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TRAVERSE TERRAIN DESCRIPTION FOR MOBILITY TEST AND
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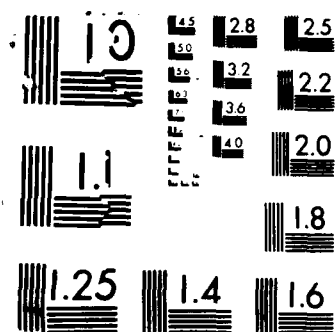
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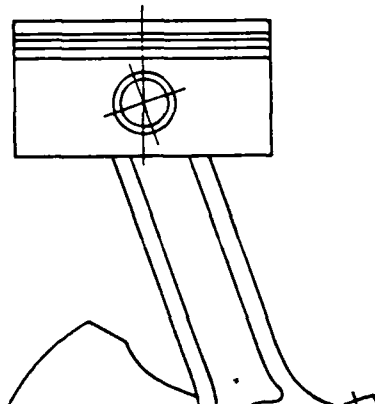
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Contract-Number: DAJA 45-86-C-0042

Traverse Terrain Description for Mobility Test
and Model Evaluation

Final Report

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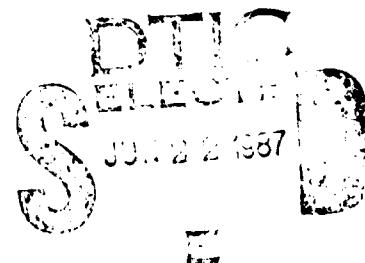
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Contract-Number: DAJA 45-86-C-0042

**Traverse Terrain Description for Mobility Test
and Model Evaluation**

Final Report



Traverse Terrain Description for Mobility Test and Model Evaluation

Final Report

by

Peter Corvin
Peter Jessl
Werner Köppel

March 1987

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Battelle Motor- und Fahrzeugtechnik GmbH, Frankfurt/Main,
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C O N T E N T S

	Page
FOREWORD	1
ABSTRACT	1
 PART I: INTRODUCTION.....	 2
Background.....	2
Purpose and Scope.....	2
 PART II: TRAVERSE SELECTION.....	 3
Preselection.....	3
Traverse Layout.....	3
 PART III: TRAVERSE DATA ESTABLISHMENT.....	 4
Field Inspection.....	4
Traverse Survey.....	4
 PART IV: CONCLUSIONS AND RECOMMENDATIONS.....	 6
Conclusions.....	6
Recommendations.....	6
 LITERATURE CITED.....	 7
FIGURES 1 - 9	8 - 17
TABLES 1 - 3	18 - 21
PHOTOS 1 - 130	22 - 86

FOREWORD

The work reported herein was conducted by Battelle Motor- und Fahrzeugtechnik GmbH (BMF, Battelle Vehicle Technology GmbH) Frankfurt, FRG on behalf of the US Army Engineer Waterways Experiment Station, CE, Vicksburg, Mississippi, under a contract from the US Army European Research Office, London. It is part of joint efforts by WES and BMF in the field of terrain data acquisition methods activities within the German theater of operations.

The personnel acquiring the various field data included: P. Jessl, P. Corvin and G. Karsubka, BMF. The report was written by P. Corvin, P. Jessl and W. Köppel. W. Köppel was the principal investigator.

ABSTRACT

This report contains the description of a traverse terrain selection, evaluation and standard mobility terrain data establishment within a selected military training area at Hammelburg, FRG. Reproducibility of the established traverse will be available in order to serve for future comparative vehicle tests.

Key words:

Traverse terrain data

Mobility

PART I: INTRODUCTION

Background

Mobility of military vehicles can be quantified by the Army Mobility Model (AMM) /1/ of the U.S. Army, which has also become a NATO Reference Mobility Model /2/ in recent years. Computer models like the AMM require - among others - terrain data input for relevant operational or mission tasks within the corresponding theater of operation. Investigating mobility on a traverse (mission-oriented) is the most efficient approach in order to evaluate both model and vehicle capability.

Purpose and Scope

The purpose of the work reported herein was to establish a standard traverse terrain description for the German theater of operation to serve as a traverse terrain data base for relevant mobility tests and computer model evaluation, too.

Steps performed were:

- the selection of a suitable traverse in cooperation with U.S. Army representatives and in succession
- the establishment of a traverse terrain data base prior to the first vehicle tests

The mobility test program addressed above was aimed at generating wheeled vs. tracked vehicles mobility data as part of the NBC Surrogate Reconnaissance System performance evaluation program. Here, the U.S. Army Waterways Experiment Station (WES) had the key coordination role to design and specify a suitable vehicle test program.

PART II: TRAVERSE SELECTION

Preselection

After a first inspection of the terrain topographical conditions at the Hammelburg infantry school, a German Army military training area, in November 1985 by personnel of WES, BMF and the Hammelburg U.S. Army liaison officer a preliminary test course was layed out by BMF which incorporated the necessary terrain, road and trail parameters. These included a sufficient traverse length of approximately 22 km, a well balanced distribution of cross-country, road, and field and forest trail segment percentages, as well as a good reproducability of the traverse.

The layout of the course was then discussed in February 1986 between BMF and the responsible commander of the military training area at Hammelburg in order to identify restrictions to be taken into account.

