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NOAA Technical Memorandum NWS WR 73

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

A Synoptic Climatology for Snowstorms in Northwestern Nevada

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CLARENCE M. SAKAMOTO

Western Region

SALT LAKE CITY,
UTAH

February 1972

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U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

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A SYNOPTIC CLIMATOLOGY FOR SNOWSTORMS IN NORTHWESTERN NEVADA

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A SYNOPTIC CLIMATOLOGY FOR SNOWSTORMS
IN NORTHWESTERN NEVADA

ABSTRACT

The purpose of this study is to provide a climatological aid for forecasting snow in northwestern Nevada. A total of 112 snowstorms affecting Reno, Lovelock, or Winnemucca were analyzed to determine if these storms could be categorized into separate types. Five separate categories were defined and are discussed. Examples of four of these types are provided. A separate discussion of the unusual thunderstorm-snowstorm occurrence on May 20 - 21, 1971, is also provided.

I. INTRODUCTION

Northwestern Nevada experiences several heavy snowstorms each year. These storms affect economic activity and at times bring transportation to a standstill. Snowstorms often hamper airline schedules, closing fields because of hazardous ice, snow and/or reduced visibility. Strong winds often accompany these storms. Commuters have difficulty getting to and from work and transportation of goods on Interstate 80 is affected. Analysis of these storms may aid those involved from the standpoint of timely anticipation and prediction by meteorologists. Therefore, a study was initiated to develop a climatological aid for forecasting snow for northwestern Nevada. The objective of this study was to categorize those storms which are similar in synoptic patterns and movements. For the purpose of this analysis, a snowstorm was defined as one which resulted in a snowfall of one inch or more during a 24-hour period. Furthermore, if a storm lasted more than one day, e.g., 3 days, then the total snowfall for the three days was used as the storm total. Subjective analysis of maps was used to identify storm duration. A heavy snowstorm was defined as a snowfall of 4 inches or more.

II. DATA

Reno, Lovelock, and Winnemucca were chosen as locations for determining areal distribution and frequency of snow storms. All three cities are located on Interstate 80, the main artery across northern Nevada. The data base of 10 years from 1961 to 1970 was selected, as it was readily available locally. Furthermore, the 10-year period was considered sufficiently long to obtain a reasonable sample size for analysis. Climatological Data for Nevada [1] was used to verify storm totals. Daily Weather Maps [5] were utilized to determine storm tracks, associated upper-air patterns, synoptic situations and frequency of each type of snowstorm.

III. RESULTS

1. Areal Distribution.

A total of 112 snowstorms of one inch or more at Reno, Lovelock, or Winnemucca was recorded for the 10-year period. Of these 112, Lovelock experienced only 23 snowfalls of at least one inch while Reno had 65 and Winnemucca 68. Table 1 shows the distribution of these storms at each location. Some of these storms were common to all three locations; most of them were not.

Analysis of each snowfall indicated that a snowstorm occurred only twice in Lovelock without occurring at Reno or Winnemucca. A snowstorm was common to both Reno and Winnemucca 23 times. Thus, 42 (65 minus 23) of Reno's snowfalls did not produce one inch or more of snow in Winnemucca and 45 (68 minus 23) of Winnemucca's snowfalls did not produce one inch or more of snow in Reno. This breakdown does not consider storms where it snowed in Winnemucca and rained in Reno or vice versa. There was a total of 29 cases of heavy snowfalls. Only 8 of these occurred at both Reno and Winnemucca. The average heavy snowfall was 7.5 inches for Reno, 6 inches for Winnemucca, and 4 inches (2 cases) for Lovelock. During the period 1961 - 1970, the heaviest snowfalls were 16.7 inches in Reno, 8.4 inches in Winnemucca, and 4.0 inches in Lovelock for one snowstorm. Heavier amounts, however, have fallen in a 24-hour period at Lovelock and Winnemucca prior to 1961.

Topography is a major factor affecting the distribution of snowfall in northwestern Nevada. For example, Reno is located in Washoe Valley with the Sierra Nevada to the west and smaller mountain ranges to the east and south. Elevation differences within the valley are also a factor in the quantity of snowfall. The airport elevation is 4,411 feet. Urban housing surrounding Reno extends up to 5,000 feet in elevation. Sometimes it may be snowing at the higher elevation area and raining at the airport. Reno is also susceptible to easterly flow that funnels through the Truckee River Valley. This easterly flow is normally associated with cyclogenesis and wave development in central Nevada. When this occurs, snowfall is usually heavy and steady, and stations on the east side of the Sierra receive greater amounts of snow than those on the normally wetter west slope.

Winnemucca (elevation 4,303 feet) is located in Paradise Valley and is not as well protected by mountains as Reno or as Lovelock. The Sonoma Range is southeast of Winnemucca and provides protection from southeasterly winds. Other low-lying hills provide some protection, but Winnemucca is particularly exposed to Pacific cold fronts approaching from the northwest.

Lovelock is located in the Humboldt River Valley which is oriented north-south with the Trinity Range to the west and the Humboldt Range to the east. Lovelock's elevation of 3,903 feet is slightly lower than Reno and Winnemucca. Lovelock is in a warm area that extends from the lee of Sierra into portions of Humboldt, Pershing, and Churchill counties. Lovelock's average yearly snowfall is only 8.7 inches compared with 24.1 inches at Reno and 30.3 inches at Winnemucca. Thus, the combination of low elevation and protected location contributes to the semiarid climate at Lovelock.

2. Storm Types and Frequencies.

One hundred twelve storms were typed using mean storm tracks for the United States after Bowie and Weightman [2]. The North Pacific Storm Track was interpreted to be the path of cyclones moving inland from northern California, Washington, and Oregon and was broken down into three types: Types I, II, and III. These were defined as follows:

Type I: A north Pacific cyclone tracking across Washington or Oregon with no wave development along the front. This type is generally associated with a 500-mb trough along the Pacific Coast with weak or no cold air advection into Nevada. (See Figures 1 and 2.)

Type II: A north Pacific cyclone tracking southeasterly across Nevada. This type is associated with a 500-mb trough along the Pacific Coast that is deepening quite rapidly and has strong cold air advection (Figures 3 and 4). (The cold advection would be more apparent on 700-mb and 850-mb charts.)

Type III: A north Pacific cyclone similar to Type I but with wave development along the frontal system. This type is associated with a 500-mb trough along the Pacific Coast moving inland with a moderate amount of cold air advection (Figures 5 through 9).

Cyclones that move inland from southern California were categorized into another type.

Type IV: A South Pacific Storm Track moving inland into California and tracking across southern Nevada. The 500-mb trough is very deep and extends over Baja, California. At times the 500-mb map shows a closed low over Baja, California (Figures 10 and 11).

Type V: Snowfall that does not conform to one of the other four storm tracks.

Table 2 shows snowstorm frequency distribution by type of storm. The North Pacific Storm Track (Types I, II, and III) had 90 cases, which is 80 percent of the total number of storms. Heavy snowfalls (4 inches or more) were quite evenly distributed among Types I, II, and III. In spring, Type III storms associated with wave formation result in precipitation more often in the form of rain than snow, at the lower elevations.

The South Pacific Storm Track (Type IV) was associated with only 7 snowfalls of an inch or more. This is because low centers from the south pick up warm, moist air off the southern California coast and generally bring rain rather than snow into northwestern Nevada. Therefore, temperature is critical in this type of storm.

Comparison of snowfall cases with 500-mb maps analyzed by Augulis [3,4] showed that many of the storms conform to his specific 500-mb patterns. Twelve cases correspond to Augulis' Winter Type 4 (Figure 12A) where the trough line lies between 130 - 140°W and 18 cases correspond to Winter Type 6 (Figure 12B) with the trough line lying just inside the West Coast. Eighteen cases correspond to Spring Type 3 (Figure 13A) which has a trough line that lies between 110 - 120°W. A total of 9 cases fit Spring Type 7 (Figure 13B), which shows a negative tilt trough between 125 - 130°W.

IV. SNOWSTORM-THUNDERSTORM OF MAY 20 - 21, 1971

This storm, although resembling a Type III storm, warrants further discussion. The storm formed and moved with such rapidity that it produced thunderstorms together with snow and a near blizzard condition which reduced visibility to zero. Temperatures preceding the storm reached a high of 72 degrees in the afternoon of May 20 and dropped to 33 degrees 9 hours later. A total of 6.3 inches of snow fell at Reno during the evening of the 20th and the morning of the 21st. Similarly, 4.3 inches fell at Winnemucca while Lovelock recorded only a trace. The snow was relatively dense as the rapid influx of cold air was preceded by relatively warm, moist layer over Nevada.

Figures 14 through 16 show the synoptic patterns beginning with May 19, 1971. A weak cold front moved through Nevada on the 19th (Figure 14) and by 1200Z May 20 had passed Las Vegas with a suggestion of a wave formation in southern Nevada (Figure 15). The 500-mb map on the 19th (Figure 14) showed a very deep trough off Alaska, extending southeastward through Washington. The following day, a closed low formed over Washington with a weak trough extending southward through northern California (Figure 15). At the same time, the ridge over western Canada was building. By 1200Z on the 21st, a closed surface low had formed over Nevada with a cold low aloft over northern California (Figure 16). Analysis of 6-hourly surface maps showed a definite deepening of the surface low on the 1800Z map and by 0000Z on the 22nd, further deepening was indicated.

The rapidity with which the storm formed and the dense snowfall accompanying it caused heavy property damage, primarily from broken branches and trees, power outages, and damage to agricultural crops.

V. CONCLUSIONS

Analysis of 112 snowstorms during a 10-year period shows the following:

1. Snowstorms moving through northwestern Nevada are much more likely to affect Reno and Winnemucca than Lovelock.

2. Local differences have a large effect on the amount of snowfall observed in any storm.

3. Over 80 percent of the snowstorms were associated with the North Pacific Storm Track, (Types I, II, and III).

4. The South Pacific Storm Track (Type IV) and Cyclogenesis resulted in very few snowstorms in northwestern Nevada.

5. Twenty-five of the 29 heavy (4 inches or more) snowstorms were associated with the North Pacific Storm Track (Types I, II, and III).

VI. ACKNOWLEDGMENT

This study was initiated by a need expressed in a graduate course in Climatology in which Clarence M. Sakamoto participated at the University of Nevada. Joseph Ganser, Meteorologist in Charge, Weather Service Office, Reno, and members of his staff were helpful with their review and suggestions. The authors also acknowledge comments and constructive criticisms by the Scientific Services Division, Western Region, National Weather Service.

