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OPTICAL MEASUREMENTS OF MISER'S BLUFF MULTIBURST CLOUD PHENOMENOLOGY

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1 October 1979

Topical Report for Period 1 October 1978—1 October 1979

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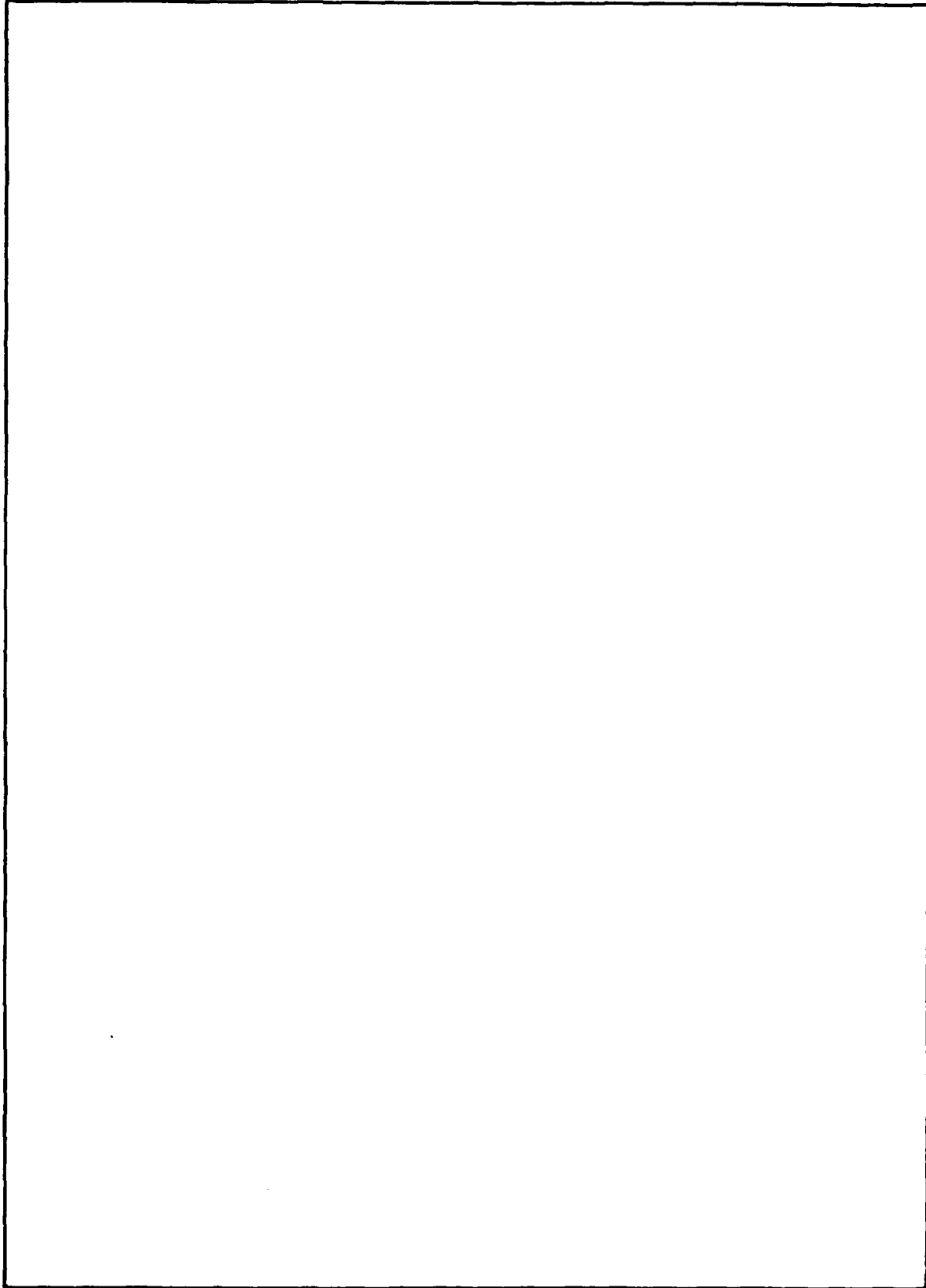
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1.0 INTRODUCTION

1.1 BACKGROUND

The Defense Nuclear Agency, in order to provide an empirical geophysical data base for shock induced environmental effects in ground soil types relevant to the U.S. Air Force MX missile site development plan, conducted a series of non-nuclear high explosive surface tests in southern New Mexico and western Arizona during 1977 and 1978. The tests were devised to provide data on the interactive effect of low frequency ground motion waves resulting from a multiple burst condition on a hardened site array complex, and, additionally, on the motion and distribution phenomenology of crater ejecta and debris induced dust clouds resulting from such nuclear burst simulation tests.

Comprehension of the overall survivability of a suitable hardened site configuration to a multiple burst reflection and focusing enhancement condition in an alluvial valley site region typical of the western United States was the basic objective of the Miser's Bluff project. Miser's Bluff I was a preliminary test program conducted at the White Sands Missile Range, New Mexico from August to December 1977. These tests were conducted with 1000 pound TNT spherical charge detonations in single and multiburst (hexagonal charge array) configurations in buried, half-buried, and surface tangent emplacement variations. From the results of these preliminary tests, parametric studies were made of the relative effects of crater induced ground motion and atmospheric overpressure to aid in the development of a multiburst waveform synthesis prediction model for larger scale tests.

The Miser's Bluff II test series was conducted at the DNA leased Planet Ranch site near the Parker Dam in western Arizona during June and August 1978. This site was chosen with the primary objective of obtaining ground motion data in a suitable geological environment representative of probable MX siting geology, in a partial valley topology, to incorporate partial shock

wave induced reverberation effects into the test measurements. The test series consisted of a single 120 ton ANFO event, and a subsequent 720 ton multiple burst ANFO event detonated several hundred yards east of the single event crater.

The Miser's Bluff events conducted by DNA Field Command in Arizona provided a unique and important opportunity for experimental participation by a number of U.S. defense agencies and by several foreign ally participants as well. In support of the overall experimental community, Technology International Corporation provided optical coverage of the morphological development and long term history of the debris-dust cloud formed by the single and multiburst detonations. This report documents the results of the coverage obtained by TIC.

1.2 OPERATIONAL PROCEDURE

In order to provide photographic coverage of the spatial and temporal characteristics of the Miser's Bluff II debris-dust clouds, TIC set up and operated two photo-optics vans along the Bill Williams river bed site at the Planet Ranch. The optics triangulation site nearest the event was located so as to have a direct view of the initial burst, at a range of about 1.5 miles from ground zero. This area was subsequently used also as an O. P. site and referred to as such hereafter. The far optics triangulation site was located at a range of about 4 miles from ground zero, near the Planet Ranch, providing a triangulation base leg of approximately 3 miles. The respective locations of the optical sites and ground zero locations for the single and multiburst events are shown in figure 1.1. In this figure the O. P. site van is identified as CV-6 and the ranch site van as CV-5. Table 1.1 presents the geodetic coordinates of the ground zero location and the optical sites for each of the two events.

An extensive array of optical instrumentation was deployed between the

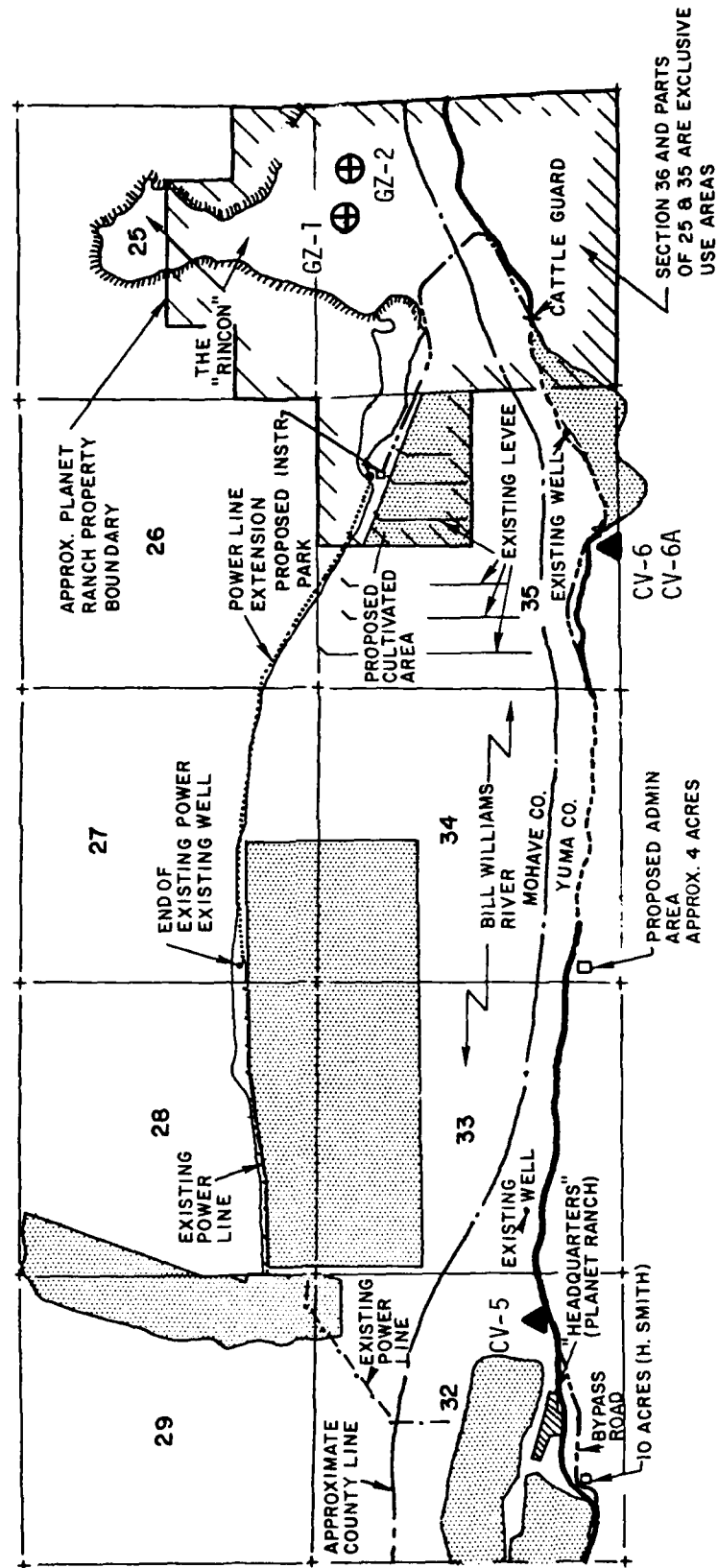


Figure 1.1 MISER'S BLUFF Optical Triangulation Sites, Planet Ranch, Az.

TABLE 1.1

MISER'S BLUFF OPERATIONAL GEODETIC COORDINATES⁽¹⁾

MISER'S BLUFF II-I EVENT	
Ground Zero (GZ-1)	Lat. = $34^{\circ}15' 31.06890''$ Long. = $113^{\circ}52' 30.46992''$ H. = 204.1341 meters (m. s. l.)
TIC O. P. Site (CV-6)	Lat. = $34^{\circ}14' 45.18926''$ Long. = $113^{\circ}53' 42.16751''$ H. = 200.6198 meters (m. s. l.)
TIC Ranch Site (CV-5)	Lat. = $34^{\circ}14' 53.60979''$ Long. = $113^{\circ}56' 30.87142''$ H. = 192.2987 meters (m. s. l.)
MISER'S BLUFF II-2 EVENT	
Ground Zero (GZ-2)	Lat. = $34^{\circ}15' 31.28009''$ Long. = $113^{\circ}52' 18.13846''$ H. = 204.4023 meters (m. s. l.)
TIC O. P. Site (CV-6A)	Lat. = $34^{\circ}14' 43.55868''$ Long. = $113^{\circ}53' 41.09170''$ H. = 202.2352 meters (m. s. l.)
TIC Ranch Site (CV-5)	(Unchanged)

(1) Clarke's Spheroid Model of 1866.

two TIC optical sites. Each site incorporated medium format (70mm) cameras operating at a rate of 1 frame per second to record the early dust cloud formation. Large format camera systems were also employed at each site to provide triangulation of the cloud for times out to H+1 hour or longer. The O.P. site, with a direct view of the initial detonation, was instrumented with medium and high speed cine cameras to record the early detonation characteristics for each event. Finally, a 16 mm documentary cine camera was operated at each site to provide a quick-look projectable record of the dust cloud formation.

Appendix A comprises a set of optical instrumentation plans describing the camera parameters used for each event. The instrument plans present the focal length (nominal), film, frame rate, and effective field of view of each camera system. The position number associated with each instrument become digits 4 and 5 in a 5 digit permanent record number assigned to each data record. The first 3 digits for a Miser's Bluff II-1 record are 638__ and the first 3 digits for the Miser's Bluff II-2 record are 639__.

1.3 RESULTS SUMMARY

Extensive photographic coverage was obtained from each of the two photo-optics sites for both of the Miser's Bluff II events. In general, coverage extended to approximately 1 hour or more after the detonation. Data reduction measurements were usually not extended beyond a half hour as a general rule, based upon interest in the effects community.

Tables 1.2 and 1.3 summarize the data results as a function of the photographic film records obtained for each of the two ANFO events. The tables identify the camera system focal length and format, exposure rate, field of view, and duration of coverage. Except where noted all records were obtained on color positive film.