Traverse Layout

The final traverse layout was then agreed upon by WES/BMF members in April 1986 and established on a topographic map sheet of the training area at a 1:10.000 scale.

Additional information obtained by BMF during the layout phase were a tracked vehicle trafficability map of the training area, a CCM-map of the Hammelburg area as well as soil type and bore hole information of the German Mil-Geo agency for the area of interest.

Based on these information, the traverse layout on the available topomap was established; Fig. 1 shows the location of the traverse on the Hammelburg area topo map as well as the bore hole locations.

PART III: TRAVERSE DATA ESTABLISHMENT

Field Inspection

In April 1986 the WES/BMF field team inspected the selected traverse layout at the Hammelburg area and determined the final necessary adjustments to be made. Wet gap crossings were not includable in the traverse due to environmental protection reasons. Generally, the Hammelburg training area is significantly built up by cohesive soils, mainly clayey silts (ML soils) to silty clays, of relatively high soil strength (CI values ≥ 200 psi) even for wet condition within the predominating areas which are grass-covered. Slopes are frequently changing with approximately maximum values at the order of 20%.

Traverse Survey

A WES/BMF field team established the traverse terrain data base in terms of standard Army Mobility Model (AMM) terrain input data prior to the vehicle tests in May 1986. During the vehicle test period relevant terrain data were updated, if necessary; this included soil strength values and course deviations which had to be made during the test period. Terrain data were taken on

- slope (including side slopes)
- soil strength
- soil type
- surface roughness
- terrain unit length and altitude
- terrain unit type
- curvature
- drivers's visibility

and provided to the WES team members for detailed evaluation. Available trigonometric points within the test area were connected to the terrain unit sequence in order to allow for quick retrieval of the traverse in case of future repetitive vehicle testing campaigns.

Soil samples were taken at selected sites in order to generate detailed moisture and plasticity limit data (table 1). Also, precipitation values were determined for an adjacent weather station (see tables 2, 3) prior to and during the vehicle test period. Also, the air temperature and precipitation in °C and mm as well as in % of long range mean values are shown in figures 2-9 for describing the meteorological bounding conditions.

The traverse was approximately 27,5 km long and consisted out of 128 terrain units, composed of many different terrain conditions as

- primary roads
- secondary roads
- tank trails
- field trails
- forest trails
- cross-country areas of varying slopes, roughness, strengths and land-use as meadows, stubble fields etc.

The overall classification into roads, unsurfaced trails and areal cross-country terrain yielded 40% roads, 27% trails and 33% areal terrain.

Photos 1-128 show the views of the terrain units which were identified on the traverse.

Photos 129-130 indicate the consecutive terrain conditions met on terrain units 58 and 59 as well as 87 and 88 which are quite representative for the majority of the cross-country meadow segments of the traverse.

PART IV: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on the traverse terrain data established within the Hammelburg training area and the vehicle tests performed in May 86 it can be concluded that for future test programs a suitable course has been identified which is easily reproducible and accessible.

Recommendations

It is recommended that the Hammelburg course available should be used as an F.R.G. reference course for future mobility test programs to allow for comparisons of competitive vehicles.

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U.S. Army Tank Automotive Command , Warren, Mich. 1979

List of Figures

Fig. 1: Location of the Traverse Within
the Hammelburg Training Area

Fig. 2: Distribution of Precipitation in mm
(April 1986, FRG)

Fig. 3: Distribution of Precipitation in % of
Long Range Average Values 1951-1980
(April 1986, FRG)

Fig. 4: Monthly Mean Values of Air Temperature in °C
(April 1986, FRG)

Fig. 5: Deviation of Monthly Mean Air Temperature
Value from 1951-1980
Value in °C (April 1986, FRG)

Fig. 6: Distribution of Precipitation in mm
(May 1986, FRG)

Fig. 7: Distribution of Precipitation in % of
Long Range Average Values 1951-1980
(May 1986, FRG)

Fig. 8: Monthly Mean Values of Air Temperature in °C
(May 1986, FRG)

Fig. 9: Deviation of Monthly Mean Air Temperature Values
from 1951-1980 Value in °C
(May 1986, FRG)

