APPENDIX No. 4—GEOGRAPHICAL POSITIONS—Continued.

Date.		Places of observation.	Distances measured by the viameter.		North latitudes.	West of Greenwich.		Authorities.
			Distance from camp to camp.	Total distance from Fort. Leavenworth.		In time.	In arc.	
1846.					Deg. min. sec.	h. min. sec.	Deg. min. sec.	
Nov.	21	Camp 105, on the Gila	26	1665	32 43 17	7 37 22.8	114 20 43	W. H. Emory.
	22	Camp 106, about one and a half mile south of the junction of the Gila and Colorado of the west	22	1687	32 42 09	7 38 23.6	114 37 09	do
	25	First camp after leaving the Rio Colorado	22	1709	32 40 22	7 39 45.8	114 56 28	do
	28	Camp 111, Cariso creek	77	1786	32 52 33	7 44 24.6	116 06 09	do
	29	Camp 112, Valle Citon	16	1802	32 58 15	7 45 22.7	116 20 40	do
Dec.	2	Camp 114, a few hundred yards south of Warner's rancheria	35	1837	33 16 57	7 46 34.8	116 38 43	do
	7	Camp 118, battle ground of the 7th	50	1887	33 03 42	7 48 14	117 03 29	do
		San Diego, (public square)	29	1916	32 45 00	7 48 44	117 11 00	Latitude by W. H. Emory. Longitude by Sir Ed. Belcher.

APPENDIX No. 5.

TABLE

OF

ASTRONOMICAL OBSERVATIONS.

APPENDIX No. 5.

ASTRONOMICAL OBSERVATIONS.

NOTE.—The lunar distances were reduced by Professor Hubbard, by Bessel's method, which is presumed to be the most accurate method known. The important changes made in the longitude of one or two leading positions, must, therefore, depend for authentication upon the observations themselves.

These observations have not, in all cases, been multiplied to the extent desired, owing to the nature of the service on which the undersigned was employed; but there is no reason on the face of them for doubting the results deduced.

W. H. EMORY.

June 21, 1846.—*Fort Leavenworth.*

DETERMINATION OF TIME.

Time, p. m.			Double altitudes of *a* Lyræ in the east.			Chronometer fast.		
h.	*m.*	*s.*	*Deg.*	*min.*	*sec.*	*h.*	*m.*	*s.*
4	01	46.5	102	00	20	6	53	14.9
4	04	52	103	09	35	6	53	14.8
4	06	15.2	103	40	30	6	53	15.4
4	07	30.0	104	08	20	6	53	15.7
4	08	27.1	104	29	35	6	53	16.0
4	09	56.7	105	02	30	6	53	17.6
4	11	18.5	105	33	30	6	53	16.6
4	12	46.2	106	07	20	6	53	14.1
4	13	57.3	106	53	35	6	53	15.0
4	15	59	107	18	40	6	53	16.7

Thermometer 60°.

APPENDIX No. 5—Continued.

June 21, 1846.—*Fort Leavenworth.*

DETERMINATION OF TIME.

Time, p. m.			Double altitude of Arcturus in the west.			Chronometer fast.			
h.	*m.*	*s.*	*Deg.*	*min.*	*sec.*	*h.*	*m.*	*s.*	
4	27	39.8	126	57	50	6	53	19.2	
4	29	18.0	126	08	10	6	53	17.4	
4	30	32.0	125	46	50	6	53	20.2	
4	32	30.2	125	10	20	6	53	18.5	
4	33	59.1	124	44	00	6	53	20.2	
4	35	31.5	124	14	40	6	53	17.0	
4	37	14.7	123	43	00	6	53	18.1	
4	38	52.8	123	12	05	6	53	17.2	
4	40	35.3	122	41	15	6	53	21.9	rej.
4	42	17.0	122	08	00	6	53	18.7	

Thermometer 60°.

	h.	*m.*	*s.*
Chronometer fast by 10 obs. of east star.....	6	55	15.68
Chronometer fast by 9 obs. of west star			18.50
Mean	6	53	17.09

DETERMINATION OF INDEX ERROR.

	m.	*s.*
Off the arc	31	50
On the arc.....	31	10

Index error = + 20″.

APPENDIX No. 5—Continued.

June 21, 1846.—*Fort Leavenworth.*

DETERMINATION OF LATITUDE.

