

Historical Information  
H.1 General

Book 7

Rulison Nocturnal Drainage Study,  
August 1970

HG26

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RULISON NOCTURNAL DRAINAGE STUDY

June 14-17, 1970

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RULISON NOCTURNAL DRAINAGE STUDY

June 14-17, 1970

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A series of four nocturnal oil fog releases were made in the RULISON Basin (upper Battlement Creek, ) Colorado, to gain some insight into the characteristics of drainage flow in an area of exaggerated terrain features (the slope in the vicinity of Ground Zero is approximately 1000 feet per mile.) Although only a few case studies were possible, drainage flow patterns, when they exist, are more or less independent of prevailing synoptic situations as decoupling from the gradient flow takes place. The fog releases were, however, supplemented by observations of surface winds and temperatures at several locations along the axis of the valley. Upper air observations of temperature and winds were also available as fog releases were in proximity to the time of the normally scheduled radiosonde release made in the valley. A supplementary vertical temperature sounding was available for three of the releases. Instrument and sounding locations are depicted in Figure 1. Wind tower 4 (T-4) is located in the lower right hand corner of this figure on Battlement Mesa which extends above 10,000 feet MSL. Following down Battlement Creek toward the opposite corner we have ground zero (GZ) and wind tower 3 (T-3) near 8300 feet MSL, tower 2 (T-2) 7000 feet, command post (CP) 6840 ft, Clem's Farm, a hygrothermograph location and tower 1 (T-1) both between 6400 and 6000 feet. Two other locations are CR-1 in the Colorado River Basin, hygrothermograph location, and CR-2, a radiosonde location near the community of Grand Valley.

The terrain above 7000 feet MSL is heavily wooded with aspen, fir, and cottonwood trees extending upward to 30-40 feet. Areas devoid of trees are usually covered with a dense shrubbery extending up to 7 feet in height. The

Morrisania Mesa area below 6400 feet MSL is generally pasture-type land with isolated trees, shrubs and buildings.

The fog was produced by a Clayton Pulse-Jet generator which vaporizes the liquid and ejects it into the atmosphere where the discharged vapor recondenses to form a fog or mist of minute droplets. The fog is much in appearance to natural radiation-type fogs. White in color, the fog has a high threshold of visibility under illumination of moonlight or twilight conditions.

Figures and tables for each fog release will follow the text for that day.

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# Rulison Bottleneck Creek Area

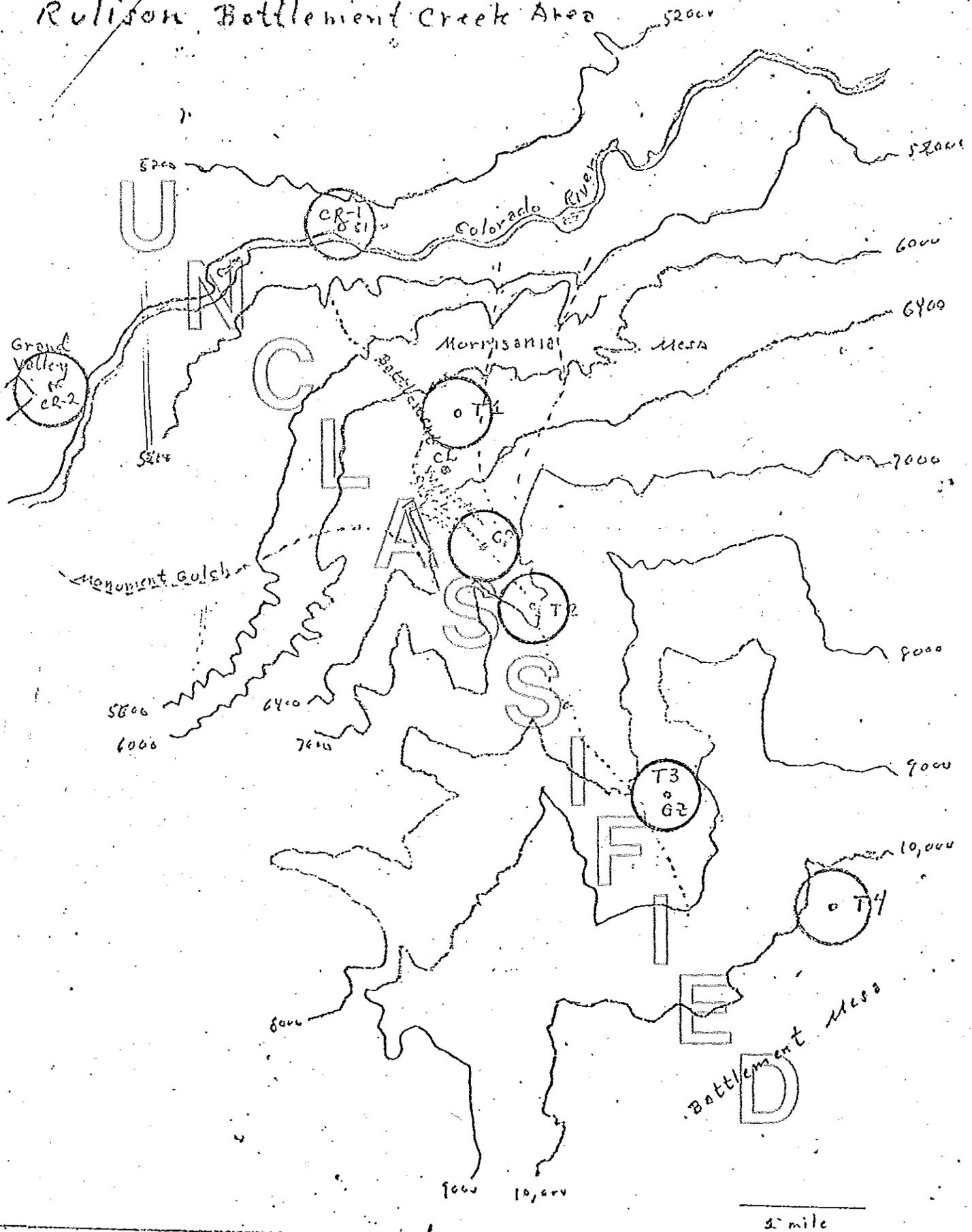


Figure 1-14 Instrument & sounding locations

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Fog Release No. 1

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Fog Release #1, June 14, 1970

Release Location: Ground Zero

Release Time: 0450 MDT Terminated: 0530

The synoptic situation:

On the 14th at 1200Z (0500 MDT) a closed low pressure cell at 500 millibars was centered over northern Idaho with a deep trough extending as far south as Baja, California. With a high pressure cell centered over eastern Texas relatively strong SSW flow was established over eastern Colorado with speeds upwards to 50 knots reported at Grand Junction. The surface pattern depicted a complex low and associated frontal system through eastern Colorado and Wyoming with the front extending on eastward. Skies over eastern Colorado were partly cloudy with thick cumulus clouds. The 700 millibar chart reflected much the same pattern as that existing at 500 mbs. (See figures 2-3-4)

Local Conditions: The 0500 MDT vertical temperature and wind sounding taken from the command post location (CP) (Fig. 2) reflected the strong SSW'ly flow with a direction of 200 degrees and 61 knots reported at 20,000 ft. There was very little shear in direction and wind speeds followed an almost perfect logarithmic profile from the surface up to 20,000 ft (see Table 1 and Fig. 5). The RULISON temperature sounding indicated a very weak (almost isothermal) surface inversion at a height of 7570 feet MSL or some 730 feet above surface level at the CP a second frontal-type inversion was present near 20,000 ft. Hygrothermographs placed along the slope at GZ, T-2, Clem's Farm (CL) and in the Colorado River Basin (CR-1) indicated the probable existence of an

inversion between the river basin and tower 2. It is not known whether this inversion followed the terrain or assumed a more or less horizontal configuration. Local tower winds (the vector average for the period of the fog release) reflected the gradient wind direction of SSW'ly (except towers). See Figure 6 values for the tower winds are given in Table II.

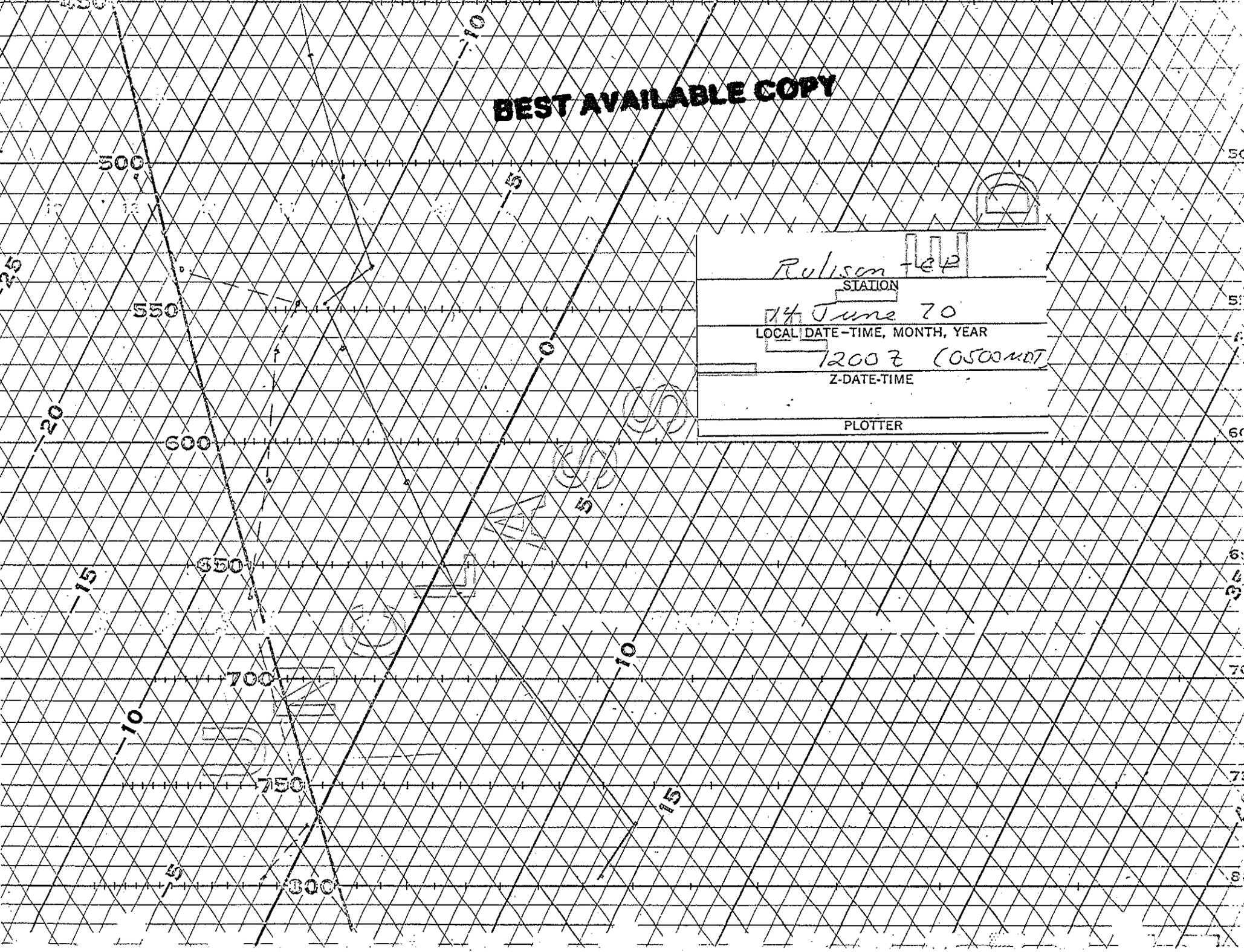
### The Fog Release

The duration of this release was restricted to approximately thirty minutes as we were not certain as to the extent which the fog would cause a pollution problem. During the period of release winds at the generator were easterly reflecting the flow from a side gully and rather gusty varying from 4 to 10 knots at rapid intervals. The resulting mechanical mixing resulted in portions of the plume being transported upward wherein it was rapidly dissipated. The bulk of the material, however, proceeded down slope where it quickly engulfed a large dense stand of aspen. Wind flow in this wooded area must have been on the order of one mph or less for after a duration of thirty minutes the fog had progressed only about a mile. Flow over heavy brush was equally slow and not well organized. Tower winds were south-southwesterly, however, the fog tended to hug the western slope of the valley which may have been caused by flow from feeder gullies on the east. The duration of the release was too short for the fog to traverse the distance to the lower mesa and the fog quickly dissipated with the arrival of sunlight into the valley. Efforts to detect the fog below the CP area were not successful. It might be noted that a patch of heavy cumulus clouds moved over the area during the period of release. It also appeared that periodically upper winds would break into the drainage flow and transport quantities of the plume upward where it would quickly dissipate. A

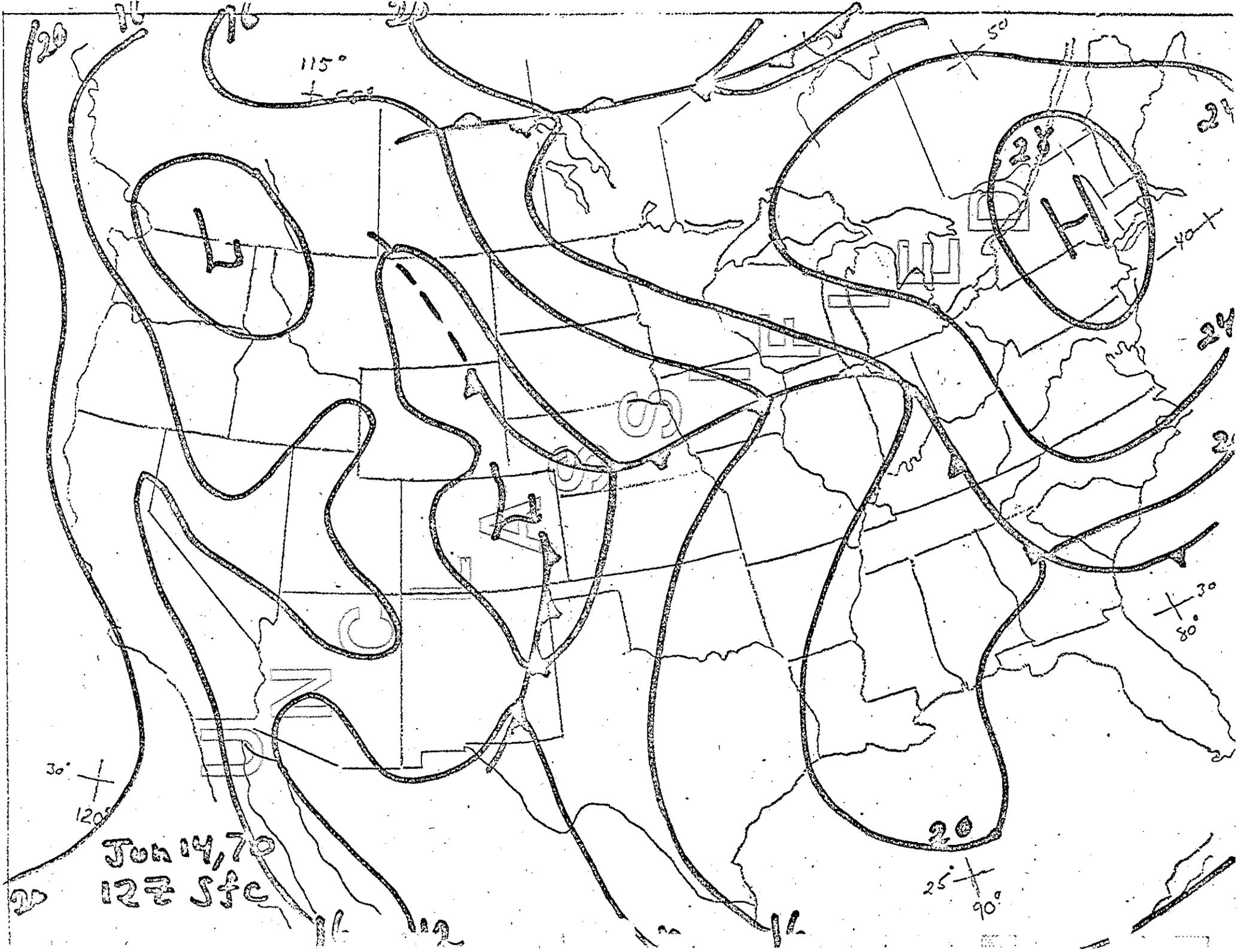
photo taken from the CP looking toward GZ is included in Fig. 9.