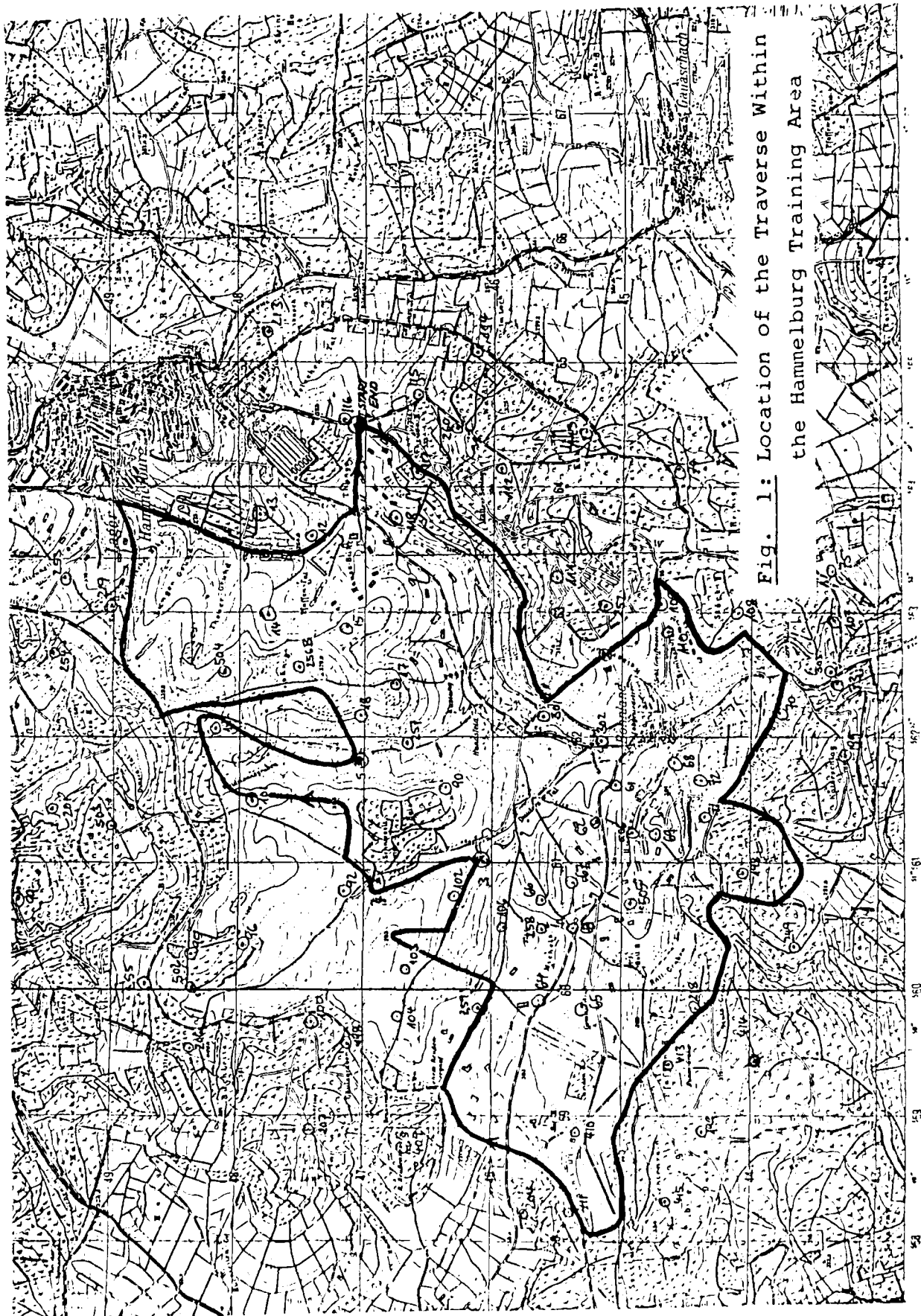


Fig. 1: Location of the Traverse Within
the Hammelburg Training Area

April 1986

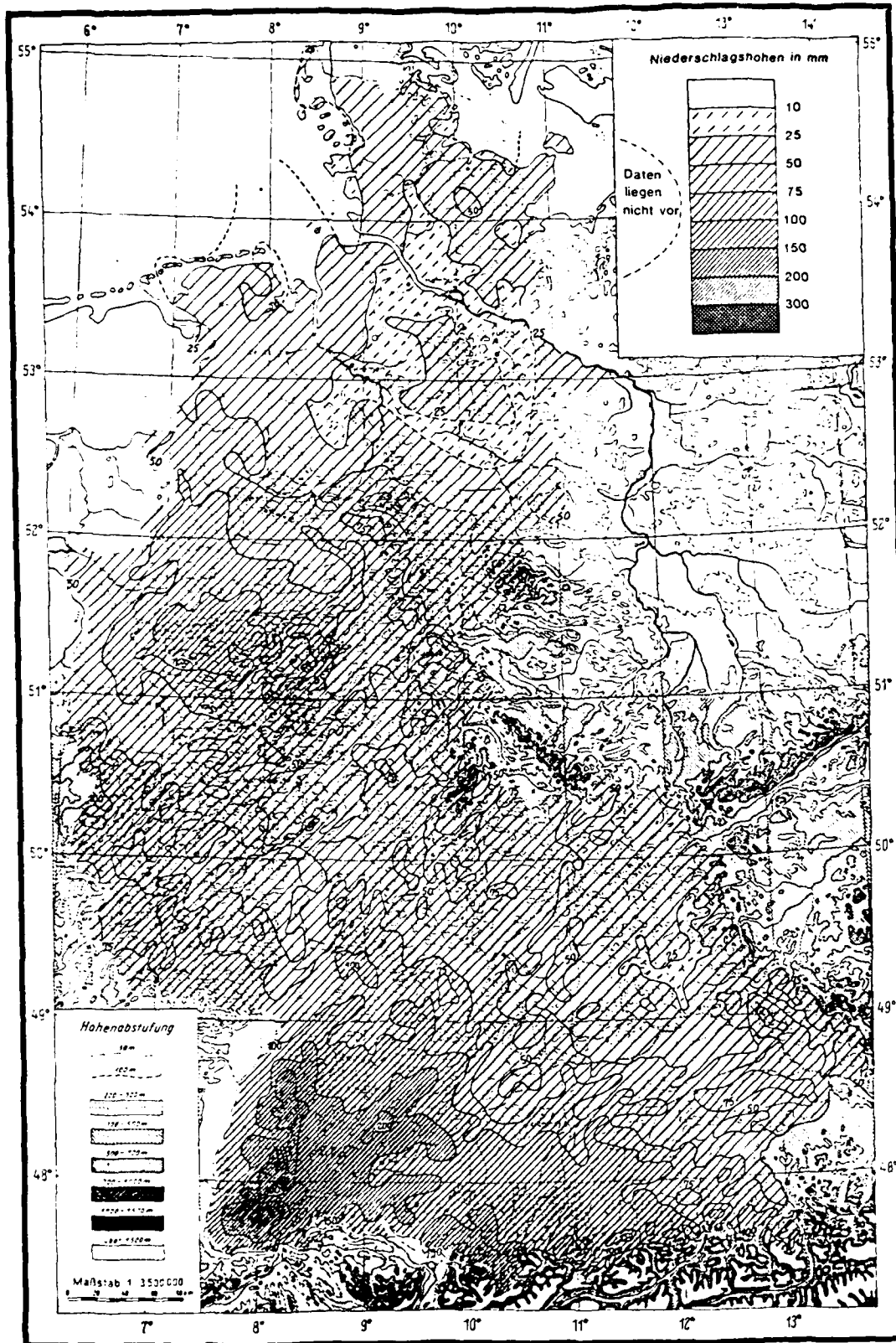