This report, together with the incorporated technical pictorial history

TABLE 1.2
MISER'S BLUFF II-1 DATA RESULTS

O. P. Site (Range = 1.5 Miles)

Record	Lens/Format	Rate	Field of View	Coverage
63811	25mm/16mm	200 fps	17 x 23 ⁰	0 - 30 sec
63812	150mm/35mm (B/W)	120 fps	6 x 8 ⁰	0 - 15 sec
63813	250mm/1/2 70mm	20 fps	6 1/2 x 13 ⁰	0 - 15 sec
63815	215mm/70mm	2, 4, 16, 32 sec	15 x 20 ⁰	[0 - 90 sec]
63816	300mm/9 1/2"	2, 4, 16, 32 sec	41 x 41 ⁰	0 - 6 min
63817	154mm/9 1/2"	2, 4, 16, 32 sec	74 x 74 ⁰	7 - 20 min
63819	210mm/5 x 7"	(2 min)	29 x 40 ⁰	0 - 50 min

() = nominal

[] = some data missing

Ranch Site (Range = 4 Miles)

Record	Lens/Format	Rate	Field of View	Coverage
63821	75mm/16mm	64 fps	6 x 8 ⁰	1 - 50 sec
63823	250mm/70mm (B/W)	(1 sec)	13 x 13 ⁰	1 - 60 sec
63824	250mm/70mm	(1 sec)	13 x 13 ⁰	1 - 45/64 - 78 sec
63825	215mm/70mm	2, 4, 16, 64 sec	15 x 20 ⁰	1 - 60 sec
63827	600mm/9 1/2"	2, 4, 16, 64 sec	21 x 21 ⁰	1 - 3 min
63828	154mm/9 1/2"	2, 4, 16, 64 sec	74 x 74 ⁰	5 1/2 - 45 min
63829	210mm/5 x 7"	(2 min)	29 x 40 ⁰	1 - 50 min

TABLE 1.3
MISER'S BLUFF II-2 DATA RESULTS

O. P. Site (Range = 1.5 Miles)

Record	Lens/Format	Rate	Field of View	Coverage
63911	25mm/16mm	200 fps	17 x 23 ⁰	0 - 30 sec
63912	50mm/16mm	2500 fps	8.6 x 12 ⁰	0 - 6 sec
63913	250mm/1/2 70mm	20 fps	6 1/2 x 13 ⁰	0 - 10 sec
63914	150mm/70mm	1 sec	21 x 21 ⁰	0 - 45 sec
63915	215mm/70mm	2, 8, 32, 64 sec	15 x 20 ⁰	0 - 45 sec
63916	300mm/9 1/2"	2, 8, 32, 64 sec	41 x 41 ⁰	0 - 50 min
63917	210mm/5 x 7"	(1 min)	29 x 40 ⁰	0 - 75 min
63918	90mm/4 x 5"	(5 min)	56 x 68 ⁰	0 - 75 min

() = nominal

Ranch Site (Range = 4 Miles)

Record	Lens/Format	Rate	Field of View	Coverage
63921	75mm/16mm	200 fps	6 x 8 ⁰	0 - 30 sec
63923	250mm/70mm	1 sec	13 x 13 ⁰	0 - 60 sec
63925	215mm/70mm	2, 8, 32, 64 sec	15 x 20 ⁰	0 - 140 sec
63926	300mm/9 1/2"	2, 8, 32, 64 sec	41 x 41 ⁰	0 - 63 min
63927	210mm/5 x 7"	(1 min)	29 x 40 ⁰	0 - 60 min
63928	90mm/4 x 5"	(5 min)	56 x 68 ⁰	0 - 75 min

of section 2.0, consolidates and updates the many technical letter reports distributed earlier by TIC to the DNA effects community during the period following the field project.

2.0 TECHNICAL PICTORIAL HISTORY

This section of the Miser's Bluff optical measurements report comprises a representative pictorial history of the formation and development of the debris-dust cloud of the Miser's Bluff single burst and multiburst events. The photographs presented here were taken from photo-optical records obtained from both the O. P. and ranch site stations, as required, in order to present a continuous history of the event clouds out to about 45 minutes after detonation.

2.1 MISER'S BLUFF EVENT II-1

Figures 2.1 through 2.6 show the early cloud formation of the Miser's Bluff II-1 120 ton event from H+2 seconds to H+4 minutes 23 seconds, as seen from the O. P. site (CV-6) at a range of 1.5 miles. (It should be noted here that the white cloud to the right of the event cloud resulted from a small secondary experiment detonated 2 seconds prior to the Miser's Bluff II-1 event). The 120 ton event was detonated at 13:05 local time (MST) with a strong prevailing lower altitude wind out of the south (ref. Figure 3.1). Figure 2.1 shows the early cloud at H+2 seconds at which time significant amounts of clumps of ejecta can be seen 5-10 feet above the top of the early debris cloud. By H+30 seconds (Figure 2.2) the cloud is seen to have moved significantly to the left in the O. P. perspective relative to the earlier figure. At this time the cloud top has reached a height of over 300 meters. By H+45 seconds the cloud has now reached a height of approximately 450 meters (Figure 2.3) and will, it shall be seen, continue rising at a rate of 10 meters/second for well over two minutes. Figure 2.6 shows the last data frame for this series from the O. P. site records. By this time the debris-dust cloud has reached an altitude of some 2300 meters, and is still rising rapidly. (Also by this time, the center of the cloud has moved a distance of 3 1/2 kilometers north, corresponding to a velocity of 13.3 meters/second or close to 30 knots). No distinctly defined stem has manifested in this cloud, undoubt-

edly due to the strong wind vectors at these lower altitudes.

Figures 2.7 through 2.14 show the Miser's Bluff II-1 cloud from H+18 seconds to H+48 minutes as observed from the ranch site (CV-5) optical station. In figure 2.9 the cloud is seen as it reaches an altitude of 3000 meters and, by this time, a maximum width of about 1500 meters. Between figure 2.9 and figure 2.10 the single burst cloud reached a stabilization height of about 3800 meters between H+8 and H+9 minutes, as can be seen in figure 4.2.

Figures 2.11 to 2.14 show the post stabilization history of the dust cloud at selected intervals to H+48 minutes. Well before this time the cloud was sufficiently diffuse to negate good height and other geometric measurements; these were, therefore, somewhat arbitrarily terminated at H+20 minutes, corresponding to a ground range of about 14 1/2 kilometers or nearly 9 miles from ground zero.

The triangulation station ground range to the geometric center of the cloud is given in table 2.1 as a function of time for the Miser's Bluff II-1 event. With this information and the additional knowledge that the camera lens focal length was 210 mm, the print magnification from the original film record was 1.83 x, and that the reticle border at the edge of the print before publication changes (if any) is 1.00 cm between major unit marks, the reader can make approximate calculations of the actual size of a given cloud or region of structure.

TABLE 2.1
TRIANGULATION STATION GROUND RANGE
MISER'S BLUFF II-I EVENT

Time (min)	Range from O. P. site	Range from ranch site
0	2.33 kilometers	6.30 kilometers
0.5	2.70	6.50
1	3.10	6.95
2	3.65	7.31
3	4.30	7.79
4	4.96	8.12
5	5.65	9.90
10	8.60	12.40
15		16.85
20		12.5
25		

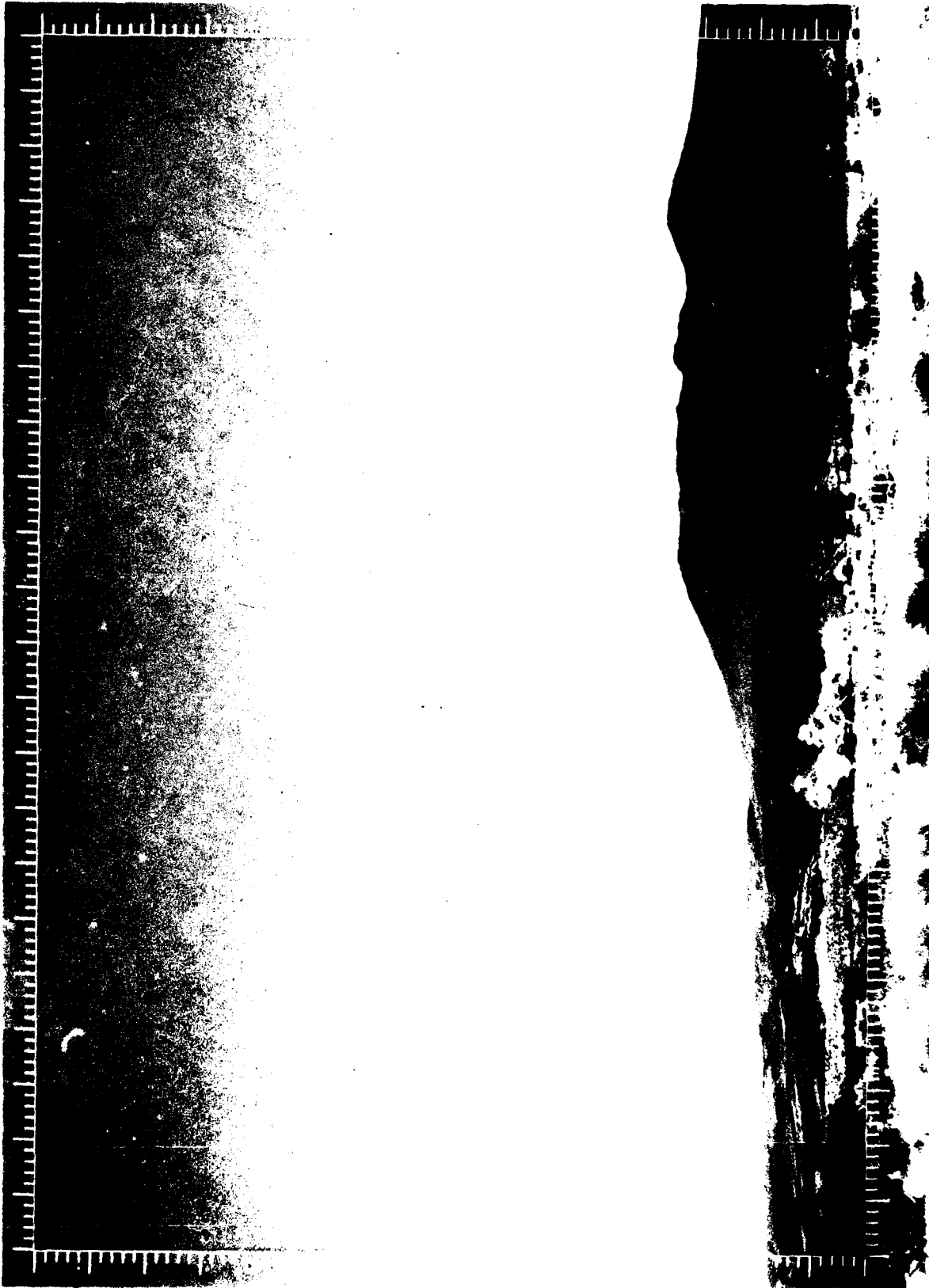


Figure 2.1 MISER'S BLUFF II-1 Event, O. P. Site, II+02 sec, Record No. 63819-60A.

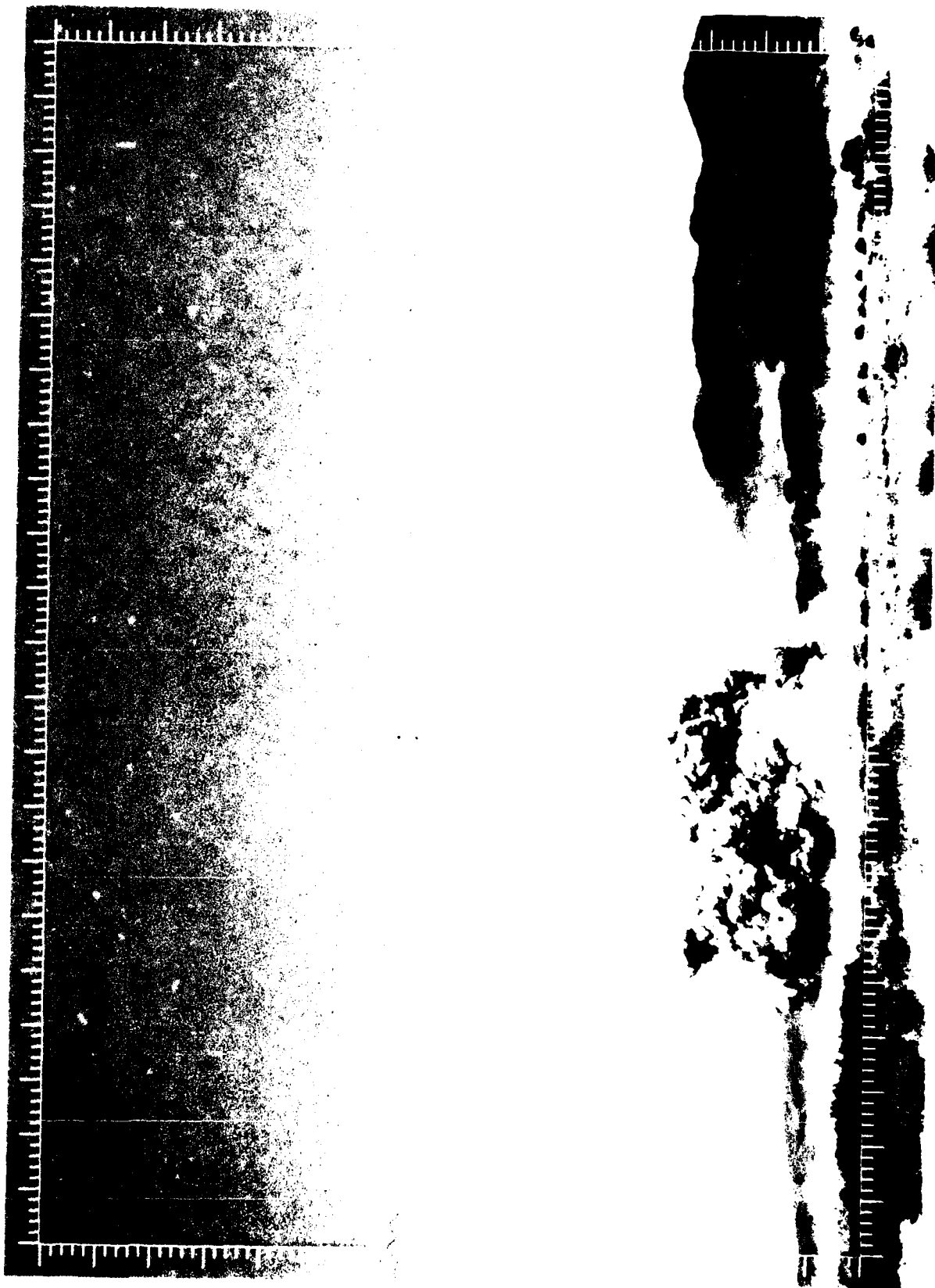


Figure 2.2 MISER'S BLUFF II-1 Event, O. P. Site, H+30 sec, Record No. 63819-60B.



Figure 2.3 MISER'S BLUFF II-I Event, O. P. Site, H+45 sec, Record No. 63819-61A.



Figure 2.4 MISER'S BLUFF II-1 Event, C. P. Site, H+1 min 06 sec, Record No. 63819-61B.



Figure 2.5 MISER'S BLUFF II-I Event, O. P. Site, H+1 min 42 sec, Record No. 63819-62B.



Figure 2.6 MISER'S BLUFF II-I Event, O. P. Site, II+4 min 23 sec, Record no. 63819-63B.

