1736.853
692	2	Lansberg P	-2.365	-23.022	1737.010
693	2	Lansberg N	-1.915	-26.456	1736.188
694	2	Lansberg B	-2.497	-28.144	1736.367
695	2	Euclides K	-4.232	-24.722	1736.298
696	2	Fra Mauro B	-4.029	-21.702	1736.132
697	2	Fra Mauro A	-5.472	-20.963	1736.710
698	1	Kuiper(Bonpland E)	-9.772	-22.668	1735.736
699	1	Bonpland P	-10.933	-21.549	1735.653
700	2	Euclides	-7.408	-29.577	* 1735.679
701	1	Euclides M	-10.462	-28.226	1736.039
702	1	Darney E	-12.437	-25.427	1735.753
703	2	Darney	-14.608	-23.567	1736.010
704	2	Darney C	-14.152	-26.048	1735.400
705	2	Darney J	-14.354	-21.446	1736.470
706	2	Lubiniezky D	-16.521	-23.479	1736.170
707	2	Lubiniezky F	-18.336	-21.848	1736.183
708	2	Agatharchides G	-20.151	-26.810	1736.601
709	2	Agatharchides A	-23.286	-28.451	1736.107
710	2	Campanus K	-26.682	-28.391	1737.350
711	2	Kies C	-26.070	-26.150	1736.110
712	2	Bullialdus E	-21.742	-24.032	1735.568
713	2	N of Bullialdus A	-21.787	-21.716	1736.706
714	2	Kies E	-28.780	-22.847	1735.904
715	2	Mercator D	-29.325	-25.351	1737.128
716	2	Campanus B	-29.309	-29.223	1736.283
717	2	Marth	-31.127	-29.299	1737.554
718	2	Mercator H	-31.047	-26.054	1736.737
719	2	Cichus H	-32.778	-22.484	1737.583
720	2	Cichus C	-33.587	-21.886	1738.356
721	2	Capuanus F	-36.959	-26.694	1736.709
722	2	Capuanus H	-39.365	-27.246	1736.897
723	2	Haidinger A	-38.669	-24.645	1737.097
724	2	Heinsius J	-39.303	-20.450	1737.580
725	2	Wilhelm WA	-42.349	-20.433	1735.961
726	2	Wilhelm F	-42.340	-23.105	1739.130
727	2	Lagalla N	-44.995	-26.116	1736.700
728	2	Mee C	-45.270	-28.675	1737.660

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
729	2	Lagalla T	-47.390	-26.616	1737.102
730	2	Bayer P	-51.714	-29.641	1737.086
731	2	Longomontanus L	-49.074	-23.637	1735.216
732	2	Clavius F	-55.467	-22.084	1737.059
733	2	Scheiner H	-56.291	-27.365	1737.528
734	2	Scheiner A	-60.440	-28.233	1734.894
735	2	Blancanus K	-60.462	-23.427	1739.065
736	2	Scheiner G	-62.573	-28.334	1738.065
737	2	Casatus C	-72.215	-30.247	1735.445
738	2	Lansberg E	-1.844	-30.336	1737.089
739	2	Lansberg D	-3.016	-30.650	1736.439
740	2	N of Lansberg FC	-0.879	-33.939	1736.627
741	2	Wichmann CA	-2.701	-36.781	1735.854
742	2	Wichmann C	-4.674	-37.430	1735.816
743	2	Wichmann	-7.536	-38.099	1736.609
744	1	Wichmann A	-7.378	-36.921	1735.844
745	2	Euclides F	-6.374	-33.729	1735.800
746	1	N of Herigonius ω	-10.424	-34.493	1735.963
747	1	Euclides C	-13.300	-30.071	1736.127
748	2	Herigonius G	-15.269	-32.453	1736.587
749	2	Herigonius	-13.356	-33.969	1736.505
750	2	Herigonius E	-13.816	-35.628	1736.796
751	1	Letronne A	-12.149	-39.090	1736.268
752	2	Gassendi N	-18.061	-39.277	1736.320