Fig. 2: Distribution of Precipitation in mm
(April 1986, FRG)

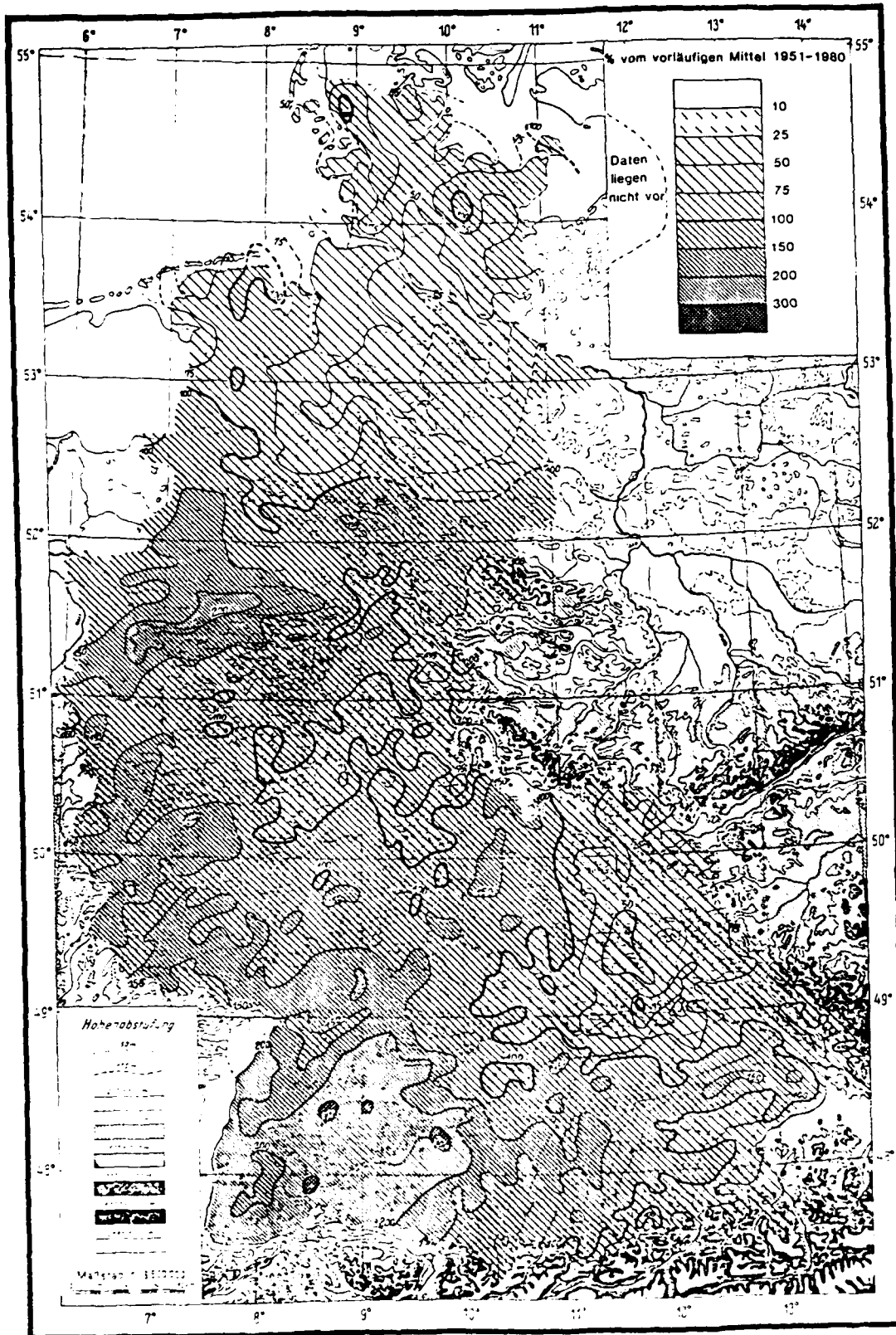


Fig. 3: Distribution of Precipitation in % of Long Range Average Values 1951-1980 (April 1986, FRG)

