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A LIMITATION OF FIRST GENERATION LUNAR ORBITER NEGATIVES AS APPLIED TO PHOTOCLINOMETRY

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INTRODUCTION

The authors have recently been investigating the photoclinometric method of determining lunar slopes from Lunar Orbiter photographic negatives using an IBM 360/65 translation of the Lambiotte-Taylor program[1/]. They have found that the film density range within which reliable slope data can be obtained is occasionally exceeded. In this computer program any density value which exceeds the densest gray step of the gray scale in the edge data (on negatives) will be recorded as the density value of the darkest step. Consequently, all lunar slopes calculated from density readings that are higher than step nine of the gray scale, will show an essentially uniform and erroneous slope within any particular scanned site. A modification of the computer program could allow for extrapolation of values along the Hurter and Driffield (H and D) curve beyond the limits of the gray scale, but such an extrapolation would probably be meaningless. Furthermore, the density readings near the upper limit of the gray scale may give unreliable results, as the curve of density versus slope is very sensitive in this area.

A test was run in order to determine approximately the percentage of Lunar Orbiter first generation photographic negatives from Missions II and III that are useful for slope determination by the photoclinometric method.

[1/] Lambiotte, J. J., and Taylor, G. R., 1967, A photometric technique for deriving slopes from Lunar Orbiter photography, presented at Space Systems for Planetary Geology and Geophysics Conf., Boston, 1967: Natl. Aeronautics and Space Adm., Langley Research Center, 22 p.

TEST PROCEDURE

Every 10th film negative canister was selected from the shelf. The 10th framelet was taken from each can chosen. Seventeen framelets from Mission II and 14 framelets from Mission III were tested (see table 1).

Only framelets that showed the lunar landscape were selected. When a canister was found to contain blank film, the next canister was selected instead. Also, framelets with bad bimat marks were skipped. Therefore, these percentages represent an already restricted sample.

Each framelet was scanned on the microdensitometer across the gray scale of the edge data, and across three areas of lunar landscape; two of these were located near each edge and one near the middle of each framelet. The parameters on the microdensitometer were set equal to those used for the Lambiotte-Taylor photoclinometry program (table 2).

For each framelet, two graphs were made. (See figs. 1-3 for representative set.) One graph (e.g. figs. 1a-3a) shows the gray scale scan from the edge data, and a scan made across the lunar landscape near the end of the framelet containing the edge data. These scans are referenced to the 0.0 density unit line determined from clear glass, and a line representing the 2.0 density unit level taken from a neutral density filter. The gray scale step nine, the starting and ending points of the picture scan, and the density unit reference lines are each labeled. Also given is the corresponding encoder count, which is the digitized equivalent of the density interval represented on the graph.

The other graph (e.g. figs. 1b-3b) shows the scan across the middle of the framelet, and the scan near the other end of the framelet. Also shown are the 2.0 and 0.0 density unit lines. By superimposing the two graphs it is possible to see the relative position of the gray scale and the three landscape scans for each framelet.

Table 1.--Lunar Orbiter framelets tested to determine suitability for photoclinometric reduction

Can	Frame	Framelet
	MISSION II	
2010	H-22	292
2020	H-61	430
2030	H-86	676
2040	M-131	786
2050	H-178	719
2060 A	M-207	767-768
2070 A	H-175	349
2080 A	H-146	526
2090 A	M-114	568-569
2100 A *	M-88	165
2110 A	M-59	352
2120 A	H-33	723
2204	H-8	486
2242	H-140	775
2274	H-162	708
2298	Unknown	550
2326	Unknown	747
	MISSION III	
3003	M-5	696
3014 †	M-40	071-072
3023 ‡	M-66	676
3033	H-98	698
3043	H-137	808
3053	H-183	822
3063 B	H-198	836
3073 A	M-168	066
3083 A	M-141	517
3093 A	H-117	183
3103 A	H-91	810
3205	H-13	506
3240	H-124	100
3278 §	H-156	480

* The 10th and 11th framelets were blank, therefore the 12th framelet was used.

† Can 3013 contains blank, over-exposed film.

‡ The 10th framelet was blank, there the 11th framelet was used.

§ The photographic image of the 10th framelet was mostly obliterated by a bimat mark, therefore the 11th framelet was used.