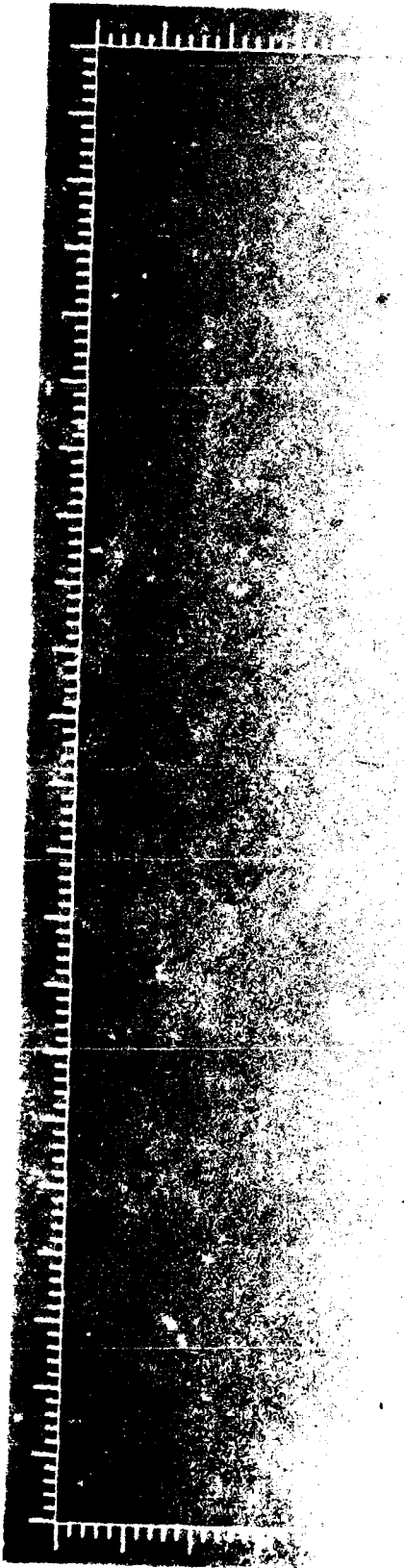


Figure 2.7 MISER'S BLUFF II-I Event, Ranch Site, II+18 sec, Record No. 63829-50A.



Figure 2.8 MISER'S BLUFF II-I Event, Ranch Site, H+2 min 31 sec, Record No. 63829-50B.

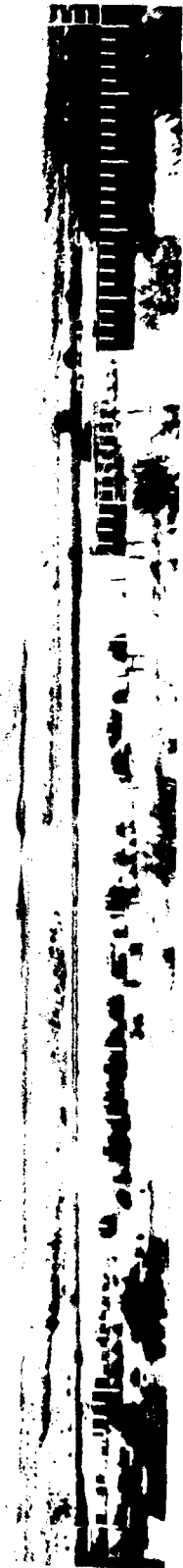


Figure 2.9 MISER'S BLUFF II-I Event, Ranch Site, H:5 min 39 sec, Record No. 63829-51A.

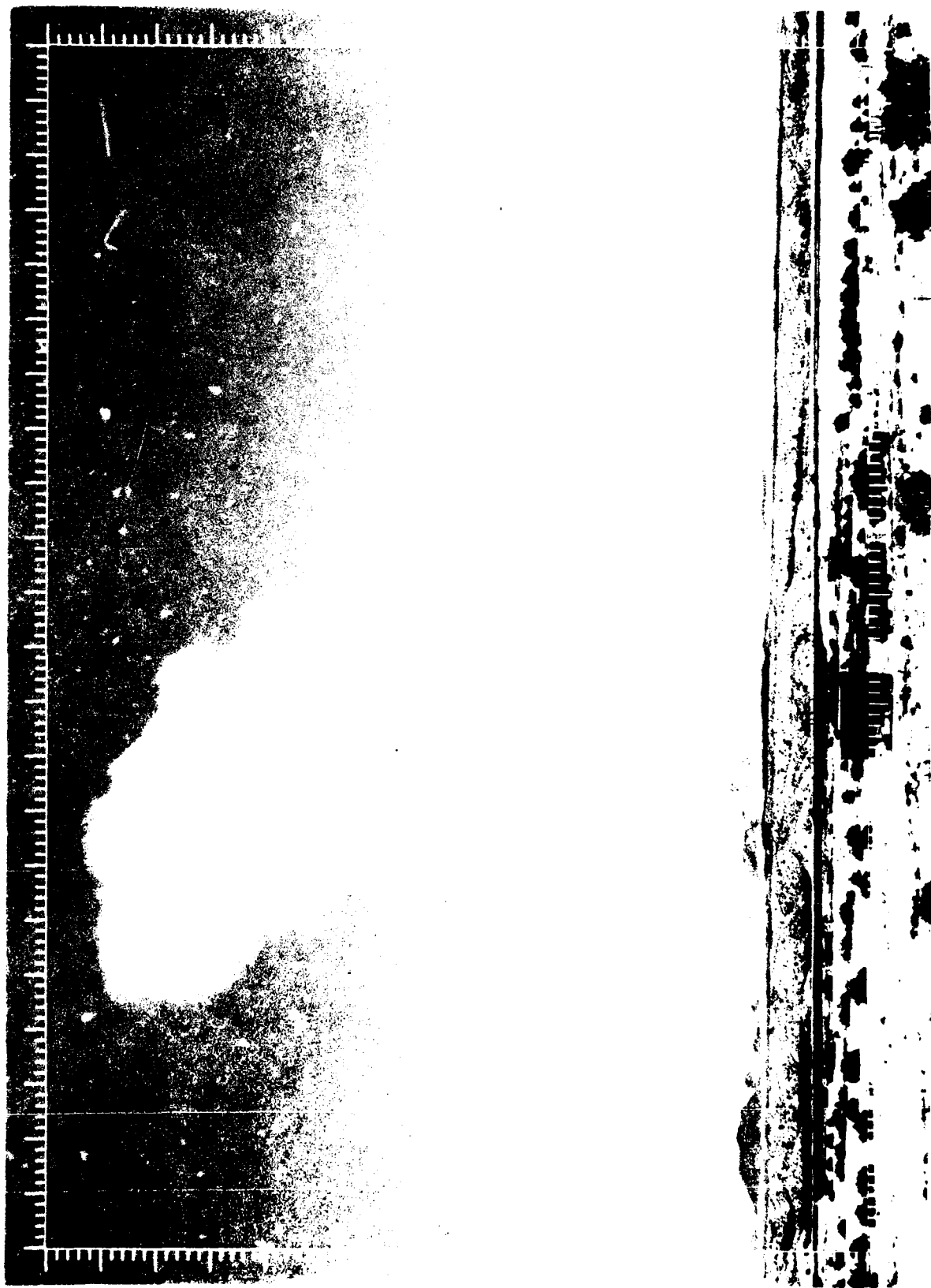


Figure 2.10 MISER'S BLUFF II-1 Event, Ranch Site, II-10 min 32 sec, Record No. 63829-52A.

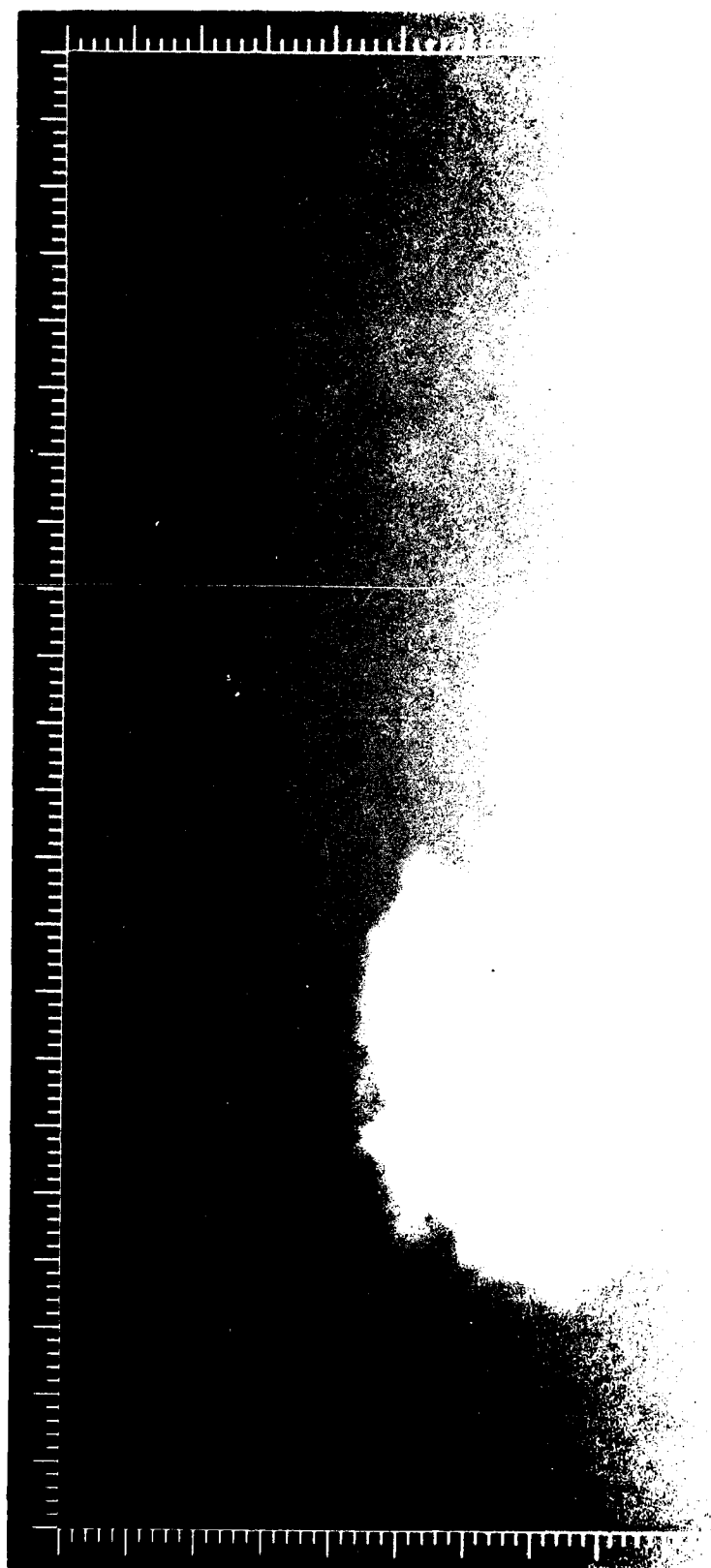


Figure 2.11 MISER'S BLUFF II-I Event, Ranch Site, H+15 min 47 sec, Record No. 63829-53B.



Figure 2.12 MISER'S BLUFF DETAIL, LOOKING SOUTH, RECORD NO. 63829-55A.

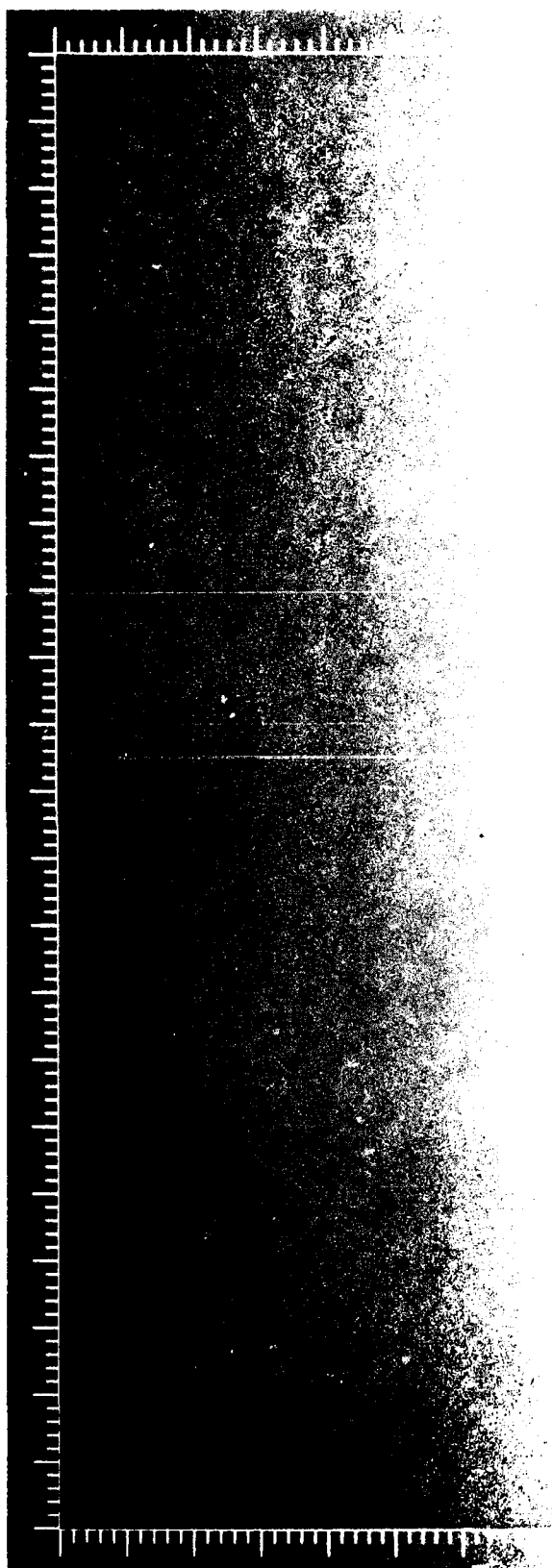


Figure 2.13 MISER'S BLUFF II-I Event, Ranch Site, II+33 min 32 sec, Record No. 63829-55B.



Figure 2.14 MISER'S BLUFF II-1 Event, Ranch Site, II-48 min, Record No. 63829-57B.

2.2 MISER'S BLUFF EVENT II-2

Figures 2.15 through 2.26 show the initial development, rise to stabilization, and early phases of atmospheric dissipation of the Miser's Bluff II-2 multiburst event as seen from the ranch site photo-optics station. (From the ranch site perspective, actual ground zero is obscured by a small intervening bluff along the optical line of sight). In general the local winds at the time of the event (11:00 local time) were considerably subdued compared to the single burst event winds discussed earlier. Thus the dust cloud with a distinct stem was in evidence by H+1 minute as shown in figure 2.17. The cloud height by this time was approximately 1000 meters compared with about 560 meters for the smaller single burst event.

By H+1 1/2 minutes a strong singular asymmetry in the upper portion of the dust cloud (evidenced earlier) is comparable in size to the remaining cloud top as seen in figure 2.18. The cloud by this time is on the order of 1300 meters high and 1000 meters wide, with a stem height of about 550 meters. The asymmetrical portion of the cloud is essentially dominant by about H+2 minutes and thereafter as seen in figures 2.19 and succeeding data frames until stabilization occurs by 6 to 7 minutes after the detonation.

By about H+13 minutes (Figure 2.23) - - while the cloud height has not changed significantly - - the cloud width has increased to about 3 1/2 kilometers and the center of the cloud has travelled about 4.7 kilometers from ground zero. (Also shown in this photographic frame is the Air Force helicopter returning to the ranch area for a landing). Figures 2.24 through 2.26 show the general appearance of the dust cloud from H+20 minutes to H+40 minutes, changes appearing gradually as the cloud drifted north from ground zero. Beyond this time the cloud gradually dissipated, but was photographed out to H+75 minutes. (Shown in figure 2.26 is the privately leased helicopter coordinated by SRI International as part of the radar transmission experiment).