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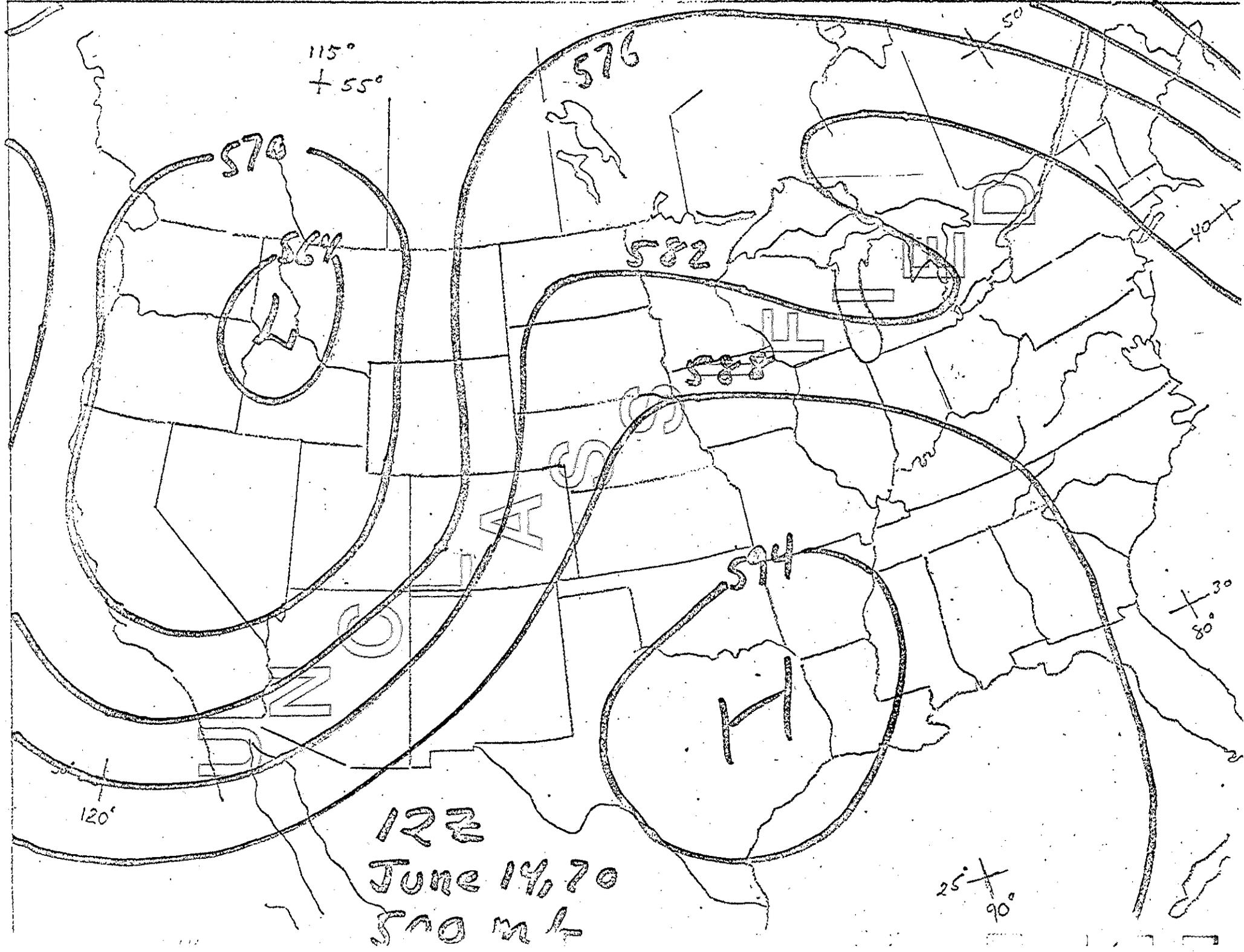


<i>Rulison</i>	<i>LEP</i>
STATION	
<i>14 June 70</i>	
LOCAL DATE-TIME, MONTH, YEAR	
<i>1200 Z (0500 EDT)</i>	
Z-DATE-TIME	
PLOTTER	



Jun 14, 70  
12Z Sfc





115°  
+ 55°

576

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564

582

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120°

122  
June 14, 70  
500 m h

25°  
90°

30°  
80°

40°

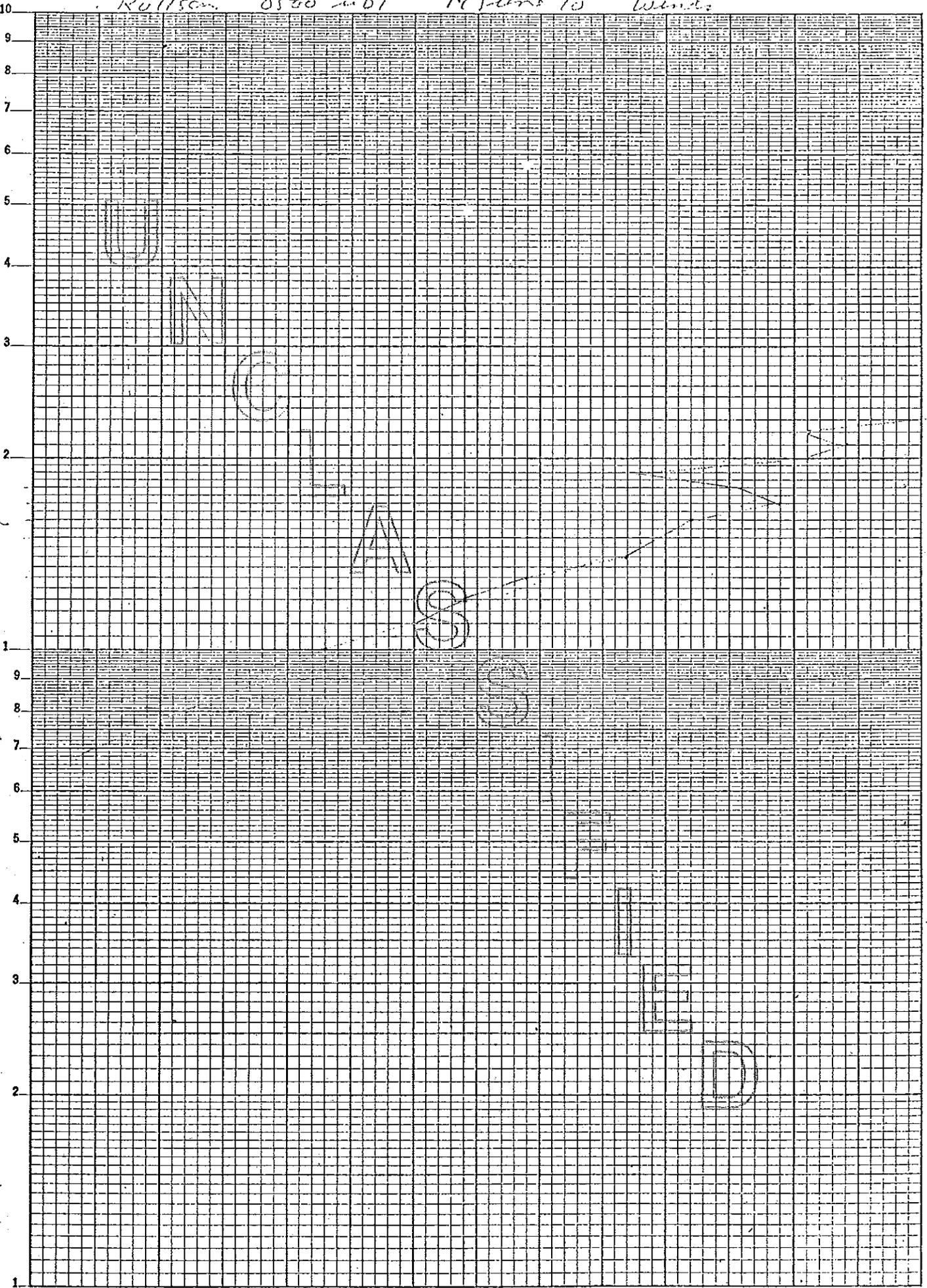
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2 CYCLES X 70 DIVISIONS

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Height Thousands of Feet (1:100,000)

Rullison 0500 MDT 14 June 70 Wind

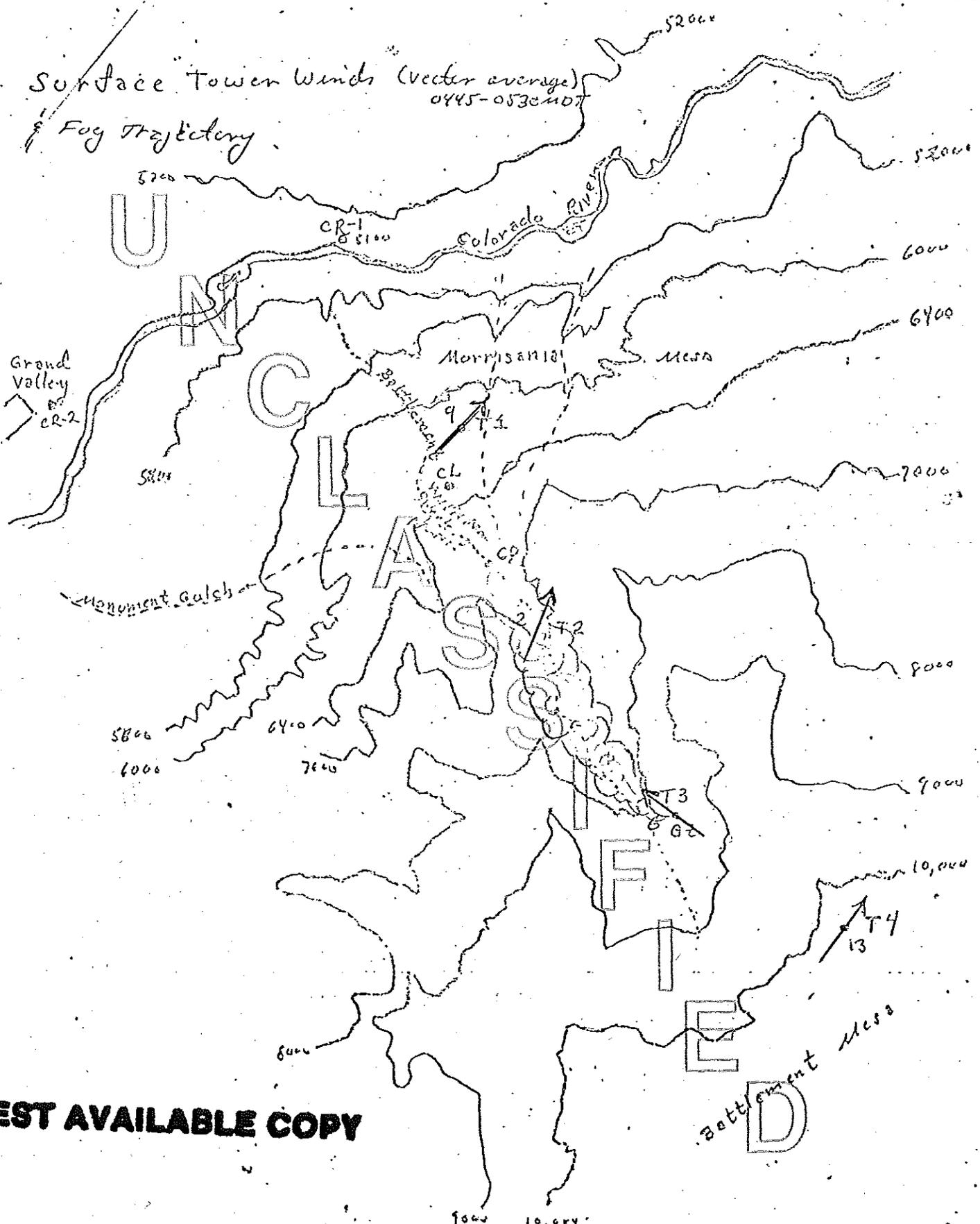


50 30 10 70

100 0 100 0 100 0

Rulison 6/14/70

Surface Tower Winds (vector average)  
0445-0530NDT  
Fog Trajectory

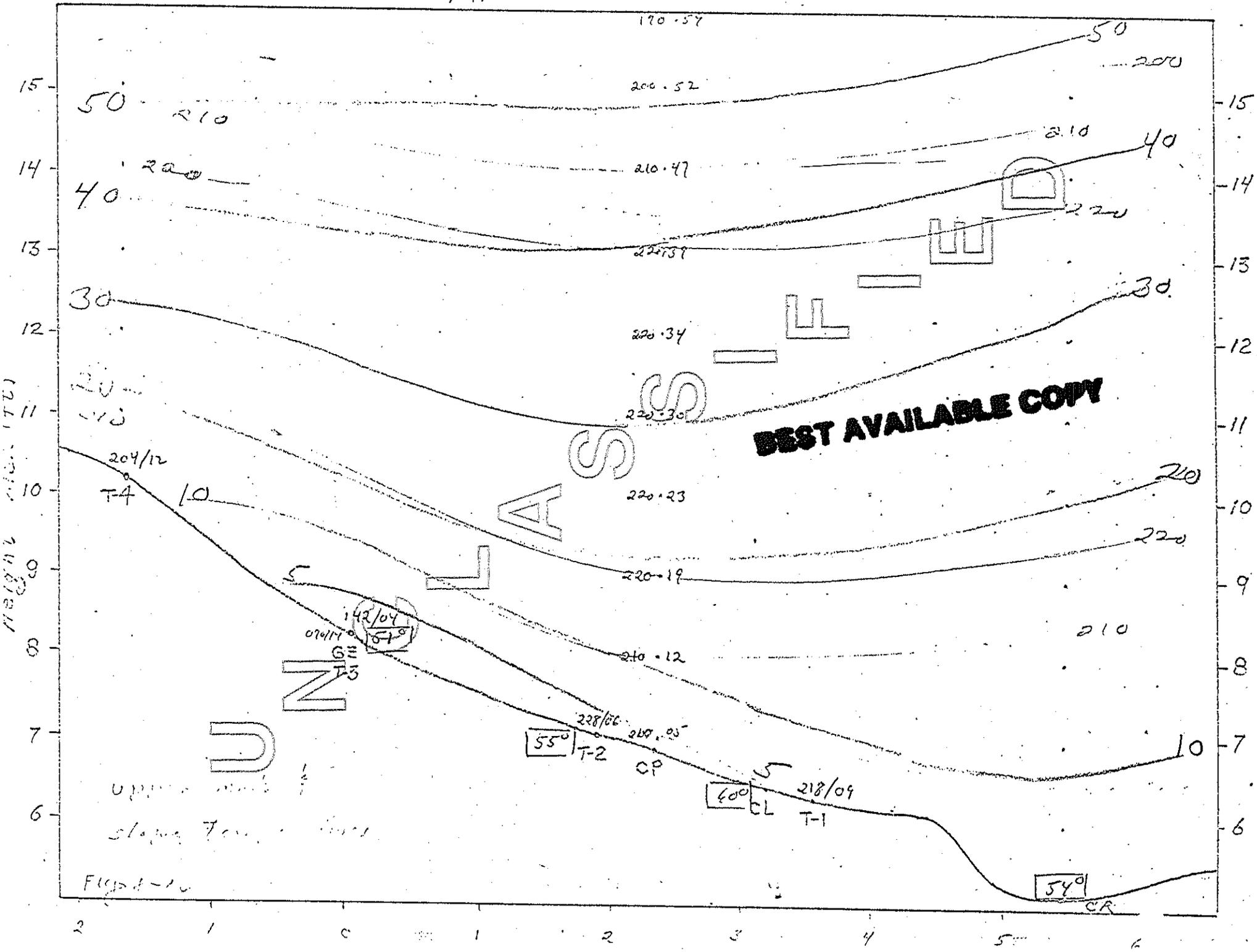


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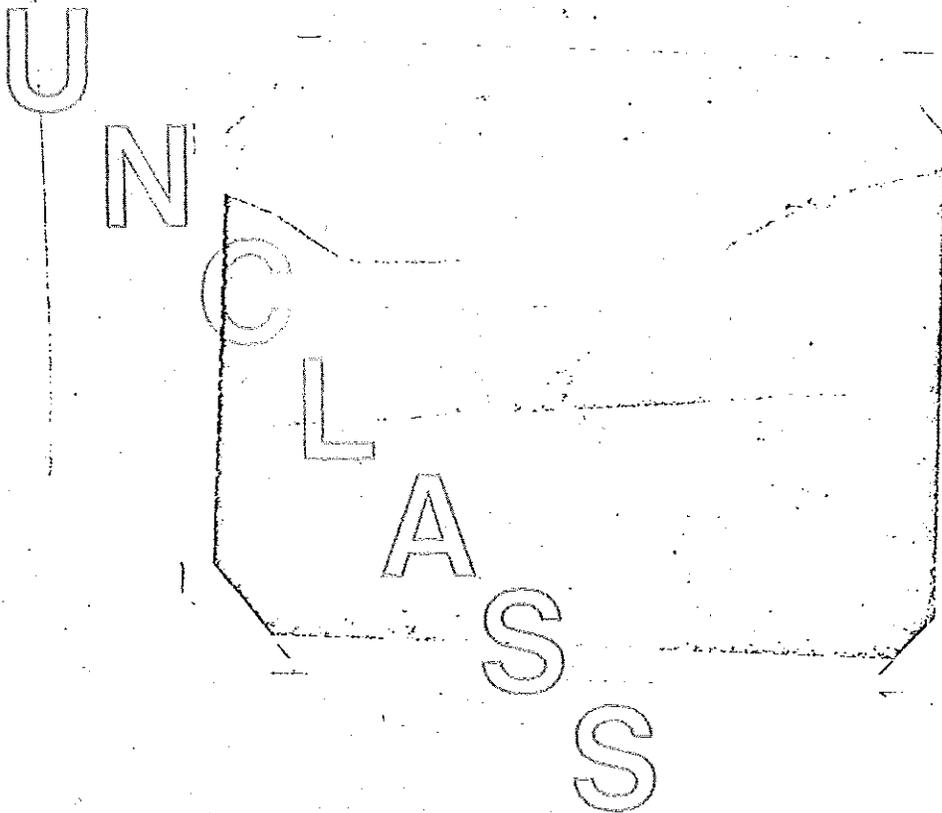
7-14

1 mile

RULLISON 6/14/79 0500 MOT



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Plume as seen from CP looking  
toward 67 0520 ~~1107~~ 6/14/70

(Disregard black smudge in sky)

Fig 9

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Fig. 9 Plume as seen from CP looking toward  
GZ 0520 MDT 6/14/70  
(disregard black smudges in sky)

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Log Release No. 2

June 1, 1970

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Fog Release #2 June 15, 1970

Release Location: Ground Zero

Release Time: 0445 MDT Termination: 0630

The synoptic situation:

The closed pressure cell at 500 millibars in the northwestern U. S. has deepened and moved northward over Alberta near the U. S. Canadian border resulting in continued strong winds, but shifting the direction of flow to the SSW. The 700 millibar chart again is almost a direct counterpart of the 500 mb chart, however, the gradient is considerably reduced. At the surface the complex low pressure cell remains in Eastern Colorado and Western Nebraska with higher pressure pushing in over the western tier of states. This resulted in relatively clear skies enhancing the radiative cooling (see Figs. 1-15, 2-15, and 3-15).