Table 2.--Joyce-Loebl MK III CS microdensitometer parameters

Condenser	32 mm
Optical magnification	20X
Mechanical magnification	10X
Vertical aperture	1.5 mm
Horizontal aperture	1.5 mm
Spot size	0.075 mm X 0.075 mm
Wedge	F-140 0-2.4d
Encoder	1-168

For evaluation of the data, the graphs have been classified into three groups. Group I graphs are those in which most, or all, of the density values of the topography scans positioned above the gray scale boundary. Group II graphs are those which show the density values of the topography scans positioned close to the gray scale boundaries. It may be possible to extract a small amount of slope data from framelets which show plots similar to these, although many of the slopes may not be reliable. Group III graphs are those that show framelet scans located well below the densest step of the gray scale. The maximum amount of slope data can be extracted from framelets which show plots similar to these.

RESULTS

The following number of Lunar Orbiter II test framelets were listed under each group: I, 6; II, 2; III, 9. Thus about 35 percent of the 17 Mission II first generation negatives are unsuitable for use with the Lambiotte-Taylor slope determination program, about 12 percent are borderline cases, and about 53 percent are acceptable.

Lunar Orbiter III negatives were grouped as follows: I, 1; II, 3; III, 10. Thus about 7 percent of the framelets are unsuitable, about 21 percent are borderline cases, and about 72 percent are acceptable.

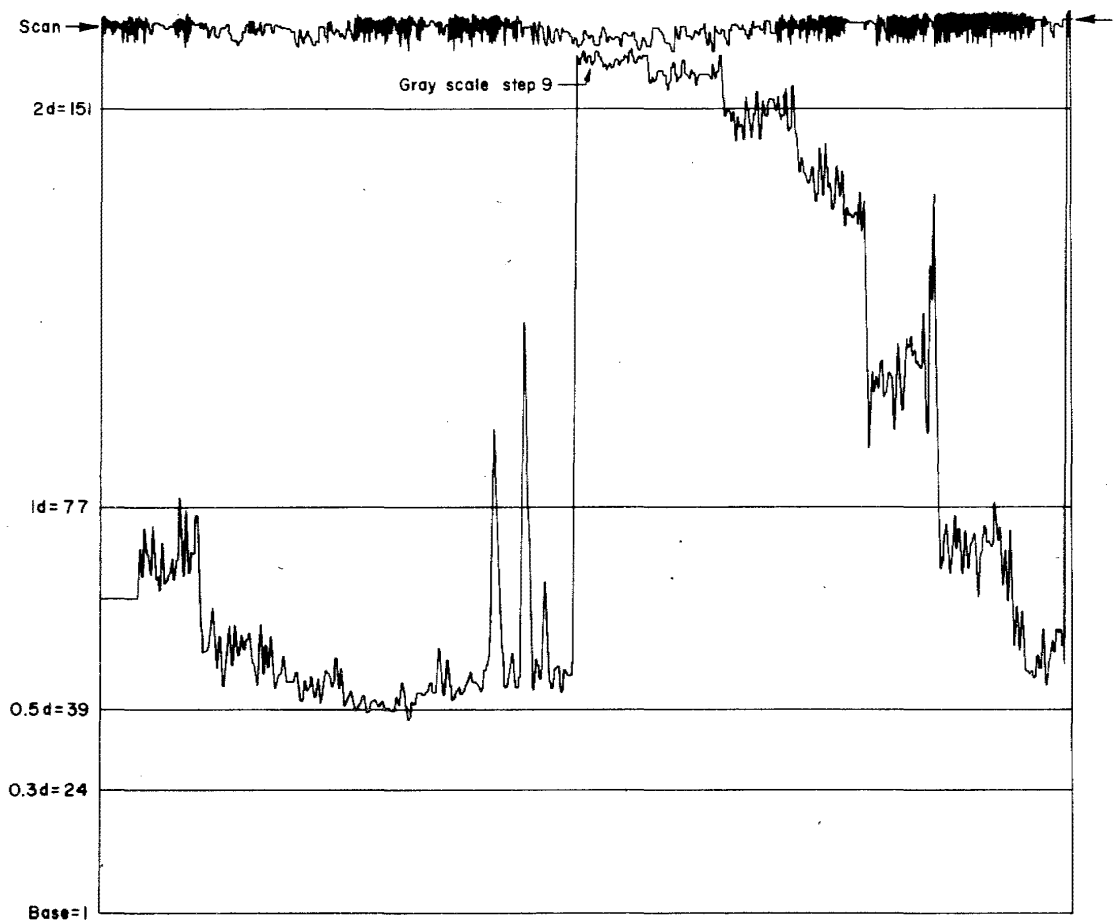

Figure 1a.--Nine-step gray scale and near-data-edge picture scan of emulsion side of Lunar Orbiter II framelet 786, Group I.