Time, p. m.	Double altitudes of Polaris.	Latitude.
h. m. s.	*Deg. min. sec.*	*Deg. min. sec.*
4 59 03.0	76 36 40	39 21 29
5 01 02.2	76 37 55	39 21 34
5 03 28.6	76 38 55	39 21 22
5 05 13.5	76 40 50	39 21 24
5 06 50.3	76 41 05	39 21 28
5 08 22.5	76 41 45	39 21 23
5 09 50.8	76 42 30	39 21 10
5 11 12.2	76 43 50	39 21 27
5 12 29.6	76 44 35	39 21 36
5 13 55.0	76 45 20	39 21 33
5 15 18.8	76 46 20	39 21 39
5 16 44.7	76 47 10	39 21 36
5 18 15.0	76 48 20	39 21 45
5 19 41.8	76 48 40	39 21 28
5 21 23.5	76 49 50	39 21 32
5 23 06.0	76 51 10	39 21 41

Mean of 16 observations, 39° 21′ 30″.

APPENDIX No. 5—Continued.

June 21, 1846.—*Fort Leavenworth.*

DETERMINATION OF TIME.

Time, a. m.—June 22.	Double altitudes of sun's upper limb.	Time, p. m.—June 21.	Chronometer fast.
h. m. s.	*Deg. min.*	*h. m. s.*	*h. m. s.*
5 05 42.0	125 50	8 45 51.8	6 53 17.8
5 03 15.8	123 40	8 46 19.8	6 53 18.23
5 02 46.0	123 30	8 46 49.7	6 53 18.33
5 02 17.0	123 20	8 47 17.0	6 53 17.48
Lost.	123 10	8 47 46.0	
5 01 19.2	123 00	8 48 15.1	6 53 17.58
5 00 51.5	122 50	8 48 43.5	6 53 17.53
5 00 23.5	122 40	Lost.	
4 59 54.5	122 30	8 49 39.7	6 53 17.58
	122 20	8 50 08.5	
	122 10	8 50 36.2	
	122 00	8 51 06.0	
	NEW SERIES.		
3 47 37.5	95 40	10 01 57.5	6 53 17.96
3 47 11.5	95 30	10 02 24.0	6 53 18.21
3 46 44.2	95 20	10 02 50.2	6 53 17.66
3 46 18.5	95 10	10 03 15.5	6 53 17.46
3 45 52.5	95 00	10 03 41.5	6 53 17.46
3 45 26.8	94 50	10 04 08.3	6 53 18.01
3 45 11.0	94 40	10 04 34.1	6 53 18.01
3 44 34.0	94 30	10 05 00.0	6 53 17.46
3 44 08.5	94 20	10 05 26.2	6 53 17.81
3 41 57.5	93 30	10 07 38.2	6 53 18.31
3 41 32.5	93 20	10 08 03.0	6 53 18.21
3 41 15.3	93 10	10 08 28.0	6 53 17.11
3 40 39.5	93 00	10 08 55.2	6 53 17.81
3 40 14.2	92 50	10 09 21.0	6 53 18.06
Lost.	92 40	10 09 47.0	
3 39 21.5	92 30	10 10 11.9	6 53 17.06
Ther. 60°		Ther. 75°	

Mean of 22 observations, 6*h*. 53*m*. 17.76*s*.

APPENDIX No. 5—Continued.

June 22, 1846.—*Fort Leavenworth.*

DETERMINATION OF TIME.

Time, a. m.	Double altitudes of sun's upper limb.	Time, p. m.	Chronometer fast.
h. m. s.	*Deg. min.*	*h. m. s.*	*h. m. s.*
3 48 02.5	95 50	10 01 42.5	6 53 16.69
3 47 37.5	95 40	10 02 08.2	6 53 17.04
3 47 11.5	95 30	10 02 33.5	6 53 16.69
3 46 44.2	95 20	10 02 59.1	6 53 15.84
3 46 18.5	95 10	10 03 26.5	6 53 16.69
3 45 52.5	95 00	10 03 52.0	6 53 16.44
3 45 26.8	94 50	10 04 18.0	6 53 16.59
3 45 01.0	94 40	10 04 45.1	6 53 17.24
3 44 35.0	94 30	10 05 11.0	6 53 17.19
3 44 08.5	94 20	10 05 36.8	6 53 16.84
Lost.	94 10	10 06 2.3	
Lost.	94 00	10 06 28.5	
3 41 57.5	93 30	10 07 45.8	6 53 15.84
3 41 32.5	93 20	10 08 11.8	6 53 16.34
3 41 05.3	93 10	10 08 38.8	6 53 16.24
3 40 39.5	93 00	10 09 05.0	6 53 16.44
3 40 14.2	92 50	10 09 30.2	6 53 16.29
Ther. 68°		Ther. 74°	

Mean of 15 observations, 6*h.* 53*m.* 16.52*s.*

APPENDIX No. 5—Continued.

June 24, 1846.—*Fort Leavenworth.*

DETERMINATION OF TIME.