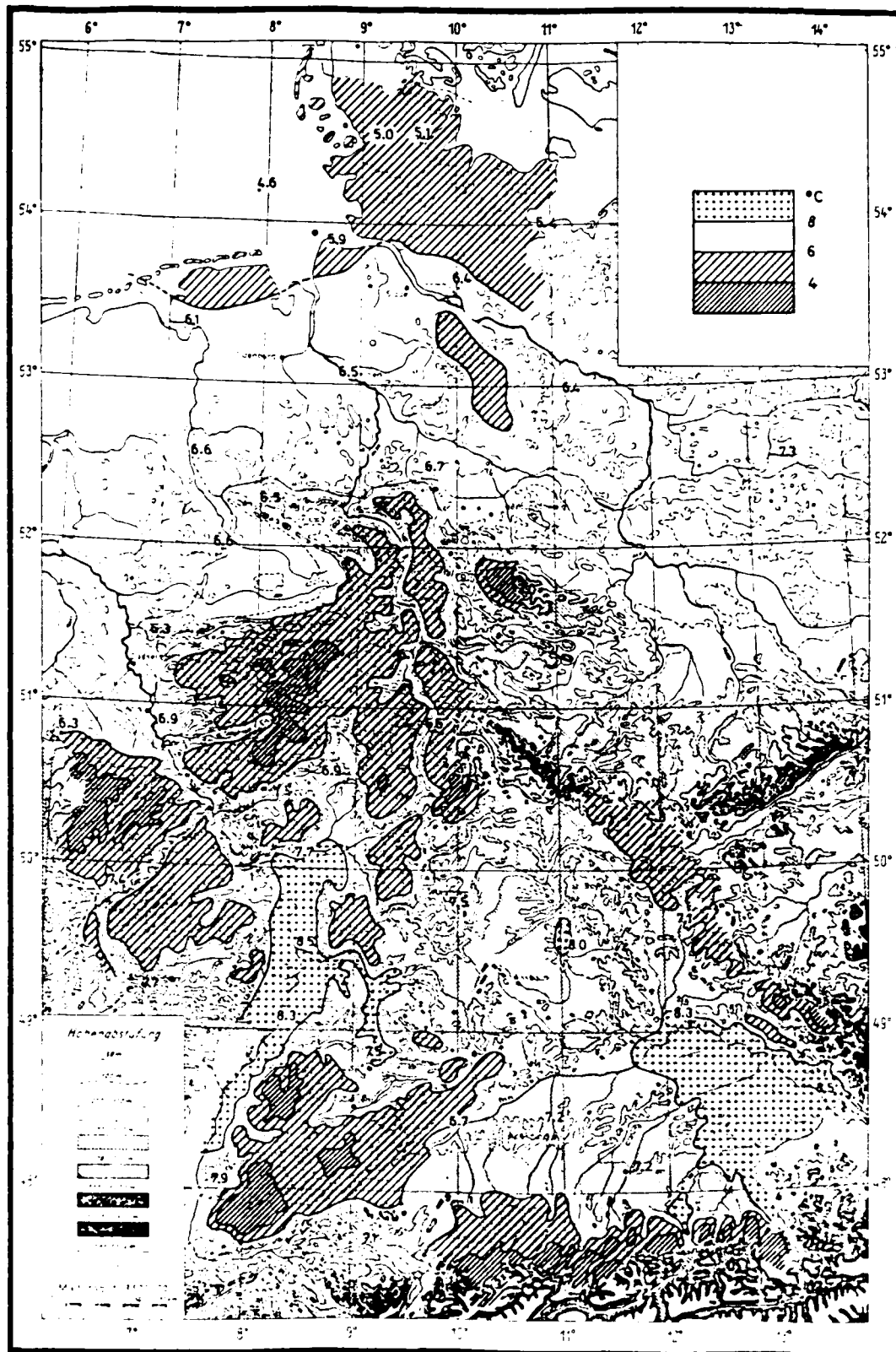


Fig. 4: Monthly Mean Values of Air Temperature in °C
(April 1986, FRG)