Table 2.2 summarizes the ground range from the ranch site (CV-5) optical station to the apparent center of the Miser's Bluff II-2 dust cloud. Using the optical parameter information presented at the end of section 2.1, the reader can determine the approximate actual dimension of the photographic print image.

TABLE 2.2
TRIANGULATION STATION GROUND RANGE
MISER'S BLUFF II-2 EVENT

Time (min)	Range from ranch site
0	6.57 kilometers
0.5	6.55
1	6.52
2	6.50
3	6.43
4	6.59
5	6.94
10	7.75
15	9.37
20	11.20
25	14.10
30	17.10

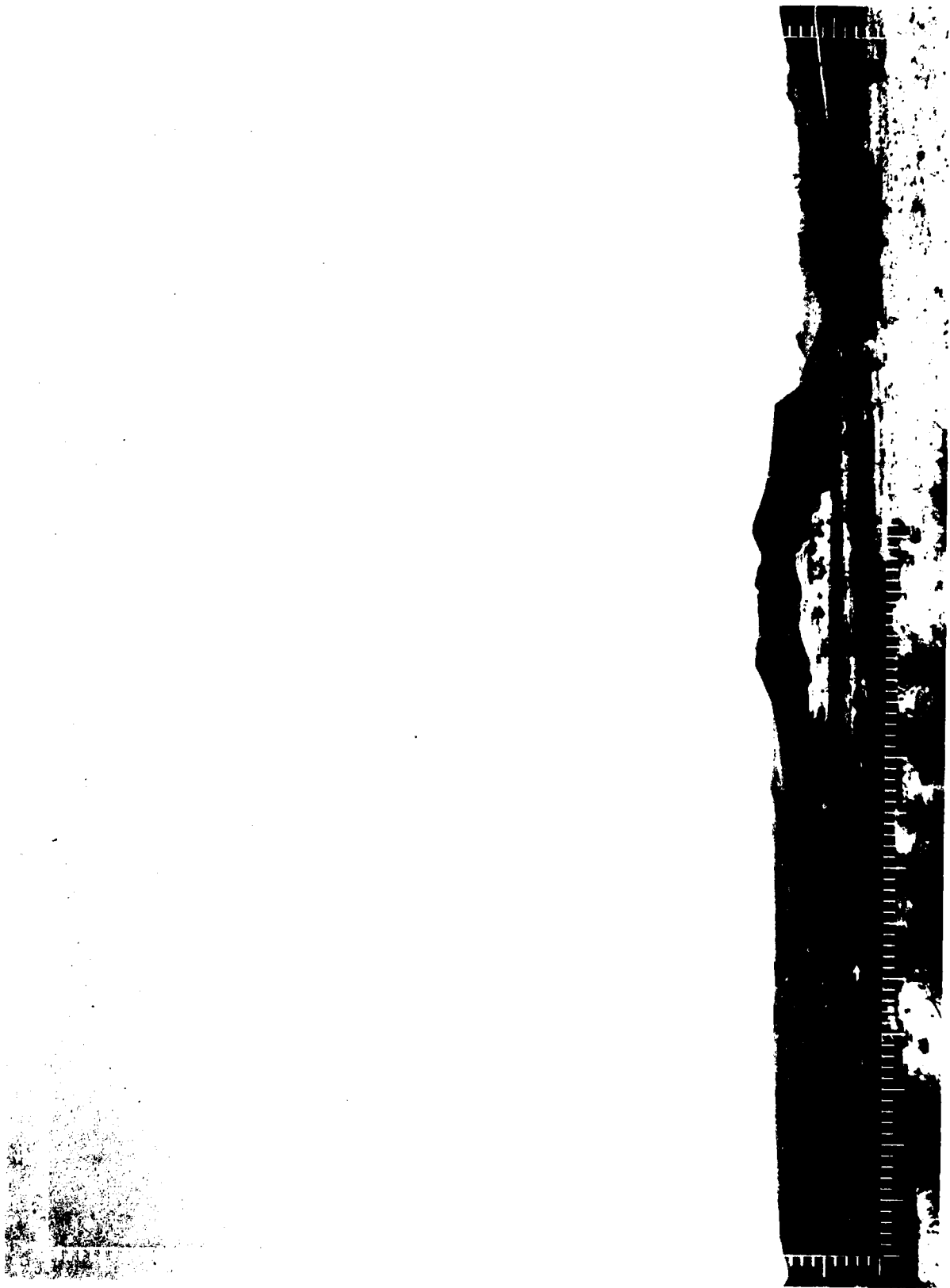


Figure 2.15 MISER'S BLUFF II-2 Event, Ranch Site, H+03 sec, Record No. 63927-50A.



Figure 2.16 MISER'S BLUFF II-2 Event, Ranch Site, H+30 sec, Record No. 63927-50B.



Figure 2.17 MISER'S BLUFF II-2 Event, Ranch Site, H+1 min 06 sec, Record No. 63927-51A.



Figure 2.18 MISER'S BLA FF II-2 Event, Ranch Site, 11:1 min 50 sec, Record No. 63927-51B.

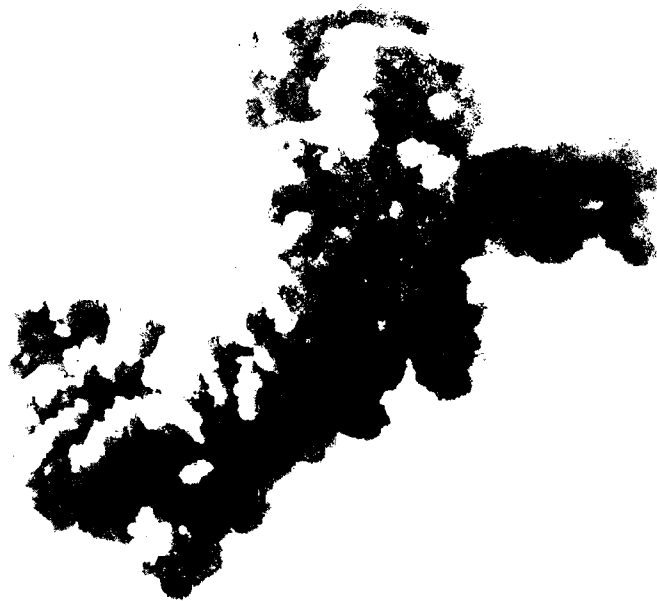


Figure 2.19 MISER'S BLUFF II-2 Event, Ranch Site, II-2 min us sec, record No. 63927-52A.

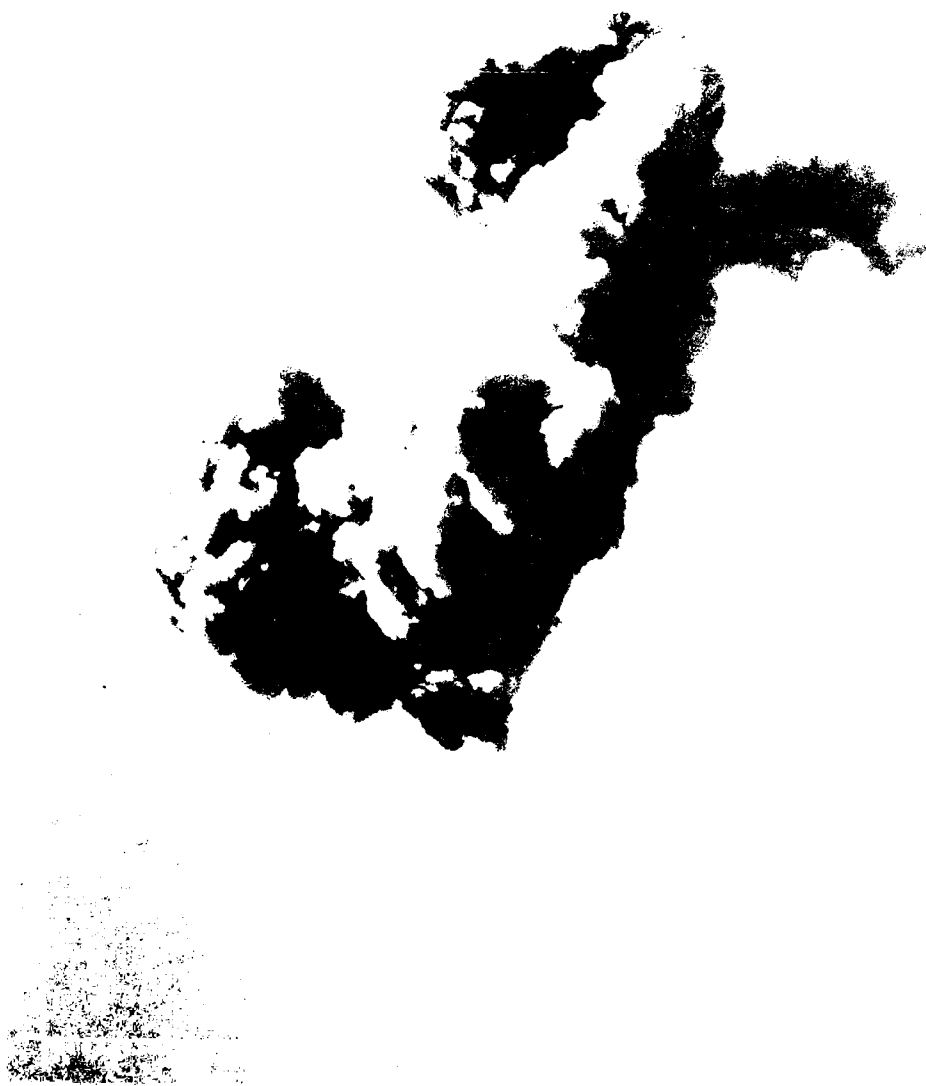


Figure 2.20 MISER'S BLUFF H-2 Event, Ranch Site, H-3 min 01 sec, Record No. 63927-52B.



Figure 2.21 MISER'S BLUFF II-2 Event, Ranch Site, H+4 min 49 sec, Record No. 63927-53A.



Figure 2.22 MISER'S BLUFF II-2 Event, Ranch Site, H+9 min 53 sec, Record No. 63927-55B.

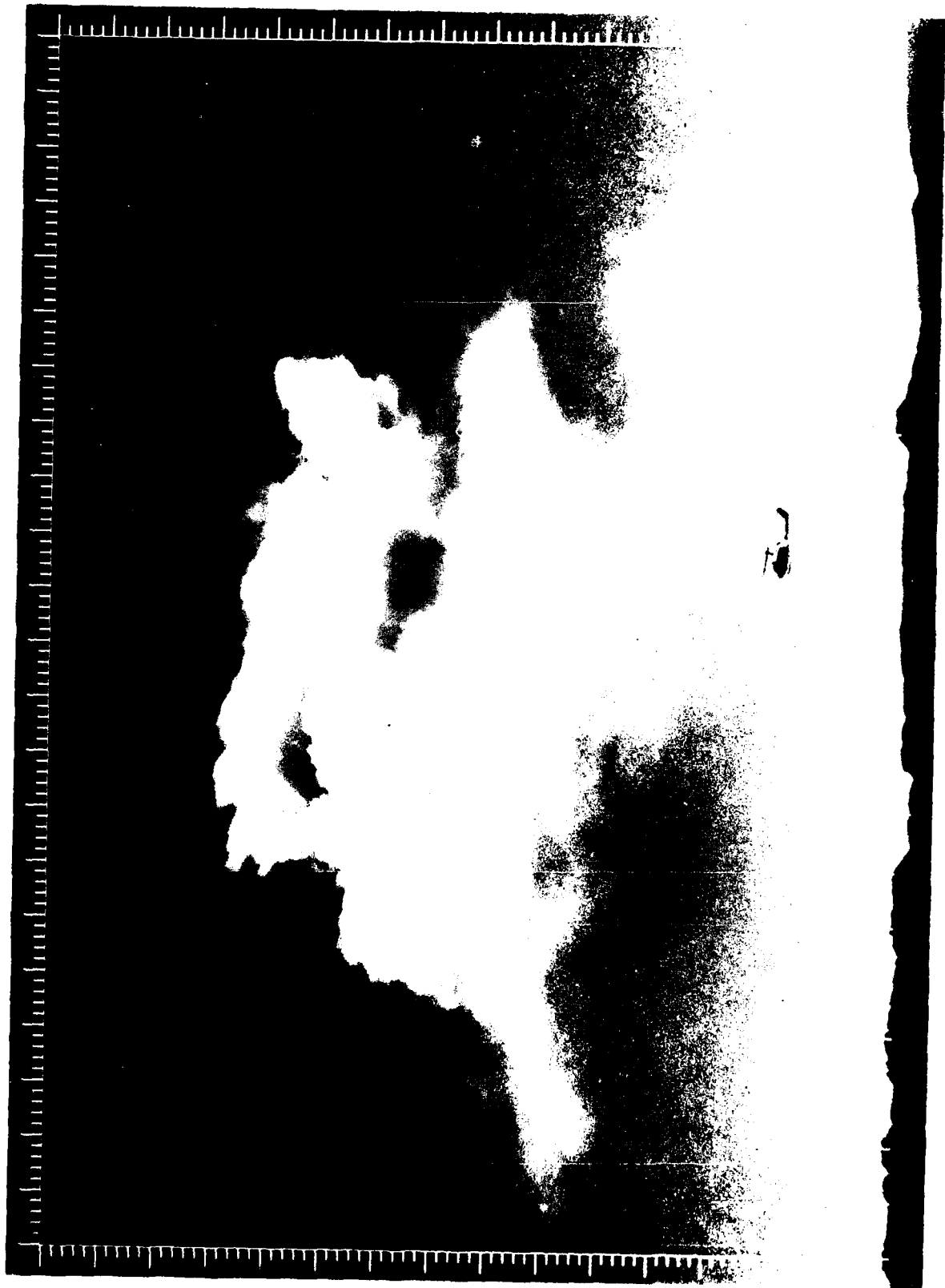


Figure 2.23 MISER'S BLUFF II-2 Event, Ranch Site, H+12 min 55 sec, Record No. 63927-57A.

