

THE FORMATION OF WEAK TROUGHS OFF THE S.W. COAST
OF WESTERN AUSTRALIA.

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1. THE ISALLOBARIC CHANGES.

The three hourly positive isallobars along the South West Coast, associated with a high pressure ridge moving across the south of the State, frequently change to marked negatives during the early hours of the morning. This change in pressure tendency is accompanied by the veering of the winds along the south west coast from South-west to West to North-west, and a strengthening of the pressure gradient. Thus, there is every evidence of a trough development off the coast.

However, for some unknown reason, the negative isallobars ahead of the trough return to positives at 0100Z, when the trough is still outside the coast. At this stage there is a slackening of the pressure gradient, and the weakening trough begins to cross the coast with little activity along the trough line.

These isallobaric changes presented a problem, for which no solution seemed readily available. At first it was thought that the three hourly diurnal pressure corrections were faulty, thereby giving rise to incorrect isallobars. However, the fact that these trough developments may extend over several months, during which the diurnal corrections vary, discounts this possibility.

Troughs formed on three successive mornings over the period 5/9/52 to 7/9/52, and each trough was characterised by similar variable isallobars. This suggested that the development may be due to diurnal factors, and with this possibility in view, the trough which developed during the early morning of 5/9/52 was examined in detail.

2. DATA.

- (a) Figs 1 to V inclusive are surface analyses with corresponding three hourly isallobars, covering the period from 040700Z to 051000Z.
- (b) Figs. VI to VIII inclusive are corresponding 700 mbs. charts.
- (c) Fig IX shows the 042200Z dry bulb temperatures for selected stations, together with overnight temperature falls.

3. DISUSSION OF DATA.

(a) Fig. 1 to V.

Fig. 1 shows a ridge moving across the south of the State, and there is no evidence of a trough forming off the coast.

In Fig. 11, the veering of Leeuwin's wind, and the north-west wind on the "Mahia," suggest that a trough may be developing.

Fig. 111 shows the change to negative isallobars and the deepening of the trough off the south west coast.

Fig. 1V shows the passage of the trough through Cape Leeuwin, and the return to positive isallobars ahead of the trough.

Fig. V, the trough has weakened and moved further eastwards.

(b) Figs VI to VIII, corresponding 700 mbs. charts, show that the trough development extends to the 700 mb. level, and that the inland high pressure cell also extends to the upper air.

(c) In Fig. IX, it may be seen that the morning (2200Z) temperatures inland, are much lower than the morning temperatures along the south west coast. Furthermore, the overnight temperature falls for the inland stations are much greater, resulting in greater subsidence inland.

4. THE TROUGH DEVELOPMENT.

The surface winds over the land during the night are light, and there is an appreciable difference in surface temperatures between land and sea. (See Fig. IX.) There is thus a widespread cooling of the lower layers of air near the ground. These layers become denser, and consequent subsidence, accompanied by an inflow of air aloft (500 mb. level,) aids the formation of a high pressure cell (or ridge) over the south of the State, and the development of a weak trough off the south west coast.

With synoptic situations such as these, it is difficult to determine the order of this subsidence without additional Raobs at night. However, when estimating 1000--700 mb. thicknesses at 2200Z, for inland stations such as Kalgoorlie, it is usually necessary to lower the height of the subsidence inversion given on the previous 0800Z Raobs by as much as several hundred feet, in order to obtain 700mb thicknesses to correspond to the 10,000 ft. pibal winds.

These facts suggest that in synoptic situations such as these, with weak cut-off high pressure cells, the main subsidence occurs during the night, and is due largely to the cooling of the lower layers. Surface warming of these layers during the day leads to convection, and consequently a weakening of the high pressure cell formed at night.

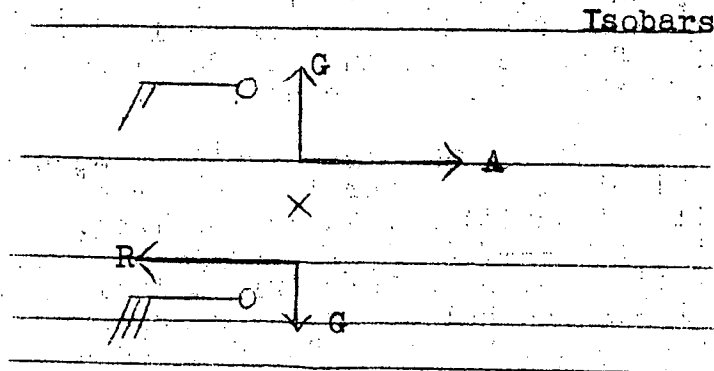
The trough, which forms off the coast between the high pressure cells (see Fig. 1V) shows a marked deepening at 2200Z. This deepening may be due to one or more of the following causes:-

(a) SURFACE DIVERGENCE.