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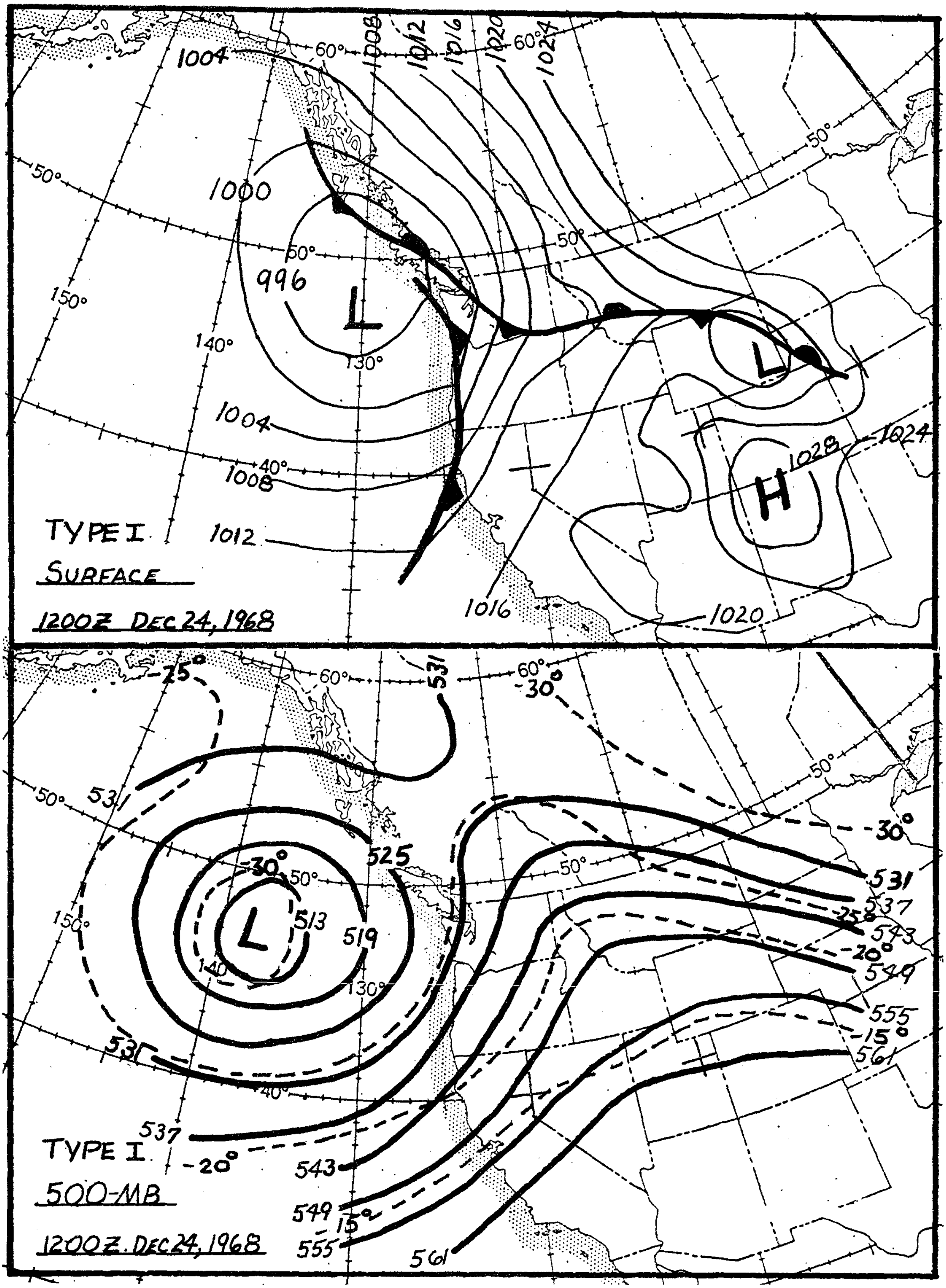
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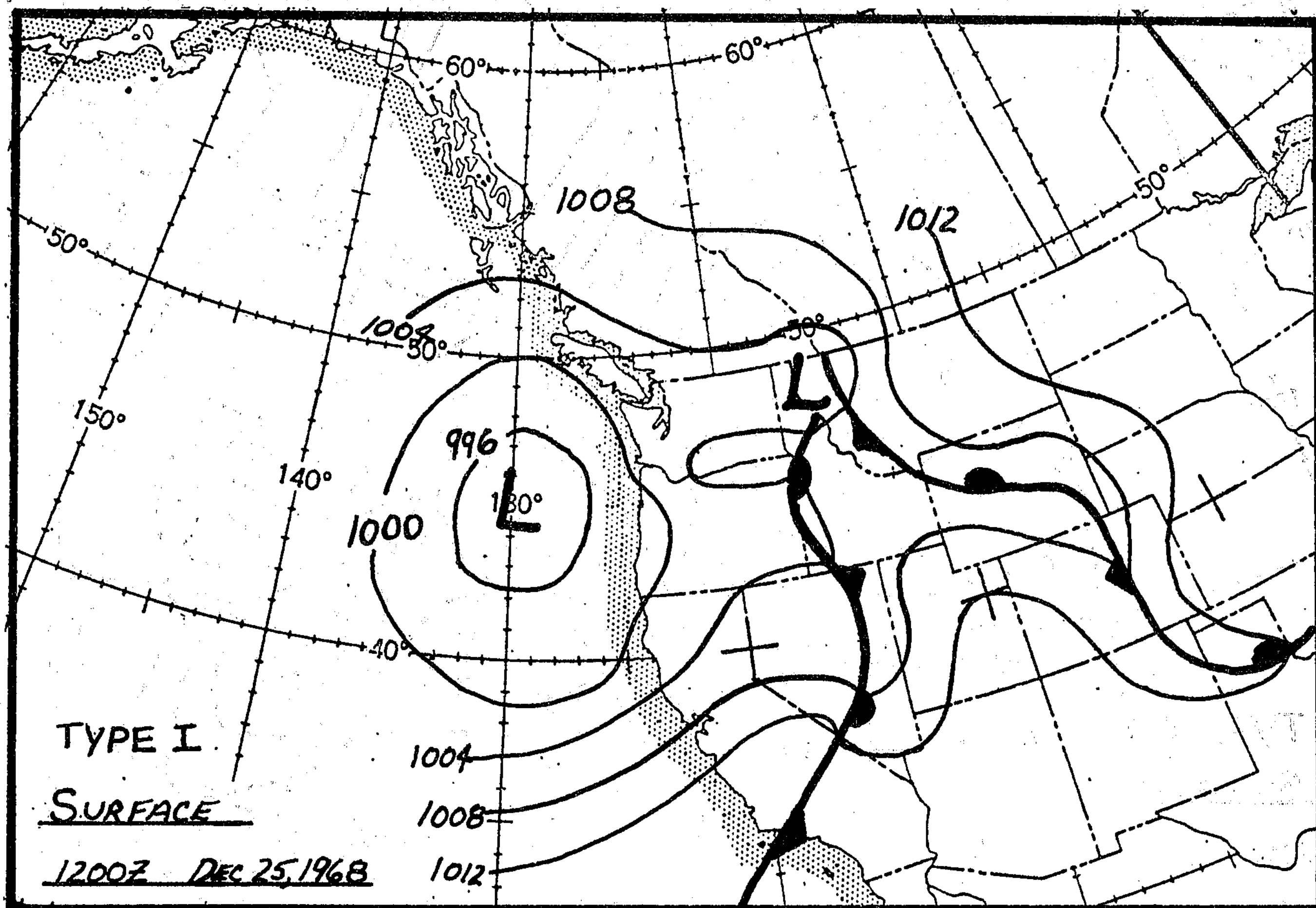
FIGURE 1



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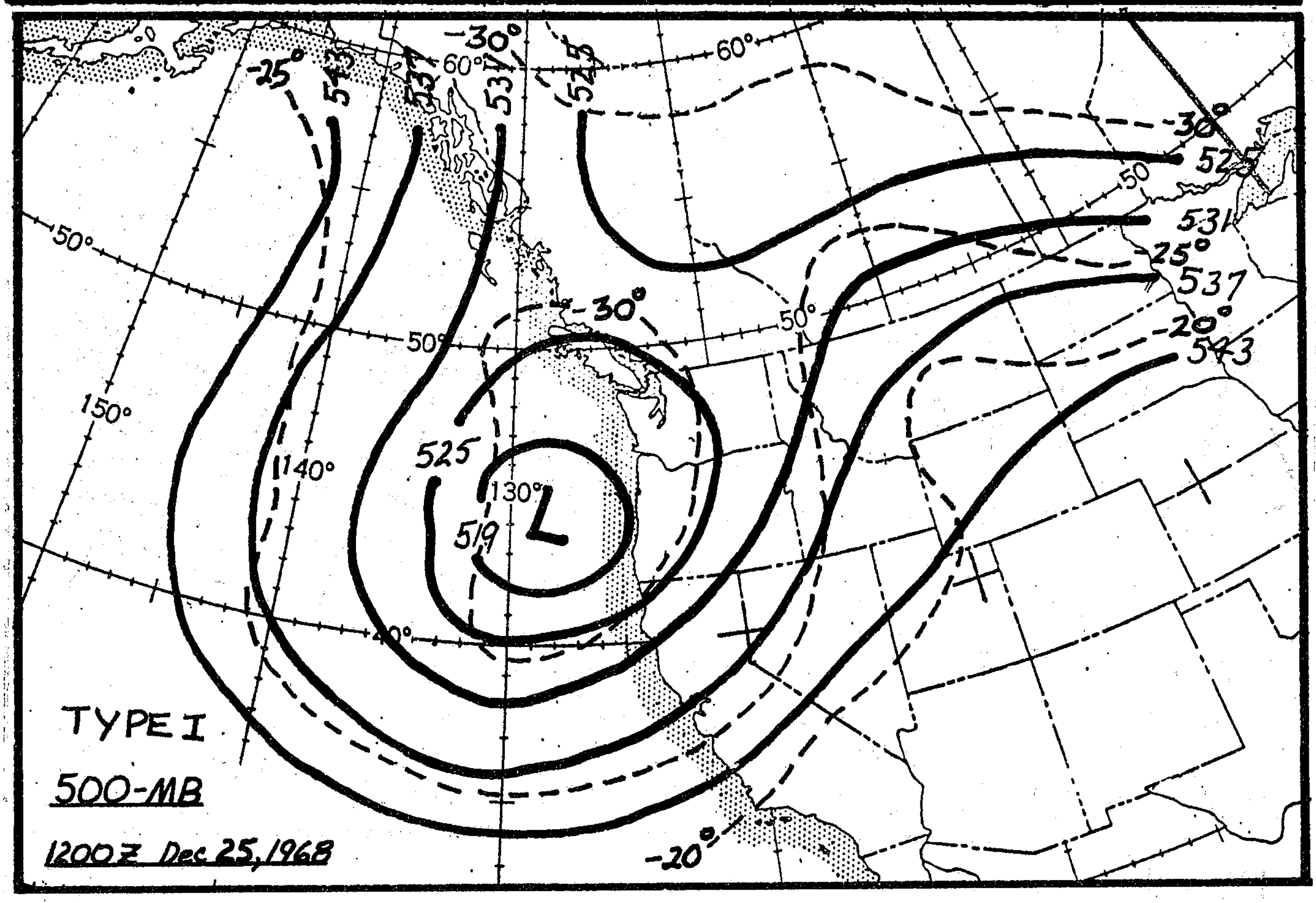