Local conditions: Tower 1 winds on the Morrisania Mesa were light and extremely variable ranging in direction from 330 degrees to 149 degrees, however, the average vector wind indicates a normal down slope flow. Winds at other towers were much less variable with towers 2 and 3 recording the normal down slope-drainage-type flow. Tower 4 on the ridge top was more in line with the gradient flow. The vector average wind direction and speed for the period of the release is shown in Figure 4-15. Wind direction and speed for each tower is shown in Table I-15 by three minute intervals.

0500 MDT slope temperatures indicate a well developed inversion in the lower basin with the top possibly in the vicinity of Clem's Farm (CL). This would present a depth in the lower valley of approximately 1500 feet. The 0500 radiosonde release however, indicated an inversion of 2.8 degrees Celsius

extending 1,790 feet above the CP compound. A supplementary radiosonde release was made at ground zero indicating a rather intense shallow inversion (200 ft) just off the surface becoming 150 thermal for another 200 feet above that level. Signal was lost at 718 millibars, but the lapse rate was approaching, adiabatic by this time. (See Fig. 6-15). From this date it would appear that a deep pool of air was present in the valley underlaid perhaps by even cooler air moving down the Colorado River Basin. It might be noted that the wind direction on the sounding (Fig. 5-15 and Table 1-15) indicates a zone of transition near the level of the inversion indicated from the sounding taken from the CP. A pibal was also taken at GZ at 0645 and although displaced in time from the 0500 sounding it would serve to indicate increased wind speeds as the air flows over Battlement Mesa.

#### The Fog Release

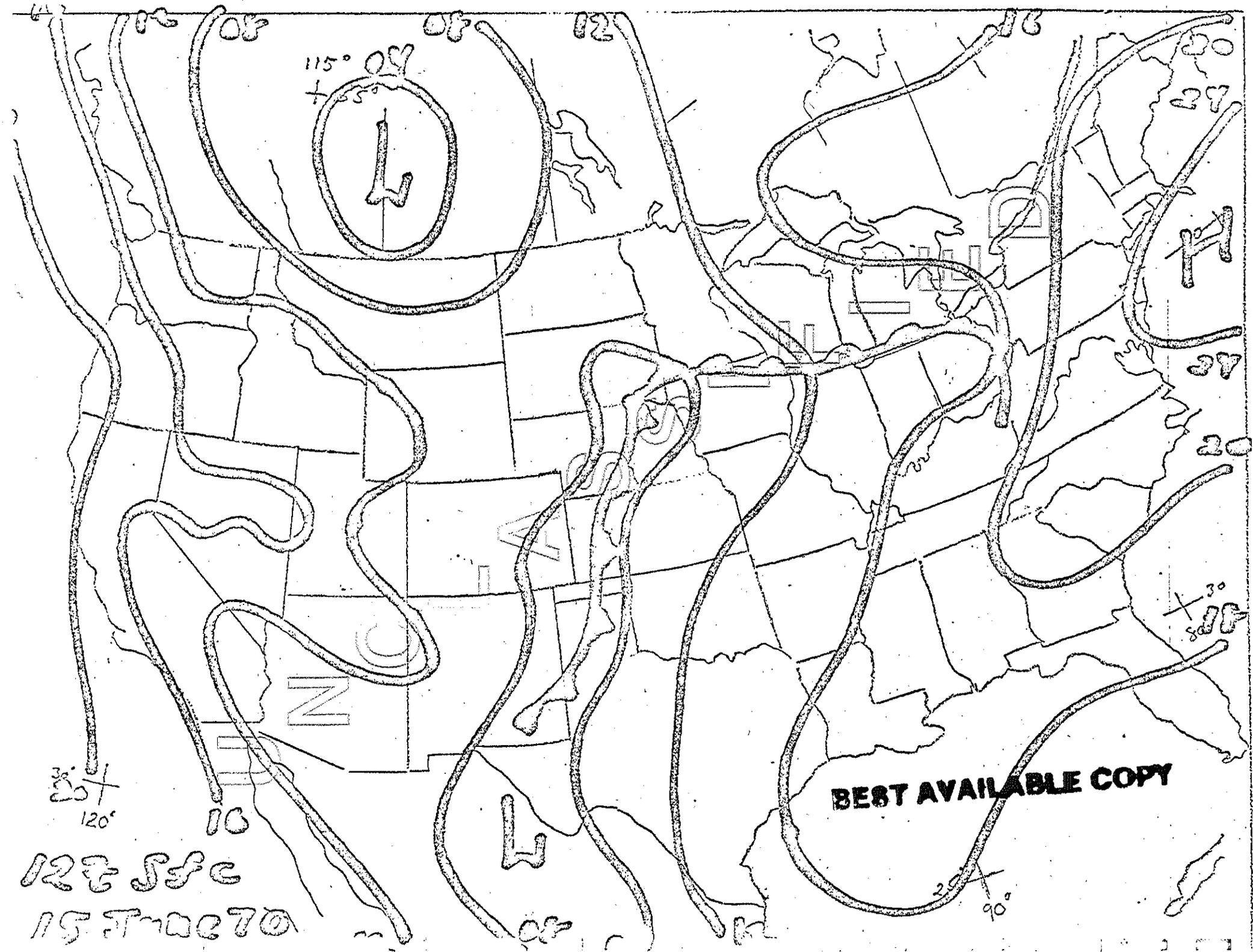
The plume originating from the generator at ground zero appeared to divide into two segments. The major portion of the plume was transported to the north with winds from about 180 degrees. This segment moved out almost horizontally and was actually forced up and over a small ridge on the east slope but staying well below the top of the major ridge projecting northward about 1000 feet above the plume. (See Fig. 4-15). A smaller amount of the fog was captured in the skin drainage and was confined to the center of the valley axis. The slow air movement among the trees and dense foliage retarded the movement of this portion of the plume causing it to be very diffuse by the time it reached the CP. Fog passing the CP appeared to turn to the west along Battlement Creek, but it could not be seen beyond this point.

Driving east along the Morrasianna Mesa road and also on the highway on 6-24,

the fog could be seen at about the 7000-foot level concentrated along the almost vertical sides of the steep cliffs to the north of the Colorado River and spreading eastward. The plant across the river was not in operation leaving no other source of pollution.

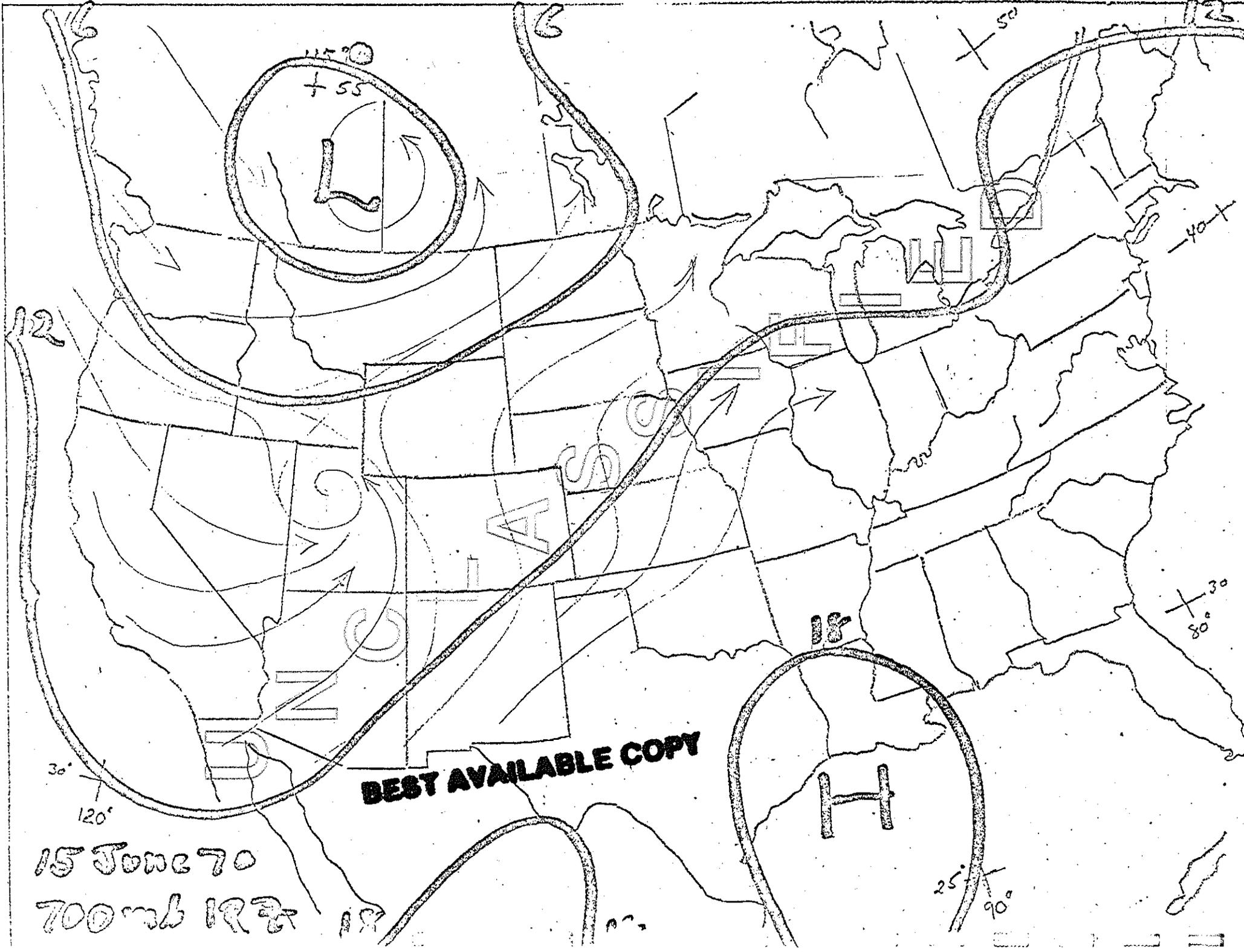
It thus appears that the bulk of the plume broke through the shallow surface inversion present at GZ either due to mechanical turbulence or some initial buoyancy and was transported over the top of the inversion, as this portion of the plume did not move downward once above the Morrisana Mesa. The air was stable enough that once along the ridge it attempted to flow around the obstruction rather than over it.

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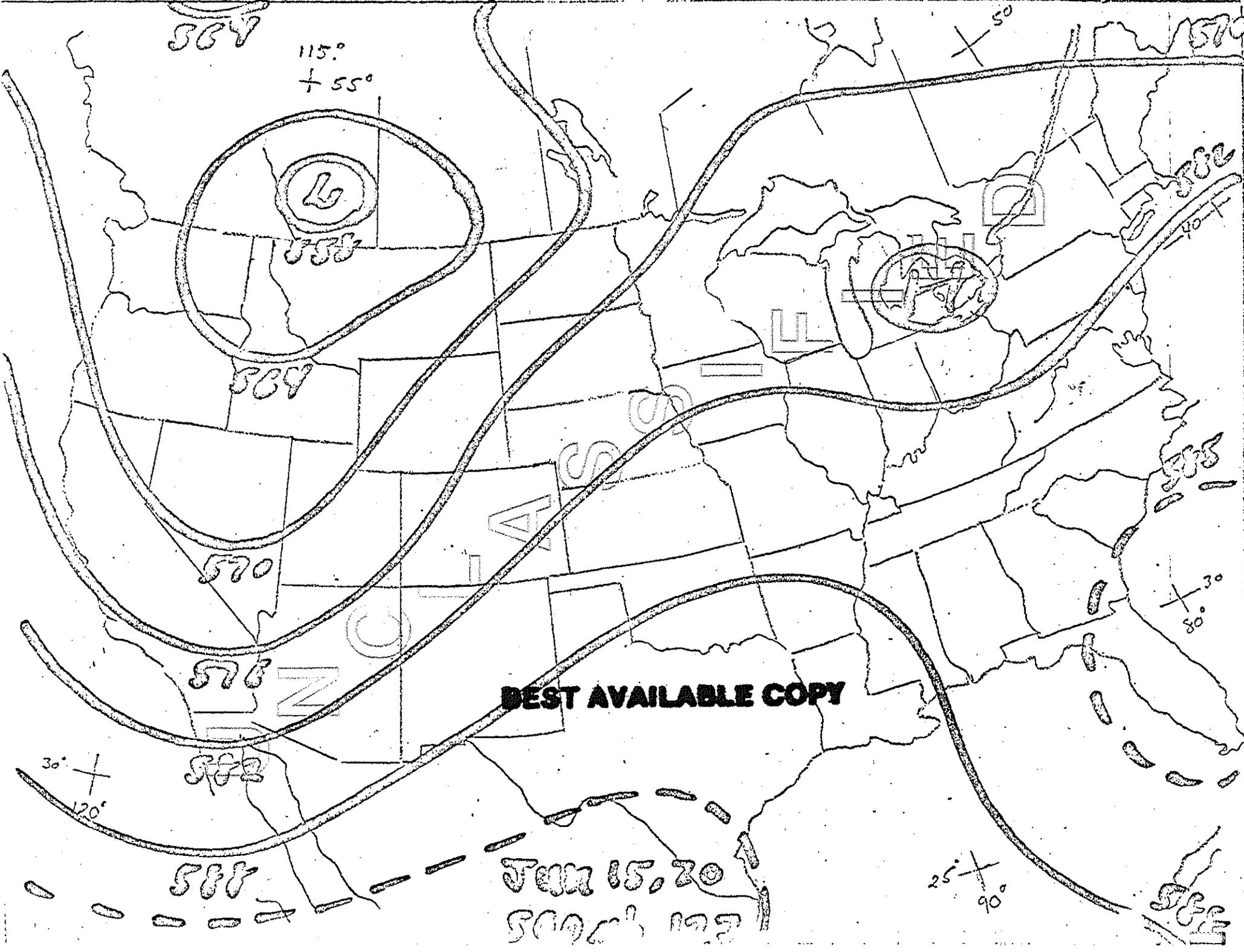
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127 Sfc  
15 June 70



**BEST AVAILABLE COPY**

15 June 70  
700 mb 197



584

115°  
+ 55°

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588

584

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JUN 15, 20

500 mb 127

570

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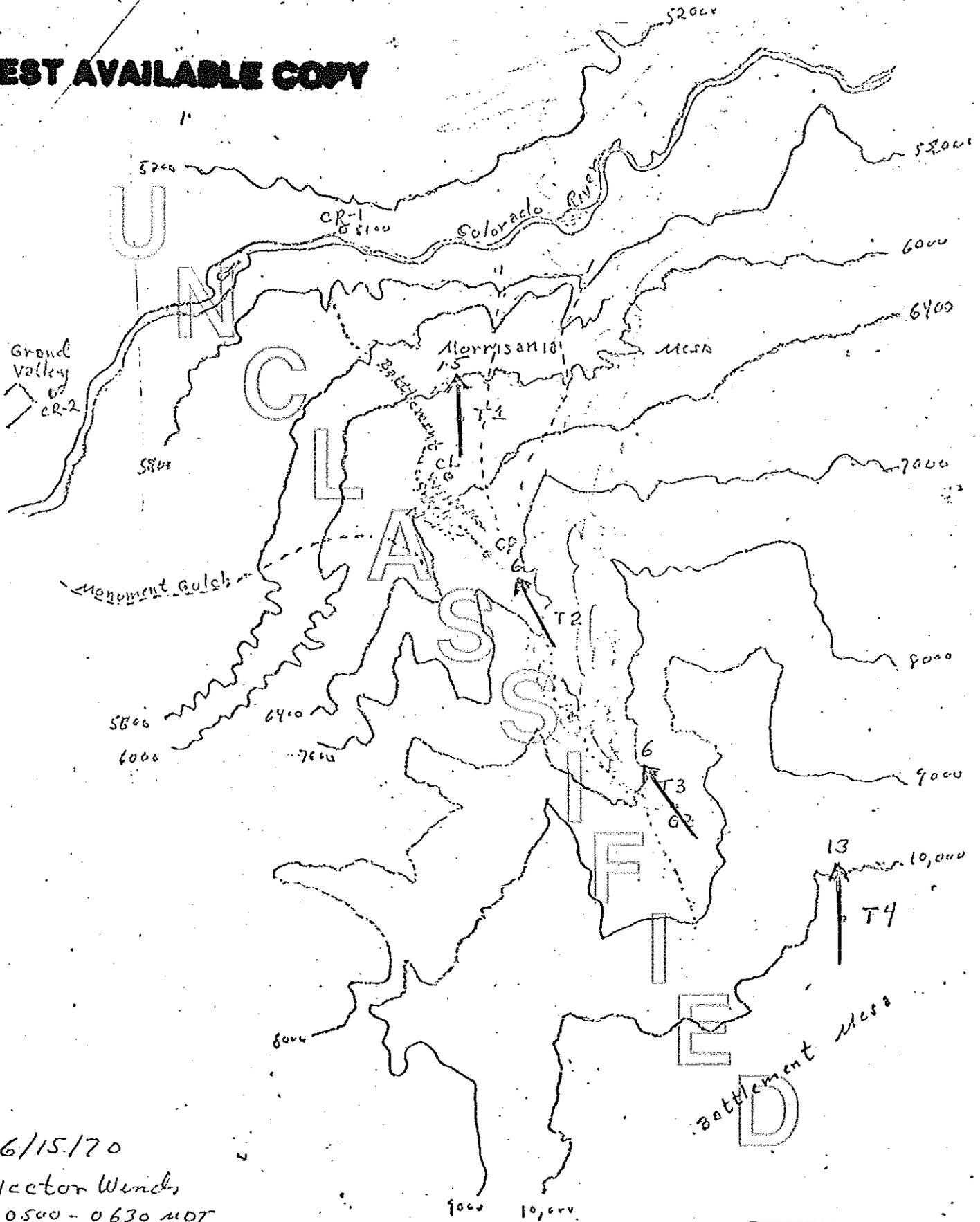
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80°