It may be seen that in Fig. 11 the isobars are diverging along the south west coast, and this may cause pressure falls in the coastal districts.

(b) SHEAR EFFECTS.

Frictional shear effects between adjacent layers in the broad north west stream, which has increasing velocity from north to south, may cause falling pressures along the coast.



A \equiv Acceleration shear above layer.

R \equiv Retardation shear below layer.

G \equiv Coriolis force.

Divergence occurs at X.

4. (c) DEEPENING OF SOUTHERN DEPRESSIONS.

Southern depressions may intensify northwards towards the cold region created by the cut-off high. It must be noted, however, that the troughs have a NW-SE orientation, and the trough line does not pass directly through the cold region, (see Fig.1V).

5. THE ISALLOBARIC VARIATIONS.

To explain the reversal of negative isallobars to positives at 0100Z, was difficult. This may be due to a delayed action subsidence in the coastal districts. The delay could be brought about by the much higher dew points and greater cloud coverage in these districts, which cause a lag in the surface radiation.

Another possible cause may be the steady drift southwards of colder air in the rear of the inland cell. This cold air is drier and denser, and combined with land breeze effects, may result in delayed subsidence.

6. GENERAL INFERENCES.

In the main, these troughs at 2200Z weaken when crossing the coast, but occasionally they deepen into major troughs. S.H.Lloyd, in a recent article in the Australian Met. Magazine, No.1 concludes that the frequency of major troughs of southern origin at Cape Leeuwin (long. 115 degrees East,) appears to follow a normal curve pattern with a maximum on the 2200Z chart. It is suggested that the cause of this maximum frequency may be due to the weakness created by the splitting of the high pressure ridge as described above.

Returning to the weaker types of troughs, it may be seen that their development plays an important part as far as forecasting over the southwest of the State is concerned. As stated above, a similar sequence of isallobaric changes took place on the mornings of 6/9/52 and 7/9/52, and a less marked sequence occurred on the morning of 12/9/52. Frequently the negative isallobars at 2200Z become less negative at 0100Z. Examples of this type occurred on the mornings of 17/9/52 and 19/9/52. Furthermore, when the overnight pressure falls are very large, as on 18/9/52, and the trough usually moves rapidly across the south west coast by 2200Z, and any effects of subsidence ahead of it are apparently masked.

It would be interesting to compare these subsidence effects with similar developments in the Eastern States, and to compare the extent to which subsidence may be masked by the operation of other factors. It is emphasised also, that further investigation may show that the trough development is caused by effects other than those outlined above. However, the purpose of this article is to discuss the situation, and offer suggestions as to causes, rather than present a finalised explanation.