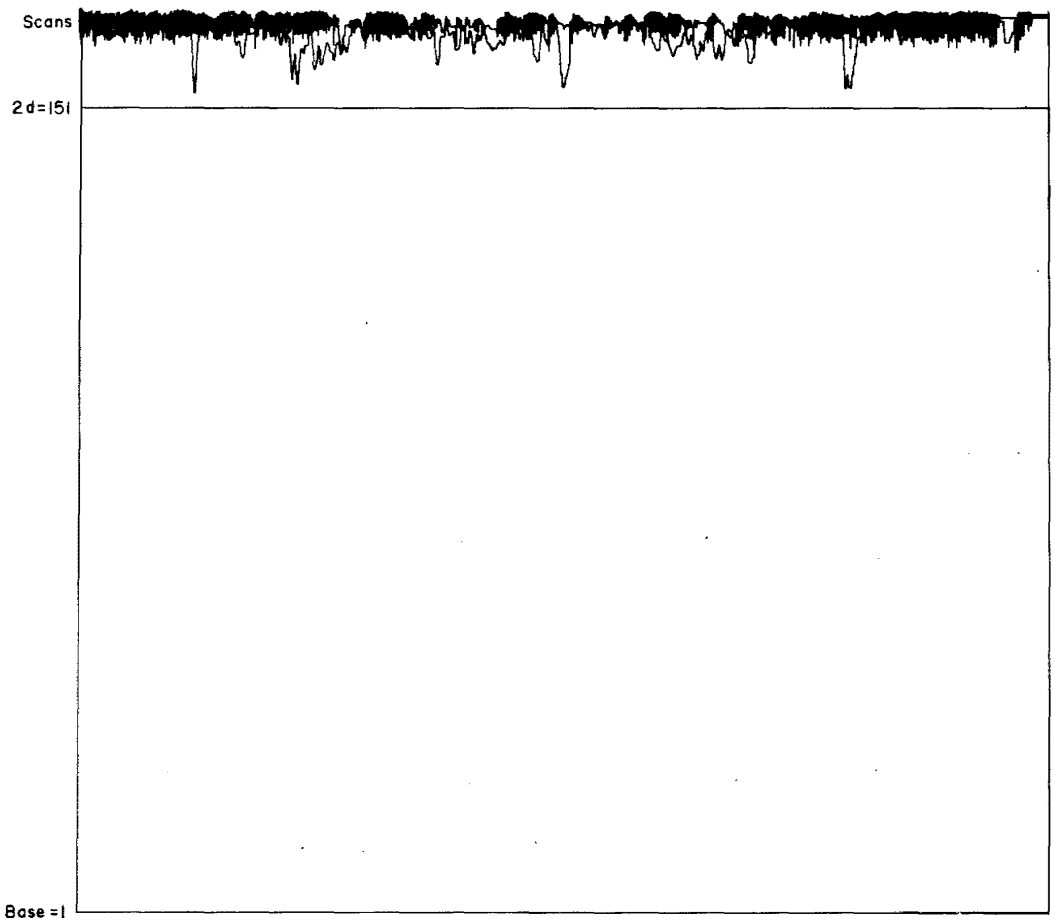

Figure 1b.--Near-center and far-edge picture scans of emulsion side of Lunar Orbiter II framelet 786, Group I.