586

25°  
90°

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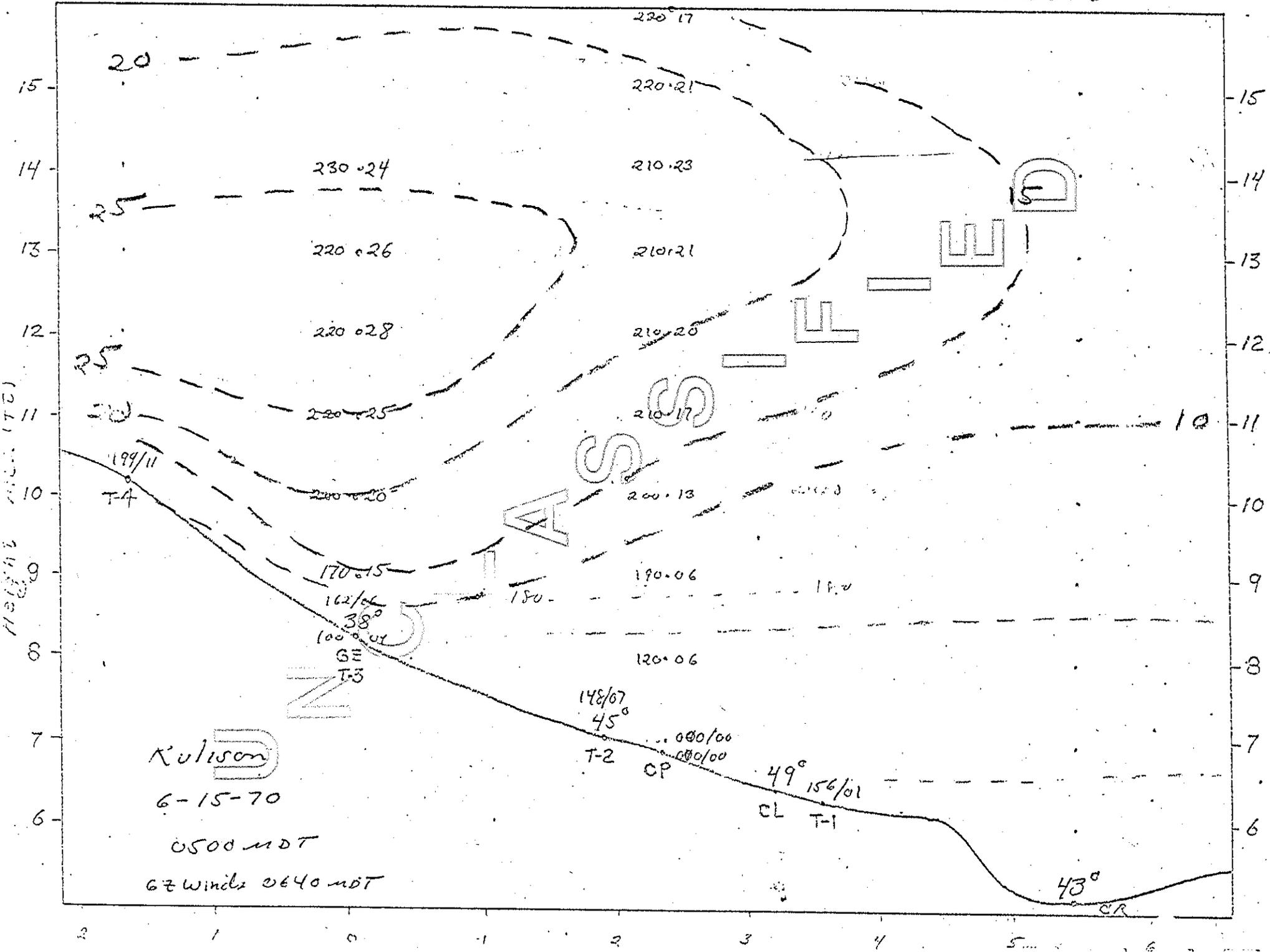


6/15/70  
Vector Winds  
0500 - 0630 MDT

FIG. 015

RULISON

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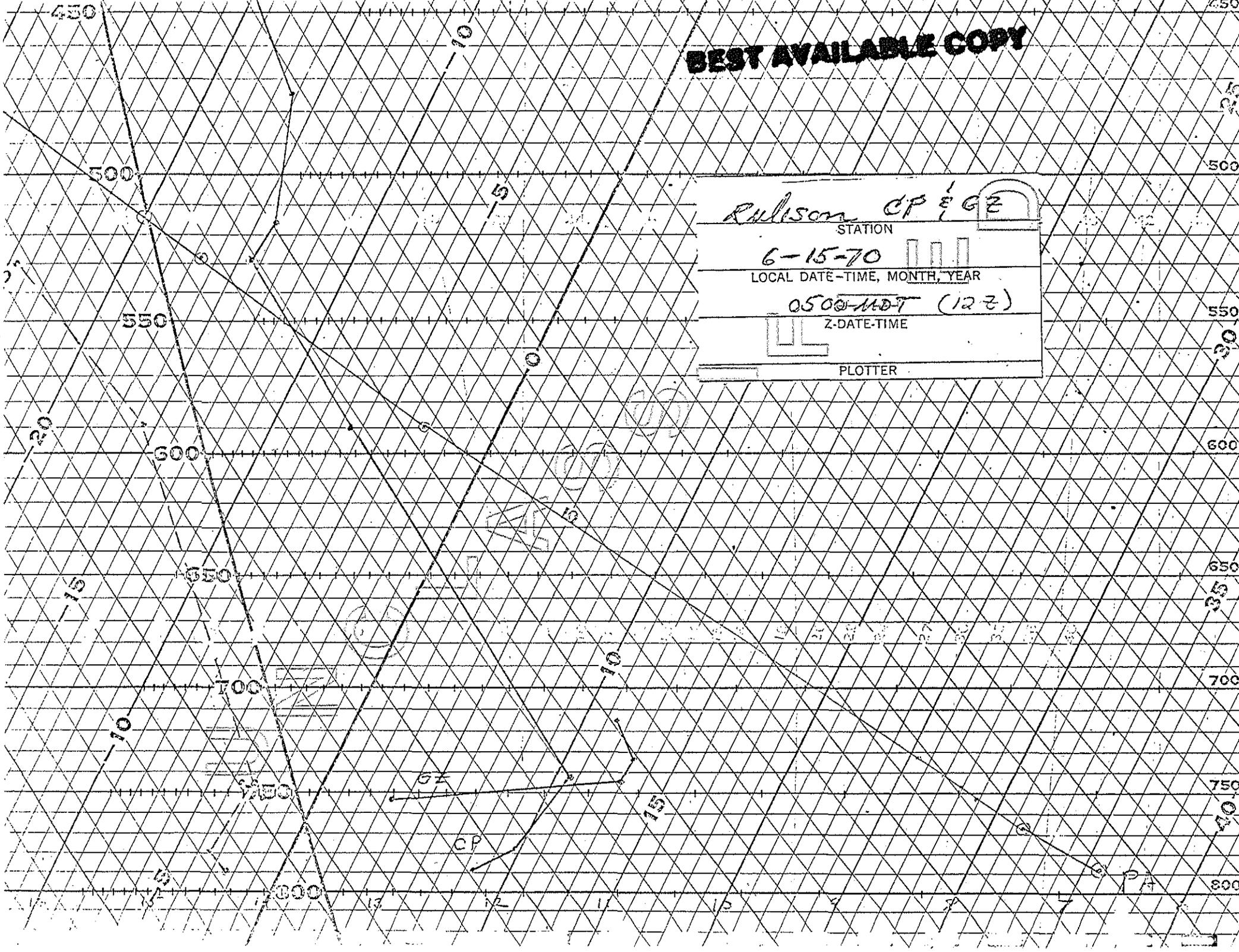
*Rulison CP & GZ*  
STATION

*6-15-70*  
LOCAL DATE-TIME, MONTH, YEAR

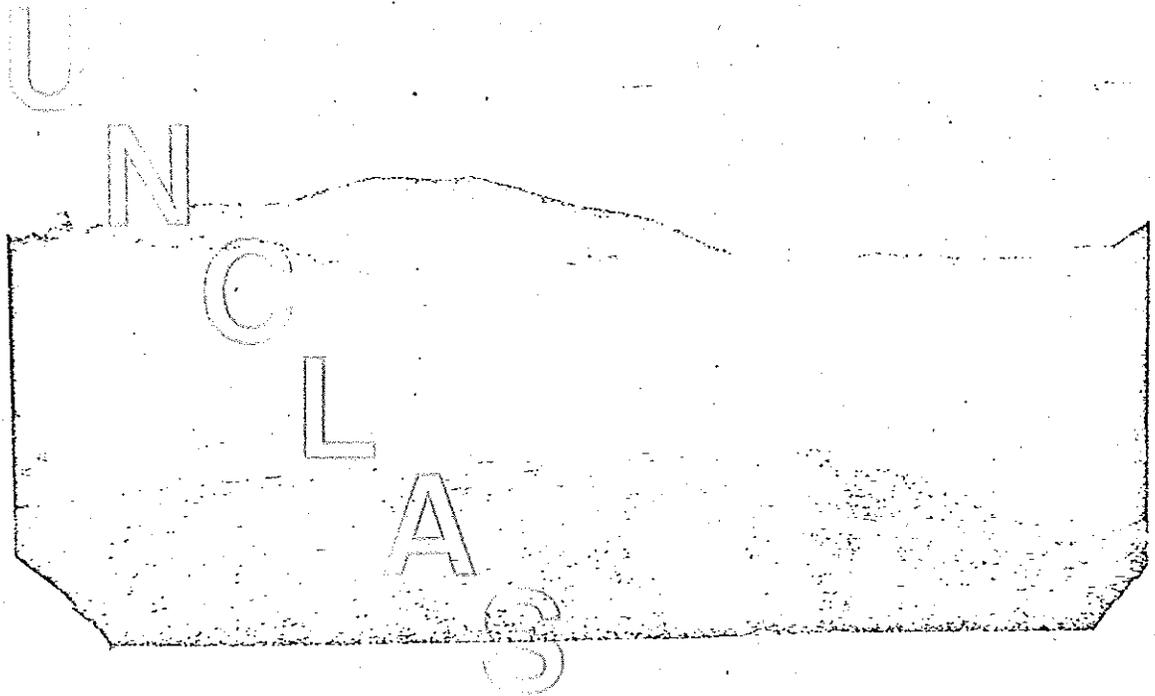
*0500 MDT (12Z)*  
Z-DATE-TIME



PLOTTER



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Photograph of **S** C - 1000 ft  
62 1/2 mi East - Taken at 05:48 & 05:55

Crater divides at **F** into a central  
valley and along ridge to east.

Some of the **I** are smaller than  
others in **E** and **D**

**E**  
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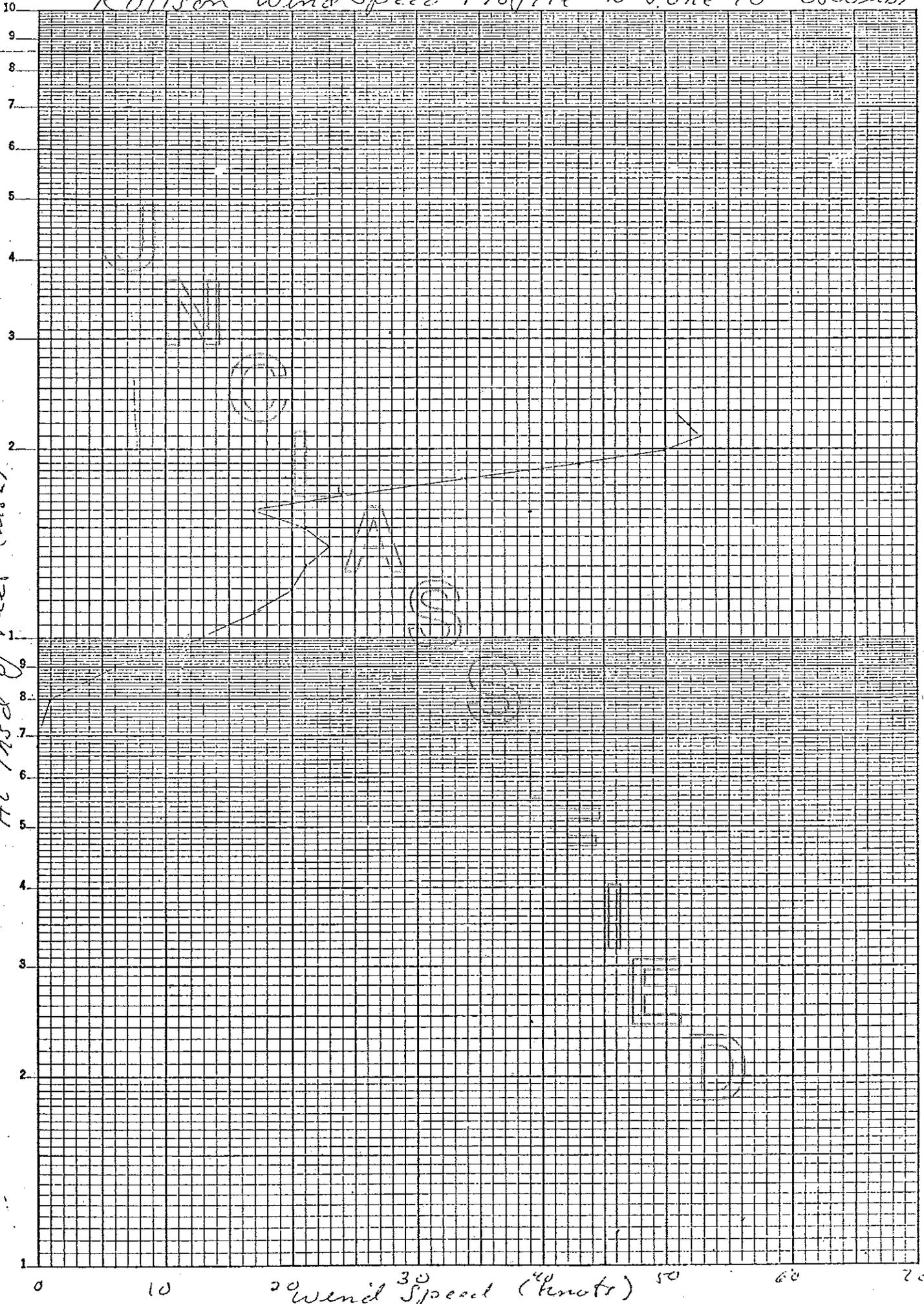
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Fig. 7-15 Looking from CP toward GZ and to east.  
Taken at 05:48 and 05:56. (Note division  
of plume into central valley and along ridge  
to east. Segments of plume are visible  
behind mound in foreground).