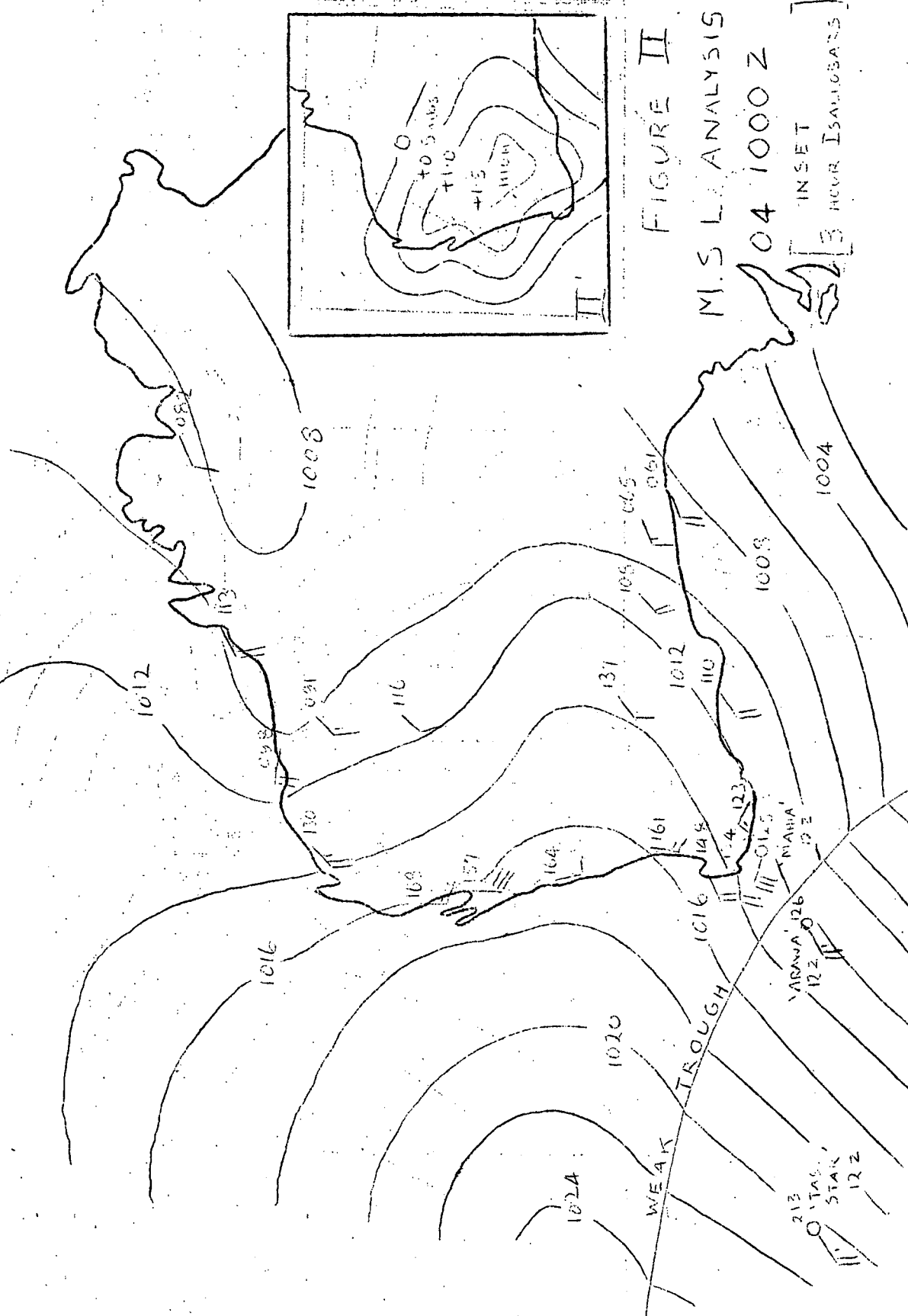


FIGURE II

M.S.L. ANALYSIS

04 1000 Z

INSET
3 HOUR ISALIBARS

'ARAWA' 126
122

'O'TAS'
STAR'
122

WEAK TROUGH

'MAHIA'
122

'4
123

'161
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'1016
1012

'1008
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'1000
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'992
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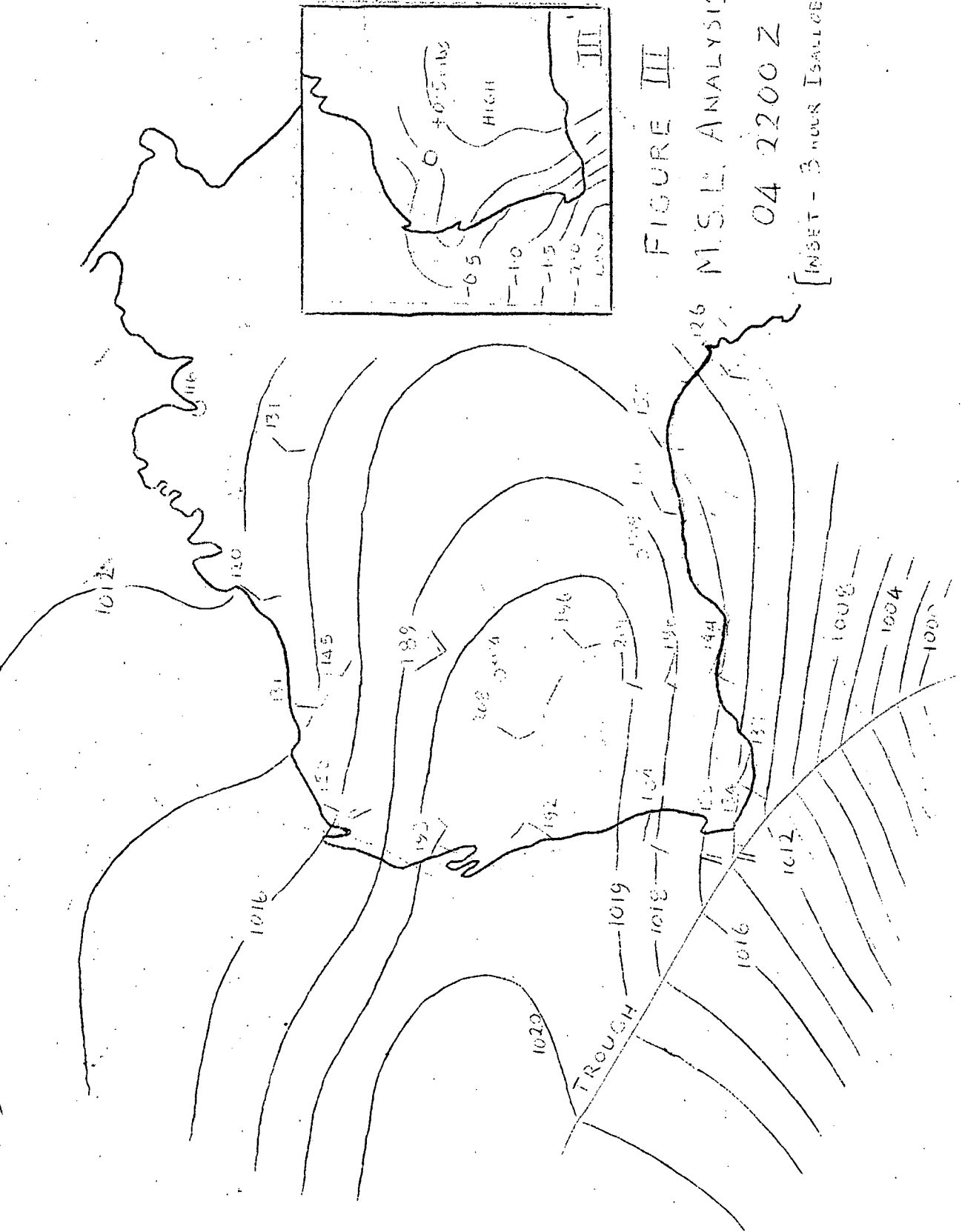