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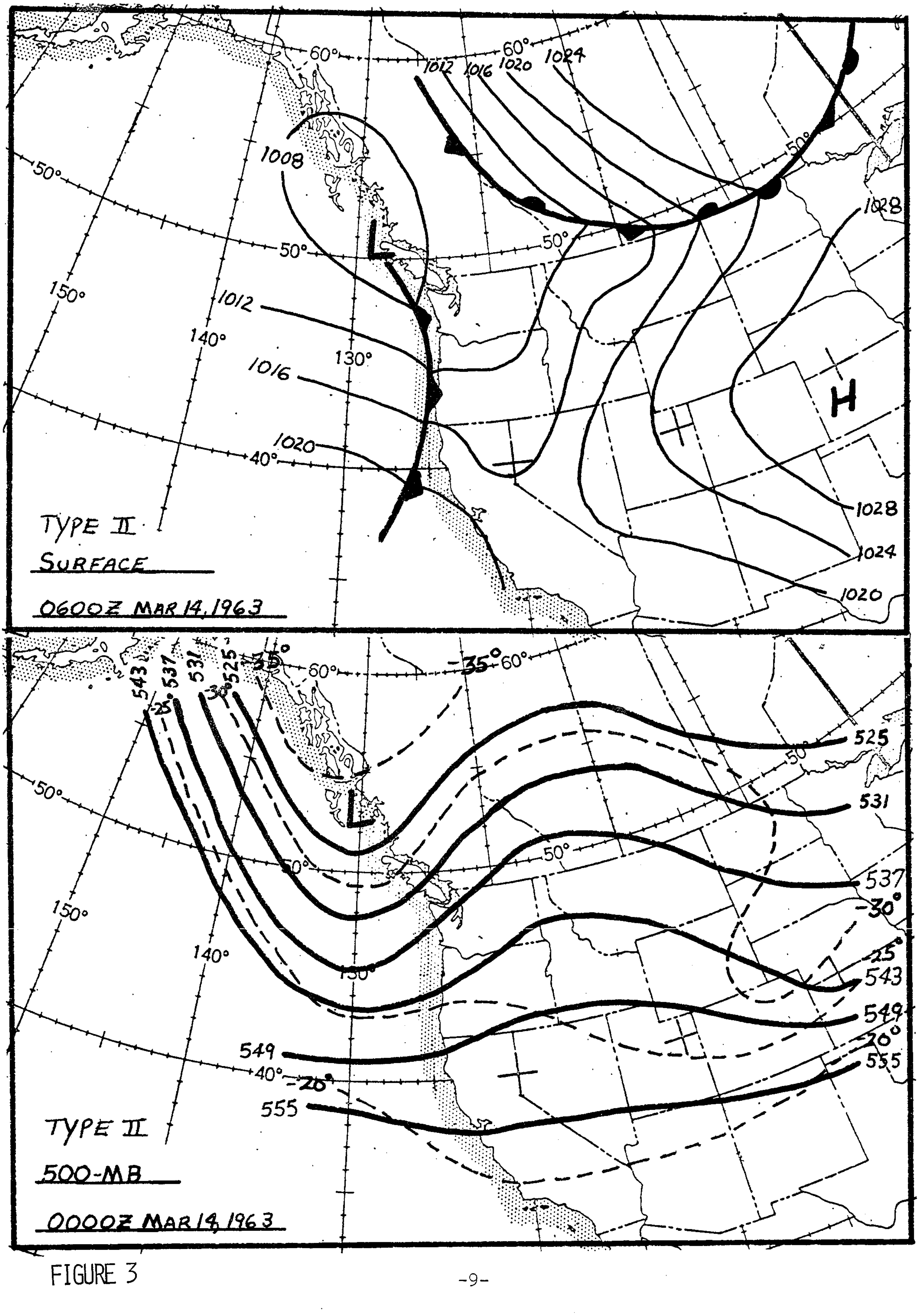
FIGURE 2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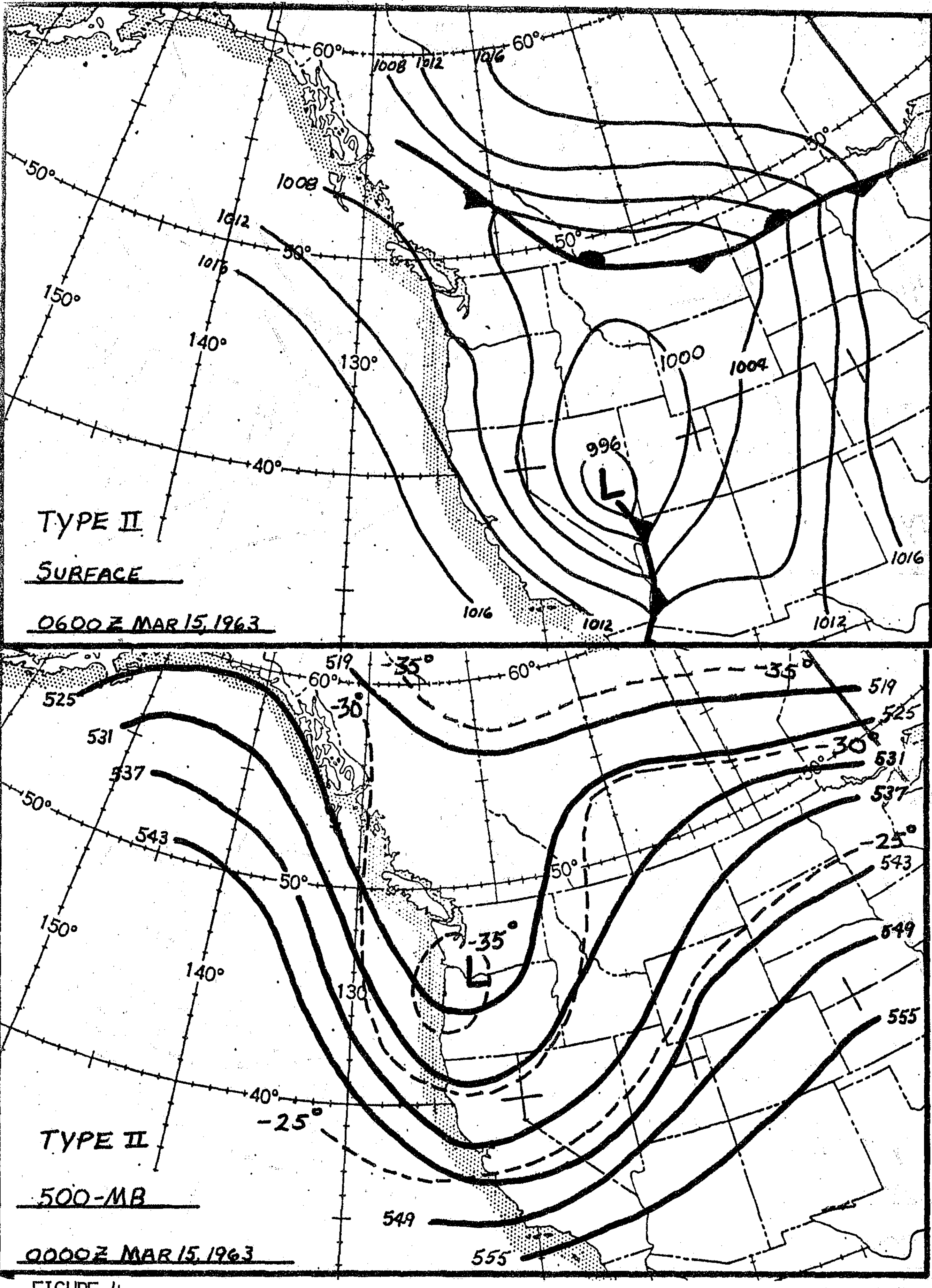
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FIGURE 4