Rutison Wind Speed Profile 15 June 70 0500 MST


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 2 CYCLES X 70 DIVISIONS

Ht Third of Feet (msec)



0 10 20 30 40 50 60 70 Wind Speed (knots)

Table 1-15 June 15, 1970

RULISON Tower Winds

Time	T-1	T-2	T-3	T-4
0444	092/01	150/09	167/06	192/11
0500	? /01	148/07	162/06	199/11
0501	156/01	156/08	168/05	203/08
03	175/00	151/08	162/03	206/09
06	219/01	146/05	152/07	207/11
09	190/02	135/08	159/04	209/10
12	200/01	117/04	157/05	202/11
15	321/01	130/04	163/05	190/11
18	244/01	144/04	143/05	197/12
21	294/01	147/05	146/04	197/12
24	226/01	137/04	133/07	205/11
27	331/00	144/04	143/07	196/10
30	201/01	150/05	129/04	201/09
33	298/01	151/05	138/04	215/09
36	202/01	152/08	142/05	200/08
39	268/01	161/06	149/07	187/11
42	200/02	154/03	139/07	205/12
45	226/02	133/06	133/05	190/12
48	187/04	182/04	130/07	19? /14
51	192/02	142/06	12? /06	200/13
54	193/02	151/07	127/05	188/14
57	201/02	149/04	136/05	202/12
0600	186/01	166/02	152/06	178/13
03	178/02	148/10	134/07	178/09
06	m	m	m	m
09	161/02	163/06	139/08	191/13
12	149/02	153/06	121/08	196/15
15	089/01	150/05	128/04	182/13
18	165/03	108/01	140/07	178/16
21	182/01	147/07	153/06	185/18
24	180/03	158/07	157/09	171/16
27	169/01	153/11	163/08	161/15
30	144/00	148/06	193/07	167/18
Vector Average	172/1.5	151/5.8	147/6	180/13

Table I-14 RULISON CP 0500 MDT Radiosonde Temperature Values

Pressure (mbs)	Height (Thsd. Ft)	Temperature C°	Dew Point C°
793	6840	13.8	-1.0
773	7570	14.0	-0.1
664	11,640	1.8	-7.5
616	13,620	-3.2	-9.1
564	15,890	-9.0	-11.8
547	16,660	-10.5	-11.8
536	17,780	-9.5	-17.4
504	18,770	-12.4	-21.7
464	20,800	-16.4	-28.0
428	22,800	-20.5	-31.3
400	29,429	-25.4	-35.1

Height (Thsd. Ft)	Winds direction/speed (degrees)/(knots)
sfc	205/04
7	210/05
8	210/12
9	220/19
10	220/23
11	220/30
12	220/34
13	220/39
14	210/47
15	200/52
16	190/59

Table II-14 Tower Winds 6/14/70 RULISON

Time	T-1	T-2	T-3	T-4
0445	205/16	139/03	133/07	213/15
0500	218/09	228/06	142/04	204/12
0515	249/06	311/02	126/06	218/13
0530	247/09	162/03	107/07	231/14

A small 30-foot mast by the generator averaged 090/06, but fluctuated between 4 and 10 mph.

Table 2-15 June 15, 1970

0500 MDT RULISON Radiosonde

	Pressure (mbs)	Height (feet)	Temperature C°	Dew Point C°
Sfc	789	6840	8.4	-2.3
	778	7250	9.8	-3.2
	741	6830	10.7	-3.0
	590	14,610	-6.6	-15.5
	529	17,360	-14.3	-24.8
	516	18,000	-14.1	-27.9
	474	20,060	-16.1	-28.6
	400	24,222	-26.0	-37.6

Ground Zero Sounding 0500-

	Pressure (mbs)	Temperature C°
Sfc	753.5	3.2
	743.0	13.3
	733.0	13.0
	718.0	11.5

0500 MDT RULISON (CP) WINDS

Height (Thsd. Ft)	Wind direction/speed (degrees)/(knots)
Sfc	calm
7	calm
8	120/01
9	190/06
10	200/13
11	210/17
12	210/20
13	210/21
14	210/23
15	220/21
16	220/17

Table III-15 June 15, 1970

Supplementary Winds GZ 0640 MDT - RULISON

Height (Thsd. Ft)	Direction/Speed (degrees)/(knots)
Sfc	
10	170/15
11	200/20
12	200/28
13	220/26
14	230/24

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Fog Release No. 3 .

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The synoptic situation:

The deep low pressure cell at 500 mbs has drifted slowly eastward to a position along the Canadian-U. S. Montana border, however, the main trough has been tilted westward due to a vigorous minor trough moving into the system. The result is a veering of the flow at this level to a mere southwesterly direction over Colorado. Wind speeds are essentially unchanged. (See Fig. 3-16). At 700 mbs the flow is more westerly as the upper portion of the trough has flattened out. The surface map indicates a relatively weak pressure gradient over western Colorado as the frontal system continues its movement eastward. Sky cover over Colorado was generally clear except for isolated scattered clouds producing another night favorable for inversion formation.

#### Local Conditions

Tower winds at the time of the release are shown in Table I-16 for each three minutes during the low release. The vector average is depicted in Figure 4-16. Tower 1 evidently reflects drainage flow down the Colorado River Basin while Tower 2 and 3 reflect the normal downslope drainage winds. Tower 4 indicated south-southwesterly flow between four and five o'clock, but a more southeasterly flow from 5 to 6 o'clock giving a vector average of southerly.

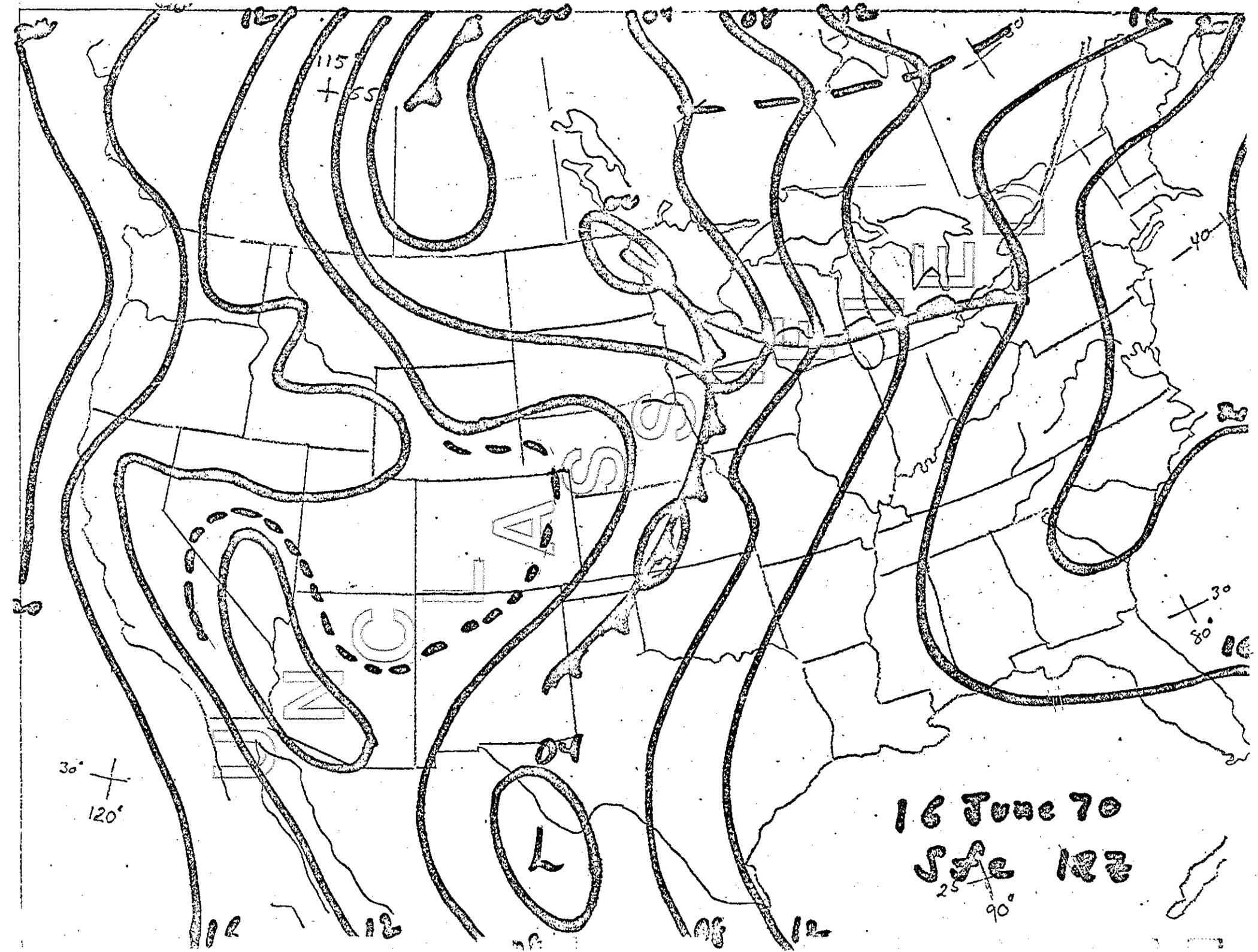
Winds from the 0500 MDT RULISON radiosonde are shown in Table II-16 and indicate a zone of transition near 9000 feet MSL. (also see Fig. 6-16) This level is, however, well above the inversion as shown on both the radiosonde observation from the CP and from Clem's Farm on Morrisana Mesa (see Fig. 5-16), which places the inversion top near 7300 feet MSL. Unfortunately, signal was again lost on the sounding from Clem's Farm after only a short distance.

Slope temperatures would also indicate an inversion up to at least Tower 2 (see Fig. 4-16) which is in relative agreement with sounding temperatures.

### The Fog Release

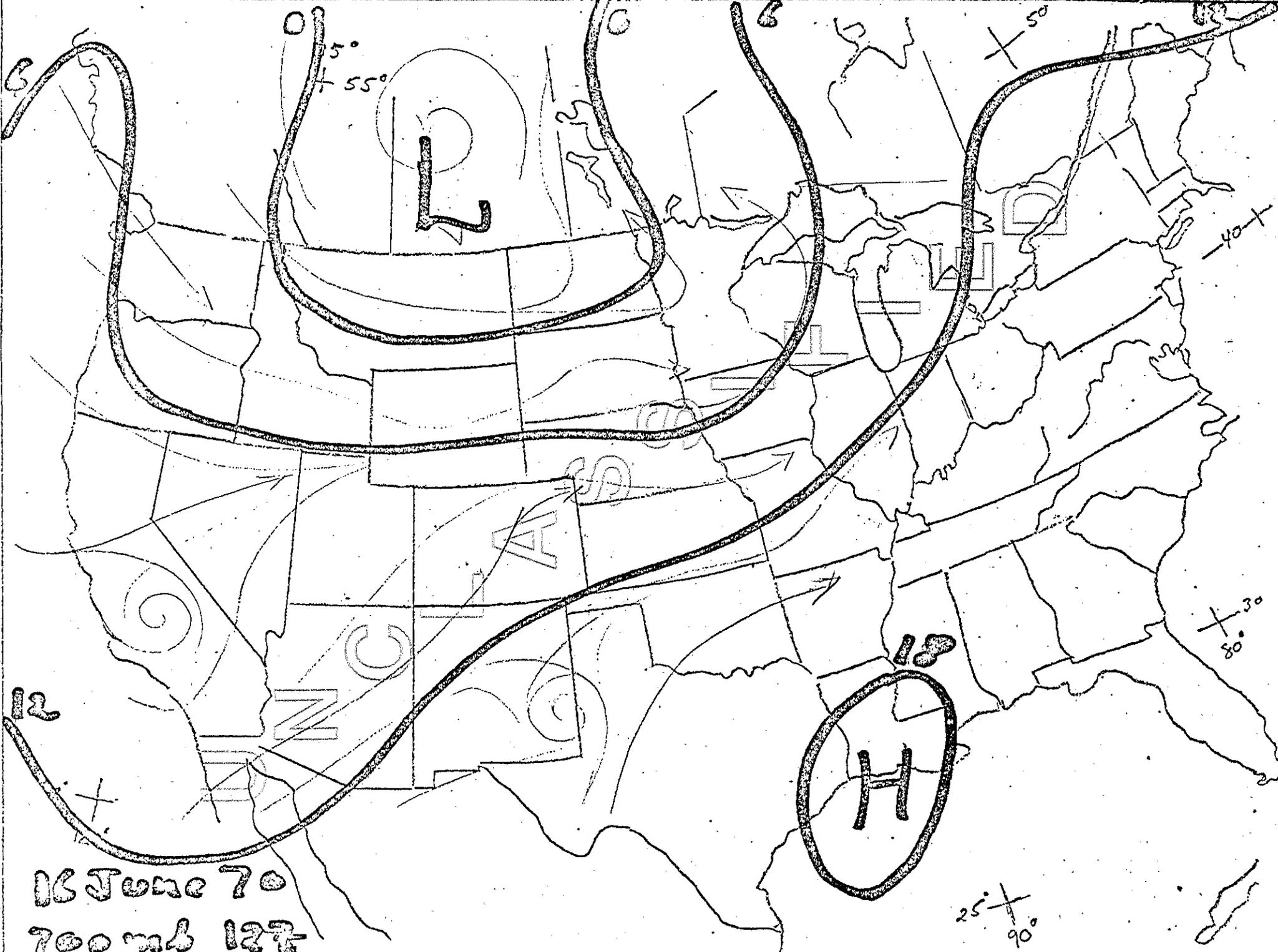
Release time 0400 from GZ - Terminated 0615

Upon release the fog drifted down canyon clinging somewhat to the west bank as it had done on the 14th, but most of the fog remained in the center of the gulch. The top of the fog generally remained below tree top level except at the release point where eddies would shear off and dissipate upward. Upon flowing past the CP area (duration time of fog increased so that the fog would have time to traverse the distance to the river) the fog did not flow onto Morrisana Mesa below Battlement Creek gulch but followed the bend in the river to where it makes a more or less right angle turn toward the west. A careful examination of the topography of the area will reveal a slight ridge protecting the eastern portion of Morrisana Mesa from low level skin drainage. The main body of the fog then followed down Monument Gulch rather than continuing down Battlement Creek. This gulch empties to the west of Grand Valley and becomes very flat and broad. The fog was very diffuse by this time although it did seem to smear a wide area. Only small segments were visible in the Battlement Creek area. Trajectories of this flow are depicted in Fig. 7-16. This condition could be accounted for by the fact that the inversion is well above the Morrisana Mesa cutting off flow from aloft while well developed drainage flow down the Colorado River Basin is controlling the flow over the Mesa.