FIGURE III

M.S.L. ANALYSIS

04 2200 Z

[INSET - 3 HOUR ISALLOBARS]

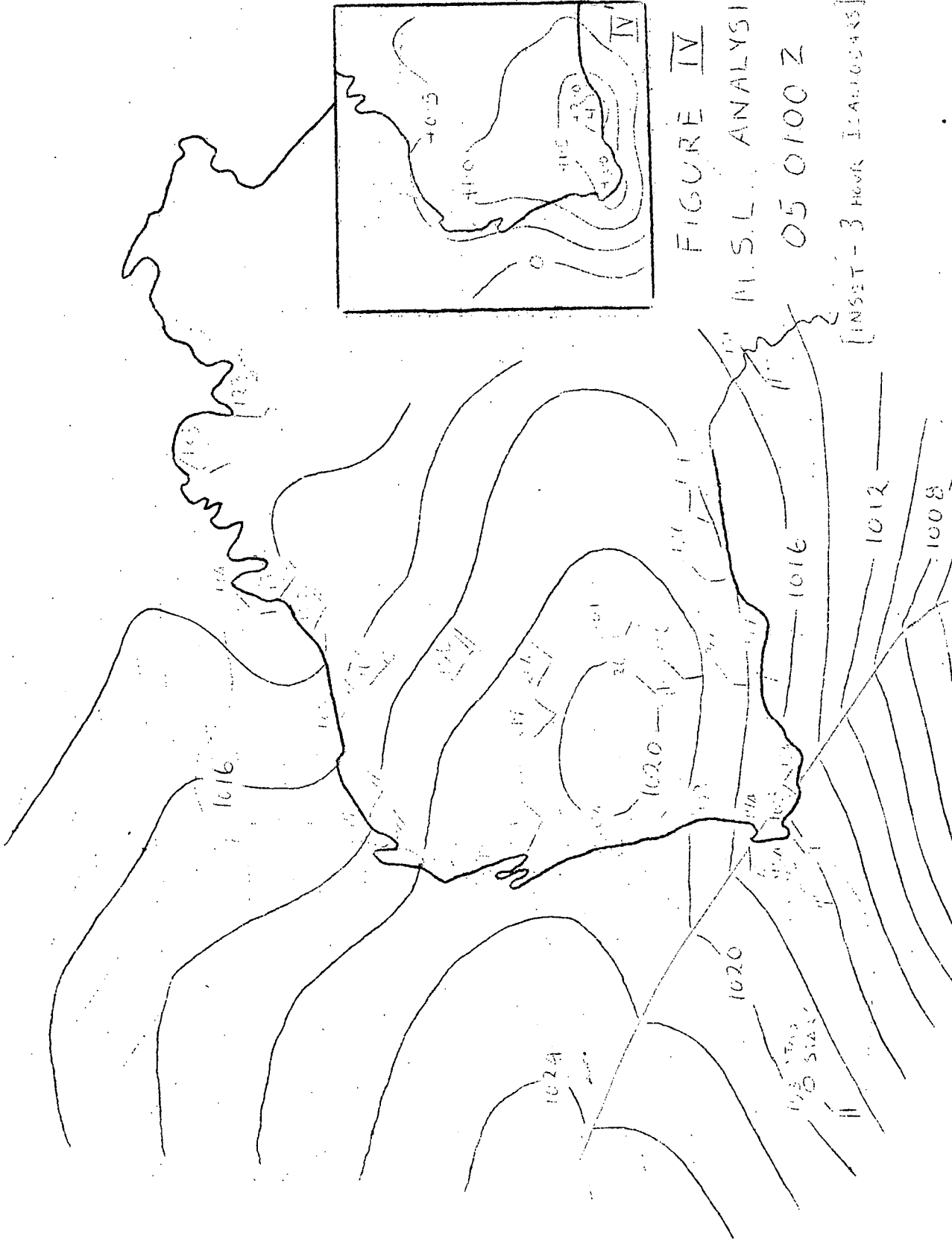


FIGURE IV
U.S.L. ANALYSIS
05 0100 Z

[INSET - 3 HOUR ILLINOIS]