Time, p. m.	Double altitudes of Lyræ in the east.	Chronometer fast.
h. m. s.	*Deg. min. sec.*	*h. m. s.*
4 26 24.0	115 45 10	6 53 06.2
4 27 37.8	116 13 05	6 53 06.0
4 29 38.0	116 58 30	6 53 06.6
4 30 55.7	117 27 55	6 53 06.7
4 32 37.5	118 06 40	6 53 06.3
4 33 58.2	118 37 10	6 53 06.7
4 35 33.7	119 13 45	6 53 05.9
4 37 47.0	120 04 25	6 53 05.9
4 39 30.2	120 44 05	6 53 04.7

Thermometer 66°.

Time, p. m,	Double altitudes of Arcturus in the west.	Chronometer fast.
h. m. s.	*Deg. min. sec.*	*h. m. s.*
4 44 52.0	117 22 50	6 53 11.5
4 46 47.5	116 44 55	6 53 14.6 rej.
4 48 19.0	116 13 00	6 53 11.8
4 50 06.8	115 35 35	6 53 09.8
4 54 31.5	114 04 40	6 53 09.7
4 55 58.5	113 34 30	6 53 09.8
4 57 14.2	113 09 10	6 53 14.3 rej.
4 58 38.5	112 38 40	6 53 09.3
5 00 26.7	112 01 45	6 53 12.0
5 02 05.0	111 27 25	6 53 12.2

Barometer 39.52 Thermometer 64°.
34.57

	h.	*m.*	*s.*
Chronometer fast by 9 obs. of east star	6	53	06.58
Chronometer fast by 8 obs. of west star			10.76
Mean	6	53	08.67

APPENDIX No. 5—Continued.

June 25, 1846.—*Fort Leavenworth.*

DETERMINATION OF TIME.

Time, p. m.	Double altitudes of sun's upper limb.	Time, a. m.—June 26.	Chronometer fast.
h. m. s.	*Deg. min.*	*h. m. s.*	*h. m. s.*
10 08 34.5	93 20	3 42 24.5	6 53 07.09
10 09 00.0	93 10	3 41 59.5	6 53 07.35
10 10 44.2	92 30	3 40 15.0	6 53 07.31
10 11 10.2	92 20	3 39 48.5	6 53 06.71
10 11 36.5	92 10		
10 12 02.8	92 00	3 38 58.0	6 53 08.02
10 14 38.0	91 00	3 36 20.5	6 53 06.88
10 17 14.2	90 00	3 33 44.0	6 53 06.73
10 17 40.0	89 50		
Ther. 78°		Ther. 74°	

Barometer, 39.50.
34.48.

Mean of 7 observations, 6*h.* 53*m.* 07.16*s.*

June 26, 1846.—*Fort Leavenworth.*

DETERMINATION OF TIME.

Time, a. m.	Double altitudes of sun's upper limb.	Time, p. m.	Chronometer fast.
h. m. s.	*Deg. min.*	*h. m. s.*	*h. m. s.*
3 38 58.0	92 00	10 12 07.0	6 53 05.97
Lost.	92 10	10 11 41.2	
3 39 48.1	92 20	10 11 14.2	6 53 04.57
3 40 15.0	92 30	10 10 48.2	6 53 05.07
3 40 40.8	92 40	10 10 22.5	6 53 05.12
3 41 09.2	92 50	10 09 57.5	6 53 06.32
3 41 33.0	93 00	10 09 30.2	6 53 05.07
3 41 59.5	93 10	10 09 04.2	6 53 05.31
3 42 24.5	93 20	10 08 40.3	6 53 05.86
3 42 50.8	93 30	10 08 10.8	6 53 05.76
3 43 16.5	93 40	Lost.	
3 44 42.0	93 50	10 07 21.2	6 53 05.06
3 45 10.2	94 00	10 06 54.5	6 53 05.81
Ther. 74°		Ther. 80°	

Mean of 11 observations, 6*h.* 53*m.* 05.45*s.*

APPENDIX No. 5—Continued.

June 26, 1846.—*Fort Leavenworth, N. W. angle of square*

DETERMINATION OF LATITUDE.

Time, p. m.	Double altitudes of *a* Ophiuchi, near the meridian.	Latitude.
h. m. s.	*Deg. min. sec.*	*Deg. min. sec.*
4 29 57.5	94 36 40	39 21 12
4 31 35.8	94 39 20	39 21 00
4 33 00.0	94 40 30	39 21 12
4 34 14.0	94 41 50	39 21 07
4 35 47.9	94 42 50	39 21 11
4 37 20.0	94 43 40	39 21 08
4 38 51.2	94 44 10	39 21 06
4 40 19.7	94 44 15	39 21 05
4 42 05.0	94 43 25	39 21 20
4 43 35.5	94 42 30	39 21 27
4 45 03.8	94 41 50	39 21 18
4 46 19.0	94 40 40	39 21 18
4 48 10.0	94 38 25	39 21 27
4 49 25.2	94 37 10	39 21 15
4 50 39.8	94 34 30	39 21 38
4 52 01.2	94 32 15	39 21 35
4 53 35.8	94 29 10	39 21 37

Thermometer 64°.