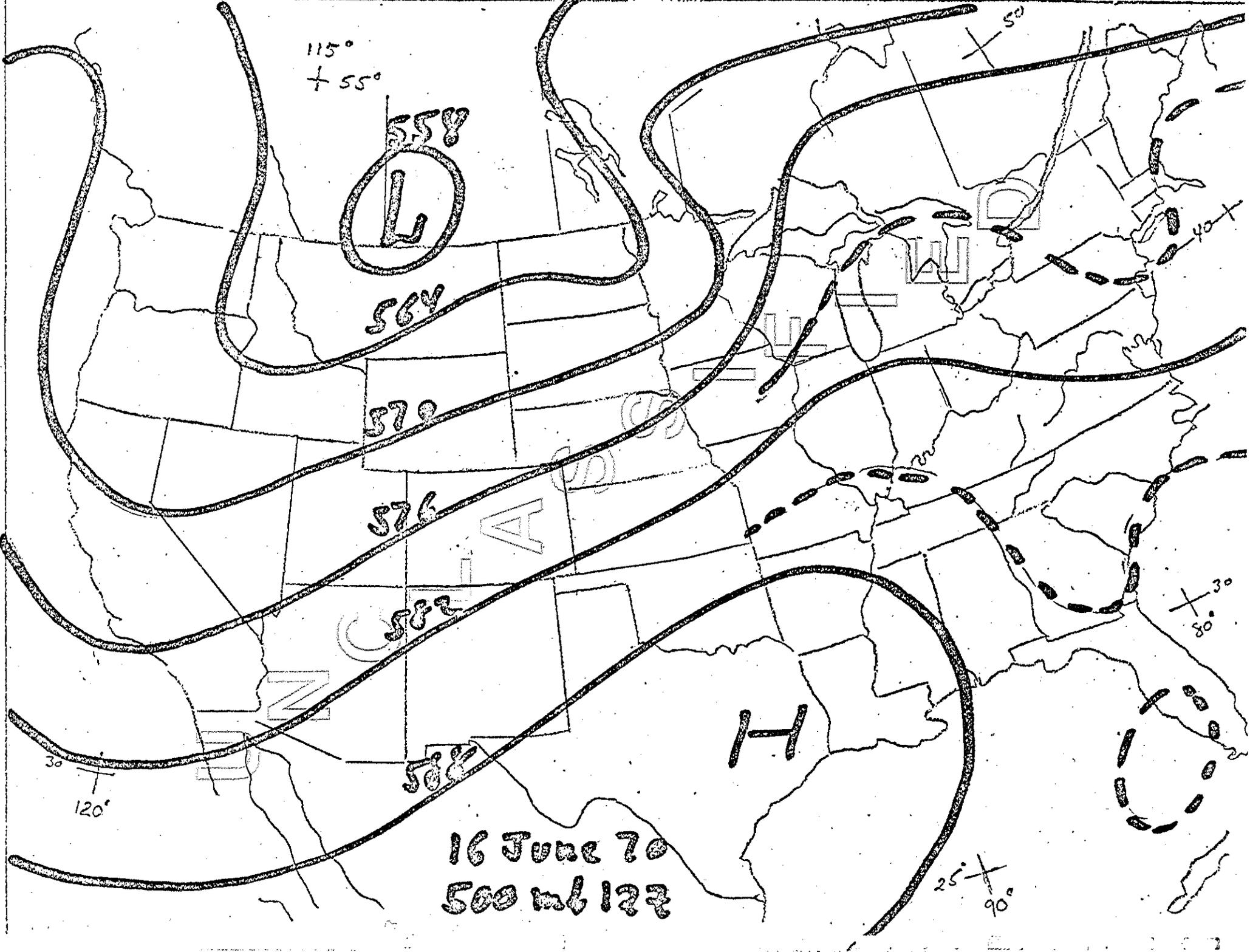


16 June 70

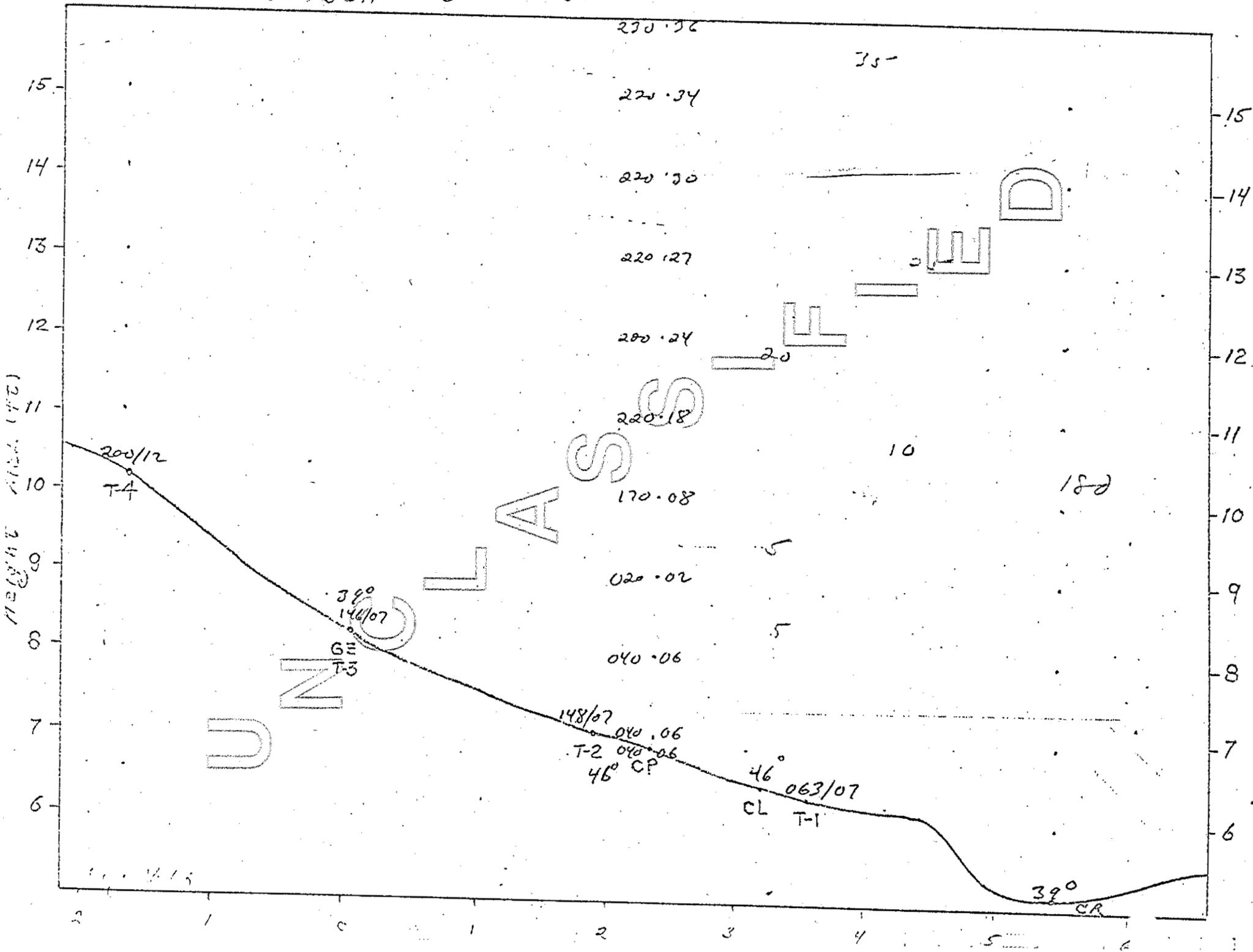
5:45 PM '70



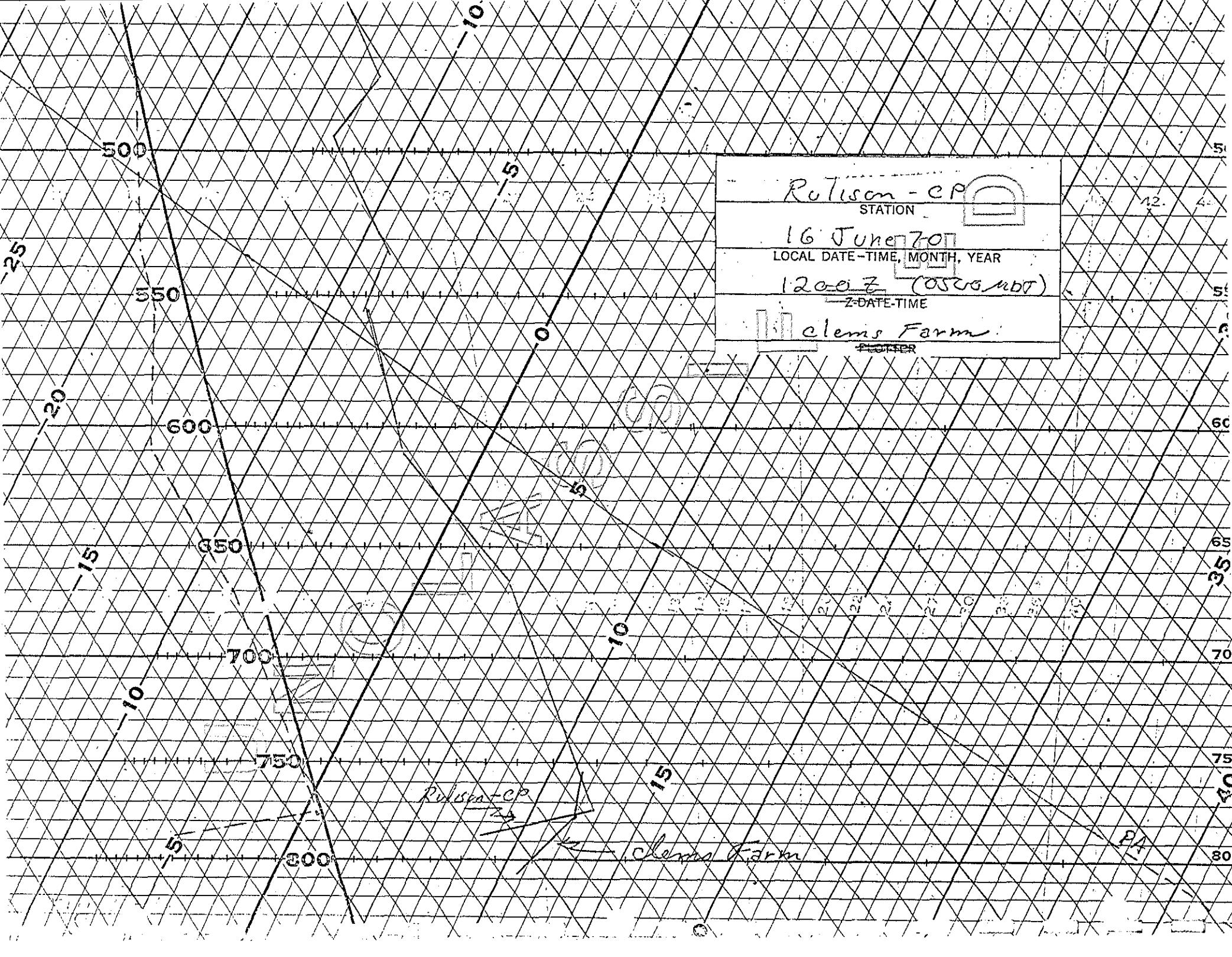
16 June 70  
700 mb 127



0500 MDT RULISON 6 JUNE 70



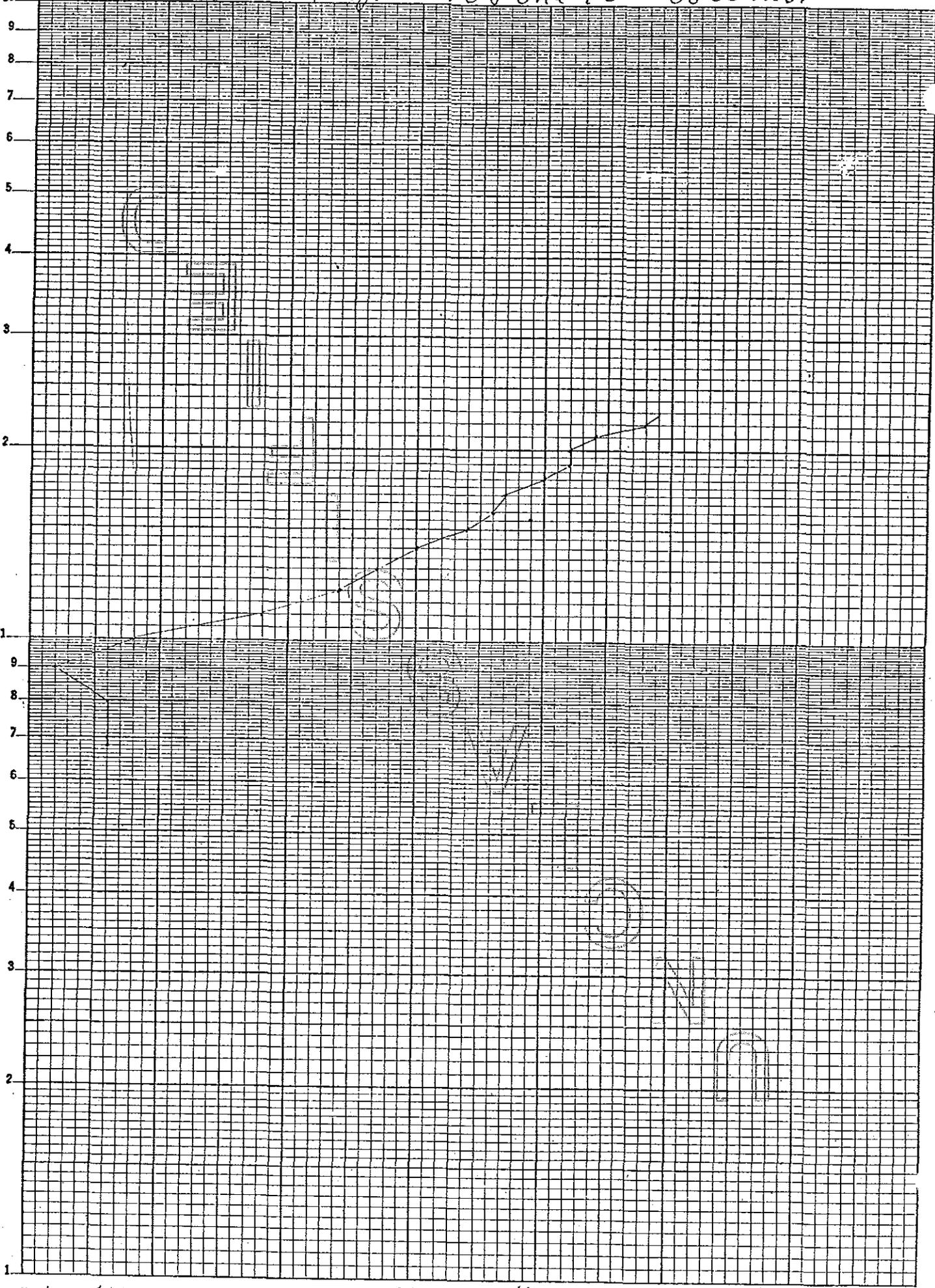
Rotison - CP	
STATION	
16 June 70	
LOCAL DATE-TIME, MONTH, YEAR	
1200 Z (0500 GMT)	
Z-DATE-TIME	
	Clem's Farm
PLOTTER	



Rutson Wind Profile 16 June 70 0500 MDT

**K&E** SEMI-LOGARITHMIC 359-61  
 KEUFFEL & ESSER CO. MADE IN U.S.A.  
 2 CYCLES X 70 DIVISIONS

Alt 73rd of PC (msl)



0 10 20 30 40 50 60 70  
 Wind Speed (knots)

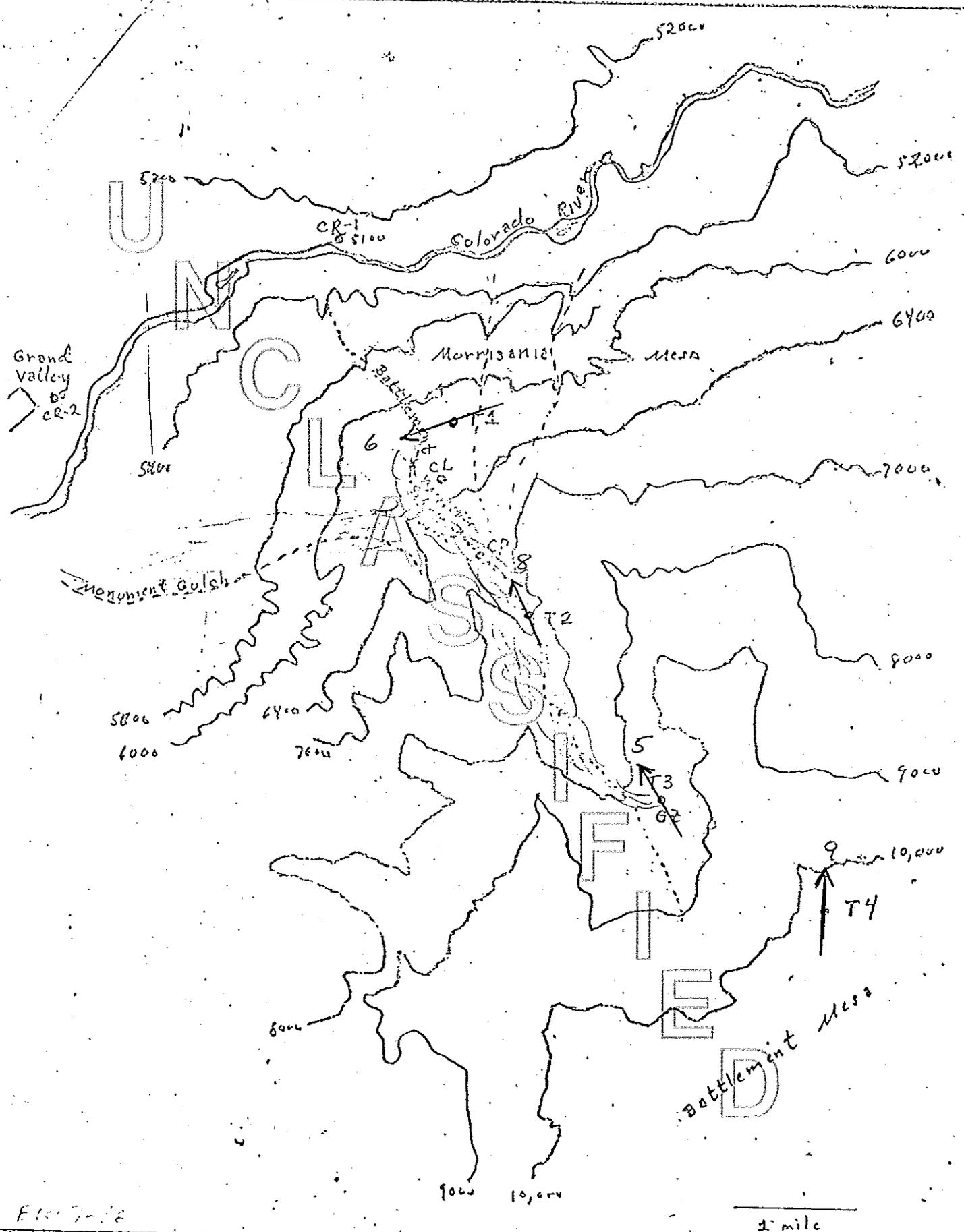


FIG 7-12

Table I-16 June 16, 1970

## RULISON Tower Winds

Time	Tower 1	Tower 2	Tower 3	Tower 4
0400	075/09	146/04	142/06	227/10
0406	141/01	150/05	134/06	227/09
0408	060/05	127/06	148/07	215/08
0411	053/05	129/06	147/07	232/04
0414	049/06	155/08	147/06	219/09
0417	049/06	166/08	149/06	217/07
0419	052/06	154/09	145/06	233/09
0422	051/06	135/07	152/06	221/10
0425	059/05	163/08	151/05	215/09
0428	063/04	165/09	160/06	223/09
0431	065/05	153/08	155/06	225/08
0433	063/07	164/10	167/06	218/07
0436	073/06	173/07	161/06	221/11
0439	049/08	166/08	154/05	218/12
0441	060/08	161/08	152/04	215/10
0444	054/08	003/00	160/04	199/07
0448	066/07	154/10	166/04	214/08
0451	056/07	156/09	149/05	212/09
0453	063/08	144/07	167/05	214/12
0456	065/06	165/09	159/04	205/09
0459	060/07	148/08	150/04	204/11
0500	063/07	148/07	146/07	200/12
0502	069/06	149/07	139/04	194/15
0504	064/08	151/08	161/03	195/12
0507	082/06	158/09	153/04	196/07
0510	080/07	157/11	150/03	160/12
0513	086/07	152/09	167/03	174/10
0516	082/09	161/11	148/04	153/16
0518	086/07	154/10	150/04	175/13
0521	088/06	159/09	145/05	167/15
0524	081/08	157/10	160/05	142/15
0527	085/09	160/06	137/05	134/10
0530	090/08	144/07	146/06	171/15
0533	104/08	152/07	153/06	161/08
0536	101/09	152/08	147/05	129/13
0539	100/07	142/07	131/05	168/18
0542	099/07	153/08	130/04	158/14
0545	095/07	154/09	139/05	136/12
0547	057/04	151/09	126/04	126/14
0551	067/05	151/09	133/04	135/10