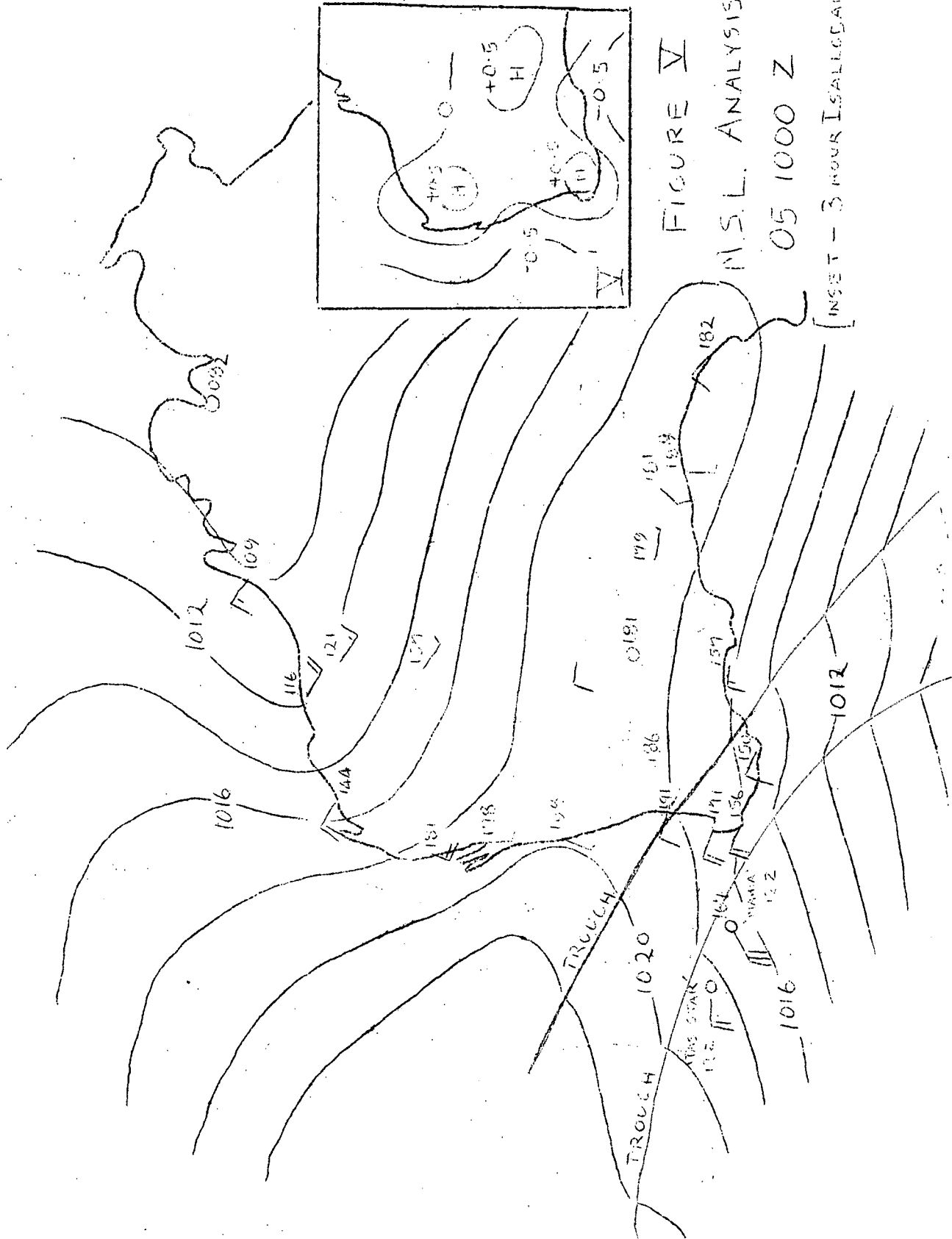


FIGURE V

N.S.L. ANALYSIS

05 1000 Z

[INSET - 3 HOUR ISALLOBAR]