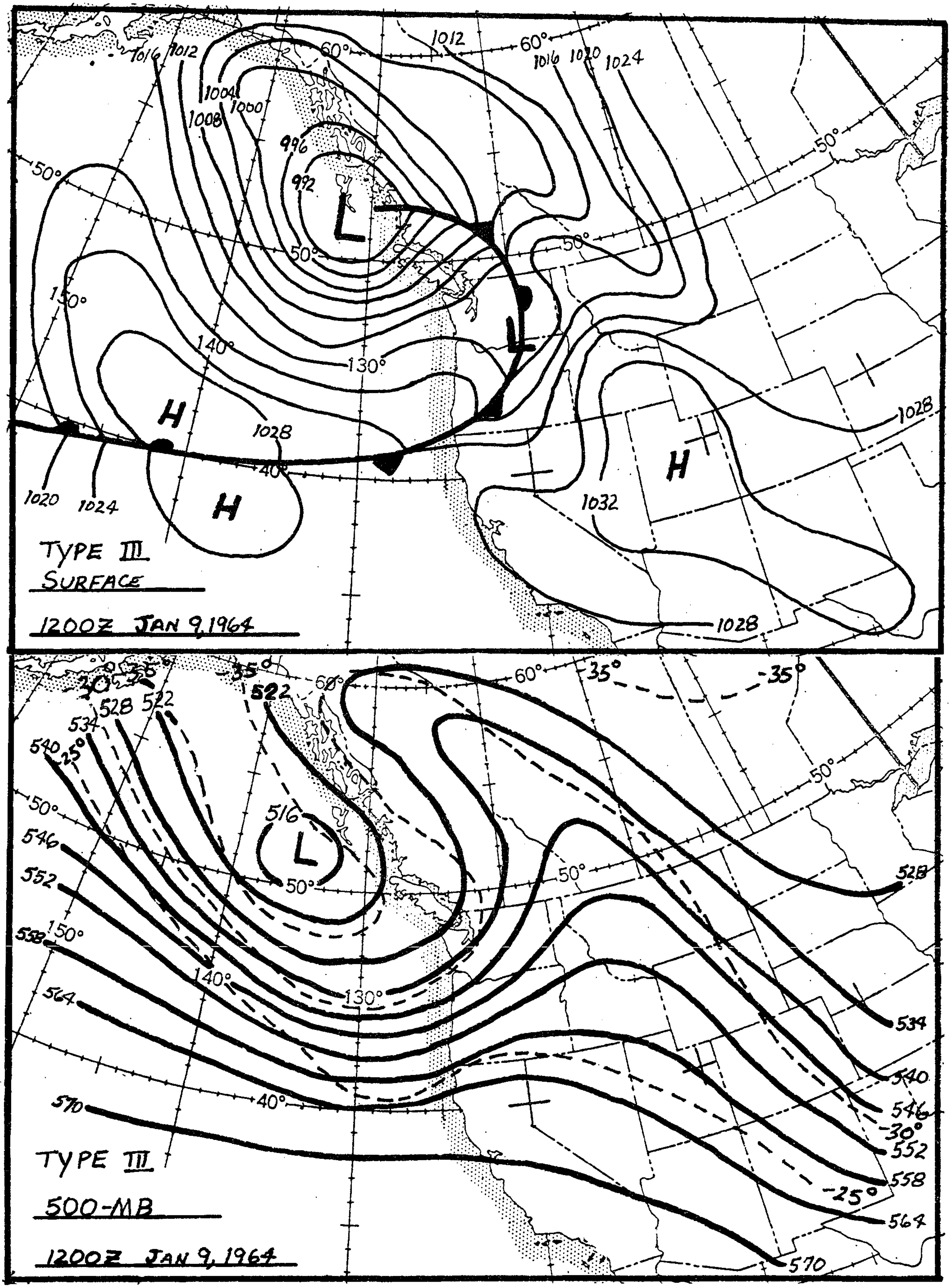
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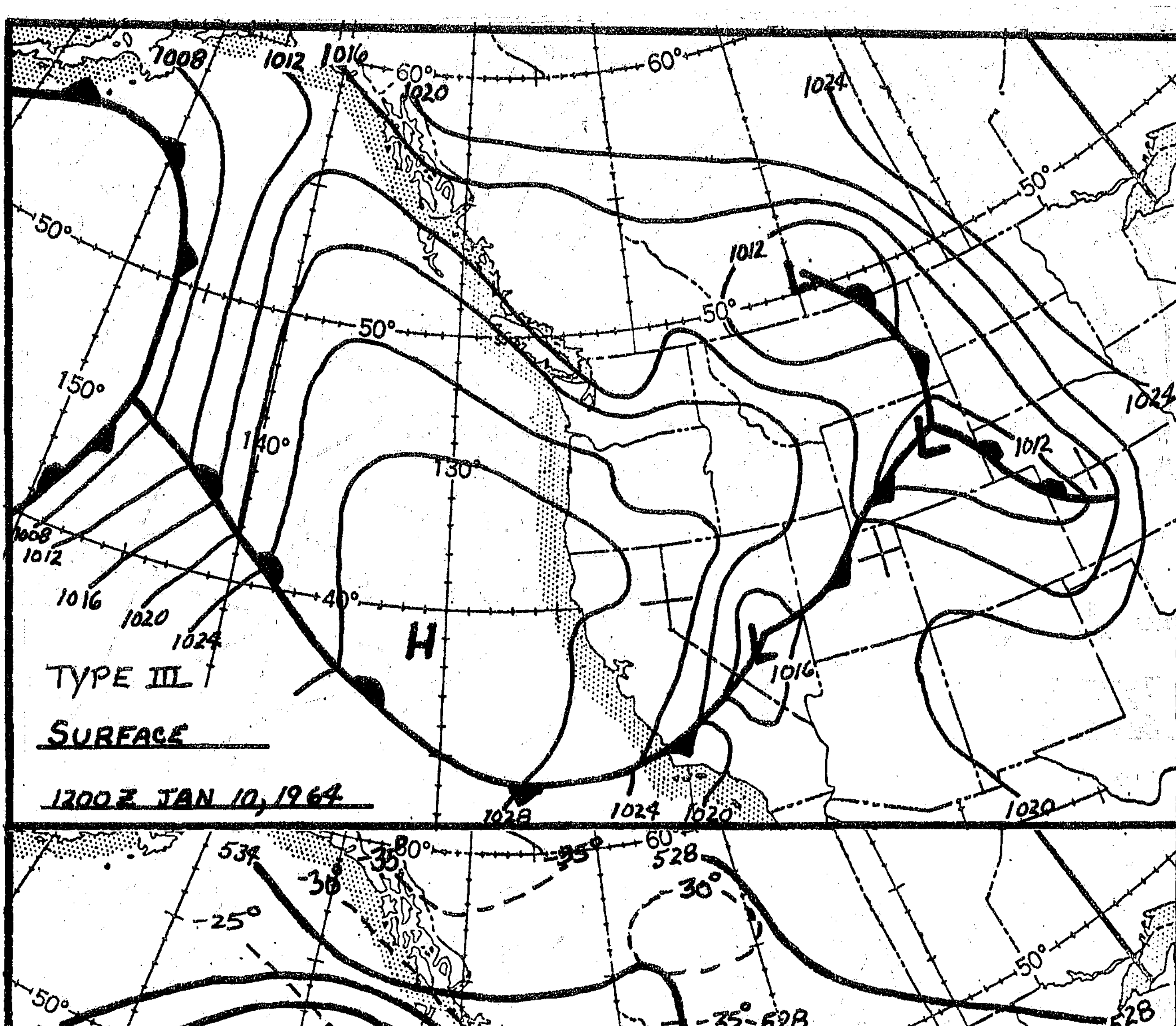
FIGURE 5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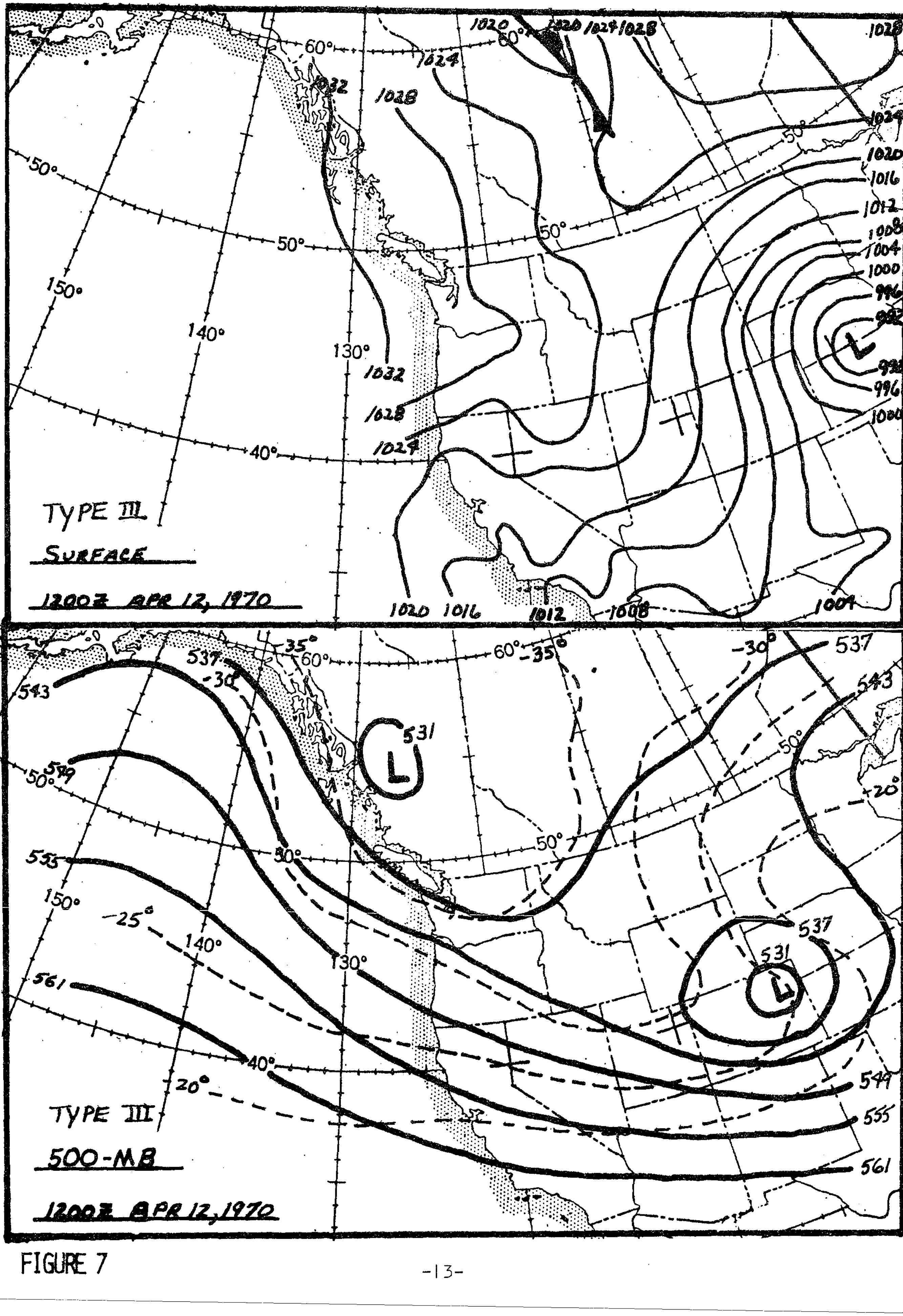