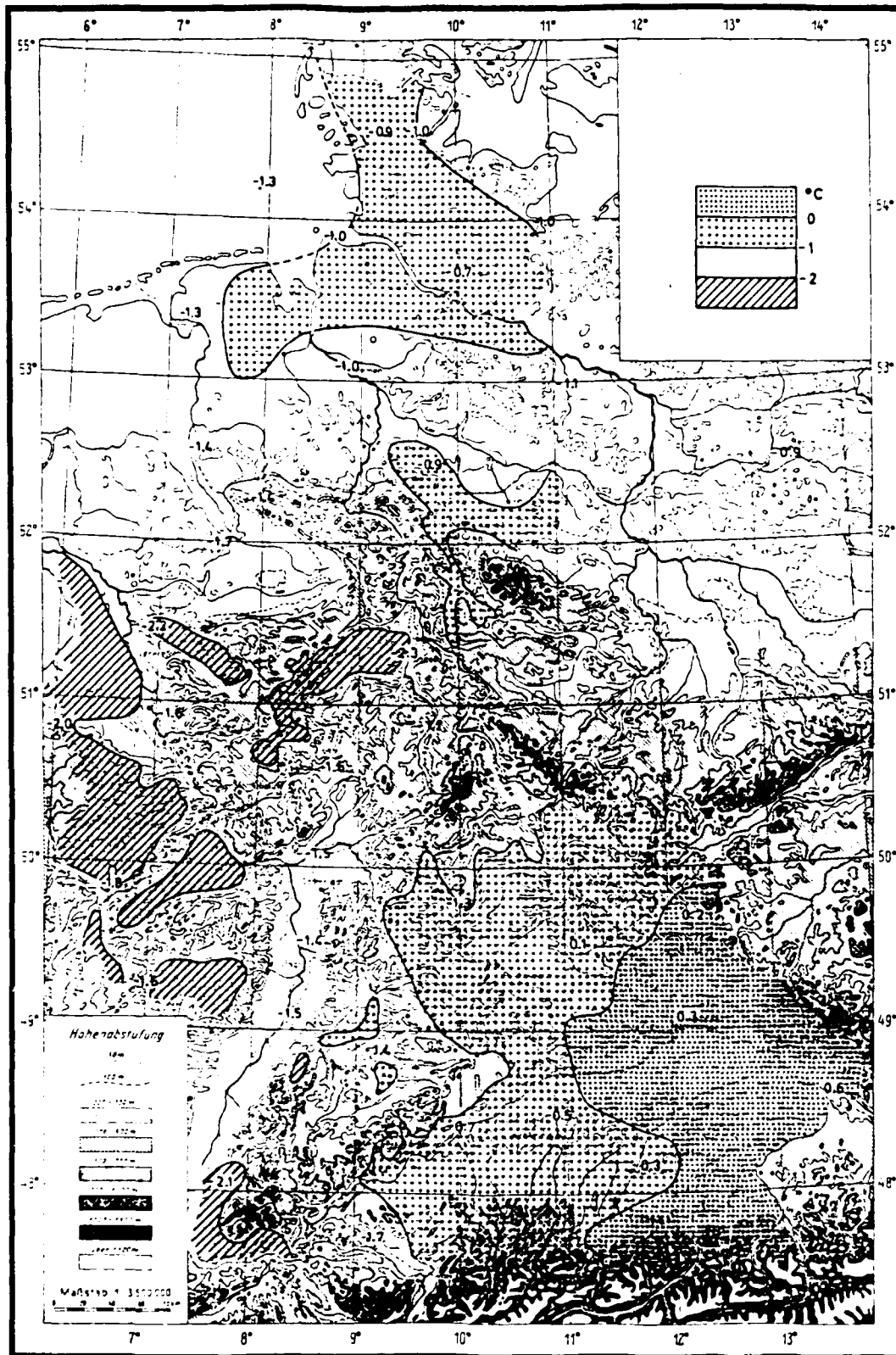


Fig. 5: Deviation of Monthly Mean Air Temperature
Value from 1951-1980
Value in °C (April 1986, FRG)