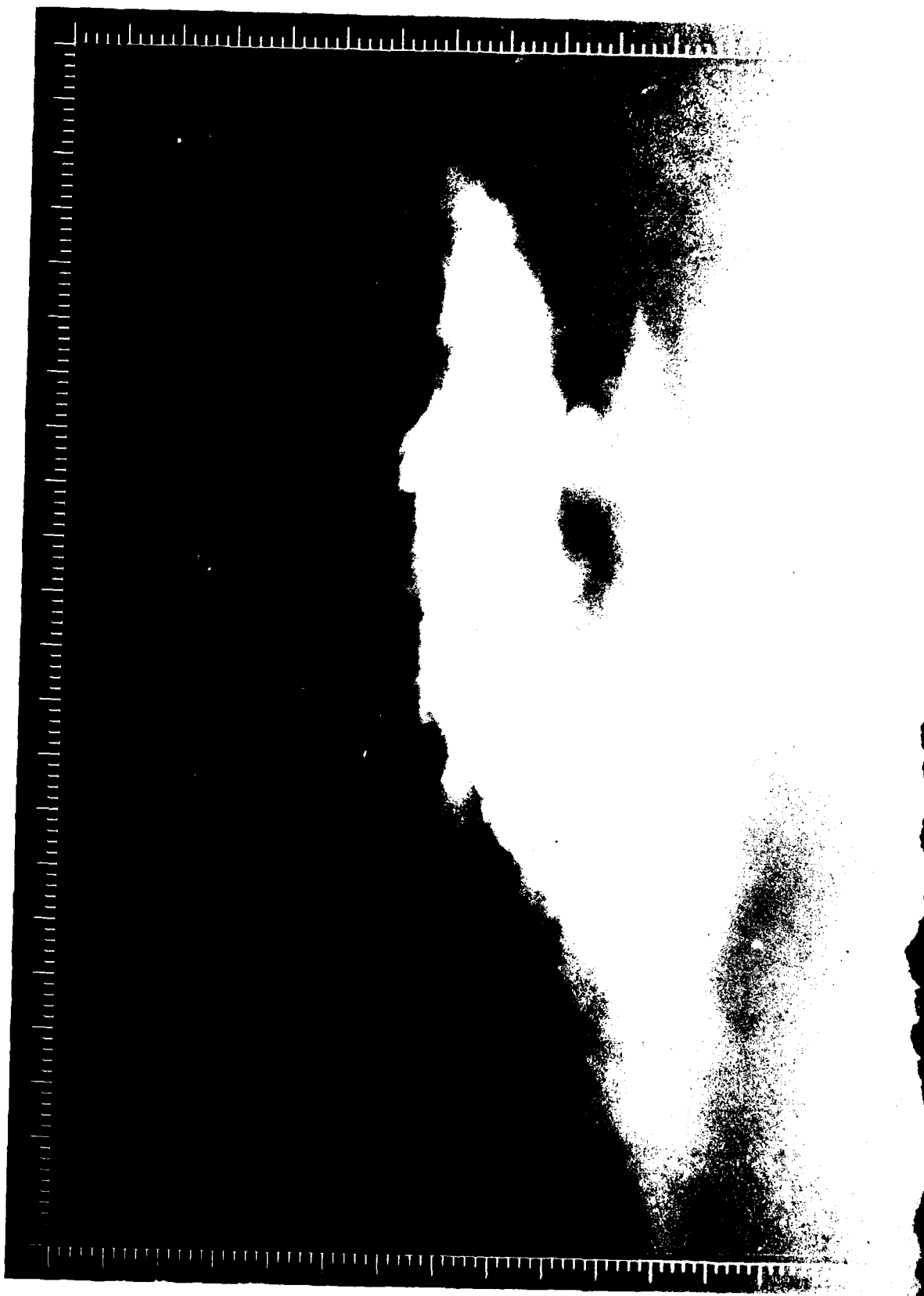


Figure 2.24 MISER'S BLUFF II-2 Event, Ranch Site, II-20 min 07 sec, Record No. 63027-59A.

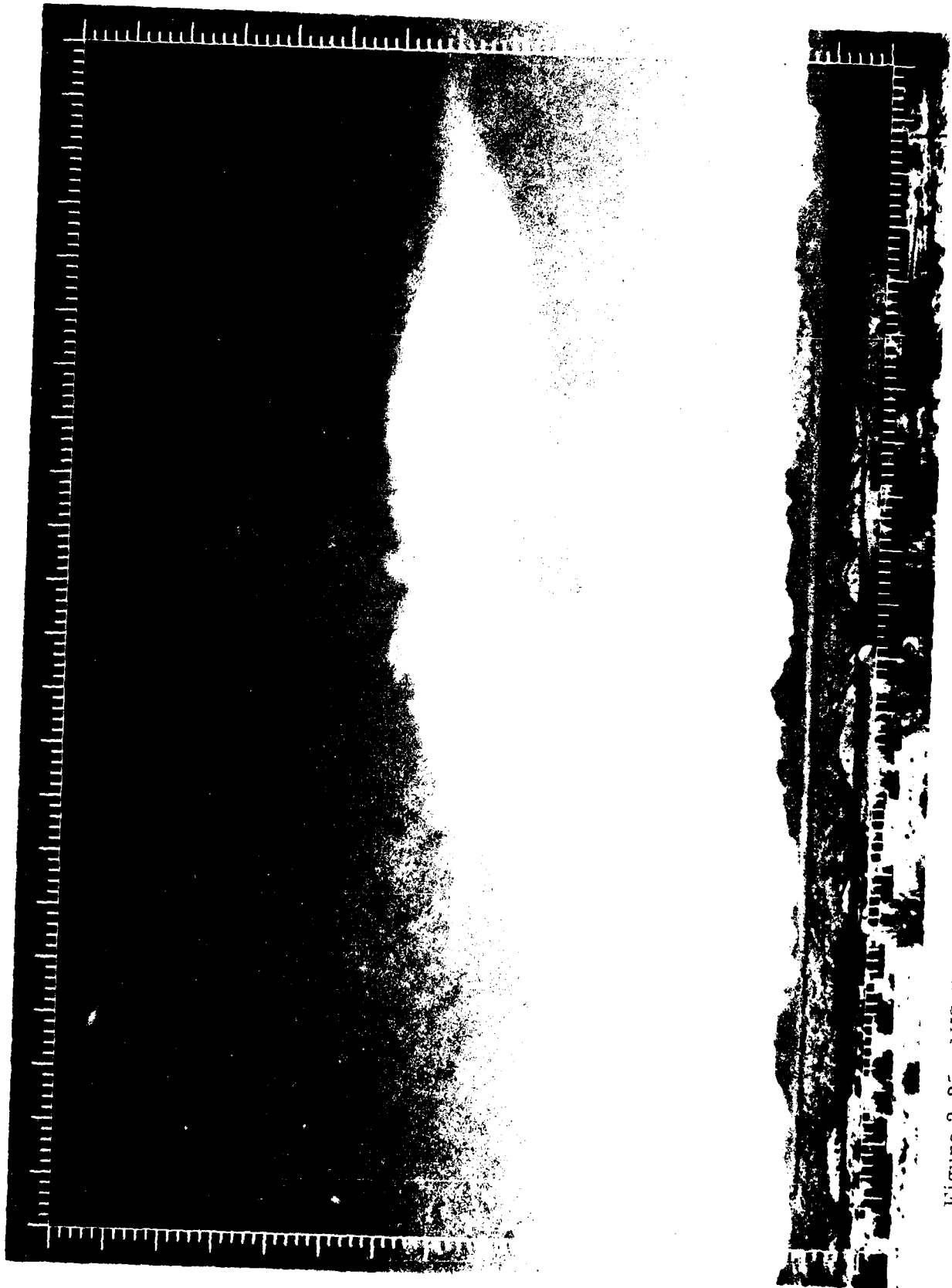


Figure 2.25 MISER'S BLUFF II-2 Event, Ranch Site, H+29 min 16 sec, Record No. 63927-81A.

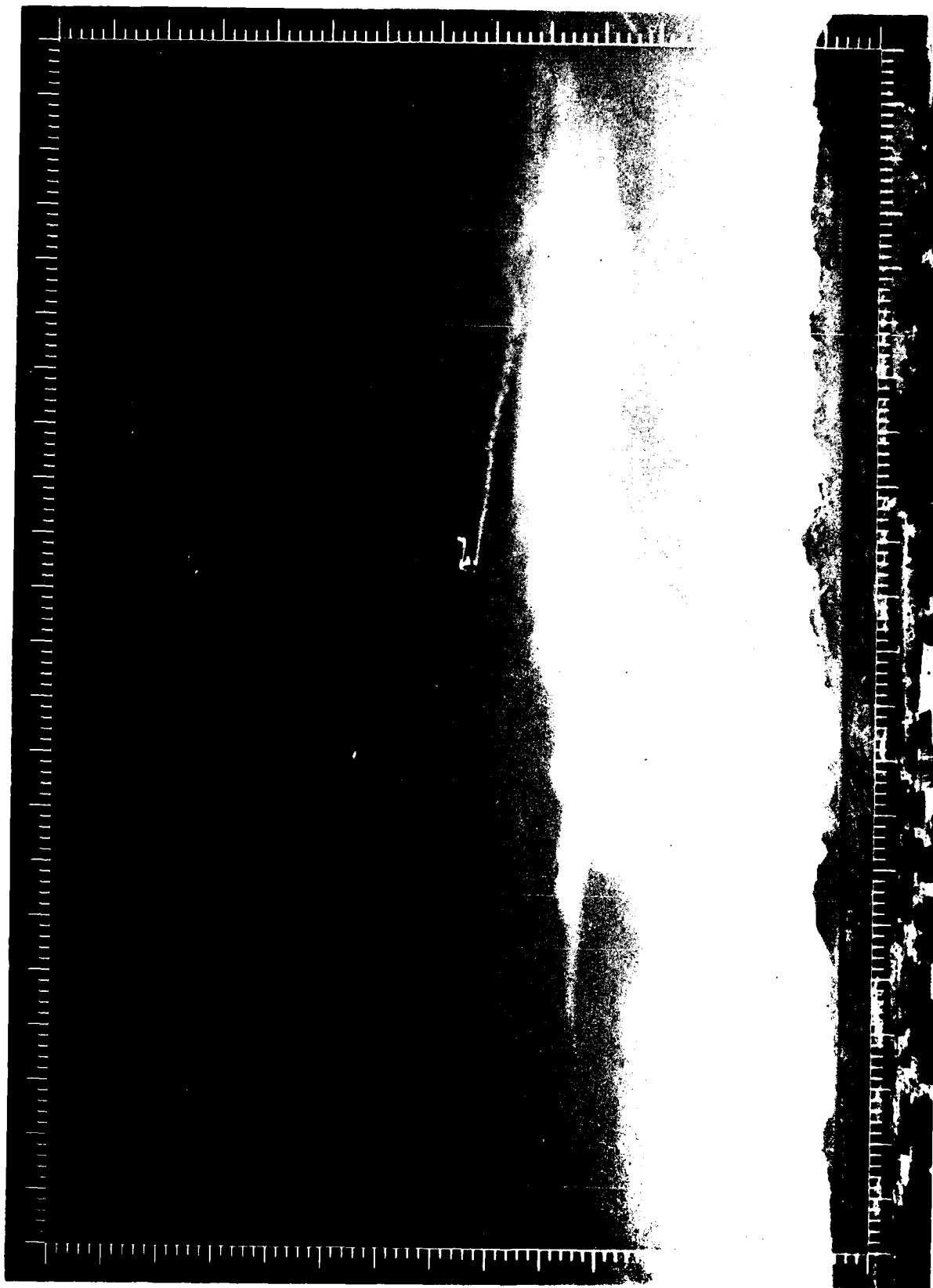


Figure 2.26 MISER'S BLUFF II-2 Event, Ranch Site, H+39 min 42 sec, Record No. 63927-82B.

3.0 DUST CLOUD TRACK TRIANGULATION

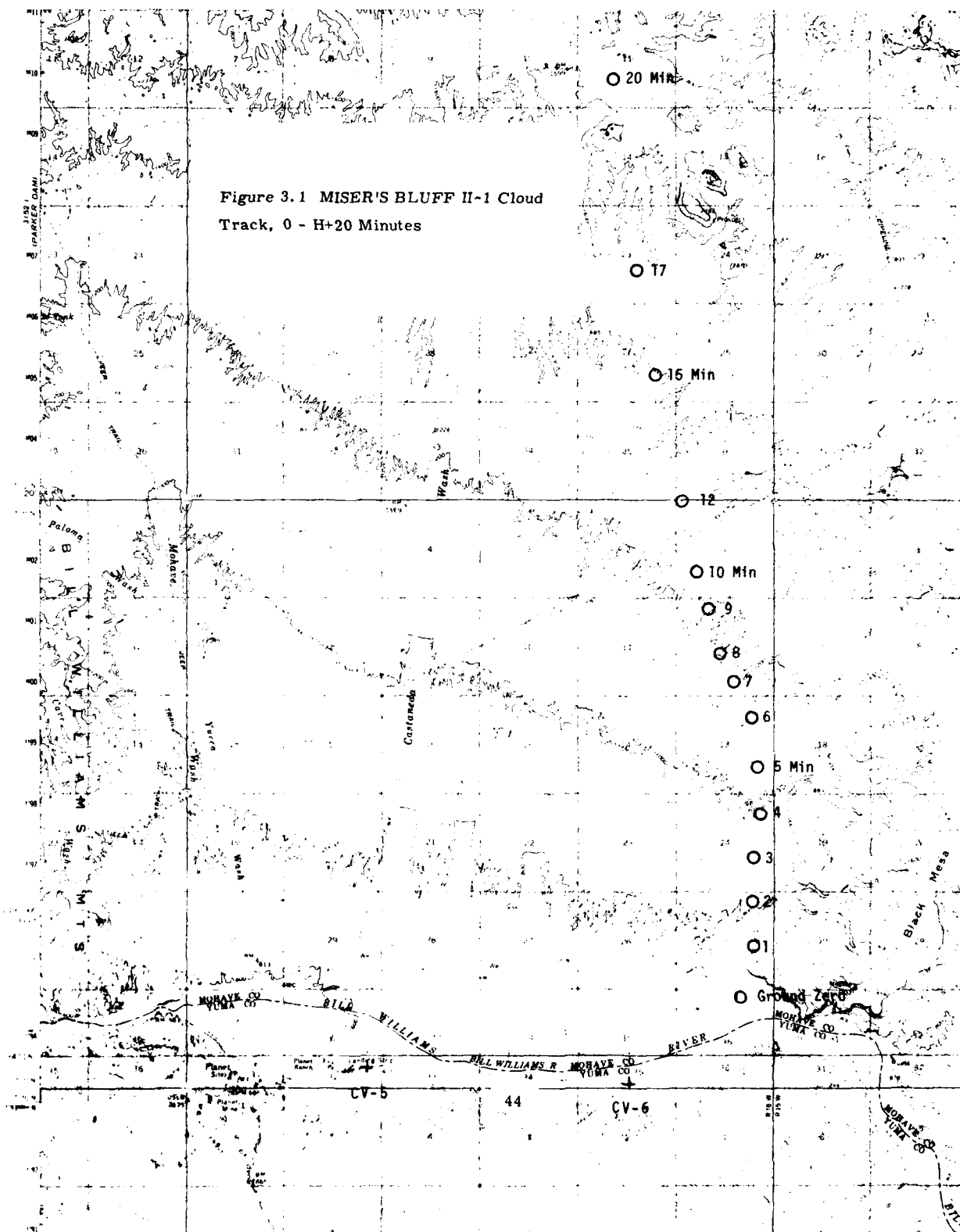
3.1 MISER'S BLUFF II-1 CLOUD TRACK MEASUREMENTS