753	2	Gassendi TA	-18.108	-35.775	1735.727
754	2	Agatharchides F	-20.233	-31.820	1736.835
755	2	Gassendi J	-21.629	-37.074	1735.894
756	2	Gassendi Y	-20.908	-38.481	1735.910
757	2	Puiseux F	-23.417	-38.882	1735.539
758	2	Puiseux A	-26.533	-39.804	1735.374
759	2	Puiseux D	-25.751	-36.196	1735.996
760	2	Hippalus A	-23.826	-32.822	1736.053
761	2	Hippalus B	-25.230	-30.385	1735.566
762	2	Dunthorne	-30.122	-31.694	1737.211
763	2	Vitello E	-29.168	-35.769	1736.611
764	2	Lee H	-31.083	-38.496	1737.938
765	2	Vitello L	-31.613	-35.294	1738.323
766	2	Hainzel X	-36.666	-36.867	1736.898
767	2	Ramsden G	-35.330	-31.637	1736.953
768	2	W of Hainzel R	-39.152	-37.141	1737.029
769	2	Hainzel K	-37.546	-32.302	1738.192
770	2	Epimenides A	-43.222	-30.116	1737.128
771	2	Mee X	-41.544	-35.906	1738.949
772	2	Mee F	-43.321	-36.762	1736.812
773	2	Mee Y	-44.451	-36.885	1736.110
774	2	Mee D	-45.338	-32.922	1739.233
775	2	Bayer L	-47.465	-33.607	1738.671
776	2	SE of Bayer Z	-49.508	-33.273	1737.285
777	2	SE of Schiller G	-51.821	-37.330	1736.821
778	2	Bayer X	-53.364	-33.722	1737.662
779	2	Rost N	-57.241	-33.118	1739.312
780	2	Weigel A	-58.717	-37.950	1735.391

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
781	2	Scheiner U	-60.919	-36.176	1738.531
782	2	Bettinus H	-64.584	-43.666	1738.404
783	2	Scheiner L	-65.850	-35.139	1736.804
784	2	Scheiner M	-65.754	-33.390	1737.086
785	2	Wilson F	-70.432	-39.345	1737.040
786	2	Flamsteed FB	-2.328	-40.669	1735.726
787	2	Flamsteed F	-4.731	-41.120	1736.944
788	2	Flamsteed K	-3.113	-43.705	1735.872
789	2	Flamsteed Z	-1.294	-47.837	1735.305
790	2	Flamsteed CA	-6.665	-49.310	1735.492
791	2	S of Flamsteed C	-6.898	-45.950	1735.371
792	1	Flamsteed A	-7.867	-42.994	1735.198
793	1	Letronne B	-11.272	-41.299	1736.053
794	2	Letronne F	-9.228	-46.099	1736.213
795	2	Billy K	-12.973	-48.843	1735.398
796	2	Billy D	-14.851	-48.340	1735.950
797	2	Billy A	-14.336	-46.293	1736.145
798	2	Gassendi G	-16.746	-44.629	1736.540
799	2	Gassendi F	-15.025	-44.989	1736.701
800	2	Mersenius S	-19.200	-46.985	1737.459
801	2	Mersenius C	-19.781	-45.985	1736.329
802	2	Gassendi L	-20.401	-41.792	1734.609
803	2	Mersenius E	-22.500	-46.073	1736.544
804	2	Doppelmayer L	-23.658	-40.601	1735.638
805	2	Liebig F	-24.662	-45.800	1735.530
806	2	Liebig BB	-26.864	-47.883	1736.925
807	2	Palmieri E	-29.262	-48.641	1737.282
808	2	Doppelmayer R	-29.259	-43.319	1735.634
809	2	Palmieri A	-32.270	-48.492	1736.886
810	2	Doppelmayer W	-33.587	-45.733	1737.813
811	2	Clausius G	-37.097	-40.973	1736.999
812	2	E of Clausius A	-36.315	-43.583	1737.282
813	2	Drebbel D	-37.949	-49.324	1737.437