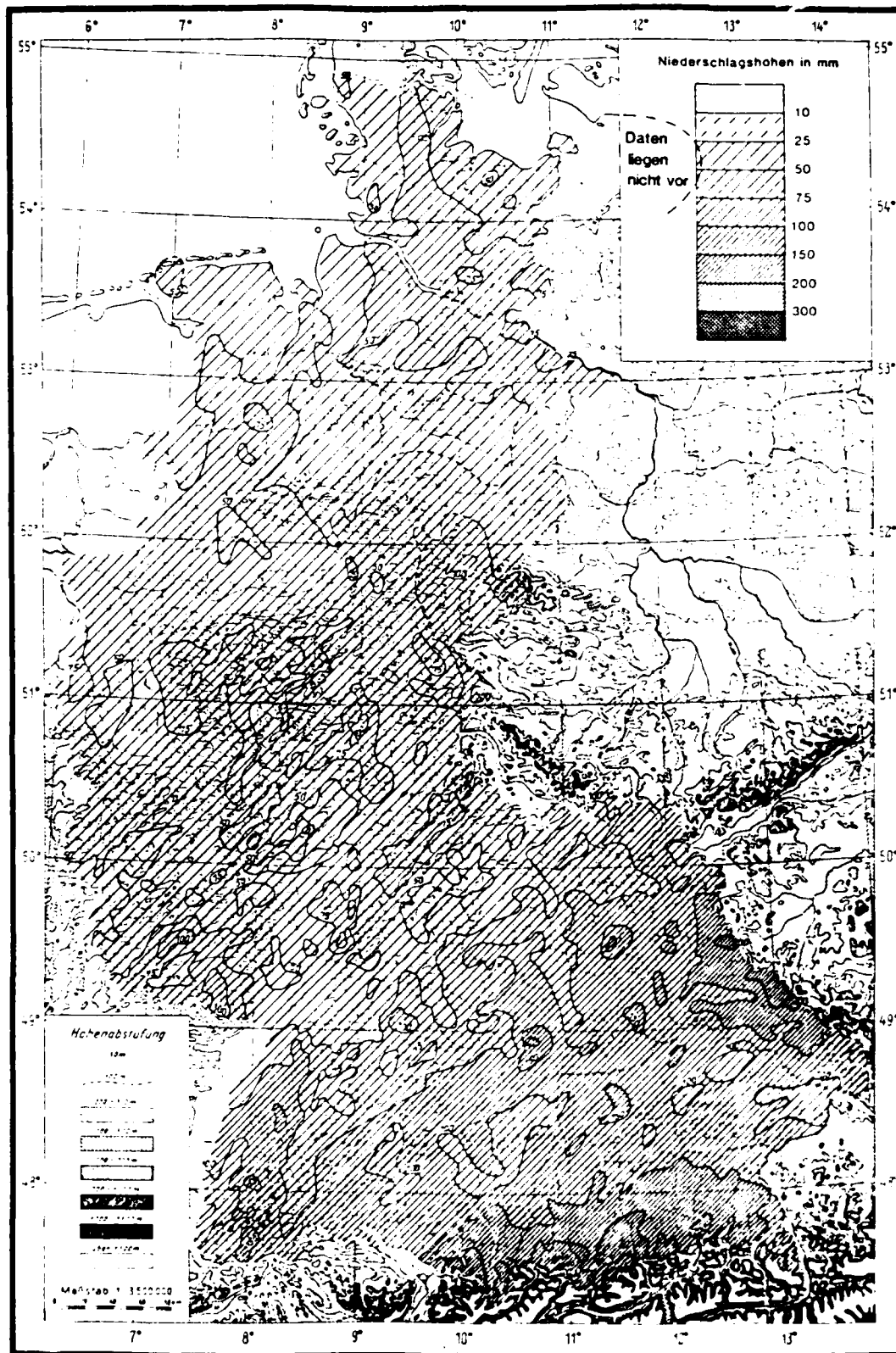


Fig. 6: Distribution of Precipitation in mm
(May 1986, FRG)