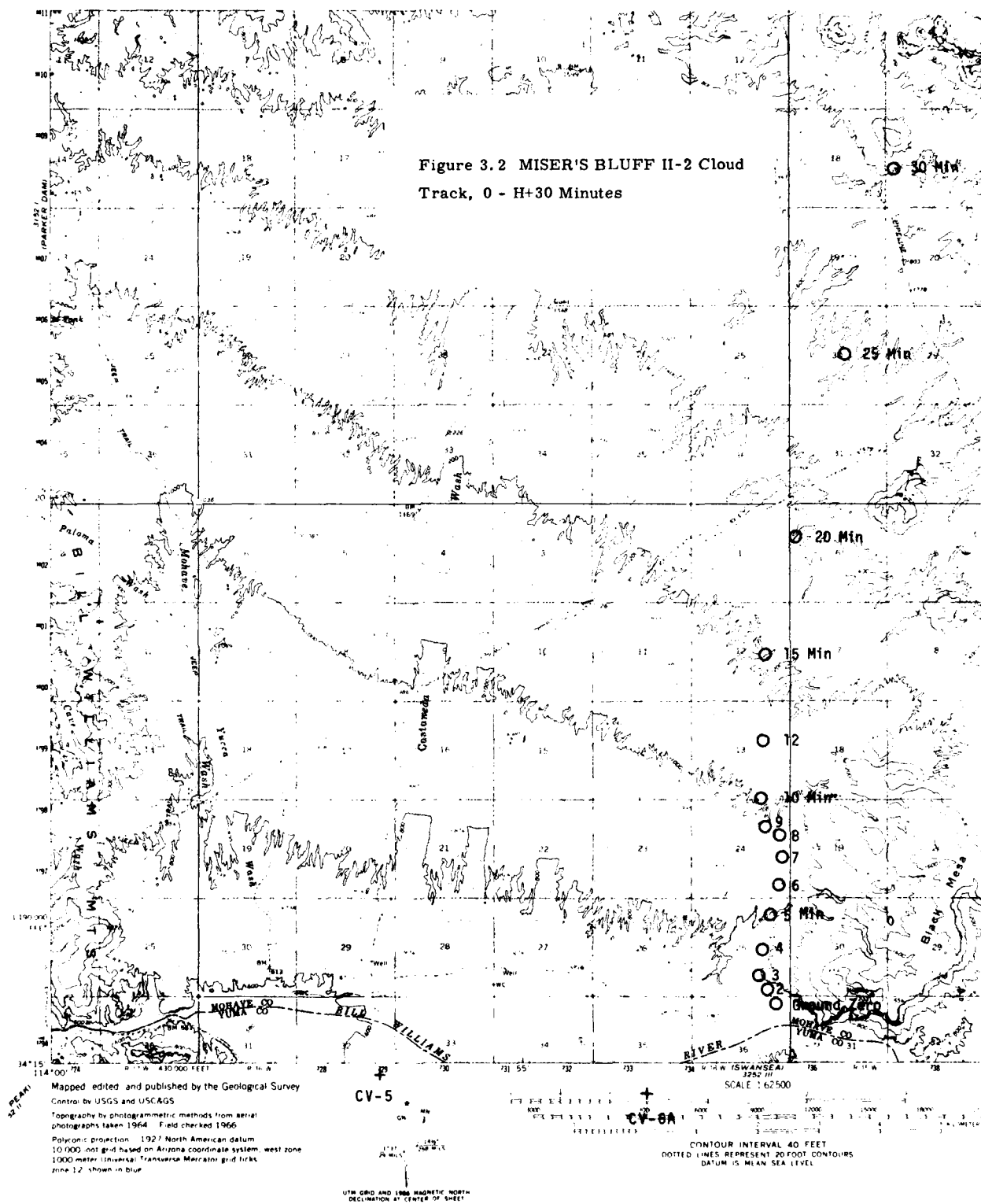
Utilizing photographic triangulation data from two photo-optics sites at station CV-5 (ranch) and station CV-6 (O. P.) an azimuthal ground track was determined for the single burst event of 28 June 1978. The base leg for the triangulation stations was essentially 3 miles and the determinations were carried out to a range of the order of 10 miles. Figure 3.1 shows the ground track path of the measured geometric center of the horizontal extent of the cloud as defined by the two station perspectives. The rapidly northward moving cloud was guided by winds initially influenced by local topography near the detonation site. The overall motion of the cloud for the next half hour was generally uniform in velocity and northerly course.

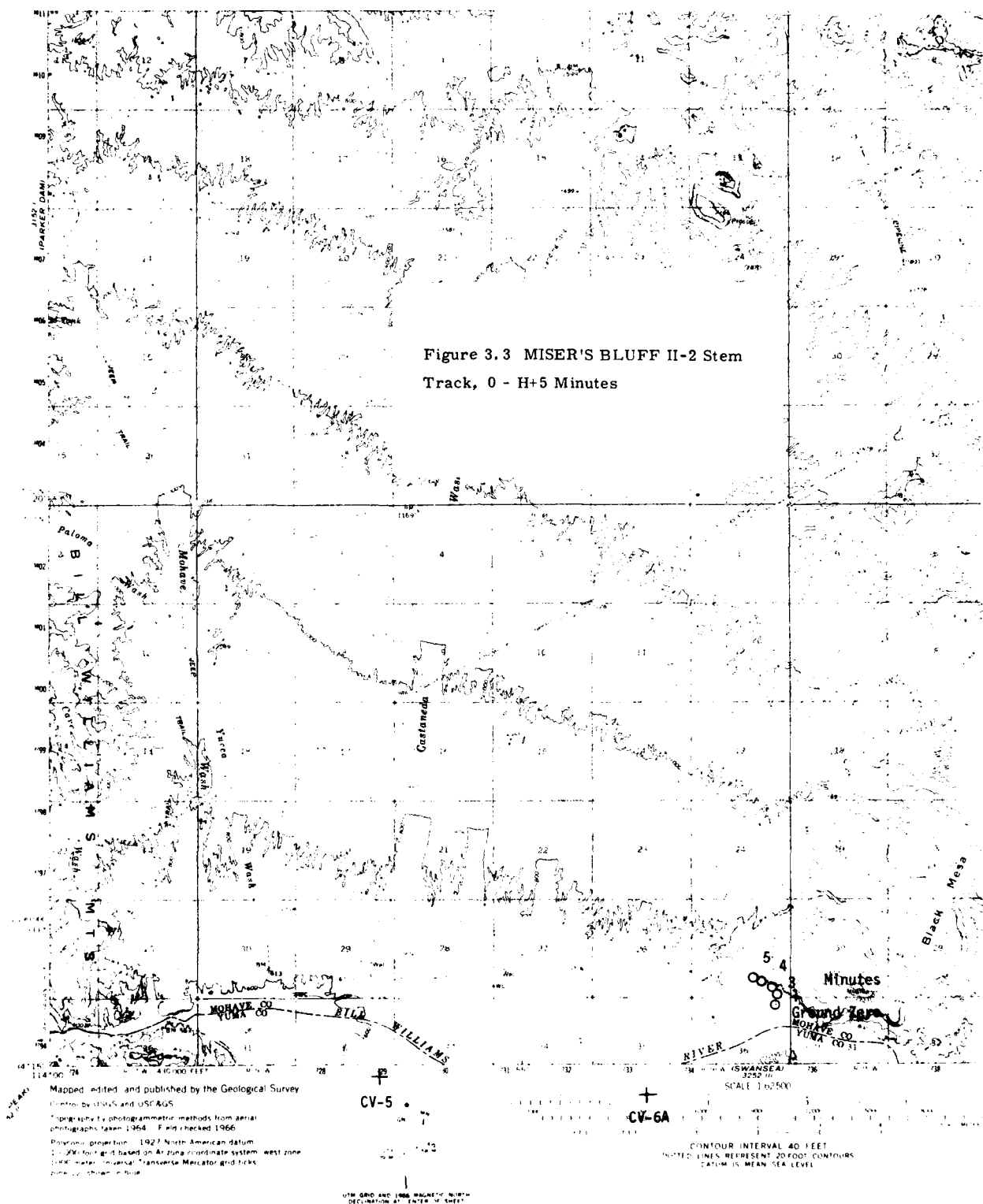
3.2 MISER'S BLUFF II-2 CLOUD TRACK MEASUREMENTS

The 30 August 1978 multiburst event cloud was triangulated in a manner similar to the single burst event. The ground track plot of the asymmetrical cloud top, shown in figure 3.2, showed a relatively slow cloud motion influenced only somewhat by the local topography at the higher elevations. At the lower altitudes, however, the local topography strongly influenced the lower cloud stem motion for as long as the stem was distinct, as illustrated in figure 3.3. The multiburst cloud was triangulated for thirty minutes at which time its apparent width was approximately 11 kilometers, as viewed from the direction of the triangulation stations.

The relative degree to which the cloud top and cloud/stem were influenced in their early motion by the local topographic features to the north of ground zero can be in a direct comparison of figures 3.2 and 3.3. The restrained motion of the stem relative to the top could be expected to concentrate the debris-dust fall-out pattern and use of this data in fall-out model analysis should be governed accordingly.







4.0 DUST CLOUD DATA MEASUREMENTS

4.1 MISER'S BLUFF EVENT II-1 PARAMETERS

Upon completion of the debris-dust cloud position triangulation, the range to the cloud was determined (e.g., Table 2.1), and subsequently the spatial parameters of cloud height and width calculated. Figure 4.1 shows the early cloud rise from ground zero to H+120 plus seconds, obtained from O.P. site data. The rise rate is seen to be nearly uniform at about 10 meters/second over this two minute period.

The maximum cloud height attained by the single burst event is shown as a function of time in figure 4.2. A stabilization height of about 3700 meters (12 kft) was reached at approximately H+8 minutes and this height remained essentially unchanged out to H+20 minutes. During this time the center of the cloud had moved north from ground zero about 15 km.

The apparent width of the Miser's Bluff II-1 dust cloud is presented in figure 4.3 from H=0 to 20 plus minutes. The difference in the cloud width data presented in this figure merely reflects the difference in perspective between the two optical sites of an irregularly shaped cloud.