814	2	S of Drebbel B	-39.543	-46.827	1737.677
815	2	Drebbel M	-41.269	-41.508	1737.700
816	2	Noggerath M	-44.032	-46.522	1738.319
817	2	Noggerath F	-48.032	-46.847	1738.433
818	2	Noggerath B	-47.023	-43.524	1737.960
819	2	Schiller M	-48.202	-41.208	1737.435
820	2	N of Phocylides KB	-51.195	-49.494	1736.212
821	2	Schiller E	-54.592	-48.804	1735.958
822	2	Schiller P	-53.573	-43.569	1736.425
823	2	Weigel C	-59.613	-42.090	1735.463
824	2	Kircher B	-65.044	-43.049	1738.576
825	2	Bailly G	-65.598	-59.301	1737.361
826	2	Hermann B	-0.338	-57.163	1736.073
827	2	Damoiseau GB	-3.217	-57.991	1735.116
828	2	Hermann D	-2.323	-54.113	1735.293
829	2	Flamsteed HA	-5.609	-52.269	1735.231
830	2	Damoiseau GA	-5.131	-55.889	1735.178
831	2	Damoiseau BA	-8.261	-59.139	* 1735.620
832	2	Sirsalis K	-10.385	-57.466	1735.014

Number	Set	Name	Latitude (degrees)	Longitude (degrees)		Radius (km)
833	2	Fontana K	-13.231	-57.454		1736.411
834	2	Hansteen A	-12.737	-52.215		1736.129
835	2	Fontana W	-17.244	-58.474		1735.502
836	2	de Vico K	-20.080	-58.358		1736.678
837	2	Zupus RA	-19.069	-51.394		1735.745
838	2	Cavendish L	-21.705	-53.694		1736.929
839	2	Cavendish B	-23.276	-55.168		1736.306
840	2	Paul Henry P	-25.708	-58.882		1740.405
841	2	Vieta C	-28.670	-58.517		1738.269
842	2	Fourier K	-30.035	-54.382		1737.205
843	2	W of Fourier D	-31.759	-51.629		1738.364
844	2	Lehmann C	-35.564	-50.125		1737.860
845	2	W of Fourier R	-33.928	-53.347		1738.343
846	2	N of Lacroix R	-33.204	-59.705		1737.144
847	2	Lacroix H	-38.650	-57.791		1737.280
848	2	Drebbel L	-40.278	-50.829		1738.109
849	2	S of Schickard N	-42.518	-54.203		1735.839
850	2	SE of Schickard R	-44.527	-52.950		1736.425
851	2	Nasmyth D	-49.223	-55.384		1738.511
852	2	Nasmyth F	-50.017	-53.580		1738.538
853	2	Phocylides X	-50.495	-50.726		1737.238
854	2	Phocylides D	-53.210	-51.759		1735.962
855	2	Lohrmann A	-0.733	-62.754		1735.352
856	2	Lohrmann BA	-1.336	-69.325	*	1737.208
857	2	Grimaldi C	-2.641	-61.644		1734.938
858	2	Damoiseau J	-4.042	-62.140		1735.582
859	2	Grimaldi G	-7.353	-65.052	*	1736.946
860	2	N of Rocca D	-10.708	-68.154		1737.130
861	2	Rocca AC	-12.714	-68.770		1736.628
862	2	Sirsalis F	-13.564	-60.153		1737.391
863	2	Cruger C	-16.869	-62.053		1736.597
864	2	Cruger G	-17.896	-68.101		1735.477
865	2	de Vico C	-20.624	-62.376		1738.652
866	2	de Vico E	-21.146	-61.481		1737.930
867	2	Byrgius A	-24.540	-63.783		1738.455
868	2	Byrgius V	-26.079	-67.904		1736.619
869	2	Lagrange H	-29.489	-66.344		1737.300
870	2	Lagrange X	-28.741	-69.364		1735.961
871	2	Vieta L	-29.497	-60.418		1739.498
872	2	Lagrange A	-32.517	-69.297		1736.479
873	2	Piazzi B	-37.495	-66.340		1736.781