Table I-16 (continued)

RULISON Tower Winds

Time	Tower 1	Tower 2	Tower 3	Tower 4
0554	056/04	148/08	145/05	169/14
0557	064/05	154/07	138/04	171/13
0600	079/06	m	m	m
0603	068/06	149/08	134/03	176/16
0606	067/07	152/06	138/05	156/09
0609	060/06	145/08	136/05	139/12
0612	060/07	149/07	135/06	168/13
0615	060/07	148/07	131/05	155/17
Vector averages	071/6.25	153/7.7	146/4.7	181/9.3

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Table II June 16, 1970 0500 MDT

Radiosonde Wind & Temperatures

Pressure (mbs)	Height (feet)	Temperature C°	Dew Point C°
786	6840	8.2	5.4
775	7300	12.8	0.3
664	11,410	4.0	-8.1
600	14,058	-3.6	-14.4
556	15,850	-8.2	-17.5
532	16,930	-8.5	-19.4
512	17,830	-10.4	-20.3
492	18,810	-13.4	-23.6
477	19,580	-12.9	-23.4
400	23,875	-23.6	-34.3

Clem's Farm Sounding (CL)

Pressure	Temperature
804.3	10.4
776.0	12.0
752	11.4

Height (Thsd. Ft)	Wind direction/wind speed (degrees)/(knots)
Sfc	040/06
7	040/06
8	040/06
9	020/02
10	170/08
11	220/18
12	220/24
13	220/27
14	220/30
15	220/34
16	230/36

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Fog Release No. 4

6/17/70

List of Tables & Figures

6/17/70

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- 2-17 700 mb 12Z chart
- 3-17 500 mb 12Z chart
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- 6-17 Slope temperature & wind
- 7-17 Fog trajectories
- 8-17 Photo - upper basin
- 9-17 Photo - lower basin

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- II Rulison temperature sounding
- III Rulison upper winds
- IV Grand Valley sounding

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## The Synoptic Situation

The low pressure cell which was situated near the Canadian-U.S. border near Montana at 500 mbs has moved rapidly north-eastward to central Canada while a ridge has built up over northern Washington. In the south a high pressure cell has formed over eastern Texas and Louisiana. The resultant flow over Colorado, in spite of the rapid translation of pressure cells is virtually unchanged with strange southwesterly flow prevailing over the state. The 700 mb chart reflects much the same pattern with the upper trough extending over eastern Colorado. The surface chart shows intensification, a low developing in Kansas with a belt of lower pressure oriented NE-SW across the central U.S. The gradient of pressure is not strong enough to disturb local drainage pattern however. Skies over western Colorado are still only partly cloudy making another favorable factor for drainage conditions to prevail. (See Fig. 1-17 - 3-17 for synoptic charts).

## Local Conditions

Tower winds in the Battlement Creek area were relatively light varying between one to six mph with intermittent gusts to 10 mph. Winds at towers 2 and 3 averaged between 3 to 6 mph with directions expected for drainage flow conditions (see table I-17). Tower 4 on Battlement Mesa was in line with the gradient flow. Upper winds from the Rulison 12Z sounding were very light varying from calm at the surface to only 4 mph at 9000 feet. Above that level winds increased almost logarithmically (see Table II-17 and Fig. 4-17). The temperature sounding (Fig. 5-17) indicated a surface based inversion extending up approximately 500 feet above the surface becoming isothermal for another 450 feet. An additional

temperature sounding taken near Grand Valley in the Colorado River Basin indicated two stable layers. The first a surface based inversion approximately 500 feet thick and a second almost 150 thermal layers occurring near the height of the isothermal layer shown on the CP sounding. This sounding is also shown on Fig. 5-17. Surface slope temperatures would also indicate an inversion between Clems Farm and the river bottom. See Fig. 6-17.

#### The Fog Release

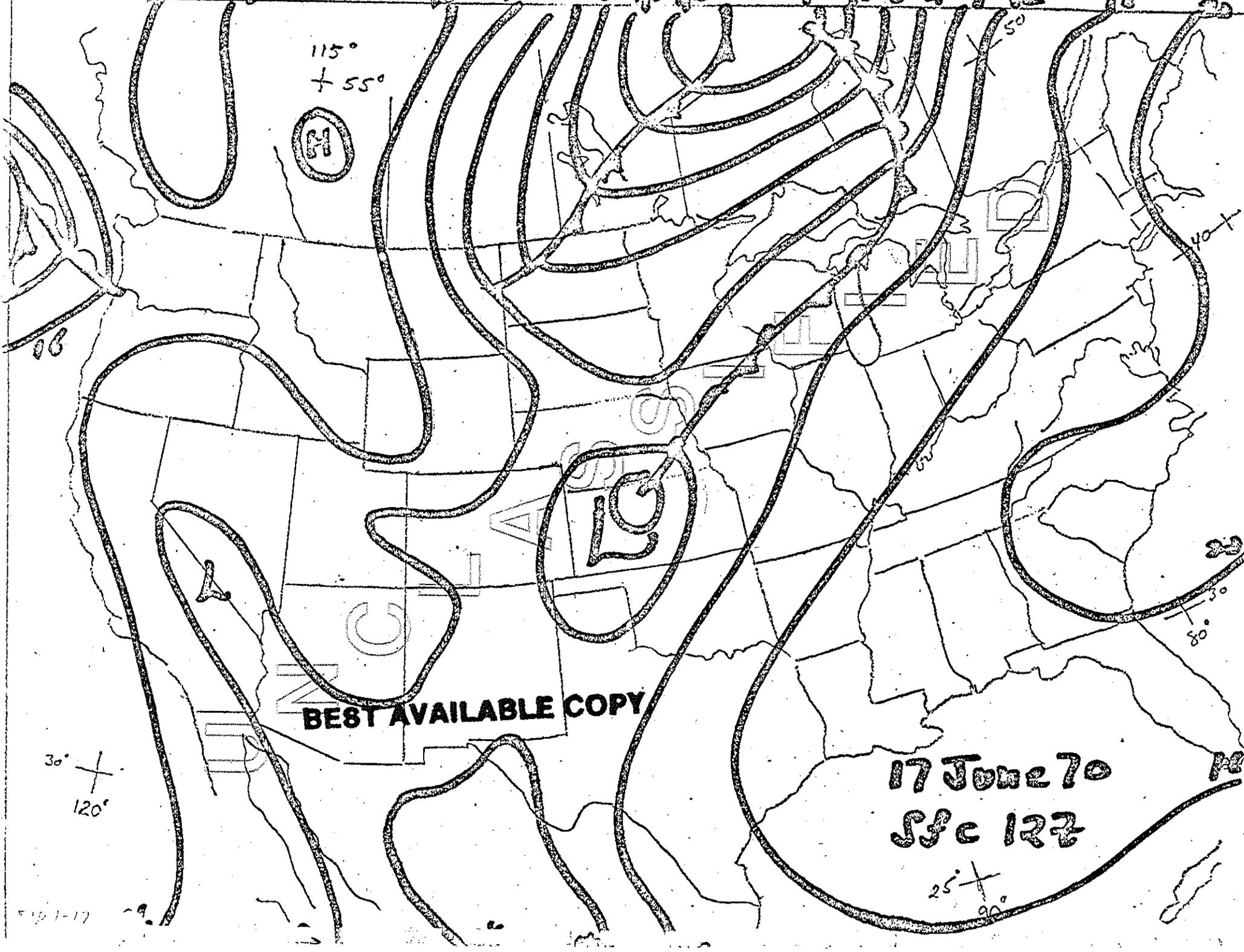
Release Location: Command Post (CP)

Release Time 0400 Terminated 0615

Because of the air flow movement through the dense foliage along Battlement Creek it was evident that in order for the tracer to reach the river basin the generator either had to be started earlier and run continuously for same period or else the source could be moved down canyon. Because the moon was setting very early, around 0230, and there would be a period of absolute darkness it was elected to move the generator to the CP area. Upon operation of the generator the fog moved to the lower portions of the gully and proceeded down canyon much as on previous occasions, however where the bend in the creek occurs below the CP area the fog failed to negotiate the turn as it had done on the previous day and actually was seen to rise over the slight ridge at this point and proceeded to flow onto Morrisania Mesa (see Fig. 6-17 for trajectories). The fog followed down two gullies which pass on either side of the Community House in heavy concentrations. Occasionally the fog would smear over a wide area. The fog even though in heavy concentrations did not traverse

the two to three miles to the river bottom, but appeared to puddle in depressions. Some difficulty was experienced with the generator on this run and whenever the device was restarted the initial fog would follow the bend in the creek bed and proceed down this path. One would assume that these particles were larger and responded to very shallow flow patterns. Several photos were taken of this plume. An excellent shot was taken by Paul Mudra from the ridge road below the CP which shows the division of the plume around a small ridge, Fig. 8-17. Another photo from just west of the community house (Fig. 9-17) looking toward the CP shows another view of the plume.

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+ 55°

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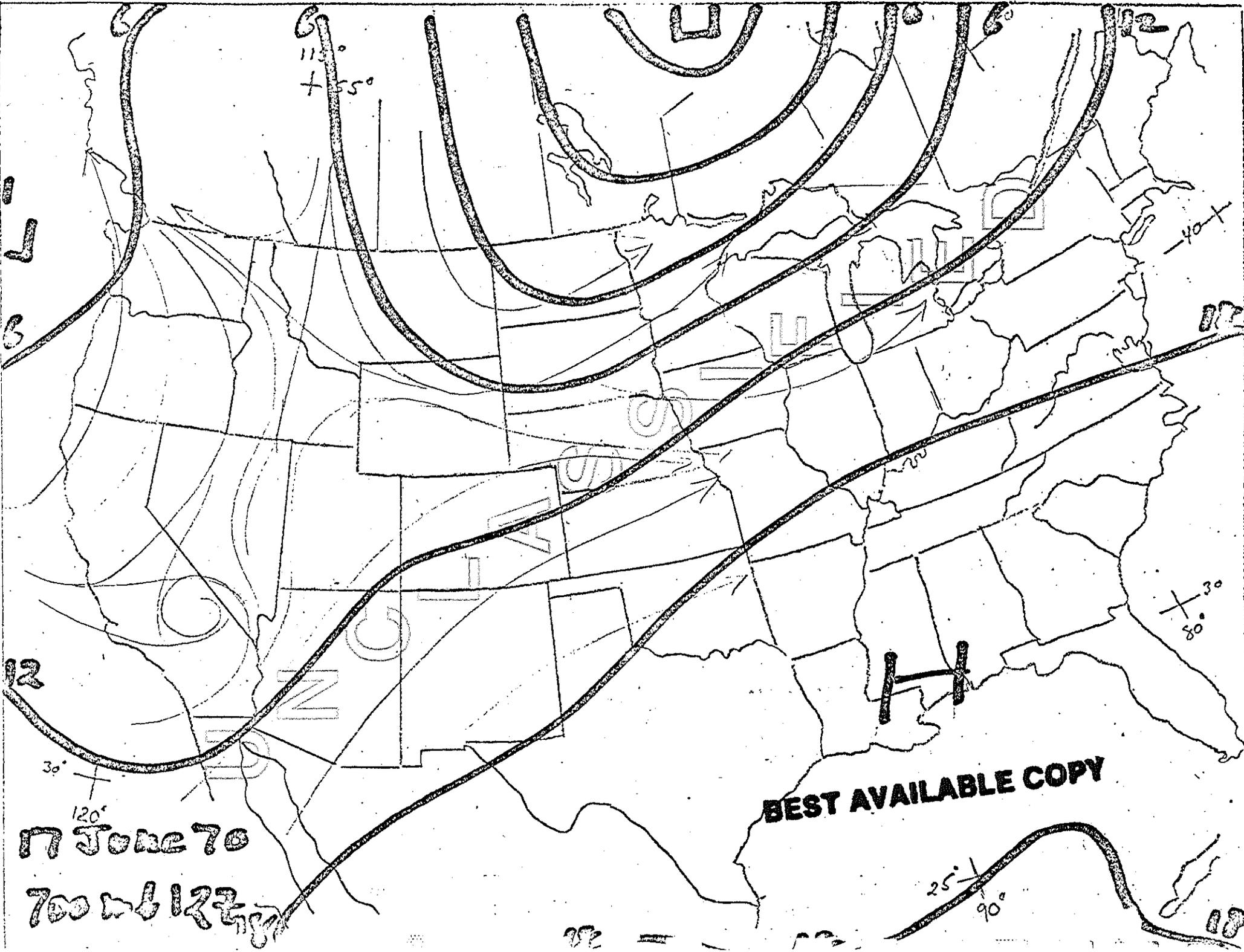
**BEST AVAILABLE COPY**