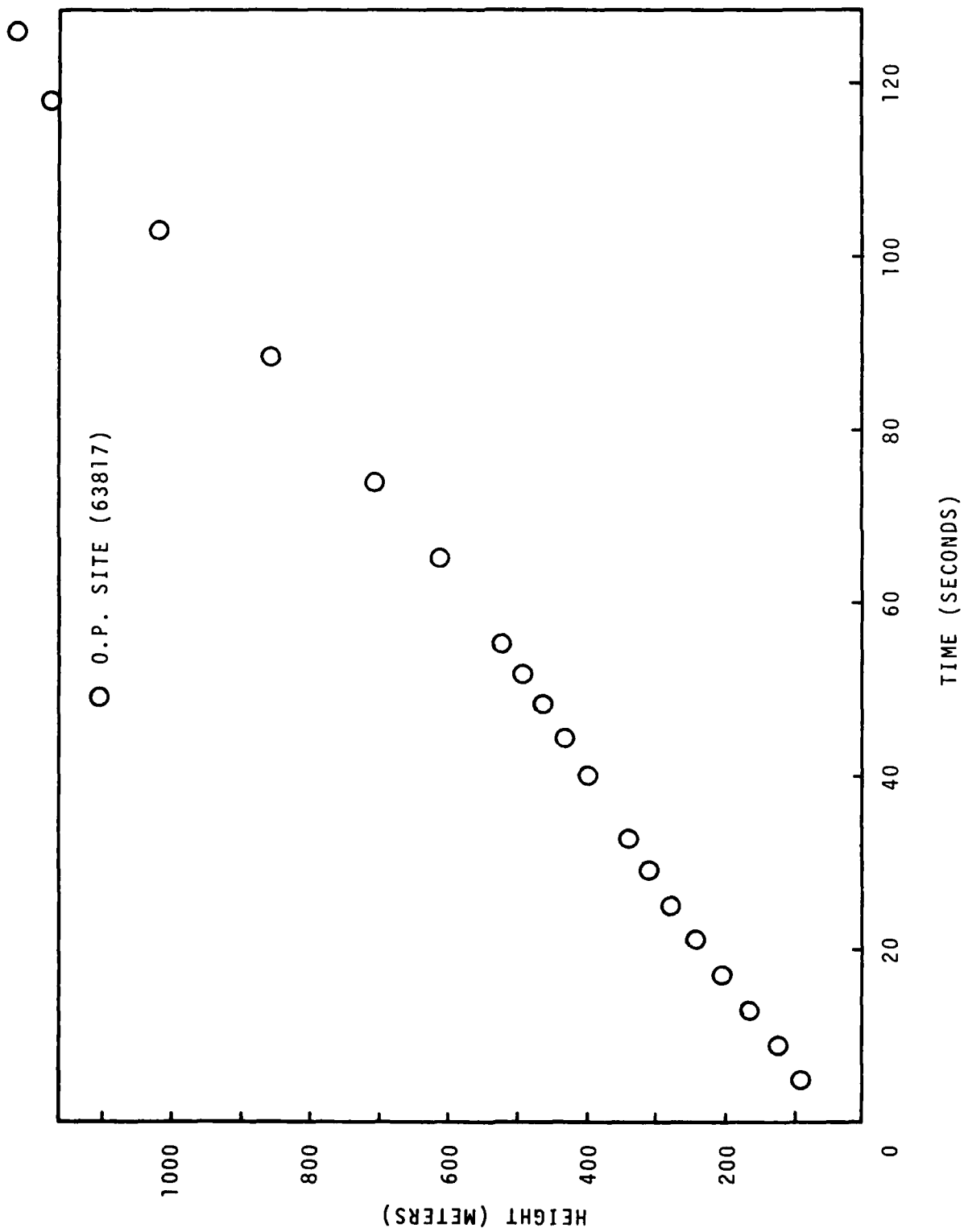


Figure 4.1 MISER'S BLUFF II-1 Early Cloud Rise Data

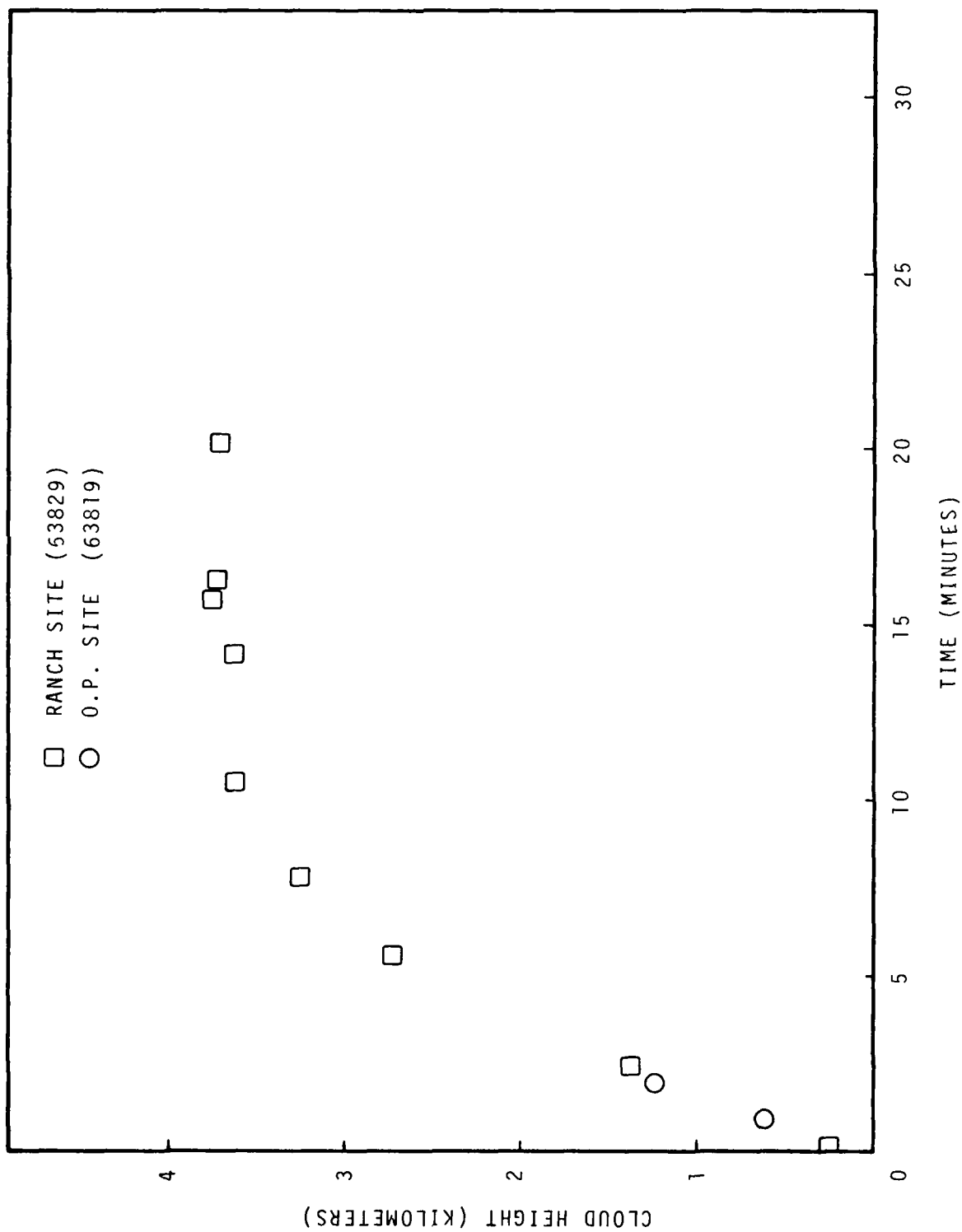


Figure 4.2 MISER'S BLUFF II-1 Cloud Height Data

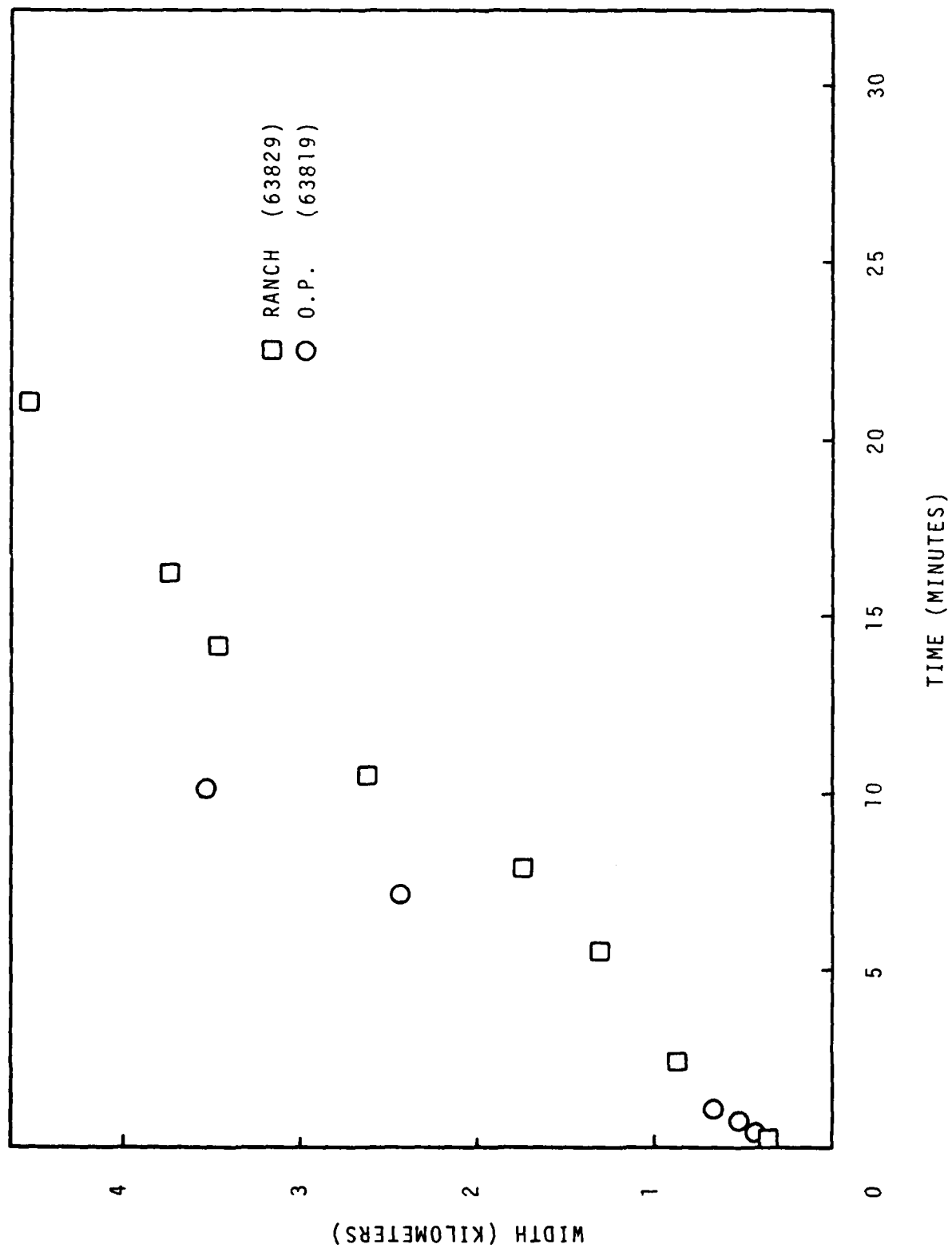


Figure 4.3 MISER'S BLUFF II-1 Cloud Width Data

4.2 MISER'S BLUFF EVENT II-2 PARAMETERS

3 The results of the multi-burst ANFO event early cloud top and stem rise measurements are presented in figure 4.4 as determined from the O. P. site photographic data. The initial rate of rise of the Miser's Bluff II-2 cloud is slightly greater than twice the rise rate of the single burst rate, or somewhat greater than 20 meters per second. In as much as a cloud stem was observable during this time period, the rise rate of the stem was also measured and incorporated into figure 4.4.

The overall cloud height of the multiburst event is presented in figure 4.5 out to H+30 minutes from ranch site data. Stem height data out to H+10 minutes is also included in this figure. The initially rapidly rising multiburst cloud reached a stabilization height of about 3200 meters in about 6 1/2 minutes. This cloud height was reasonably constant until about H+20 minutes at which point the center of the cloud was about 7 1/2 kilometers north of ground zero. At this point in time the top of the cloud began to rise slowly until an altitude of about 4000 meters was reached by about H+30 minutes.

Figure 4.6 shows the measured height of the cloud base to about H+20 minutes. The data is consistent between the two photo-optical sites as can be seen by the plotted data. This data is, by and large, higher than the top of the stem data from figure 4.5 because of the definition model used in making the independent measurements. An interesting plateau exists in the data between H+5 and 10 minutes.

The Miser's Bluff II-2 cloud width measurements are presented in figure 4.7 out to H+30 minutes as obtained from the ranch site photo-optical station. At H+5 minutes the cloud is about 2000 meters wide compared to a little over 1000 meters wide for the single burst event at this time. By H+10 minutes, however, both clouds exhibit a width of the order of 2500 meters. An inflec-

tion in the width curve of the multiburst event is evidenced at H+20 minutes at which time the curve begins to increase significantly - - in phase with and not inconsistent with the increased rate of rise observed in figure 4.5.