874	2	Piazzi F	-35.707	-61.218		1736.284
875	2	Piazzi G	-40.202	-64.706		1737.300
876	2	Schickard H	-43.519	-62.433		1736.365
877	2	Inghirami T	-49.870	-67.956		1736.830
878	2	Wargentin C	-47.410	-61.389		1737.168
879	2	Inghirami W	-44.435	-67.501		1736.887
880	2	Riccioli G	-1.247	-71.222		1735.575
881	2	Grimaldi H	-4.874	-71.563	*	1736.623
882	2	Grimaldi T	-7.746	-71.148		1734.124
883	2	W of Rocca E	-11.866	-70.569		1737.409
884	2	Rocca J	-15.007	-74.065		1737.097

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
937	2	Theon Senior A	-0.197	15.383	1736.609
938	2	Theon Senior	-0.804	15.405	1737.534
939	2	SW Wall of Delambre	-2.687	16.892	1738.776
940	1	Taylor D	-5.327	15.692	1739.142
941	1	Alfraganus C	-6.137	18.081	1738.331
942	2	Dollond D	-8.190	12.482	1739.644
943	2	Andel D	-10.786	11.689	1737.958
944	2	Abulfeda R	-12.793	12.967	1737.834
945	1	Dollond	-10.478	14.417	1739.117
946	2	Dollond E	-10.251	15.682	1738.576
947	1	Kant P	-10.817	17.372	1738.185
948	2	Tacitus C	-13.679	19.772	1739.193
949	2	Tacitus N	-16.970	19.437	1738.920
950	2	Abulfeda BC	-13.787	15.790	1739.424
951	2	Abulfeda M	-16.221	12.050	1738.464
952	2	SE of Abulfeda X	-15.321	14.503	1739.229
953	2	Abulfeda A	-16.430	10.736	1738.283
954	2	Abulfeda E	-16.763	10.120	1737.805
955	2	Almanon F	-15.928	14.232	1738.115
956	2	Inside Almanon	-16.628	15.601	1736.809
957	2	Almanon L	-18.992	16.558	1738.701
958	2	Geber E	-20.542	12.940	1737.993
959	2	Azophi C	-21.815	13.049	1735.980
960	2	Abenezra B	-20.810	10.036	1738.713
961	2	Sacrobosco P	-20.936	17.421	1739.847
962	2	Sacrobosco W	-24.364	17.262	1737.041
963	2	Pontanus K	-25.748	12.629	1738.883
964	2	Pontanus F	-27.865	11.582	1738.273
965	2	Zagut F	-30.382	17.534	1736.885
966	2	Apianus L	-29.116	10.842	1737.629
967	2	Zagut P	-32.467	17.408	1736.881
968	2	White Spot S of Zagut P	-33.692	17.231	1738.047
969	2	Gemma Frisius M	-34.329	12.446	1735.068
970	2	Gemma Frisius K	-37.481	10.917	1737.594
971	2	Gemma Frisius EB	-36.938	13.281	1738.802
972	2	Busching E	-36.676	18.358	1739.069
973	2	Buch B	-37.898	16.940	1738.840
974	2	Maurolycus B	-40.456	11.709	1736.094
975	2	W Wall of Barocius C	-43.278	16.851	1736.794
976	2	N of Barocius B	-43.309	18.245	1737.795
977	2	Inside Barocius	-44.681	16.020	1734.291
978	2	Breislak A	-46.979	17.335	1737.965
979	2	Cuvier B	-51.665	13.816	1736.842
980	2	Jacobi B	-54.512	13.952	1736.711
981	2	Jacobi J	-58.026	10.509	1736.317
982	2	Kinau L	-59.275	18.760	1737.133
983	2	Pentland F	-62.124	11.343	1737.425
984	2	Pentland E	-68.090	13.366	1738.476
985	2	Schomberger Z	-73.529	27.302	1739.463
986	2	Hypatia E	-0.326	20.386	1737.532