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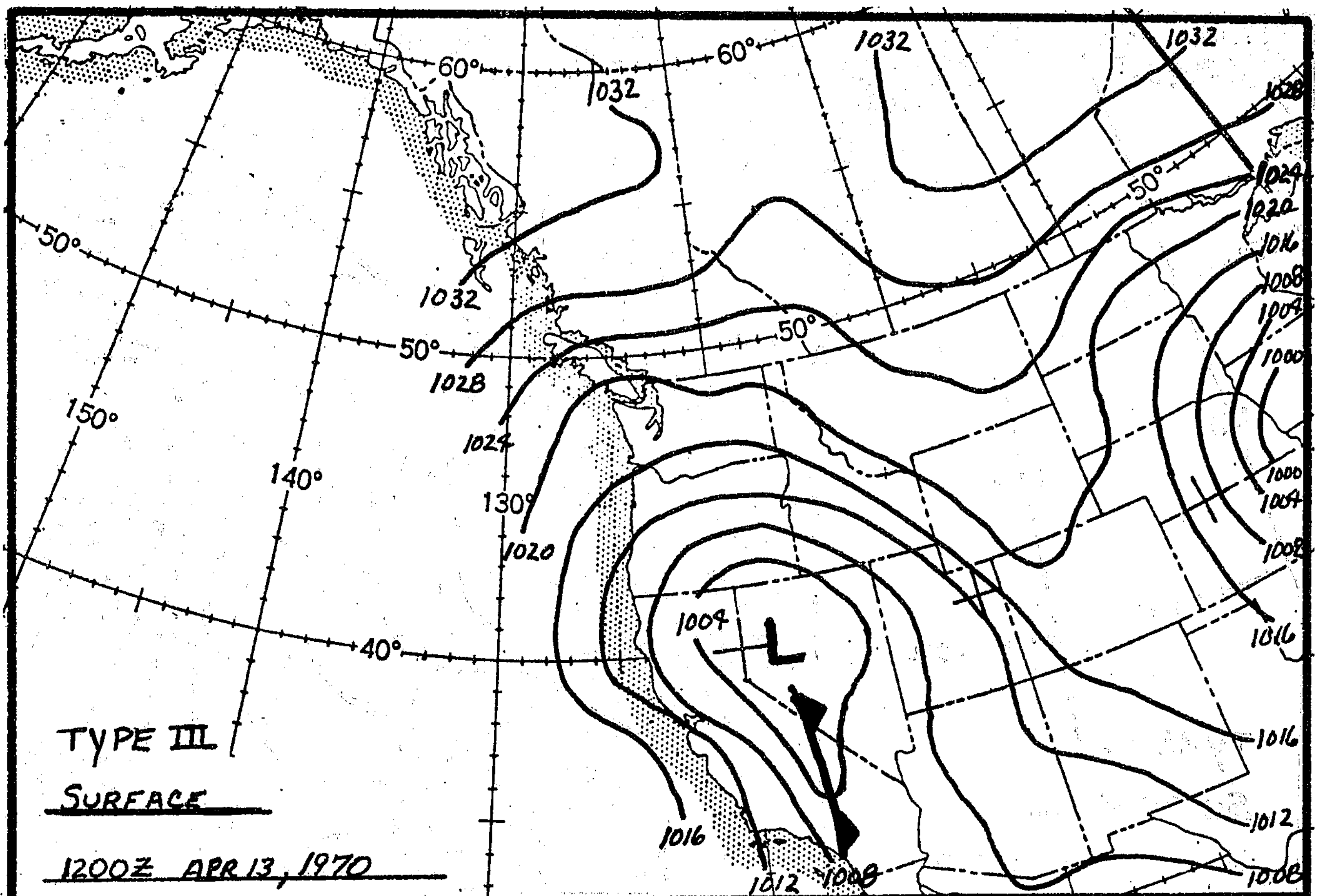
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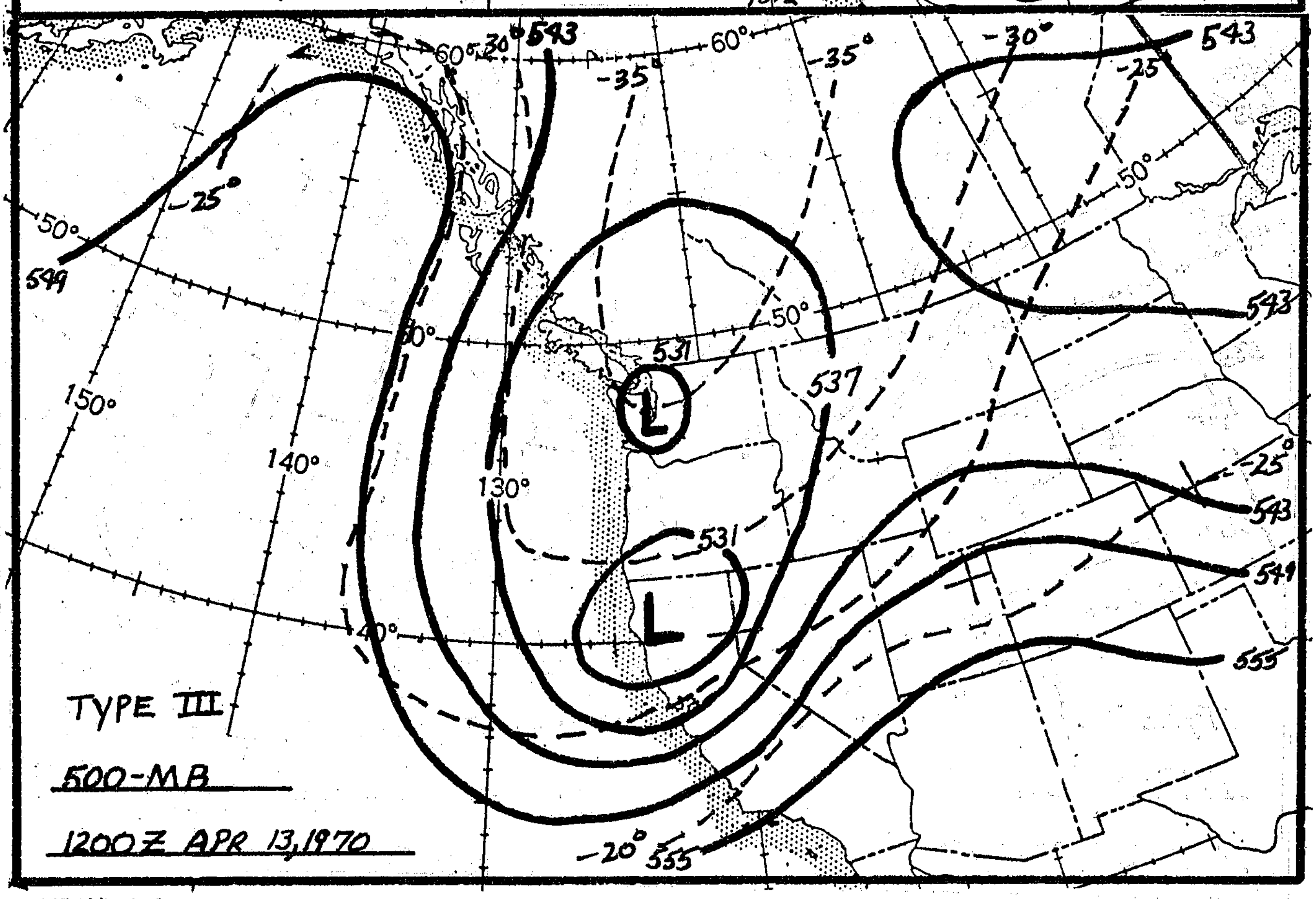
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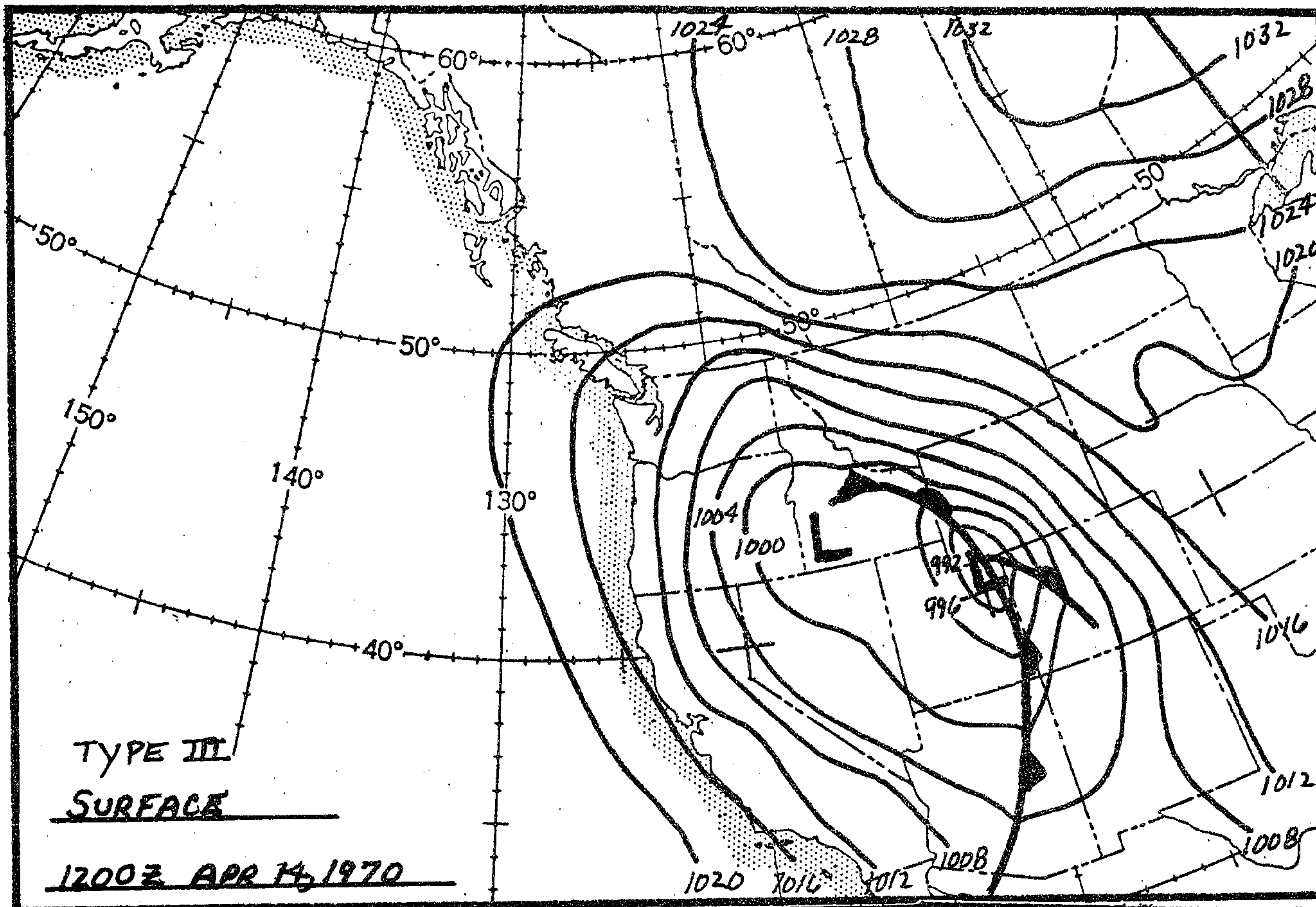
FIGURE 8