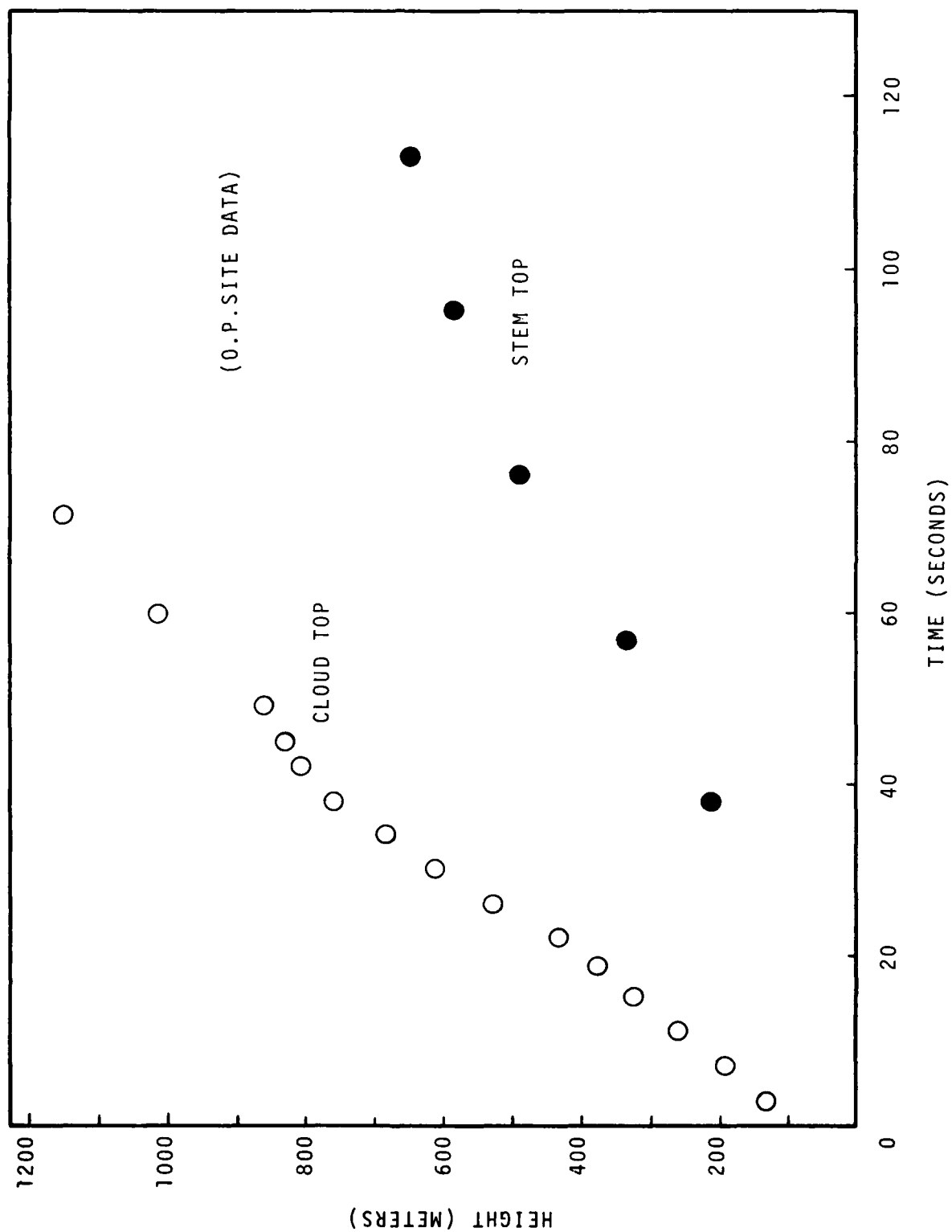


Figure 4.4 MISER'S BLUFF II-2 Early Cloud Rise Data

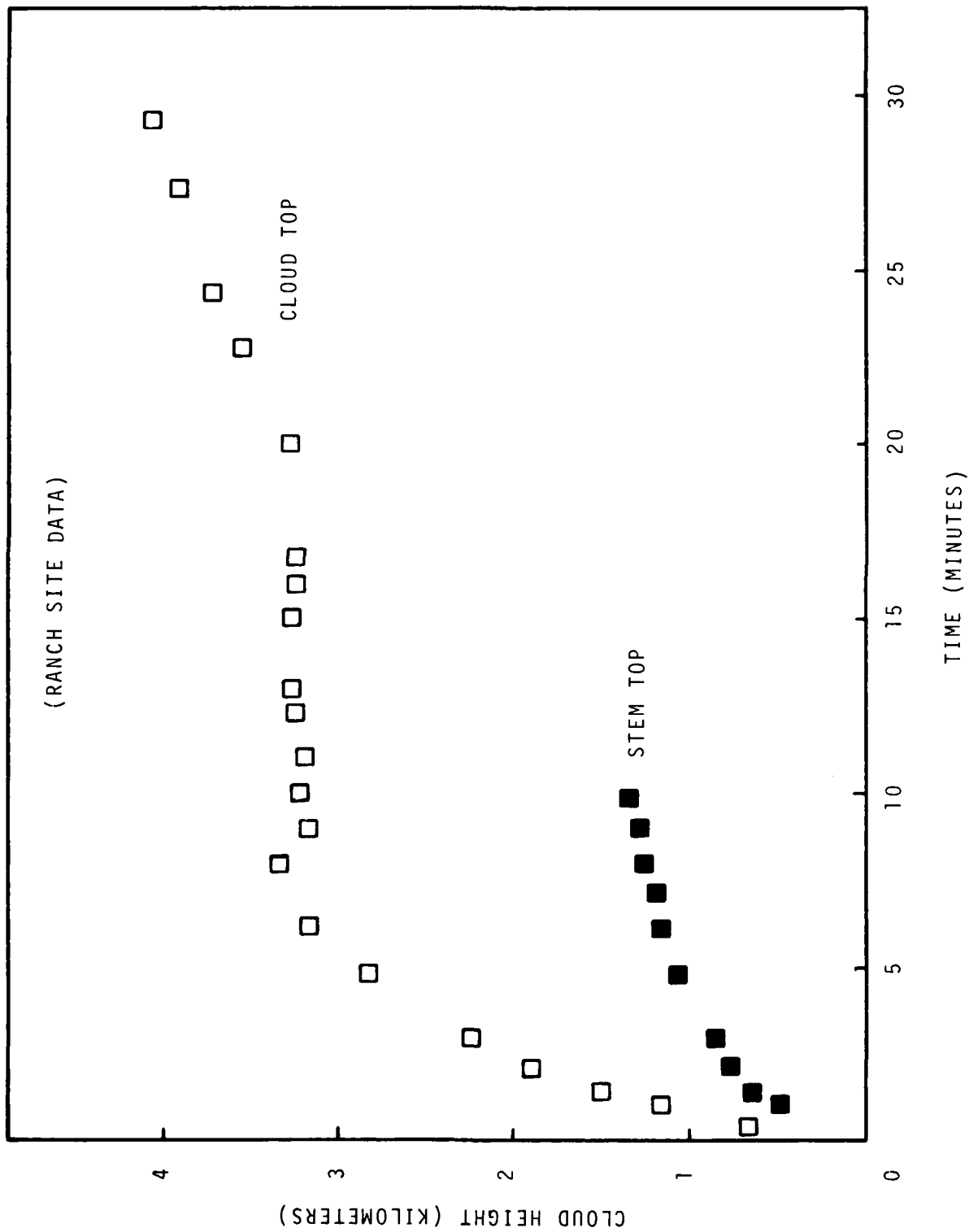


Figure 4.5 MISER'S BLUFF II-2 Cloud Height Data

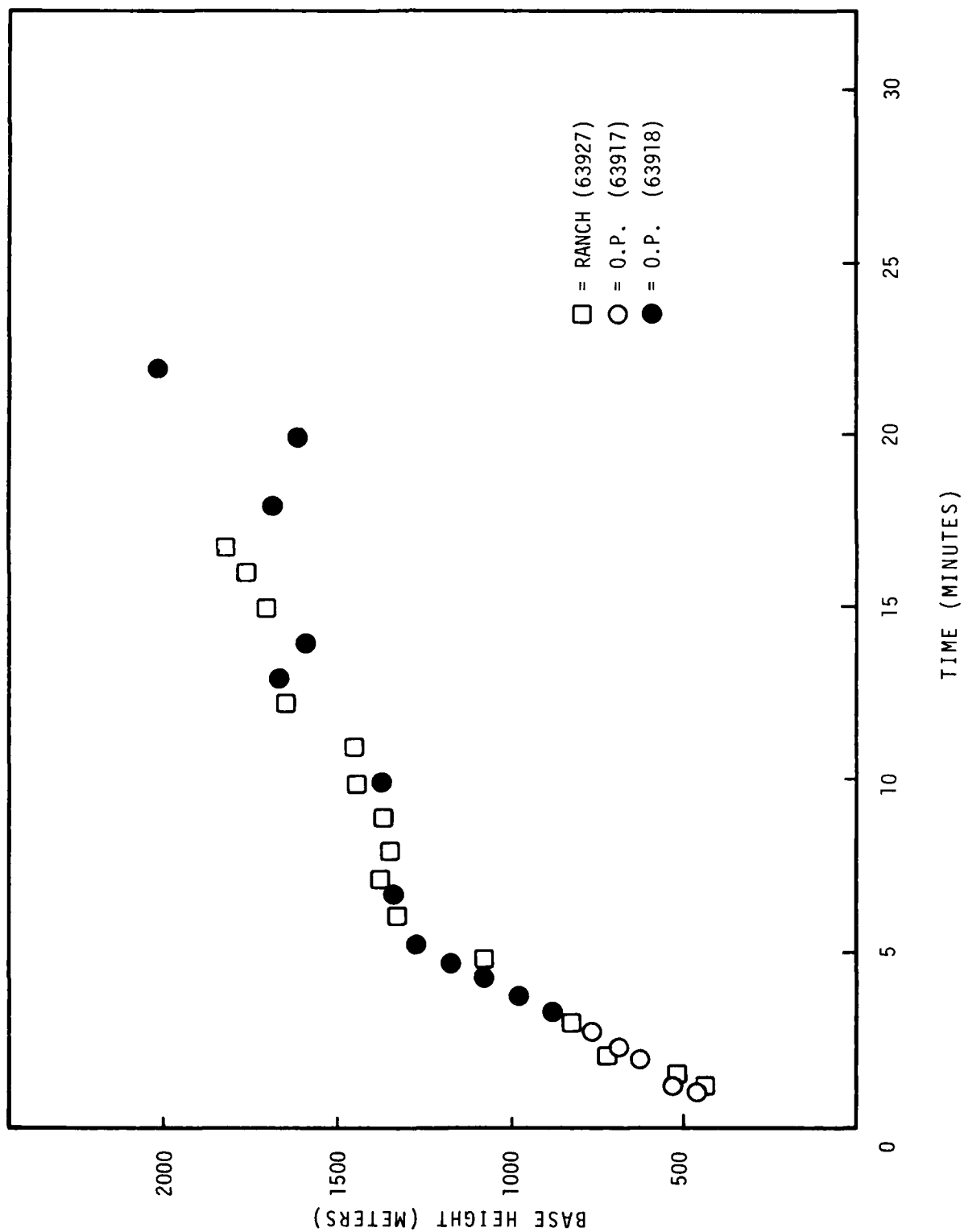


Figure 4.6 MISER'S BLUFF II-2 Cloud Base Height Data

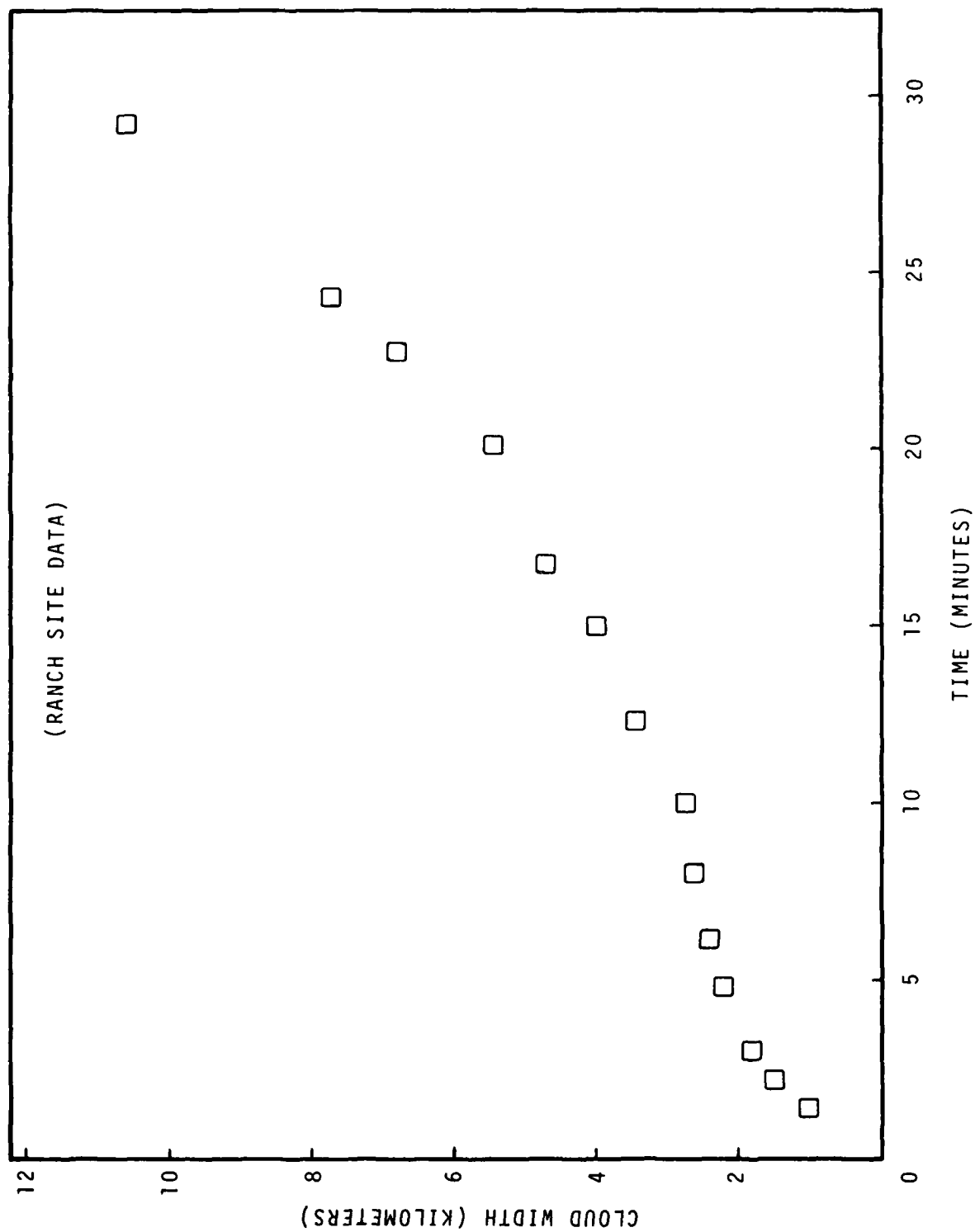


Figure 4.7 MISER'S BLUFF II-2 Cloud Width Data

5.0 CONCLUSIONS AND SUMMARY

The instrumentation/site matrix utilized by TIC for the Miser's Bluff II ANFO experiments provided an extensive data base from which triangulated cloud track and spatial dimensions were obtained as a function of time. The success of the optical plan employed would dictate that a comparable if refined plan be utilized in future experiments of this type.

The data presented in this report was extracted from the larger data content of the TIC photographic records to provide parametric information on the relative characteristics of a single and multiburst detonation for subsequent interpretation and model development within the DNA community. In addition, it should be noted as a matter of record that significant additional data is contained in the TIC records such as ejecta motion, shock wave motion, sampling aircraft penetration paths, and other data.

In addition to the dust cloud phenomenology coverage provided by TIC for the Miser's Bluff II experiments, it is appropriate to summarize for the reader other optical coverage of a phenomenological nature performed on these experiments. Early time blast and shock effects, DRI; radar correlated cloud photography, SRI International; overhead early time detonation photography, Williamson Aircraft Corporation; other airborne photographic coverage, PMS Incorporated.

APPENDIX A
COMPILATION OF MISER'S BLUFF II
INSTRUMENTATION PLANS

TECHNOLOGY INTERNATIONAL CORPORATION

INSTRUMENT PLAN

OPERATION: MISER'S BLUFF **DATE:** 6-28-78 **STATION:** O. P. SITE
EVENT: MB II-1 **LOCATION:** PLANET RANCH AZ **PROJ./ENGINEER:** DNA/RAAE

POSITION	INSTRUMENT	FOCAL LENGTH	FILTER	FILM	f/n	SHUTTER/RATE	REMARKS
11	DMB-4A	25mm	-	EMS 16mm x 200'		200 fps	17 x 23°
12	GCC	150mm	-	PXN 35mm x 400'		100 fps	6 x 8.5°
13	PS-5C	250mm	-	EMS 70mm x 200'		20 fps	7 x 13°
14	EL-500	250mm	-	SGE 70mm x 100'		1 sec	13 x 13°
15	BCD	215mm	-	EMS 70mm x 100'		program	15 x 20° clock
16	K-17D	305mm	-	AMS 9 1/2 x 125'		program	41 x 41°
17	K-17D	154mm	RGD	AMS 9 1/2 x 125'		program	74 x 74°
18	T-6	154mm	88A	HIR 4 x 5		manual	38 x 43°
19	K-8	210mm	-	6117		manual	29 x 40°

ADDITIONAL INFORMATION:

TECHNOLOGY INTERNATIONAL CORPORATION
INSTRUMENT PLAN

OPERATION: MISER'S BLUFF
EVENT: MB II-1

DATE: 6-28-78
LOCATION: PLANET RANCH AZ

STATION: RANCH SITE
PROJ/ENGINEER: DNA/RAAE

POSITION	INSTRUMENT	FOCAL LENGTH	FILTER	FILM	f/n	SHUTTER/RATE	REMARKS
21	DMB-4A	75mm	-	EMS 16mm x 200'		64 fps	6 x 8°
23	EL-500	250mm	-	SGE 70mm x 15'		1 sec	13 x 13°
24	EL-500	250mm	-	ACN 70mm x 100'		1 sec	13 x 13°
25	BCD	215mm	-	EMS 70mm x 100'		program	15 x 20° clock
26	K-17D	305mm	-	PXA 9 1/2 x 125'		program	41 x 41°
27	K-17D	610mm	-	AMS 9 1/2 x 125'		program	21 x 21°
28	K-17D	154mm	-	AMS 9 1/2 x 125'		program	74 x 74°
29	K-8	210mm	-	6117 5 x 7		manual	29 x 40°

ADDITIONAL INFORMATION:

TECHNOLOGY INTERNATIONAL CORPORATION

INSTRUMENT PLAN

OPERATION: MISER'S BLUFF

DATE: 8-30-78

STATION: O. P. SITE

EVENT: MB II-2

LOCATION: PLANET RANCH AZ

PROJ./ENGINEER: DNA/RAAE

POSITION	INSTRUMENT	FOCAL LENGTH	FILTER	FILM	f/n	SHUTTER/RATE	REMARKS
11	DBM-4A	25mm	-	EMS 16mm x 200		200 fps	17 x 23°
12	WF-14	50mm	-	EMS 16mm x 400		2500 fps	9 x 12°
13	PS-5C	250mm	-	EMS 70mm x 200		20 fps	7 x 13°
14	EL-500	150mm	-	EMS 70mm x 15		1 sec	21 x 21°
15	BCD	215mm	-	EMS 70mm x 100		program	15 x 20° clock
16	K-17D	305mm	-	AMS 9 1/2 x 125		program	41 x 41°
17	K-8	210mm	-	6117 5 x 7		program	29 x 40°
18	T-90	90mm	-	6117 4 x 5		program	56 x 68°

ADDITIONAL INFORMATION:

TECHNOLOGY INTERNATIONAL CORPORATION

INSTRUMENT PLAN

OPERATION: MISER'S BLUFF DATE: 8-30-78 STATION: RANCH SITE
 EVENT: MB II-2 LOCATION: PLANET RANCH AZ PROJ./ENGINEER: DNA/RAAE

POSITION	INSTRUMENT	FOCAL LENGTH	FILTER	FILM	f/n	SHUTTER/RATE	REMARKS
21	DMB-4A	75mm	-	EMS 16mm x 200'		200 fps	6 x 8°
23	EL-500	250mm	-	EMS 70mm x 15'		1 sec	13 X 13°
25	BCD	215mm	-	EMS 70mm x 100'		program	15 x 20° clock
26	K-17D	305mm	-	AMS 9 1/2 x 125'		program	41 x 41°
27	K-8	210mm	-	6117 5 x 7		manual	29 x 40°
28	T-90	90mm	-	6117 4 x 5		manual	56 x 68°

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for

DNA 5192T dated 1 October 1979

Reference DNA 5192T, "Optical Measurements of MISER'S BLUFF Multiburst Cloud Phenomenology," mailed to your organization 25 July 1980. MISER'S BLUFF should be changed to MISERS BLUFF throughout the report.