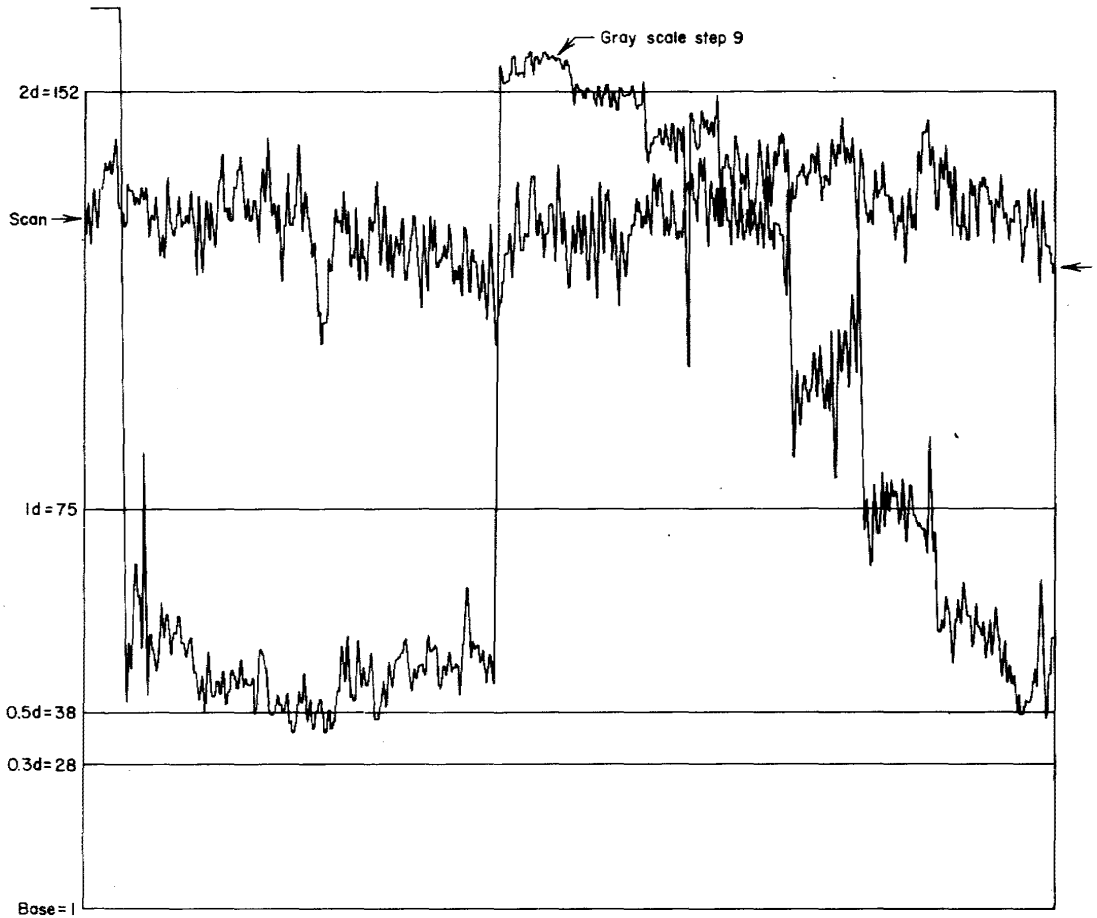

Figure 2a.--Nine-step gray scale and near-data-edge picture scan of emulsion side of Lunar Orbiter II framelet 292, Group II.