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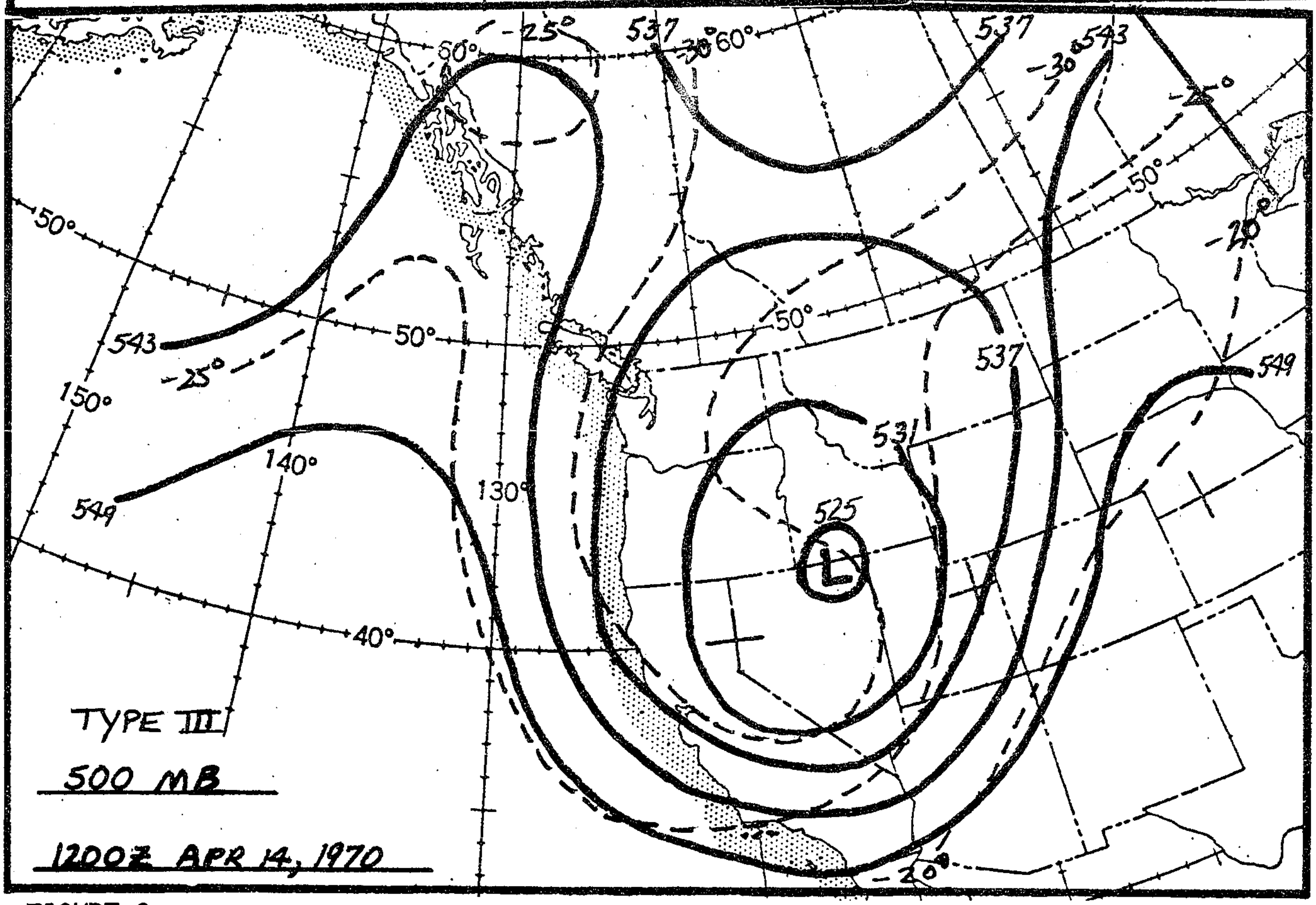

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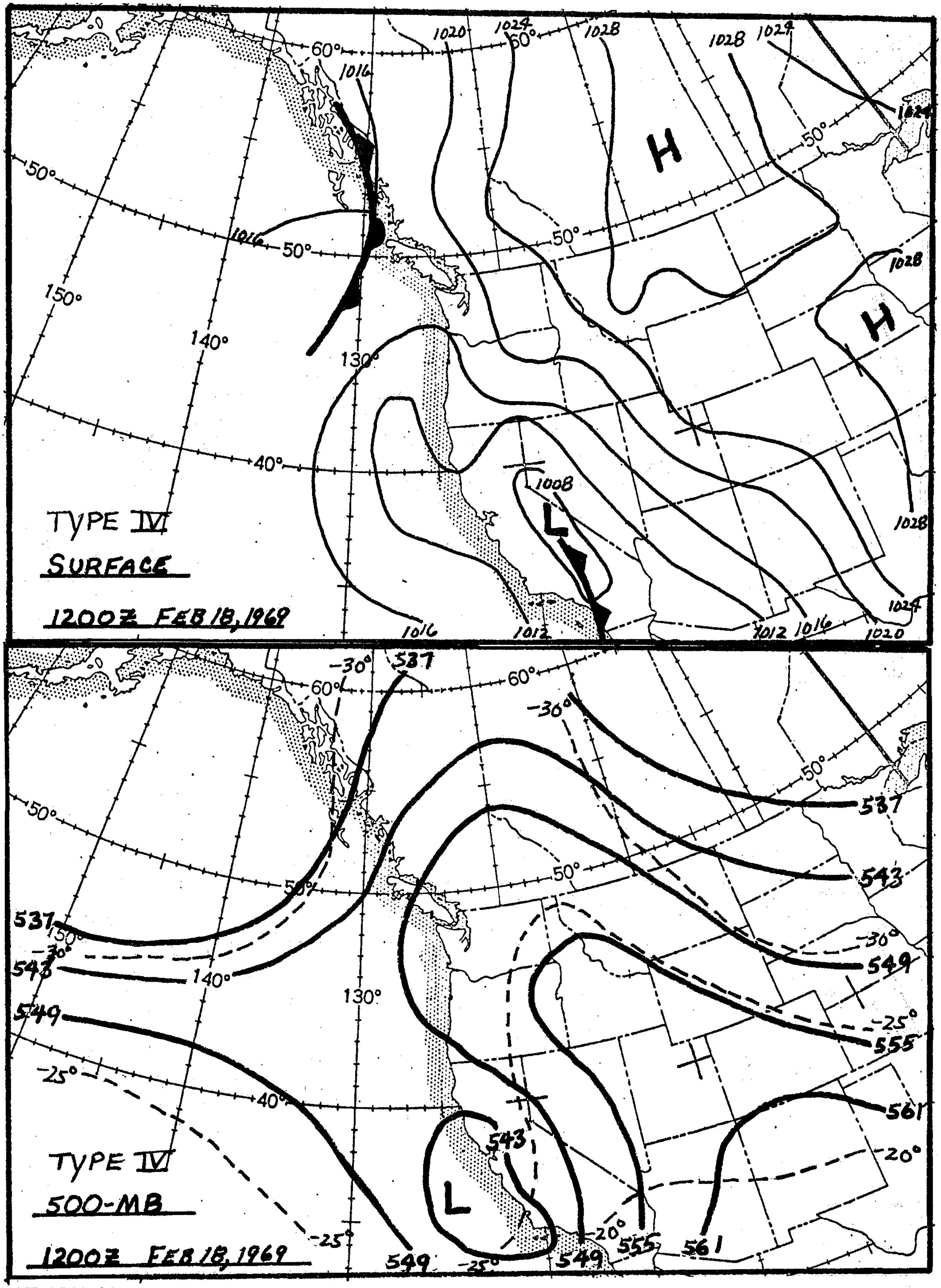
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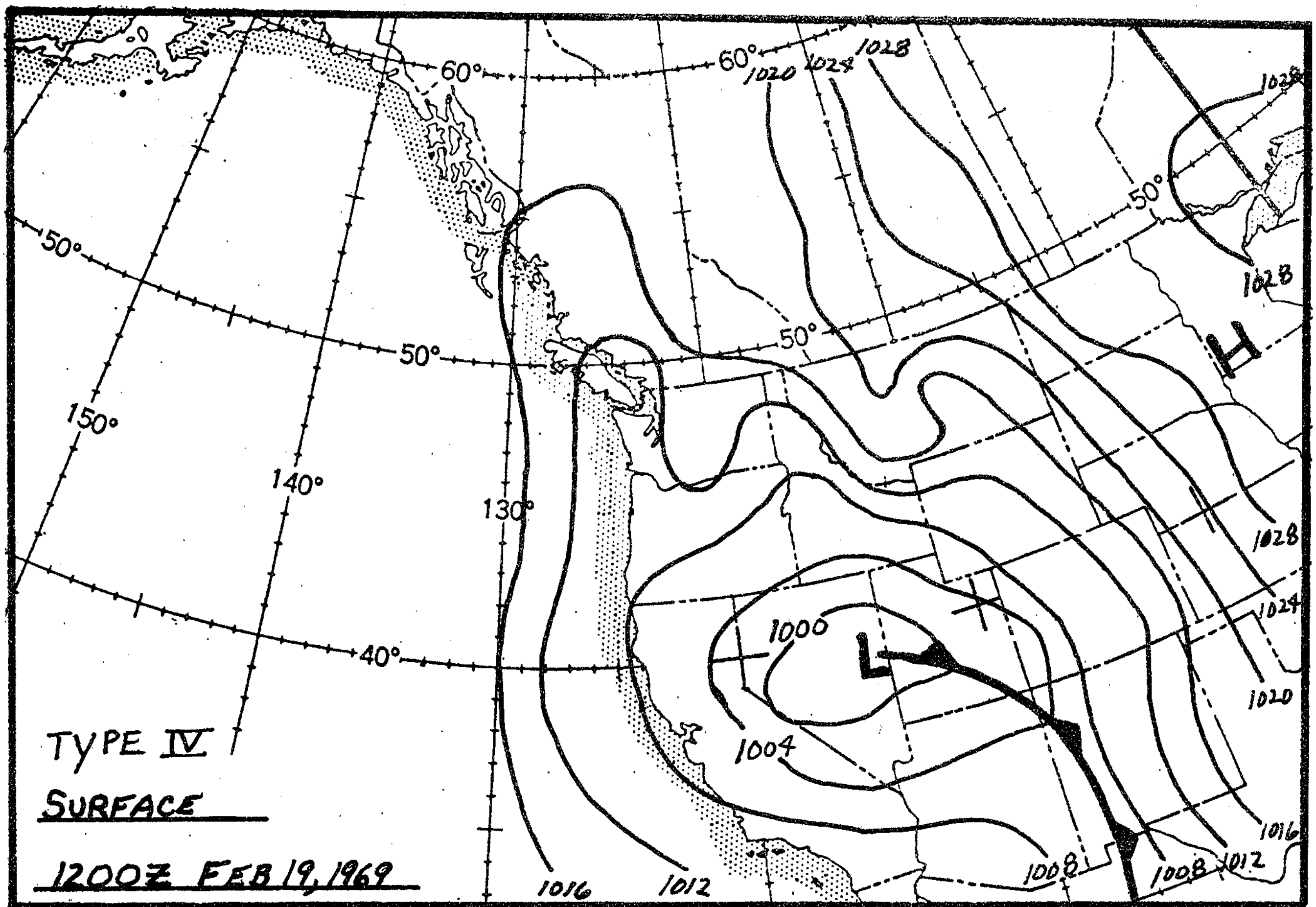
-20°