Mean of 17 observations, 39° 21′ 17″.

APPENDIX No. 5—Continued.

June 26, 1846.—*Fort Leavenworth.*

DETERMINATION OF LATITUDE.

Time. p. m.	Double altitude of Polaris.	Latitude.
h. m. s.	*Deg. min. sec.*	*Deg. min. sec.*
4 58 46.5	76 47 45	39 21 21
5 00 03.2	76 48 40	39 21 24
5 01 37.2	76 49 50	39 21 30
5 02 50.8	76 50 20	39 21 23
5 03 59.0	76 51 20	39 21 31
5 05 07.2	76 52 10	39 21 35
5 06 12.1	76 53 05	39 21 42
5 07 55.2	76 53 40	39 21 29
5 09 20.0	76 54 50	39 21 38
5 10 27.1	76 55 35	39 21 39
5 11 19.8	76 56 05	39 21 37

Barometer, 39.42 inches.
" 34.41 "

Thermometer 64°.

Mean of 11 observations, 39° 21′ 32″.

APPENDIX No. 5—Continued.

[Without using horizon glass.]

June 26, 1846.—*Fort Leavenworth.*

DETERMINATION OF LATITUDE.

Time, p. m.	Double altitudes of *a* Ophiuchi, near the meridian.	Latitude.
h. m. s.	*Deg. min. sec.*	*Deg. min. sec.*
5 49 39.8	126 23 20	39 20 01
5 51 37.8	126 28 40	39 20 00
5 52 20.2	126 32 55	39 20 19
5 54 26.0	126 35 05	39 20 00
5 56 40.7	126 38 20	39 20 48
5 58 38.6	126 38 40	39 21 06
6 00 57.0	126 40 50	39 20 44
6 02 39.2	126 39 55	39 21 05
6 04 05.4	126 38 15	39 21 36
6 06 34.0	126 36 45	39 21 16
6 07 55.1	126 34 20	39 21 55
6 09 18.7	126 33 05	39 21 15
6 10 21.2	126 29 50	39 19 45
6 11 43.5	126 27 20	39 19 32
6 13 23.2	126 23 45	39 20 16

Thermometer 63 .

Barometer, 39.42.
34.41.

Mean of 15 observations, 39° 20′ 37″.

	Latitude of Fort. *Deg.*	*m.*	*s.*
Latitude by 16 observations of Polaris, June 21..	39	21	30
" 11 " Polaris, June 26..		21	32
" 17 " *a* Ophiuchi, June 26		21	17
" 15 " *a* Ophiuchi, June 26		20	37
Mean.....	39	21	14

APPENDIX No. 5—Continued.

June 26, 1846.—*Fort Leavenworth.*

DETERMINATION OF TIME.

Time, p. m.			Double altitudes of ——— in the east.		
h.	*m.*	*s.*	*Deg.*	*min.*	*sec.*
6	21	08.0	117	18	45
6	22	49.0	117	55	10
6	25	23.5	118	42	15
6	27	06.0	119	25	50
6	28	20.0	119	52	10
6	31	13.2	120	53	50
6	32	11.0	121	13	00
6	33	17.5	121	38	25
6	34	41.0	122	08	05

Barometer, 39.42.
34.41.

Thermometer 60°.

So much noise from the barracks, that I have no confidence in these observations.

APPENDIX No. 5—Continued.

June 27, 1846.—*Fort Leavenworth.*

DETERMINATION OF TIME.

Time, a. m.—June 21.			Double altitudes of sun's upper limb.		Time, p. m.—June 26.			Chronometer fast.			
h.	*m.*	*s.*	*Deg.*	*min.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	
3	39	19.0	92	00	10	12	07.0	6	52	06.09	
3	39	40.0	92	10	10	11	41.2	6	52	06.63	
3	40	04.8	92	20	10	11	14.2	6	52	05.63	
3	40	32.0	92	30	10	10	48.2	6	52	06.13	
3	40	57.2	92	40	10	10	22.5	6	52	05.88	
3	41	22.8	92	50	10	09	57.5	6	52	06.18	
3	41	47.7	93	00	10	09	30.2	6	52	04.98	rej.
3	42	16.0	93	10	10	09	04.2	6	52	06.15	
3	42	41.0	93	20	10	08	40.3	6	52	06.68	
3	43	07.8	93	30	10	08	13.8	6	52	06.83	
3	43	32.6	93	40	lost.						
3	44	00.0	93	50	10	07	21.2	6	52	06.63	
3	44	24.8	94	00	10	06	54.5	6	52	05.68	

Mean of 11 observations, 6*h*. 52*m*. 06.22*s*.