987	2	Alfraganus D	-4.044	20.129	1737.221
988	2	Torricelli C	-2.718	25.965	1735.683

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
989	2	Torricelli B	-2.622	29.172	1734.929
990	2	S of Torricelli A	-5.187	29.620	1734.830
991	1	Zollner K	-6.528	20.818	1738.254
992	2	NE of Kant C	-8.308	23.246	1735.504
993	1	Kant X	-11.160	21.052	1736.878
994	1	Theophilus B	-10.572	25.272	1734.812
995	1	NW of Madler	-10.440	28.817	1735.193
996	2	Beaumont L	-14.449	30.026	1735.036
997	2	Inside Cyrillus	-14.265	24.871	1738.029
998	2	Cyrillus E	-15.902	25.314	1737.851
999	2	Cyrillus G	-15.653	26.604	1738.612
1000	2	Beaumont D	-17.079	26.159	1737.928
1001	2	Fermat E	-19.937	19.854	1740.130
1002	2	Beaumont J	-19.948	26.499	1737.363
1003	2	Polybius L	-22.008	28.238	1736.556
1004	2	Polybius A	-23.044	27.989	1737.672
1005	2	N Wall of Polybius	-21.882	25.712	1739.681
1006	2	W of Polybius F	-22.512	22.119	1737.955
1007	2	Pons F	-23.762	21.116	1740.674
1008	2	Polybius B	-25.552	25.502	1738.744
1009	2	Piccolomini K	-25.718	29.704	1737.525
1010	2	Pons B	-28.753	20.725	1739.465
1011	2	Zagut LA	-30.292	21.552	1740.694
1012	2	Zagut A	-32.029	21.617	1738.745
1013	2	Lindenau E	-31.680	26.487	1737.617
1014	2	Lindenau G	-33.268	27.289	1737.153
1015	2	Rabbi Levi L	-34.731	22.975	1737.771
1016	2	Zagut S	-33.377	22.637	1740.877
1017	2	Celsius H	-33.835	20.097	1738.190
1018	2	Busching A	-38.358	20.440	1736.525
1019	2	Rabbi Levi J	-37.565	23.143	1737.819
1020	2	Riccius M	-37.891	26.471	1737.279
1021	2	Nicolai D	-41.785	25.586	1737.473
1022	2	Pitiscus T	-47.121	27.912	1736.817
1023	2	Barocius EB	-46.686	21.636	1736.999
1024	2	Barocius EC	-48.205	22.513	1736.844
1025	2	Ideler C	-51.338	23.278	1735.467
1026	2	NW of Asclepi G	-52.793	23.741	1736.295
1027	2	Hommel K	-55.537	26.990	1737.076
1028	2	Mutus K	-57.862	21.537	1736.854
1029	2	Mutus P	-59.099	25.586	1737.159
1030	2	Hommel M	-59.870	27.506	1736.511
1031	2	Manzinus M	-63.525	22.759	1737.661
1032	2	SW of Censorinus	-0.774	32.165	1736.632
1033	2	Censorinus W	-1.016	37.457	1738.561
1034	2	NW of Leakey(Censorinus F)	-2.442	36.935	1737.202
1035	1	Lubbock G	-3.705	39.264	1735.455
1036	2	Lubbock L	-4.983	39.283	1735.878
1037	1	Capella D	-6.791	37.531	1736.100
1038	1	Isidorus D	-4.283	34.097	1736.784
1039	1	Isidorus U	-7.954	31.536	1735.204
1040	1	Isidorus A	-8.053	33.208	1735.304

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
1041	2	Capella J	-9.491	36.076	1735.825
1042	1	Gaudibert D	-10.611	36.335	1734.644
1043	2	Gaudibert J	-11.184	39.143	1735.569
1044	2	Daguerre K	-12.243	35.805	1734.329
1045	1	Daguerre B	-10.829	33.730	1734.873