FIGURE VI

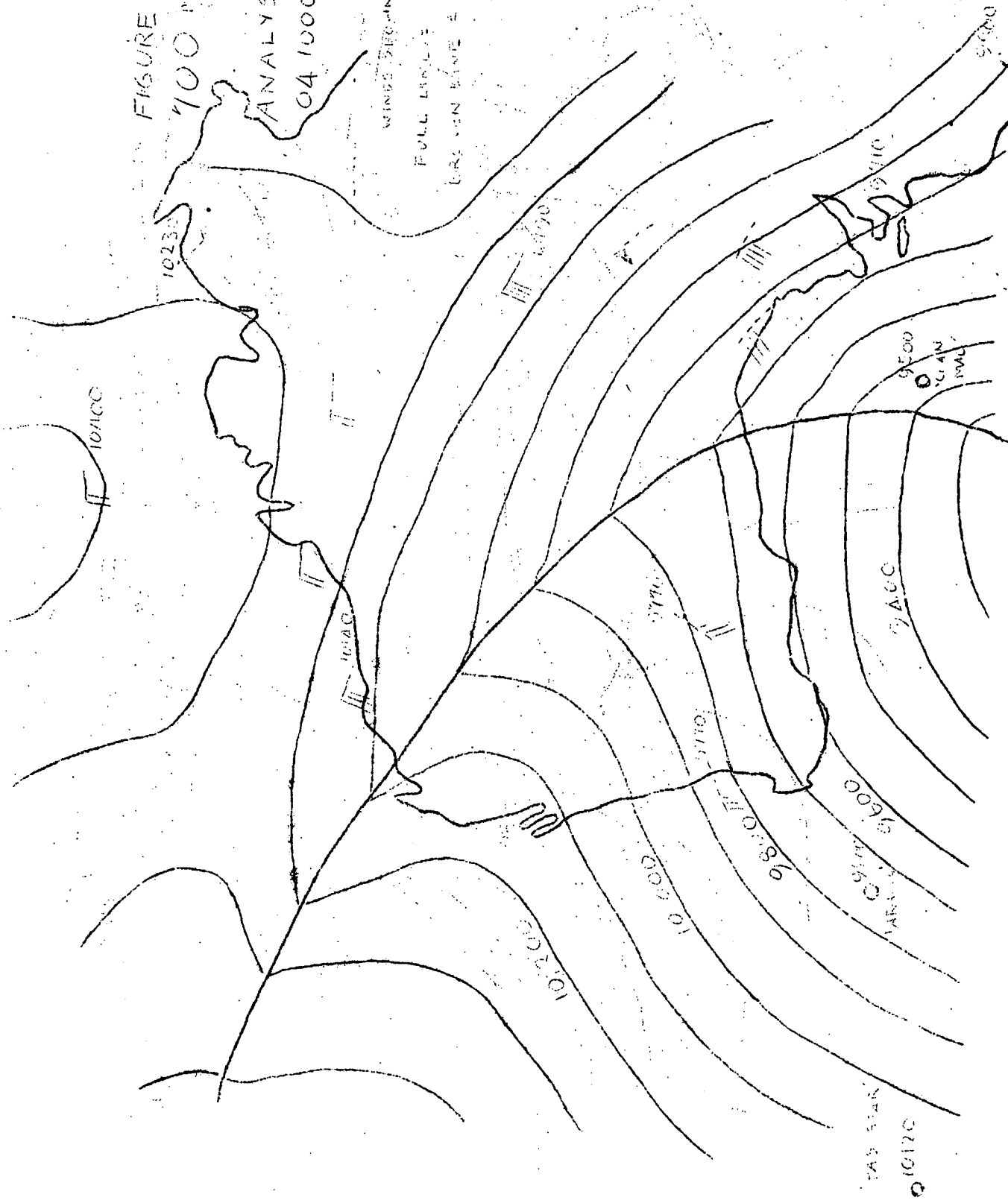
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ANALYSIS
04 1000Z