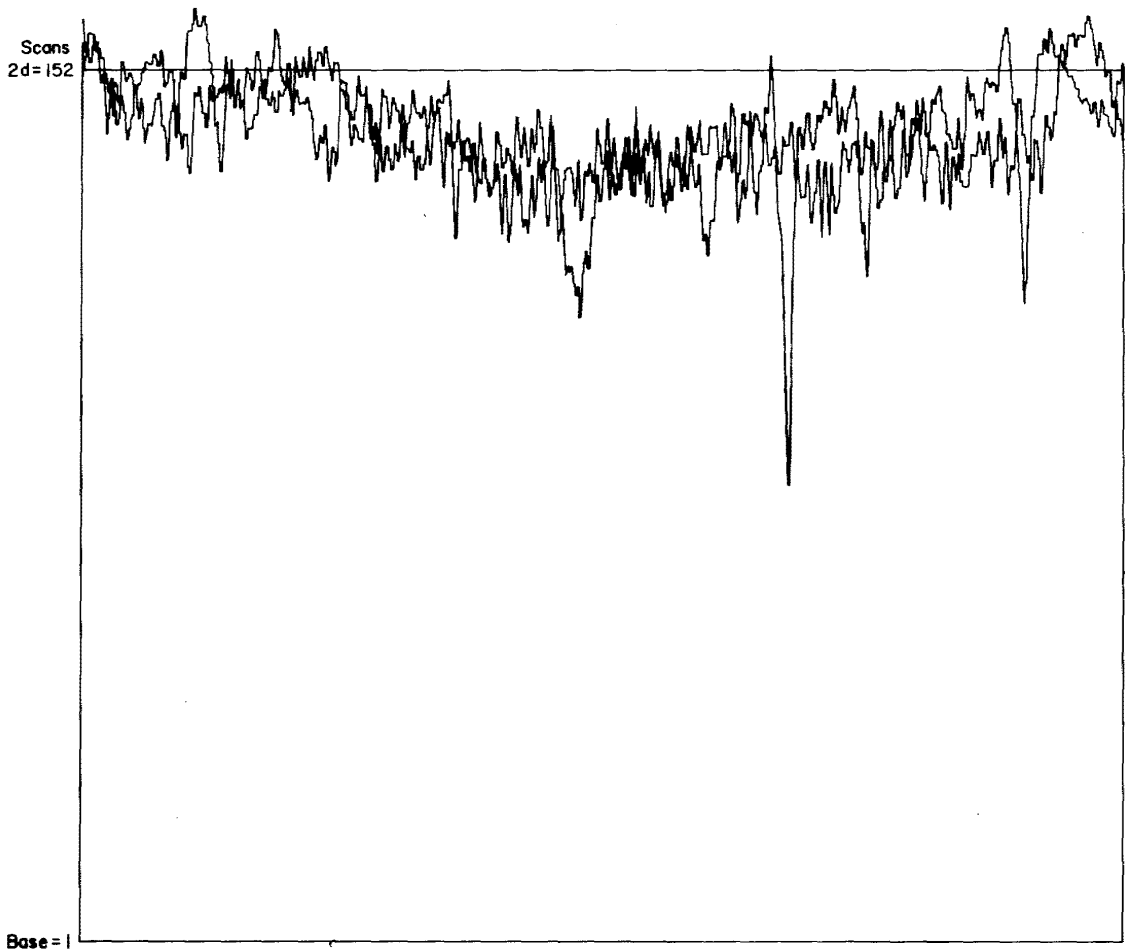

Figure 2b.--Near-center and far-edge picture scans of emulsion side of Lunar Orbiter II framelet 292, Group II.

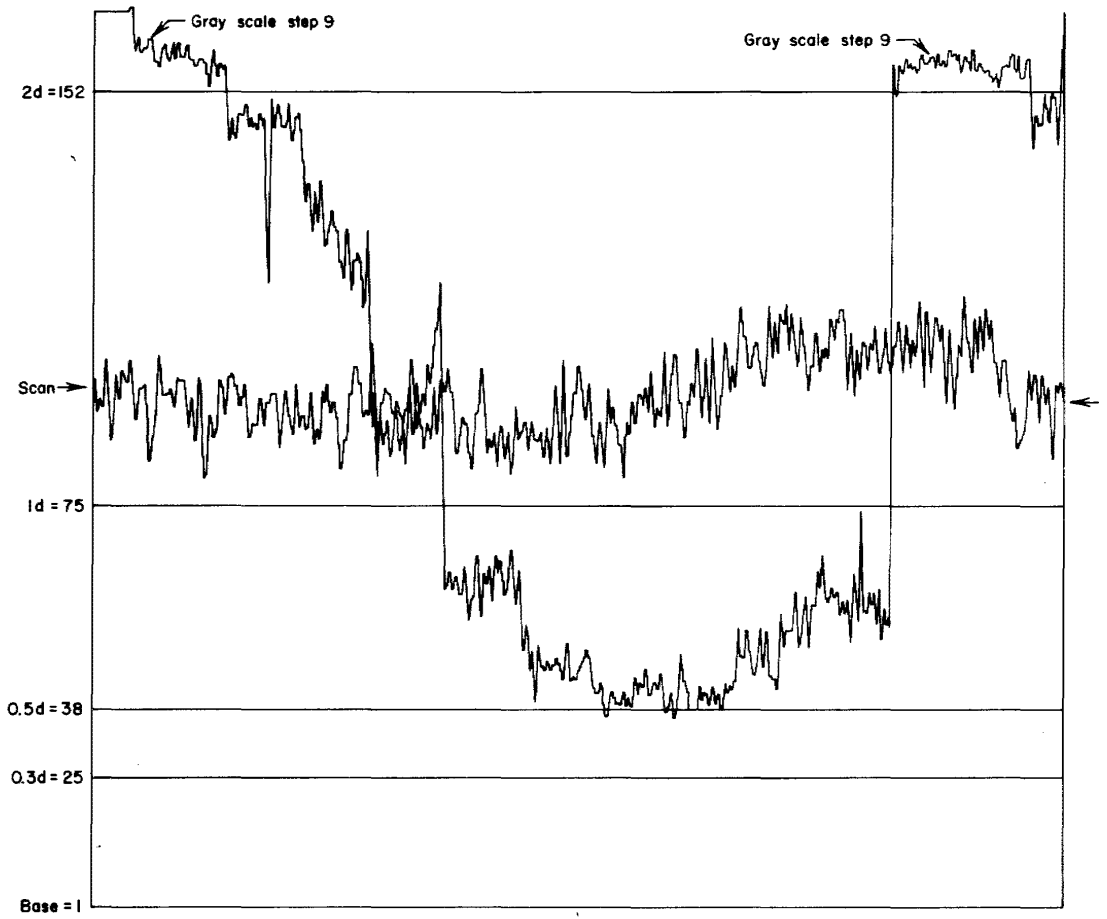

Figure 3a.--Nine-step gray scale and near-data-edge picture scan of non-emulsion side of Lunar Orbiter II framelet 676, Group III.

