NO. 83 SURVEYOR I LOCATION*

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B y attempting to correlate the positions of summits of lunar hills, situated beyond the horizon of Surveyor I, with features given on the Aeronautical Chart and Information Center map of the area, Jaffe *et al.* (*1*) derive a location (Site I) situated well outside the 2 σ uncertainty ellipse based upon the tracking data. Furthermore, the correlation is only partial. By repeating the process with a suitable Earth-based photograph, I find that only one location of Surveyor is possible, well within the tracking-data ellipse.

Figure 1 depicts the NE portion of the large, incomplete ring Flamsteed P (*2*); it was made from two stacked negatives taken with my laboratory's NASA-sponsored 61-in. (153-cm) reflecting telescope at 0315 hours U.T., 2 April 1966. The lines of latitude and longitude were carefully transferred from (*3*). The radial lines represent the directions of horizon features *A–F* (*1*, Fig. 16), the azimuths having been adjusted for the computed inclination of the lunar surface from the plane perpendicular to the line of sight. The small dot indicates the location of Surveyor for optimum correlation between these lines and the various hills, while the ellipse represents the theoretical horizon as seen from Surveyor's camera. Table 1 gives the coordinates of the landing site derived from the preceding correlation and from the tracking data; the former is approximately 2.4 km south of the latter, well within the 2 σ uncertainty ellipse.

TABLE 1

SURVEYOR LANDING SITES

	SITE	
DERIVED FROM	SOUTH LATITUDE (deg)	WEST LONGITUDE (deg)
Photo correlation	2.57 ± 0.02	43.34 ± 0.02
Tracking data	2.49	43.32

In order to verify the correctness of the correlations, the heights of several hills in the group were obtained from shadow measurements made on a print similar to Figure 1 (Table 2). These values may be compared with those calculated from the angular dimensions given in (*1*, Table 2) and the assumed

TABLE 2

HEIGHTS (ABOVE THE PLAIN) OF HILLS FROM SHADOW MEASUREMENTS. FEATURE *B* CANNOT BE MEASURED BECAUSE SHADOW FALLS ON HILLS *D* AND *d*.

FEATURE	SHADOW LENGTH (km)	SOLAR ALTITUDE (deg)	HEIGHT (m)
A	.5.4	3.25	300
a	3.0	3.10	160
C	5.0	2.75	230*
D	7.5	2.65	330†
d	6.6	2.60	290†
F	4.5	3.00	230

*Underestimate, because end of shadow falls on hill *D*.
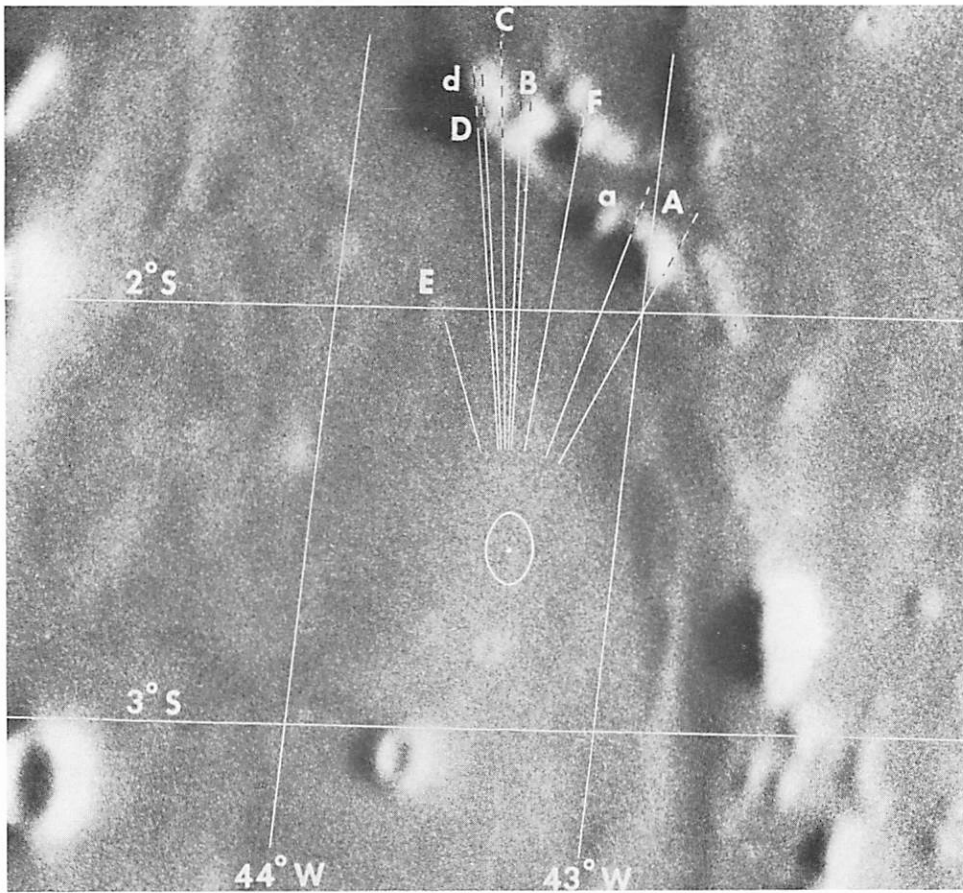†Overestimate, because end of shadow falls in large, somewhat depressed area.

Fig. 1. Northeast portion of Flamsteed P, showing Surveyor location derived from horizon features; $1° \approx 30$ km.

position of Surveyor (Table 3). The agreement is remarkably good in view of the uncertainties of the

TABLE 3

HEIGHTS OF HILLS FROM SURVEYOR DATA. FEATURE *d* IS INVISIBLE TO SURVEYOR.

FEATURE DISTANCE FROM SURVEYOR (km)	HEIGHT		
	SEEN ABOVE HORIZON (m)	BELOW HORIZON (CALC.) (m)	TOTAL (m)
A, 23.4	180	130	310
a, 24.8	$\leq$ 0	$\leq$ 150	$\leq$ 150
B, 31.3	130	240	370
C, 29.8	40	220	260
D, 30.9	80	230	310
F, 30.0	20	220	240

shadow measurements; differences do not exceed 10 m except where the shadows are cast on rising or falling terrain. Hill *d* appears larger than *D* in Figure 1, but *D* is higher since it casts a longer shadow and thus occults *d* in the Surveyor view. Feature *E* is not identified; the walls of the small crater situated at the location indicated are well below Surveyor's horizon, so this feature is presumably a small object situated relatively close by. The summit of *a* must be almost exactly at horizon level.

REFERENCES

1. L. D. Jaffe, *et al.* 1966, *Science,* **152**, 1737.
2. D. W. G. Arthur, *et al.* 1965, *Comm. LPL,* 3, 62.
3. D. W. G. Arthur and E. A. Whitaker 1961, *Orthographic Atlas of the Moon,* ed. G. P. Kuiper (Tucson: Univ. of Arizona Press), sheet E5.