WINDS DETERMINED BY

FULL LENGTH 692

CRASH ON BANE ± 16 Z



700 MB
10170

FIGURE VII

700 mb

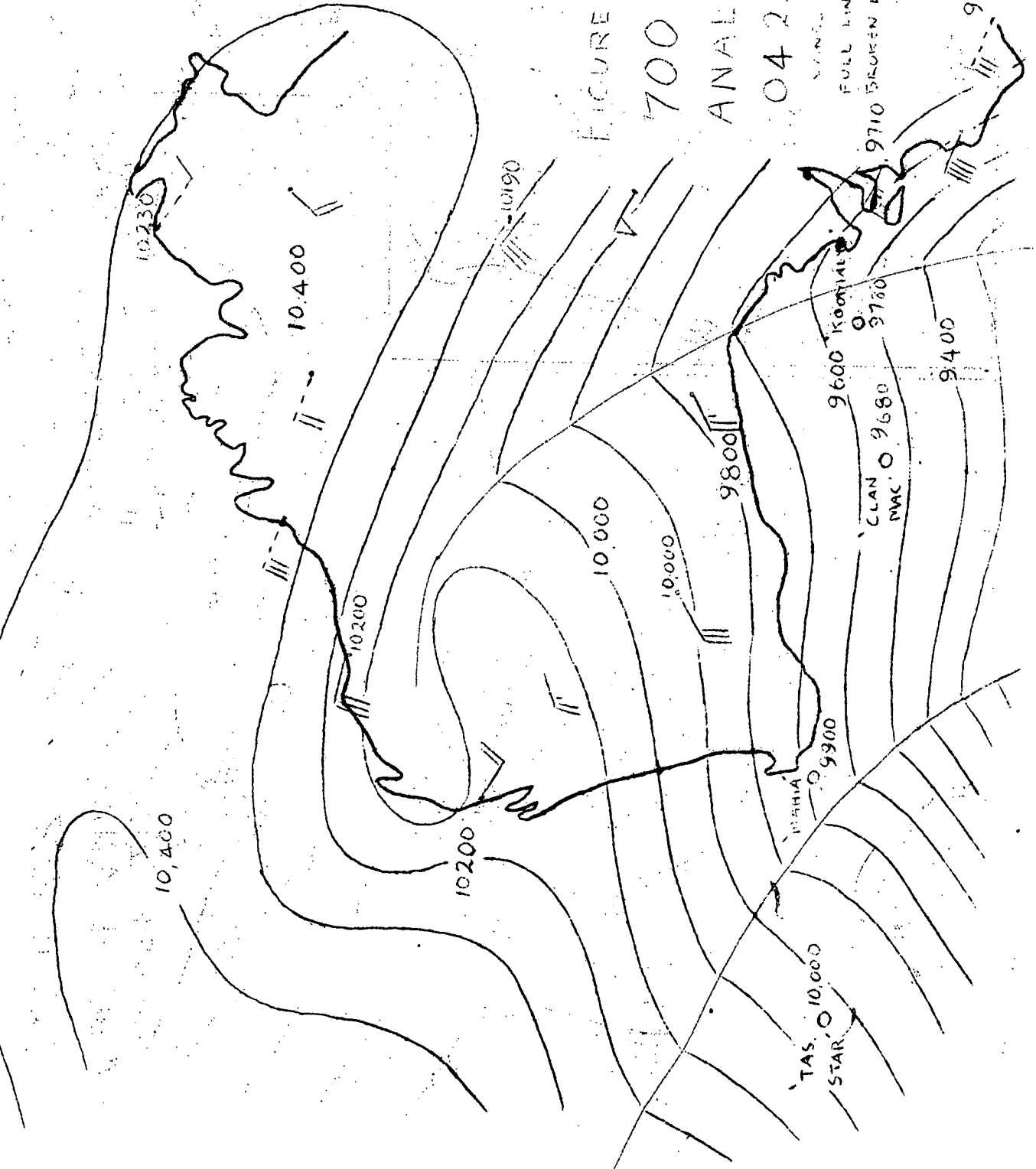
ANALYSIS

04 2200 Z

SYMBOL SHOWN BY

FULL LINE = 21 Z

9710 BROKEN LINE = 03 Z



10,230

10,400

10,190

10,200

10,000

10,000

9,800

9,600

9,700

9,400

9,800

10,400

10,200

TAS. 10,000

STAR. 10,000

CLAN. 9,680

MAC. 9,680

PARIA 9,900

KOORIAL 9,600

9,700

9,710

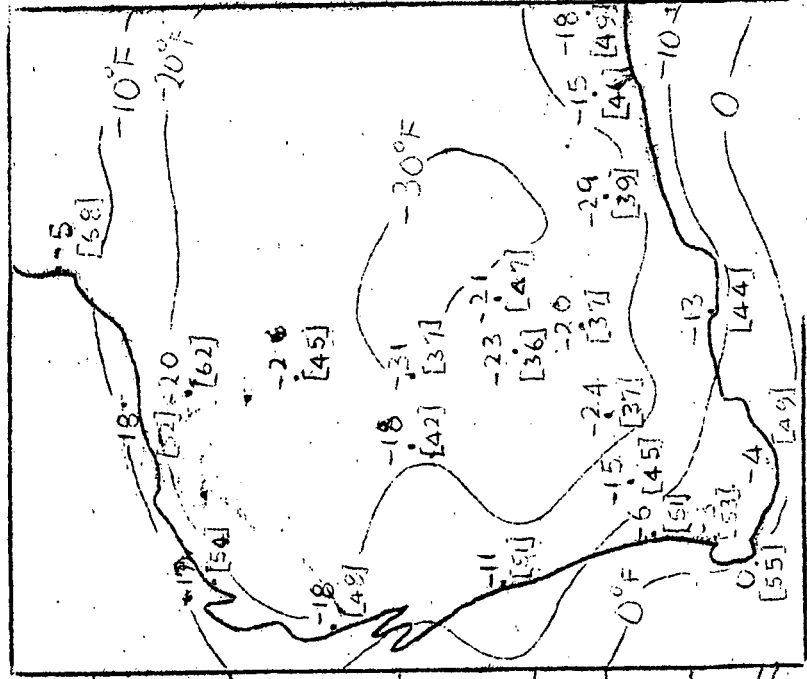


FIGURE IX
 15 HOUR
 TEMPERATURE
 FALLS
 04 0700 Z
 to 042200 Z

BRACKETED
 FIGURES ARE
 2200Z DRY
 BULB TEMPS.