17 June 70  
SFC 127

30°  
+ 120°

25°  
+ 90°

1-17



17 June 70

700 mb 12Z

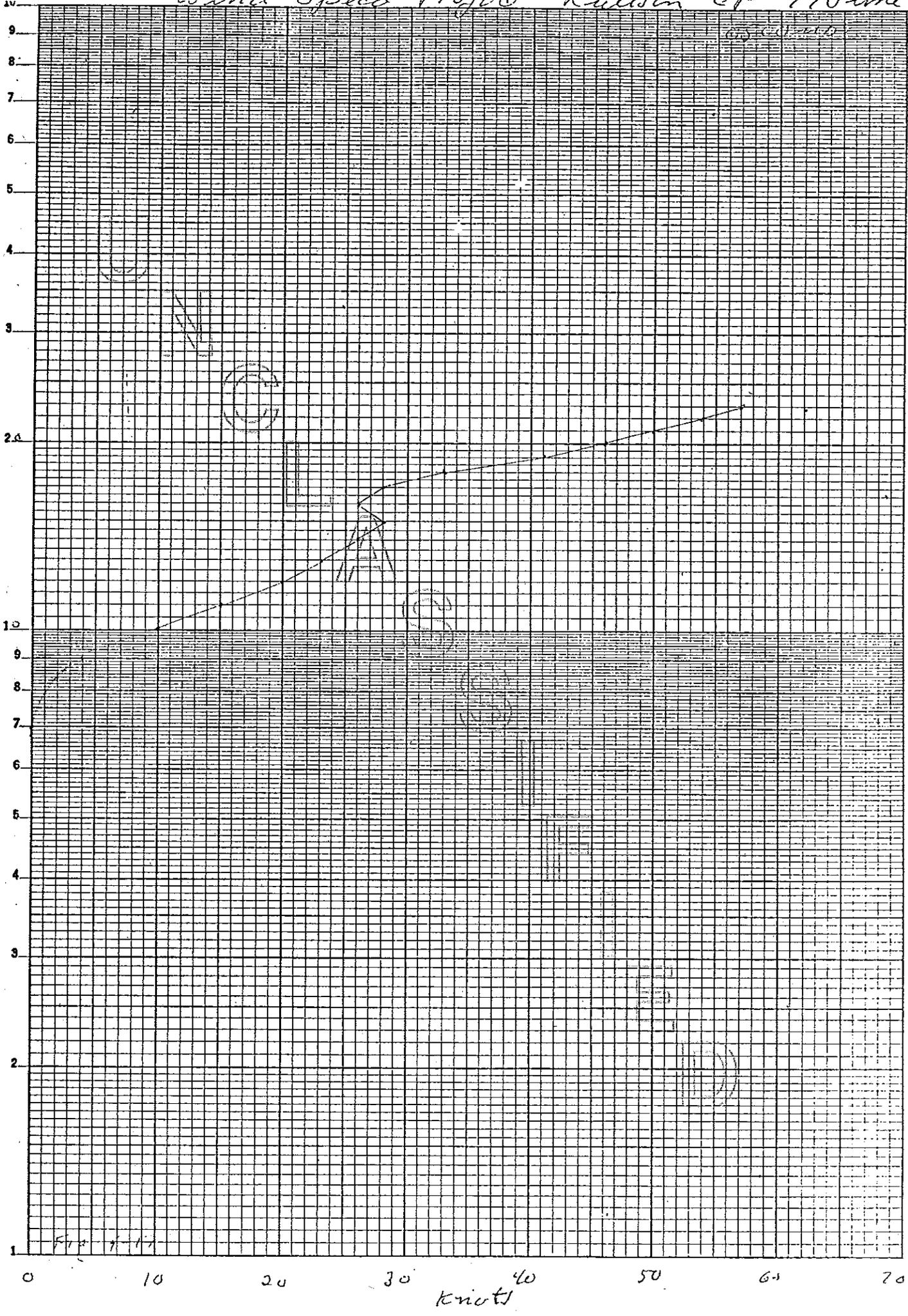
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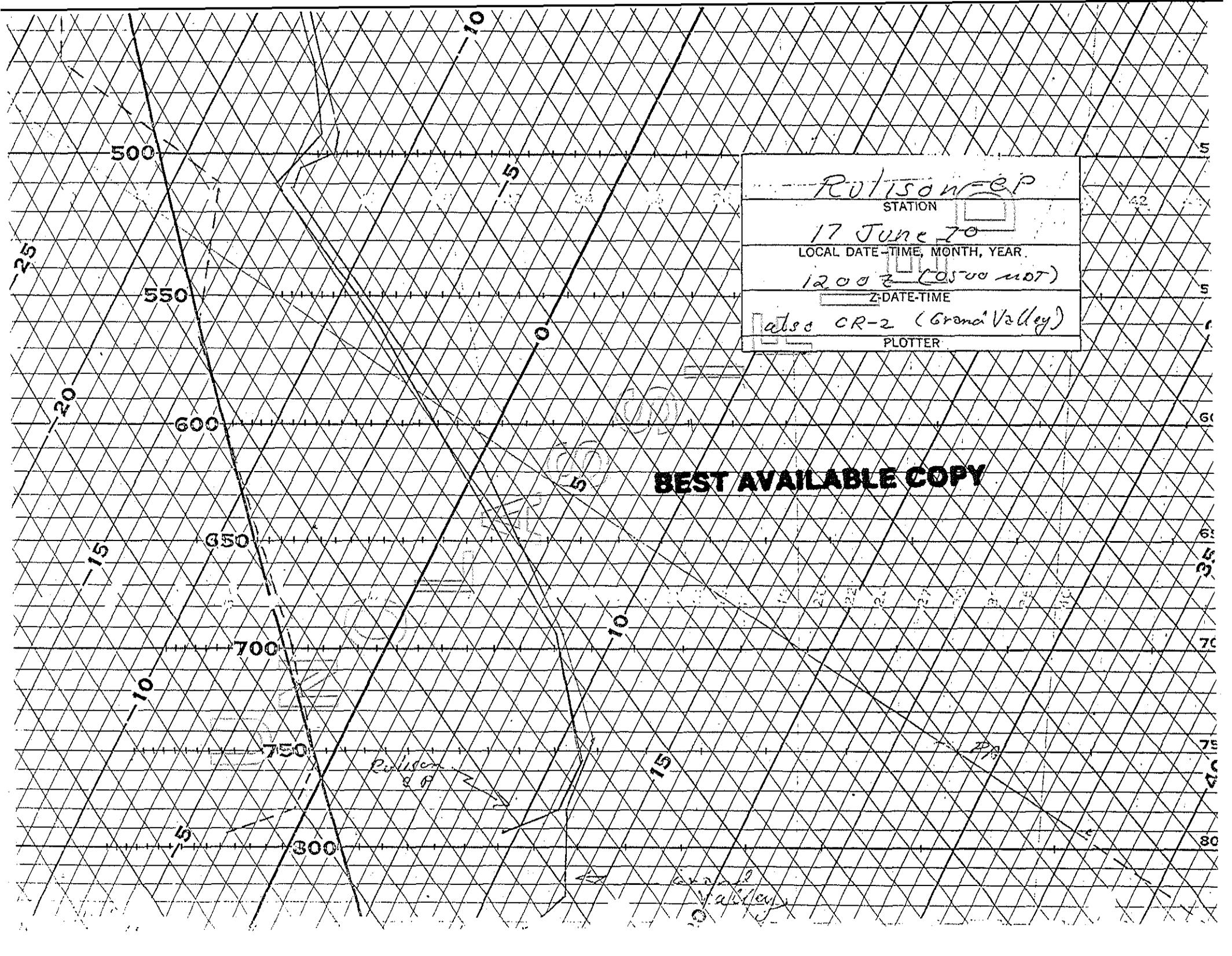


WATER SPEED LOGS NELSON ET AL. 11/11/60

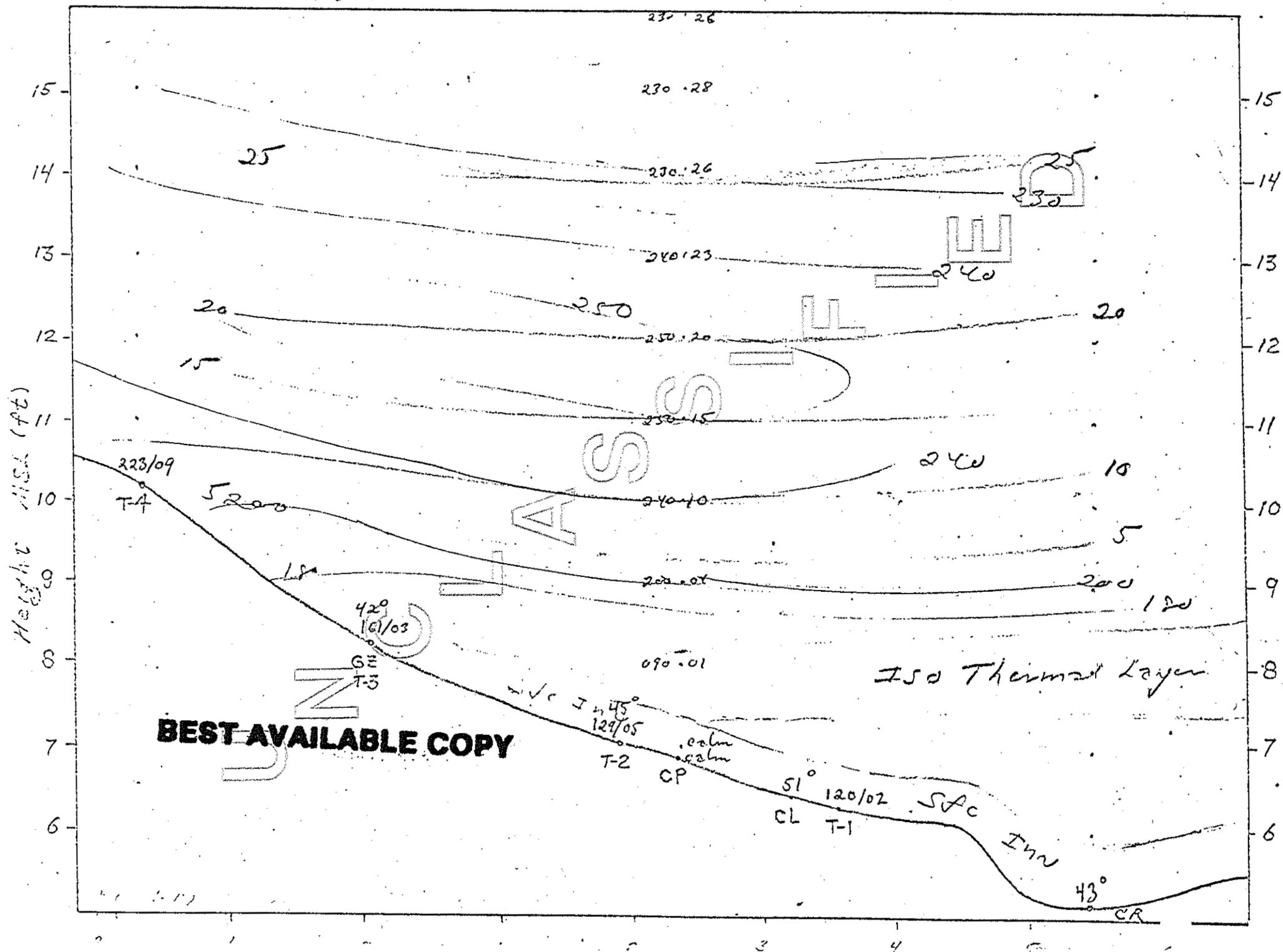
KE SEMI-LOGARITHMIC 359-61  
KEUFFEL & ESSER CO. MADE IN U.S.A.  
2 CYCLES X 70 DIVISIONS

Ht Thsd at Ft MSZ





# RULISON



Rullison 17 June 70

Fog Release  
0430-0600  
1 MDT

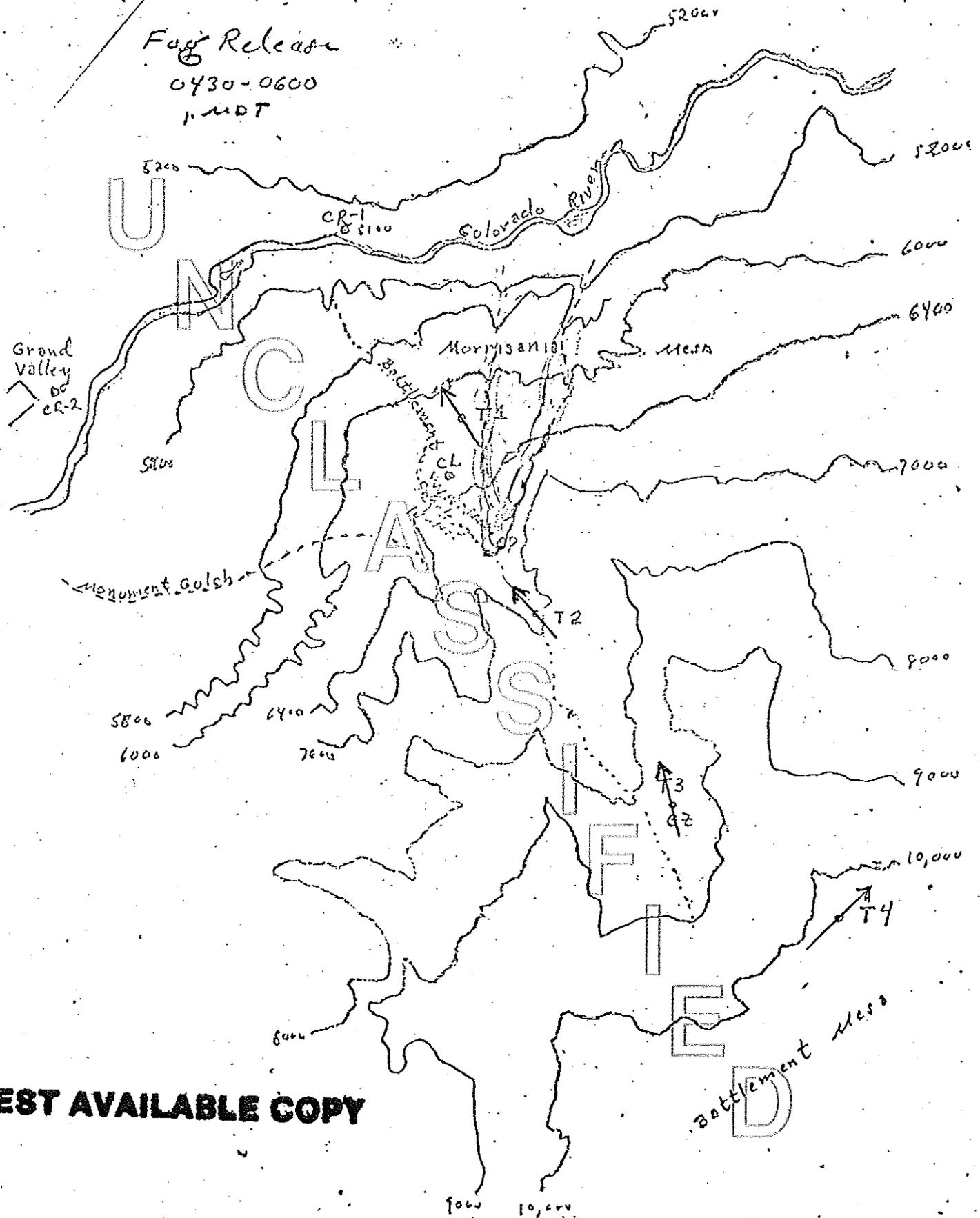


Fig. 7-17

Vector Wind Averages  
0430-0600 MDT  
(15 min present)

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Picture taken by S...  
-taken by ...  
Mount in right of ...  
... taken ...  
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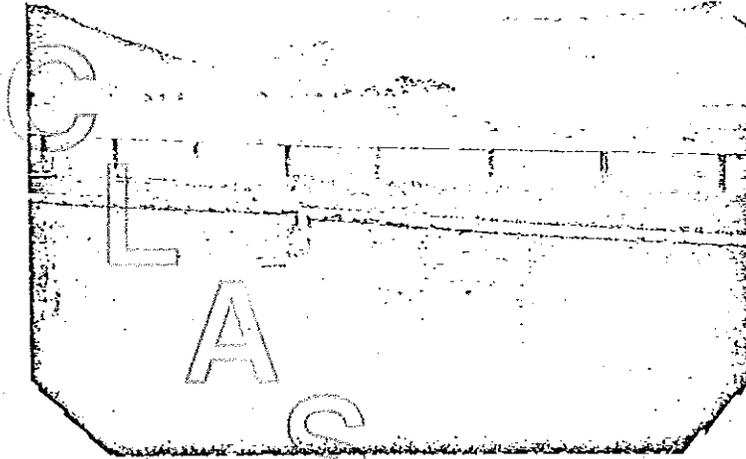
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Picture taken from East Ridge Road below CP.  
Divergent flow around mound in right of picture  
clearly visible. Photo taken 0515 courtesy Paul Madra,  
AEC.

**BEST AVAILABLE COPY**

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Picture taken at 1555 200 yds  
west of community house

Flow down gutter to east of  
west wall. Looking  
south toward

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418-2-17

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Picture taken at 0555 200 yds west of community house on Morrisiana Mesa. Divergent flow down gullies to east and west are visible. Looking south toward CP.

Table I-17 Rulison Tower Winds 6/17/70

Time	T-1	T-2	T-3	T-4
0430	181/12	148/09	142/04	225/10
0445	077/02	119/06	160/05	221/09
0500	120/02	124/05	161/03	223/09
0515	150/03	125/03	152/01	213/10
0530	076/01	144/05	184/04	230/09
0545	124/02	137/05	156/02	223/09
0600	076/04	150/06	191/01	216/09
0615	078/06	167/05	189/02	216/09
Vector average	142/2.7	137/5.5	162/2.7	221/09

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Table II

Rulison 0500 MDT Temperature Sounding 6/17/70

Pressure (mbs)	Height (feet)	Temperature (C°)	Dew Point (C°)
792	6840	9.2	-3.1
780	7280	11.3	-0.6
755	8140	11.3	-0.8
692	10540	7.6	-4.9
562	15970	-7.2	-15.4
510	18500	-15.1	-17.7
493	19330	-14.2	-26.3
470	20480	-16.4	-27.7
413	23680	-22.7	-31.7
400	24413	-25.6	-34.1

Table III

Rulison Upper Winds 0500 MDT

6/17/70

Height (Thsd of ft)	Direction/Speed (degrees)/(knots)
Surface	calm
7	calm
8	090/01
9	200/04
10	240/10
11	250/15
12	250/20
13	240/23
14	230/26
15	230/28
16	230/26

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Table IV

## Grand Valley Temperatures

0500 MDT

6/17/70

	Pressure (mbs)	Temperature C°
U		
Sfc	843.6	12.3
	779	11.5
	744	11.4
	696	8.8
	618	0.1
	511	-14.5
	504	-14.5
	500	-13.5
	450	-18.0
	420	-21.5
	400	-25.3

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## Acknowledgments

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Appreciation is expressed to all ARL meteorological technicians who had increased work loads as a result of the study and to Mr. Heinrichs for his efforts in operation of the portable 403 radiosonde. Special praise should be given to Mr. Shibata who not only operated the fog generator but contributed extra hours in equipment set-up. Thanks are also offered to Mr. Skinner of PHS, Paul Mudra, AEC, and to Dr. Mason of Battelle for their assistance in observing the plume trajectories.

## Conclusions

One would conclude from the limited fog releases conducted in the Rulison-Battlement Creek area that the inversion which forms in the summer months, under more or less ideal conditions, creates a deep horizontal pool of cool air extending from the river basin up to approximately the 7000-foot level or as a double type of inversion structure with one layer at this level overlaid by even colder air in the lower river basin. The river basin air draining laterally toward the west. The inversion which extends to higher elevation acts like a skin which follows the slope of the terrain and becomes thinner as elevation increases. With the thermal and inertial forces expected during flaring, one would expect the bulk of the effluent to break through the shallow inversion present at 6Z. This effluent would remain on top of the inversion, assuming a continuous source, until heating would cause overturning which would start on those slopes first exposed to the sun's rays. Due to entrainment or in event the effluent did not break through the surface inversion, the material would be transported downslope concentrating in the center of the Battlement Creek valley down to the bend in the river just below the CP area. Very small amounts would tend to stay close to the surface and follow the bend with drainage generally toward the community of Grand Valley. In event larger amounts of material drain down slope some would be transported toward the west, but much of the material would be high enough to pass over the slight barrier the river bend presents and drain toward the community on Morrisania Mesa directly north of the CP concentrating in gullies and stagnating in depressions. Local variability of the wind, even under drainage flow would result in some smearings across the country side. Brief fumigation conditions could be expected upon break-up of the inversion. Further meteorological investigation would be desirable, as it is well known that inversion layers

vary in intensity, time and space resulting from combinations of complex variables.

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