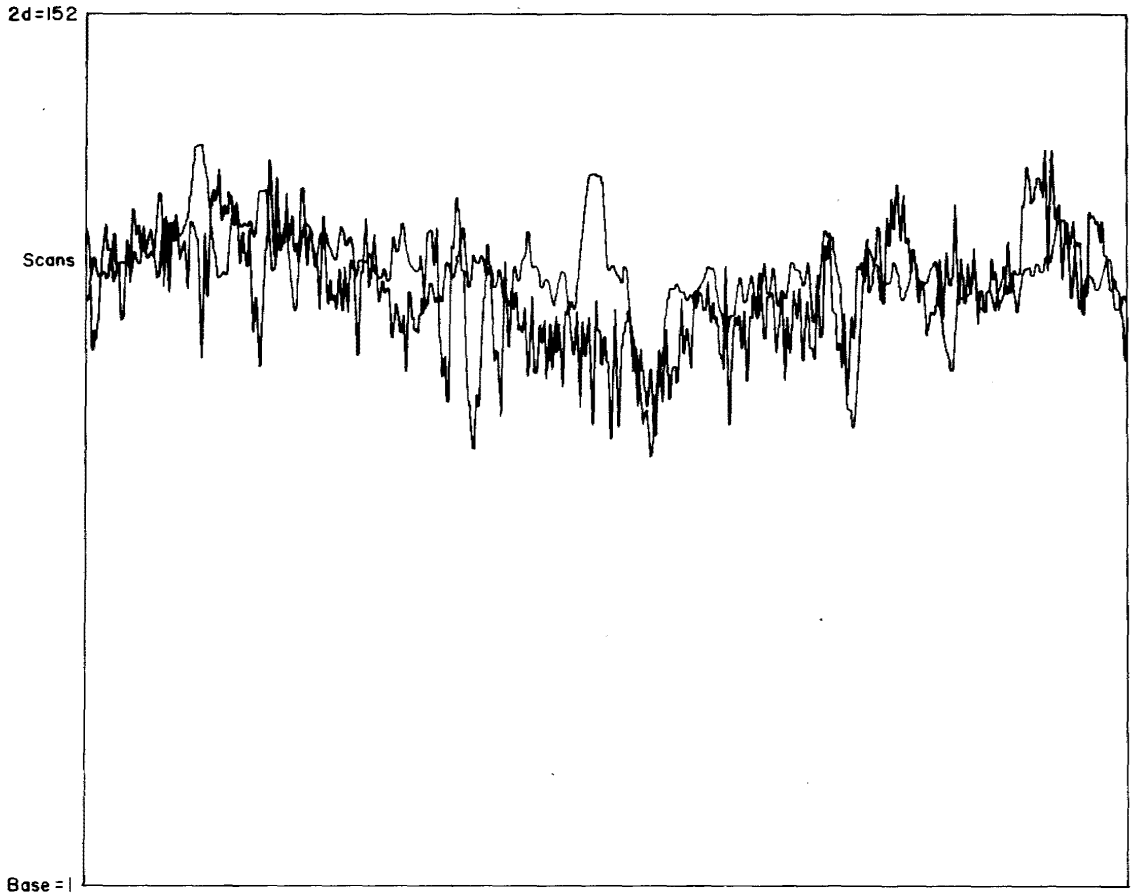

Figure 3b.--Near-center and far-edge picture scans of non-emulsion side of Lunar Orbiter II framelet 676, Group III.

CONCLUSIONS

A significant number of Lunar Orbiter II and III first generation negatives are completely unsuitable for photoclinometric reduction. Also, many may give unreliable slope information because the density ranges fall largely in the area of the upper gray scale limits, where very small density differences represent large differences in slope. Therefore, each negative must be carefully analyzed before it is accepted for use in lunar slope determination. The same limitation applies to Lunar Orbiter I, IV, and V photographs, though their first-generation negatives were not specifically tested. The Branch of Astrogeologic Studies now tests all material submitted for photoclinometric reduction to evaluate potential suitability.