1046	2	Daguerre X	-14.062	34.409	1736.474
1047	2	Daguerre Y	-13.925	35.345	1735.364
1048	2	Rosse	-17.957	35.001	1733.763
1049	2	N of Fracastorius S	-18.506	32.212	1735.347
1050	2	Inside Fracastorius	-20.437	33.989	1735.421
1051	2	SE Fracastorius B	-22.969	38.065	1739.063
1052	2	Weinek D	-26.009	36.529	1737.508
1053	2	Piccolomini L	-26.137	33.752	1737.526
1054	2	Inside Piccolomini	-29.734	31.512	1736.228
1055	2	Piccolomini P	-30.495	35.901	1738.434
1056	2	Neander A	-30.939	39.632	1737.107
1057	2	Neander V	-31.238	38.059	1740.401
1058	2	Neander X	-33.048	37.790	1738.958
1059	2	Neander Y	-34.605	38.180	1738.213
1060	2	Stiborius F	-35.771	32.458	1738.801
1061	2	Stiborius G	-37.369	35.786	1737.923
1062	2	Riccius R	-41.494	30.709	1736.339
1063	2	Brenner S	-38.441	36.221	1738.158
1064	2	W of Fabricius	-42.753	38.960	1736.187
1065	2	Lockyer HA	-45.061	32.244	1735.775
1066	2	W of Lockyer	-46.488	35.349	1736.961
1067	2	Vlacq K	-51.266	36.686	1736.895
1068	2	Pitiscus A	-50.366	30.951	1734.188
1069	2	Hommel HA	-52.080	30.636	1737.163
1070	2	Nearch J	-57.413	37.619	1737.310
1071	2	Hommel E	-59.068	31.064	1736.510
1072	2	Nearch E	-61.464	33.998	1738.375
1073	1	Secchi X	-0.769	43.660	1736.039
1074	1	Messier D	-3.589	46.319	1735.842
1075	1	NW of Ibn-Battuta(Goclenius A)	-6.180	49.557	1735.265
1076	1	E of Lubbock	-3.845	42.642	1735.677
1077	2	Gutenberg A	-9.025	39.942	1736.321
1078	2	E of Gutenberg E	-7.960	43.465	1736.230
1079	2	E of Goclenius	-10.507	47.877	1736.473
1080	2	Magelhaens β	-11.801	45.545	1737.275
1081	2	Bellot	-12.479	48.222	1736.514
1082	2	Bellot B	-13.550	47.719	1737.191
1083	2	McClure B	-15.469	49.335	1737.623
1084	2	Colombo K	-15.828	46.484	1734.733
1085	2	Bohnenberger J	-14.892	40.393	1734.825
1086	2	Bohnenberger G	-17.223	40.166	1734.720
1087	2	Cook G	-18.938	48.636	1737.312
1088	2	NW of Santbech E	-22.311	44.509	1737.365
1089	2	Santbech B	-24.722	41.561	1738.230
1090	2	Borda F	-26.198	47.938	1736.014
1091	2	Reichenbach H	-28.893	49.659	1737.218
1092	2	Reichenbach K	-28.885	42.396	1737.966

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
1093	2	Reichenbach G	-31.771	49.388	1736.927
1094	2	Neander H	-33.117	42.538	1736.111
1095	2	Rheita F	-35.421	48.502	1737.365
1096	2	Brenner E	-38.932	40.488	1736.614
1097	2	Metius C	-44.202	49.125	1736.441
1098	2	NW of Fabricius A	-44.293	43.308	1736.856
1099	2	Watt A	-50.353	46.459	1736.551
1100	2	Watt B	-50.264	48.301	1734.431
1101	2	Rosenberger H	-54.888	46.375	1738.419
1102	2	Rosenberger F	-56.064	40.606	1736.505
1103	2	Boussingault R	-64.360	48.651	1738.727
1104	2	W of Webb B	-1.267	55.774	1734.900
1105	2	Webb B	-0.844	58.421	1734.985