FIGURE 10


TYPE IV
SURFACE
1200Z FEB 19, 1969
60°
50°
40°
150°
140°
130°
1000
1004
1008
1012
1016
1020
1024
1028
L
H

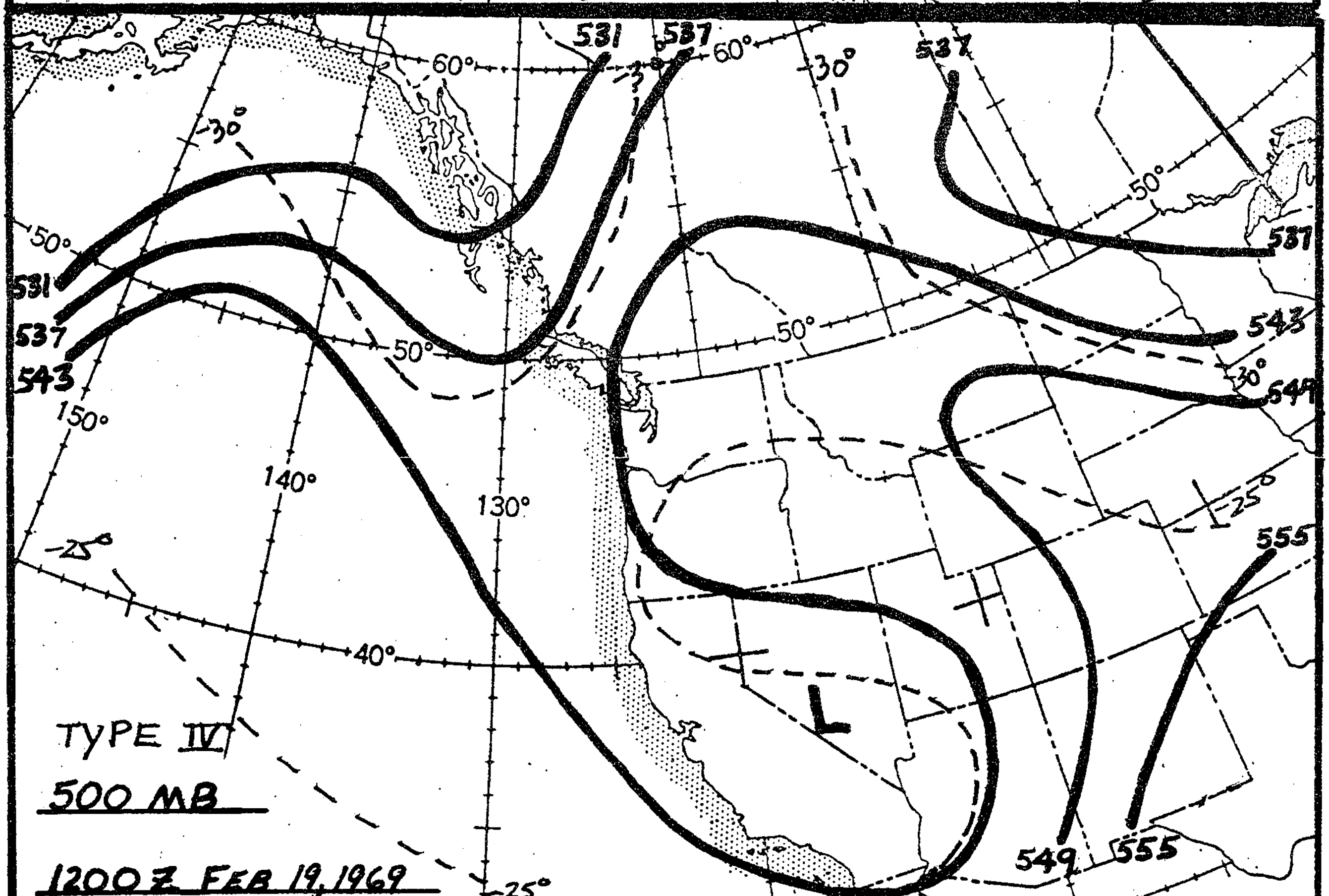

TYPE IV
500 MB
1200Z FEB 19, 1969
60°
50°
40°
150°
140°
130°
-30°
-25°
531
537
543
549
555
L

FIGURE 11

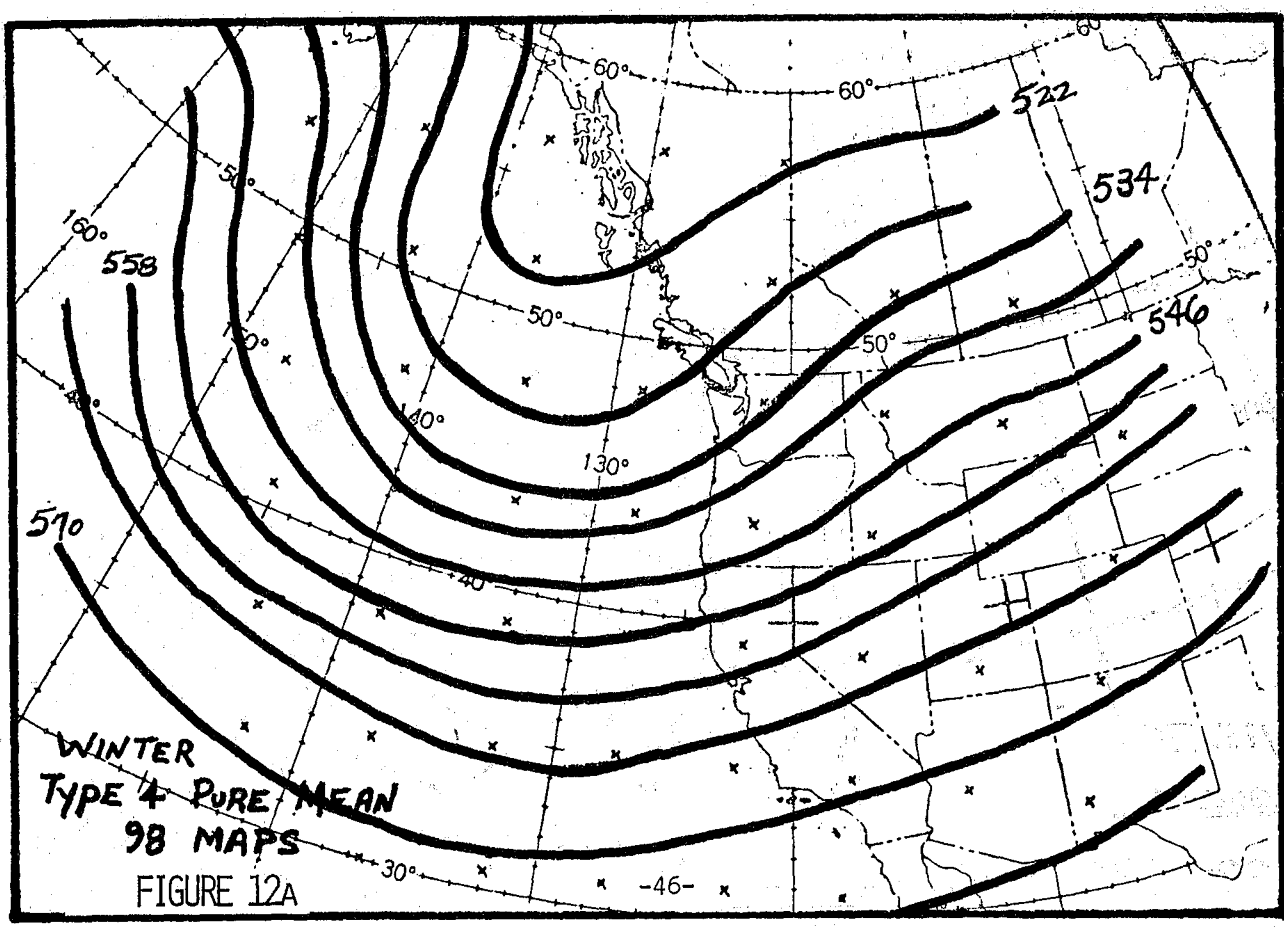


FIGURE 12A

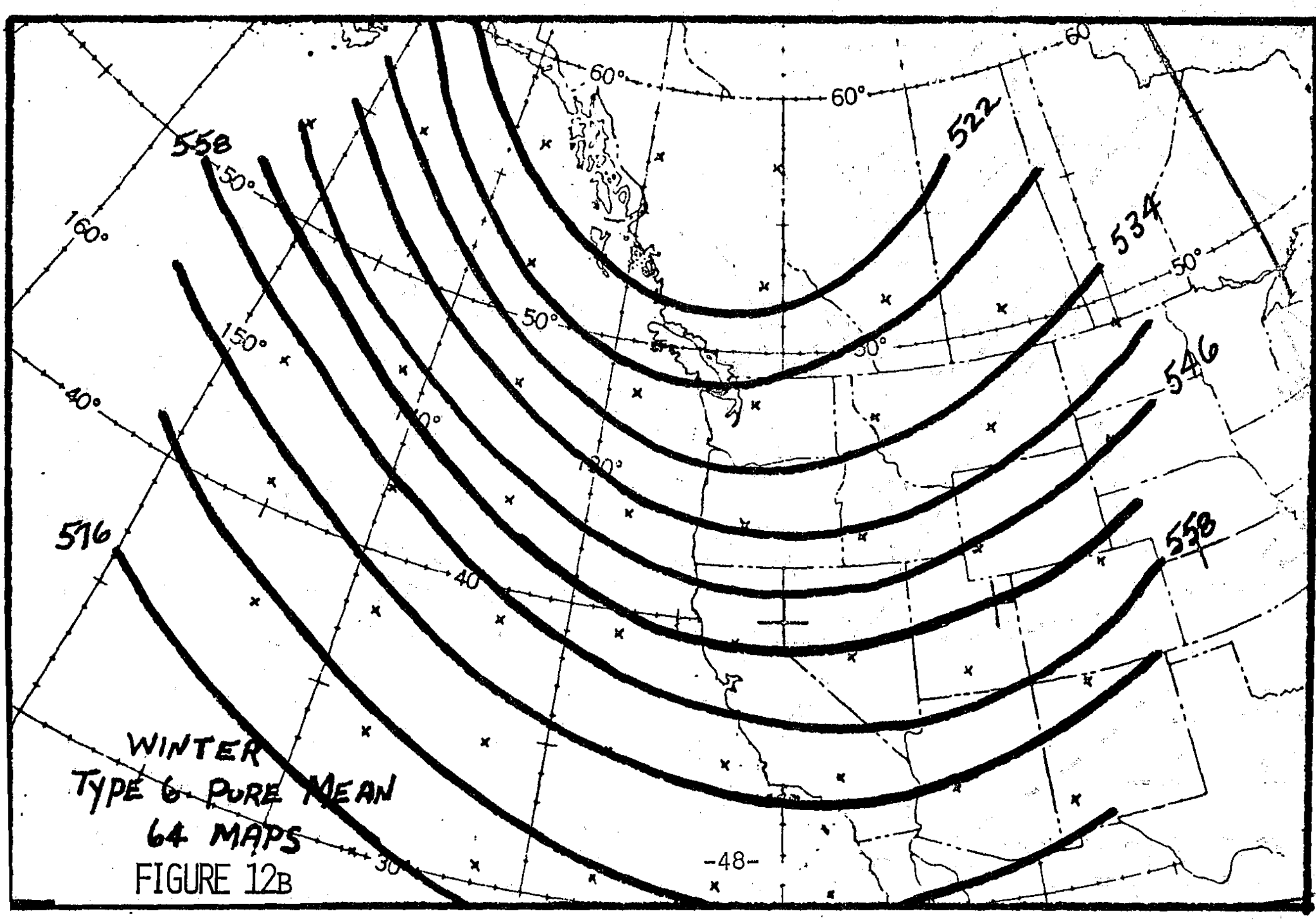


FIGURE 12B

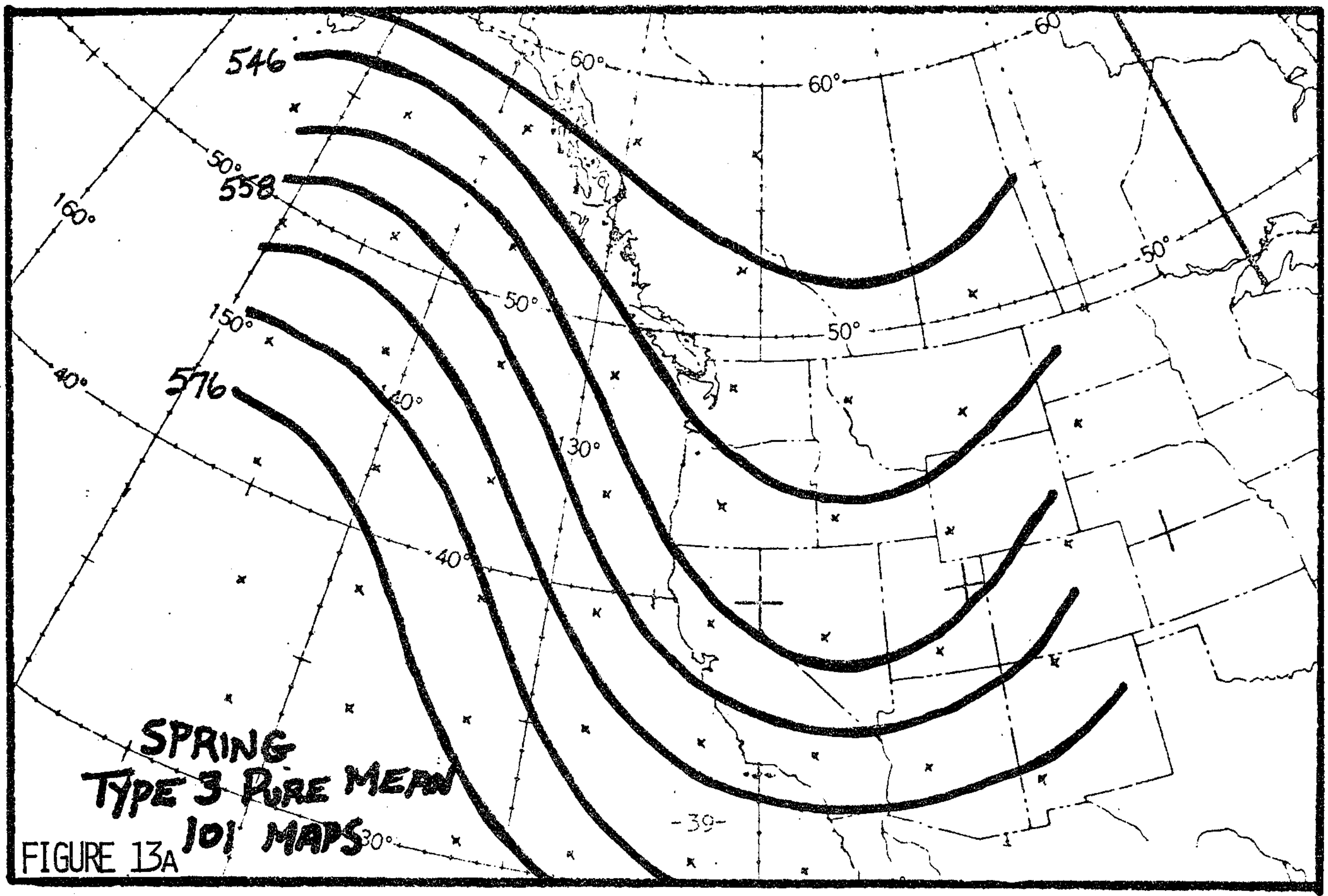


FIGURE 13A

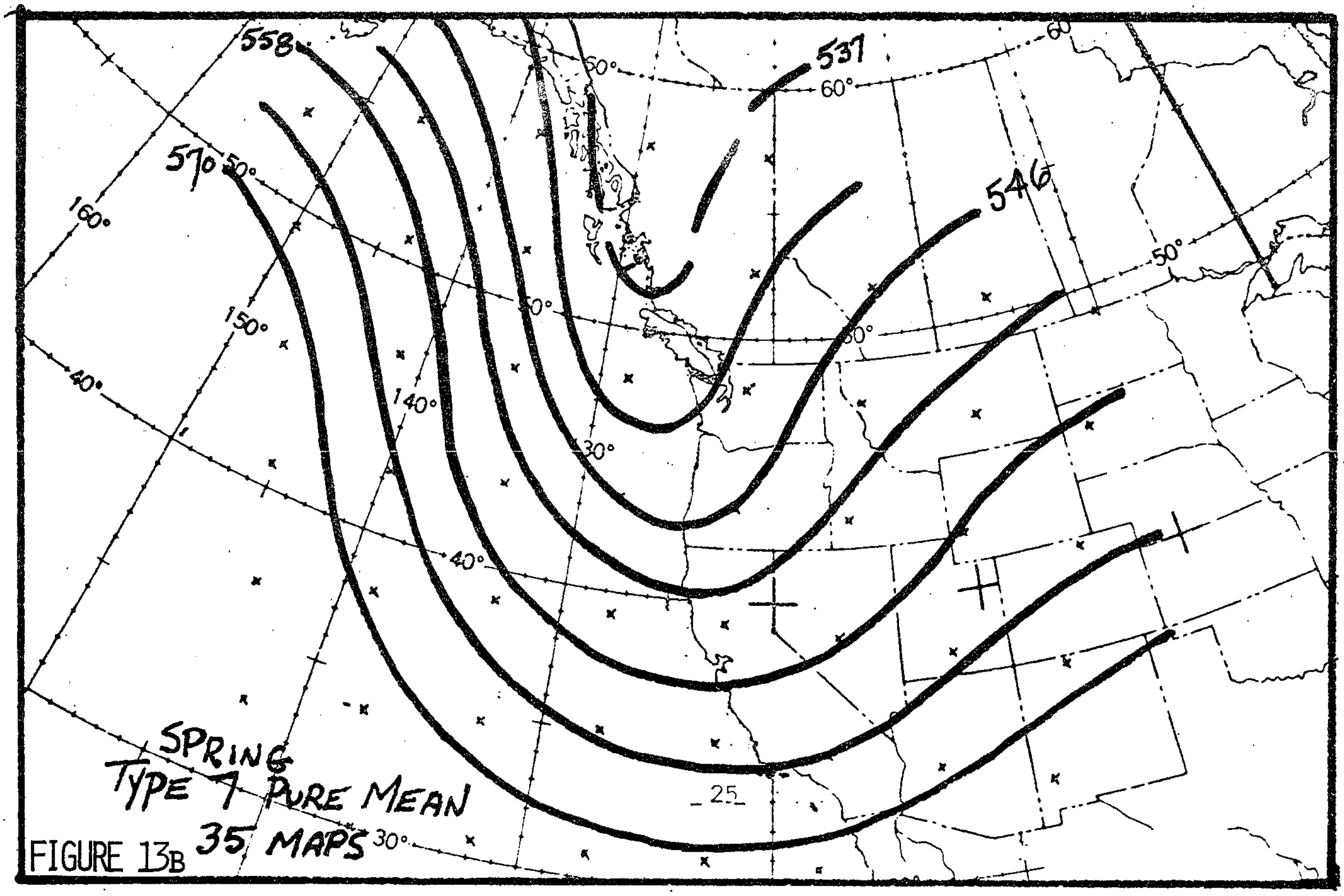


FIGURE 13B

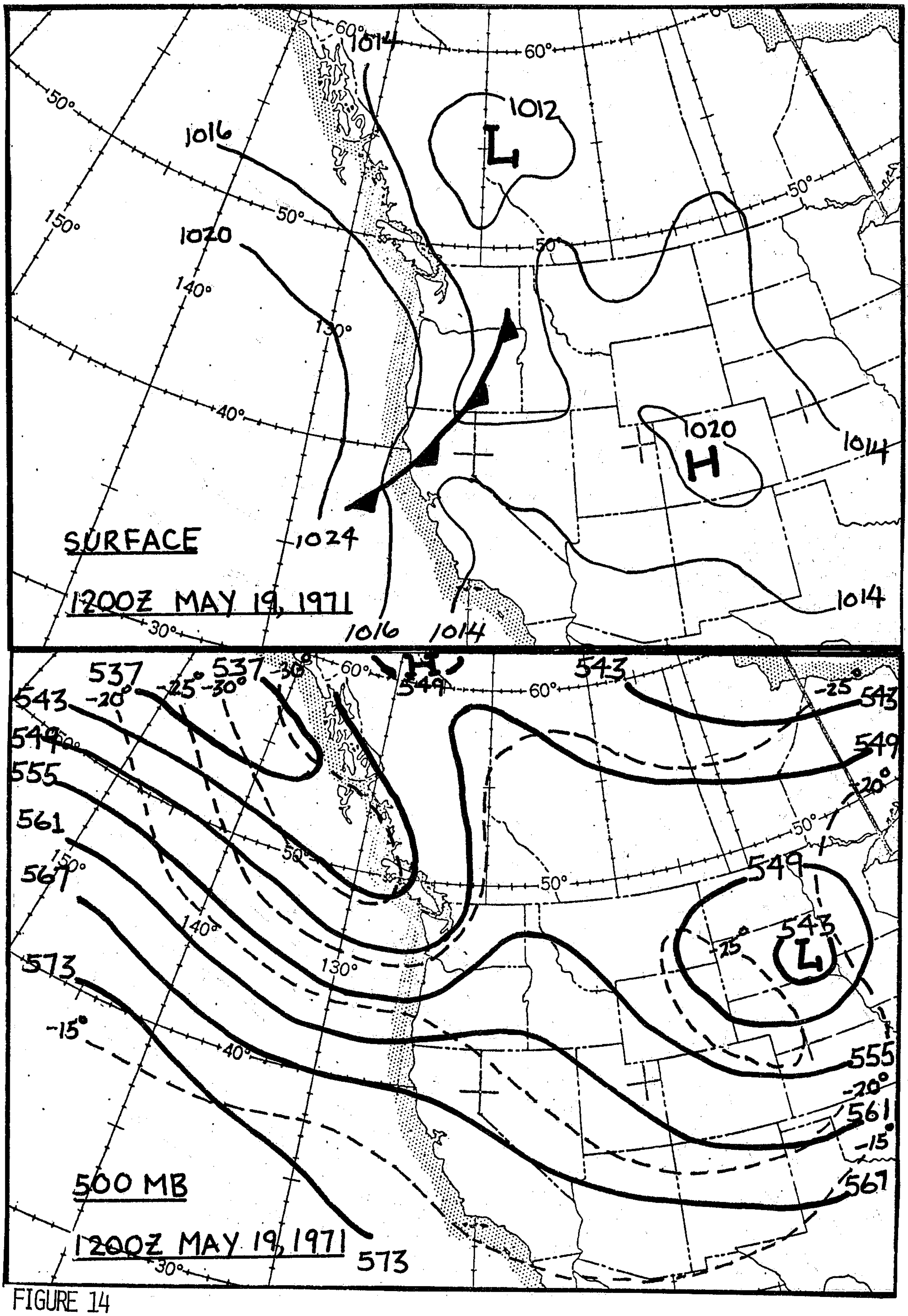

SURFACE
1200Z MAY 19, 1971
1012
L
1016
1020
1024
1014
1020
H
1016
1014
500 MB
1200Z MAY 19, 1971
537
543
549
555
561
567
573
L
-15°
-20°
-25°
-30°

FIGURE 14

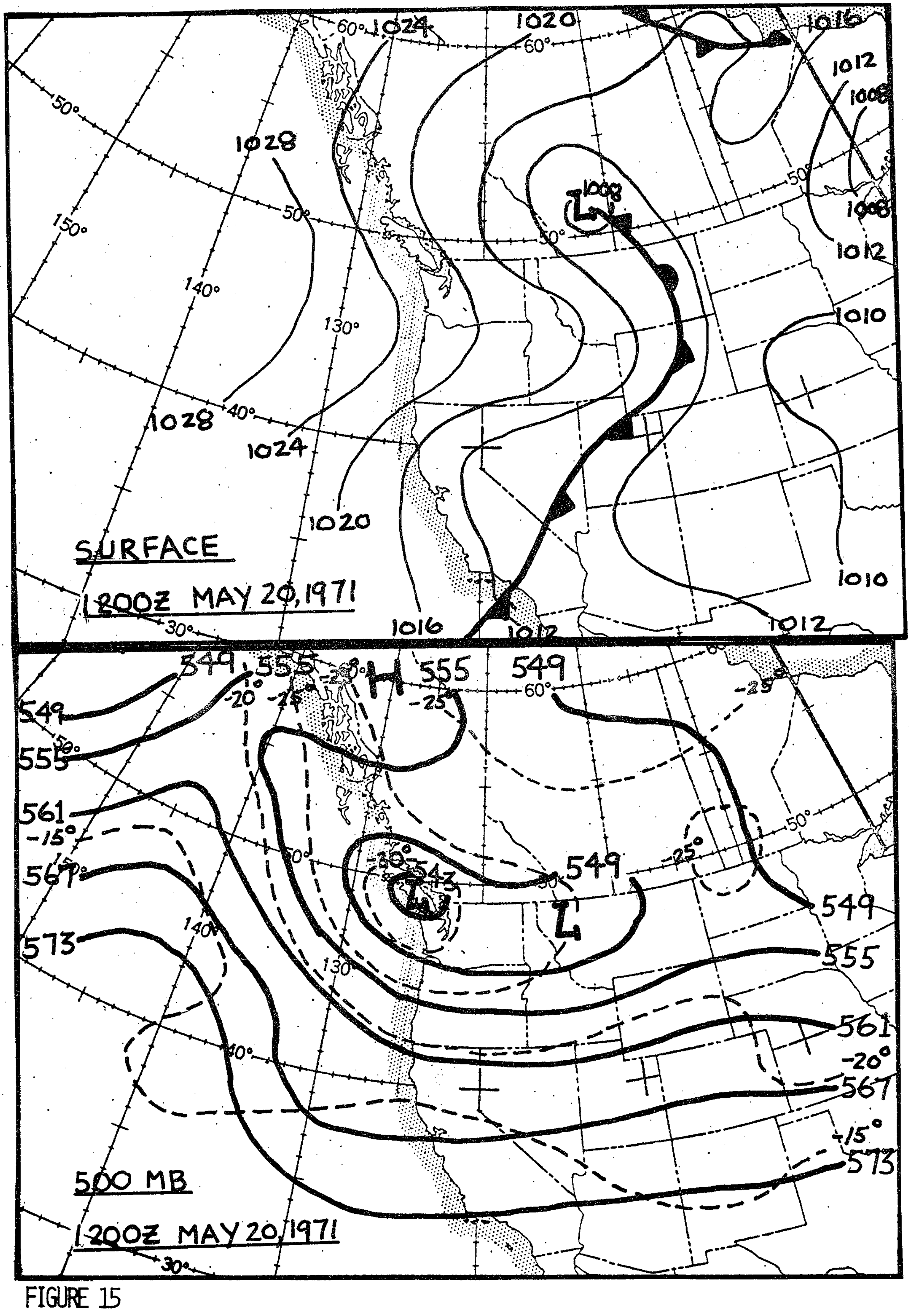


FIGURE 15

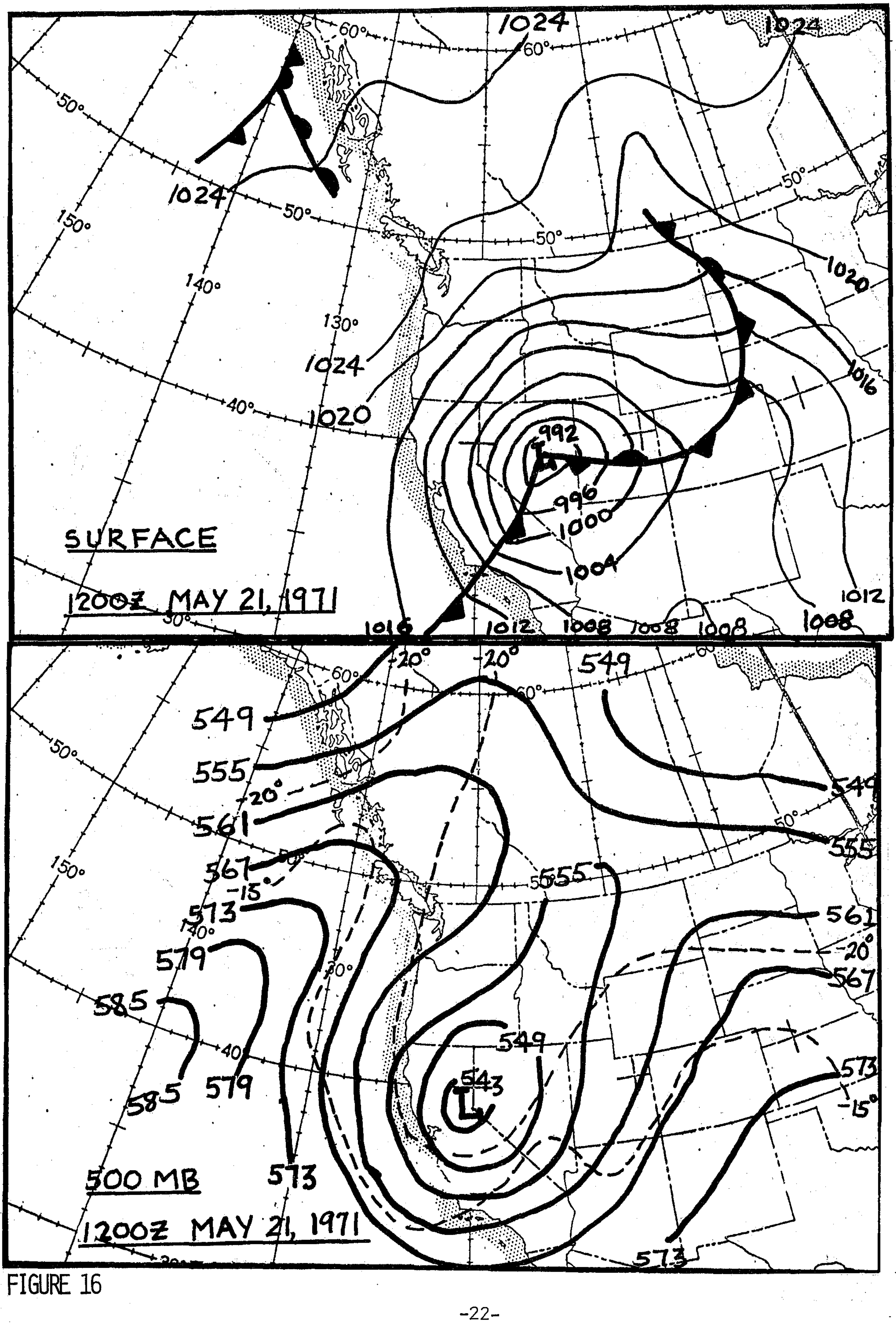

SURFACE
1200Z MAY 21, 1971
1024
1020
1016
1012
1008
1004
1000
996
992
500 MB
1200Z MAY 21, 1971
549
555
561
567
573
579
585
543
L

FIGURE 16

TABLE 1

DISTRIBUTION OF SNOWSTORMS AT RENO, LOVELOCK, AND WINNEMUCCA, NEVADA (1961 - 1970)

SNOW AMOUNT	LOCATION		
	Reno	Lovelock	Winnemucca
At least 1 inch	65	23	68
At least 2 inches	42	15	39
4 inches or more	19	2	18

TABLE 2

FREQUENCY OF THE FIVE TYPES OF SNOWSTORMS OF 1 INCH OR MORE AND 4 INCHES OR MORE IN NORTHWESTERN NEVADA (1961 - 1970)

STORM TRACK	NUMBER OF SNOWSTORMS	
Type	1 inch or more	4 inches or more
Type I	35	6
Type II	27	9
Type III	28	10
Type IV	7	1
Type V	15	3

No. 45/2 Precipitation Probabilities in the Western Region Associated with Spring 500-mb Map Types. Richard P. Augulis. January 1970. (PB-189434)
No. 45/3 Precipitation Probabilities in the Western Region Associated with Summer 500-mb Map Types. Richard P. Augulis. January 1970. (PB-189414)
No. 45/4 Precipitation Probabilities in the Western Region Associated with Fall 500-mb Map Types. Richard P. Augulis. January 1970. (PB-189435)
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