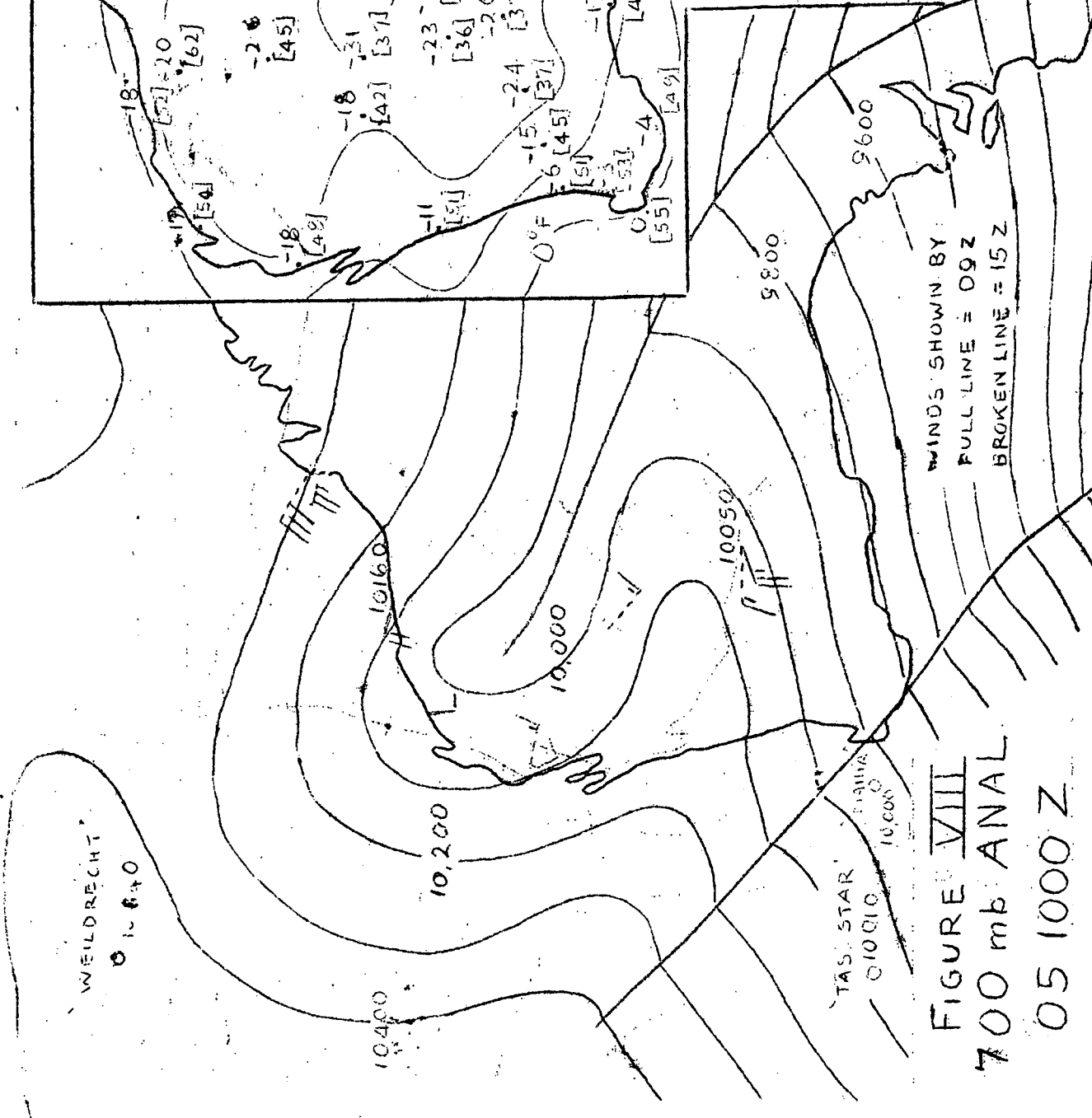


FIGURE VIII
 700 mb ANAL
 05 1000 Z

WINDS SHOWN BY
 FULL LINE = 09 Z
 BROKEN LINE = 15 Z

WEILDRECHT
 10 640

TAS STAR
 FINNIA
 10000