1106	2	Webb H	-2.144	59.551	1733.827
1107	2	Langrenus KA	-6.666	58.376	1734.824
1108	1	Langrenus FE	-5.886	54.003	1735.451
1109	2	Lindbergh(Messier G)	-5.408	52.903	1735.190
1110	2	Goclenius UA	-8.827	51.385	1735.389
1111	2	Al-Marrakushi(Langrenus D)	-10.439	55.839	1735.259
1112	2	W of McClure δ	-15.294	53.354	1736.770
1113	2	Vendelinus V	-15.905	55.334	1736.108
1114	1	Cook F	-17.620	55.347	1736.730
1115	2	Biot	-22.675	51.053	1737.574
1116	2	Snellius Y	-25.717	52.216	1737.363
1117	2	Snellius X	-27.502	54.894	1738.507
1118	2	Petavius C	-27.712	60.041	1737.191
1119	2	Furnerius A	-33.538	59.076	1738.506
1120	2	Fraunhofer G	-38.504	58.426	1737.461
1121	2	Rheita L	-37.715	53.131	1735.547
1122	2	Rheita H	-39.820	51.713	1736.380
1123	2	Reimarus H	-49.240	62.217	1736.664
1124	2	Mallet E	-45.067	54.396	1734.393
1125	2	Watt E	-49.649	55.111	1737.449
1126	2	Watt K	-51.508	56.022	1735.977
1127	2	Biela G	-56.343	54.172	1736.942
1128	2	Maclaurin MC	-3.392	69.554	* 1736.561
1129	2	Maclaurin EA	-3.263	65.088	* 1735.716
1130	2	Webb L	-0.463	62.797	1736.938
1131	1	Acosta(Langrenus C)	-5.646	60.137	1735.716
1132	2	Maclaurin D	-7.040	69.952	1735.690
1133	2	Langrenus R	-7.750	63.755	1736.838
1134	2	W of Maclaurin DB	-7.128	68.292	1737.037
1135	1	Langrenus M	-9.821	66.407	1736.584
1136	2	Vendelinus T	-13.490	62.865	1737.189
1137	2	Vendelinus H	-15.277	61.565	1734.361
1138	2	Lame W	-13.097	65.994	1736.393
1139	2	Lame M	-15.831	66.588	1736.630
1140	2	Holden V	-18.503	62.082	1736.996
1141	2	SE of Holden	-20.782	63.616	1737.408
1142	2	Phillips F	-25.129	68.899	1738.154
1143	2	Hase A	-28.983	62.952	1735.572
1144	2	Adams B	-31.515	65.769	1737.820

Number	Set	Name	Latitude (degrees)	Longitude (degrees)	Radius (km)
1145	2	Fraunhofer X	-39.685	60.555	1737.858
1146	2	Furnerius X	-33.696	62.497	1738.155
1147	2	Vega A	-47.235	65.265	1737.164
1148	2	La Perouse A	-9.224	74.662	1739.070
1149	2	N of Kapteyn	-9.192	70.760	1736.733
1150	2	Ansgarius C	-14.702	74.893	1737.751
1151	2	Behaim N	-16.086	73.611	1736.961
1152	2	W of Hecataeus	-20.648	75.008	1737.359
1153	2	Phillips A	-27.132	73.665	1736.812
1154	2	Legendre N	-27.466	70.477	1738.147
1155	2	Peirescius A	-45.220	71.300	1736.420
1156	2	Hagecius S	-59.077	55.060	1735.979
1157	3	Meton B	71.383	18.291	1736.369
1158	3	Bel'Kovich B	58.876	86.632	1735.739
1159	3		45.051	81.077	1736.000
1160	3		78.598	134.550	1736.898
1161	3	Dugan J	61.409	107.629	1736.000
1162	3		62.037	132.105	1737.194
1163	3		58.585	124.712	1736.086
1164	3		61.834	142.517	1736.734
1165	3		47.184	121.226	1736.000
1166	3		50.026	128.631	1736.629

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