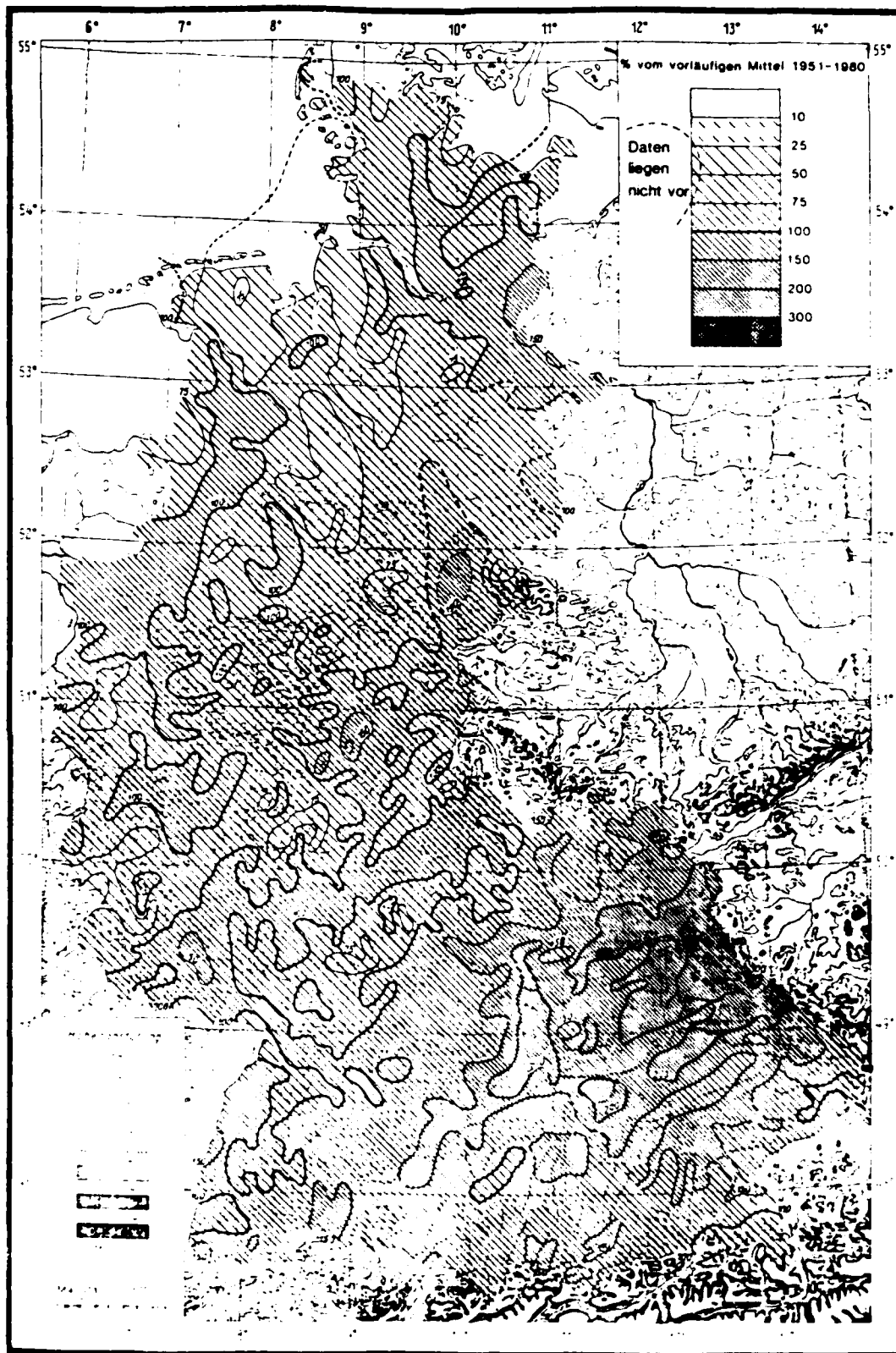


Fig. 7: Distribution of Precipitation in % of Long Range Average Values 1951-1980 (May 1986, FRG)

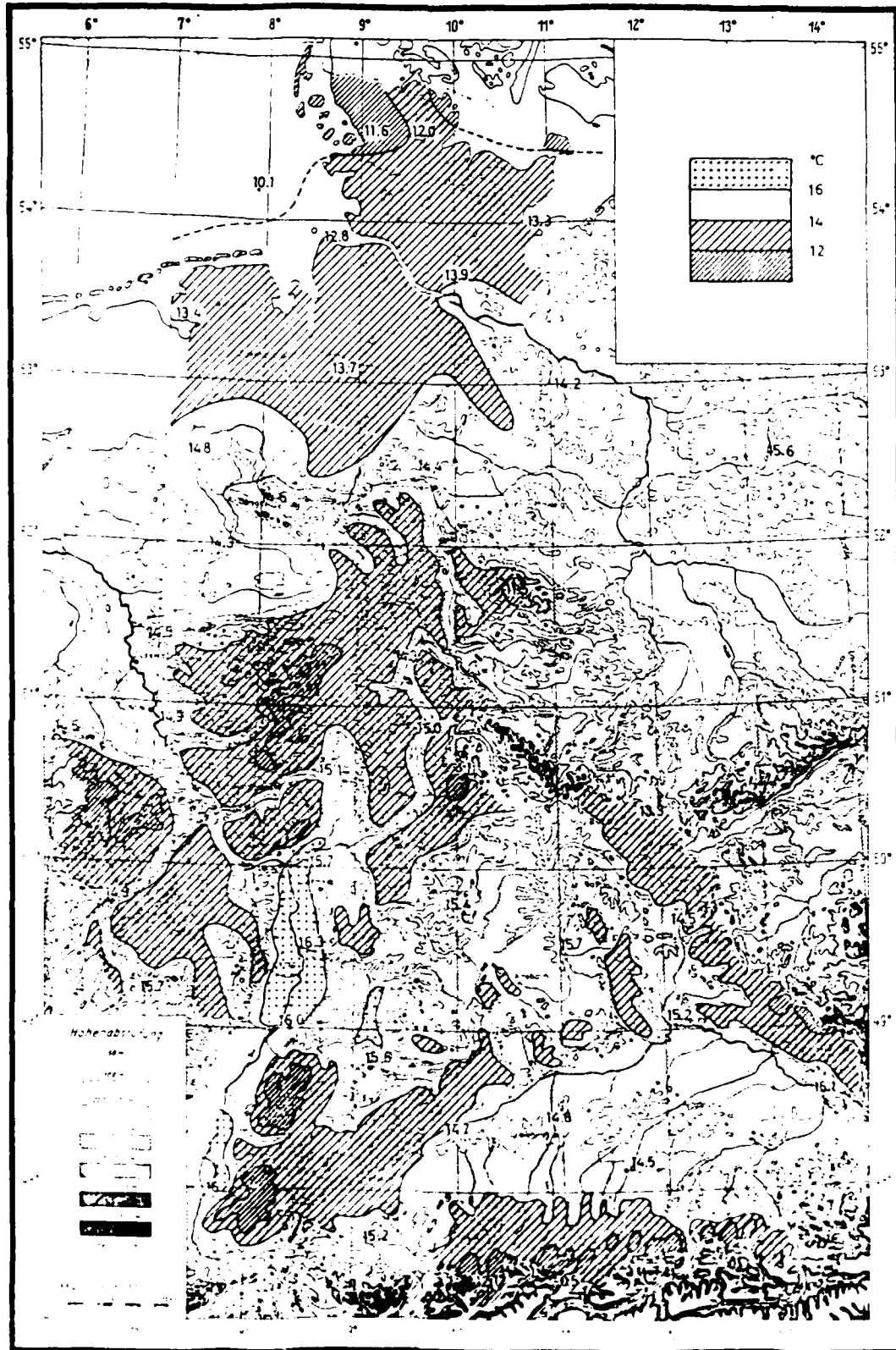


Fig. 8: Monthly Mean Values of Air Temperature in °C
(May 1986, FRG)

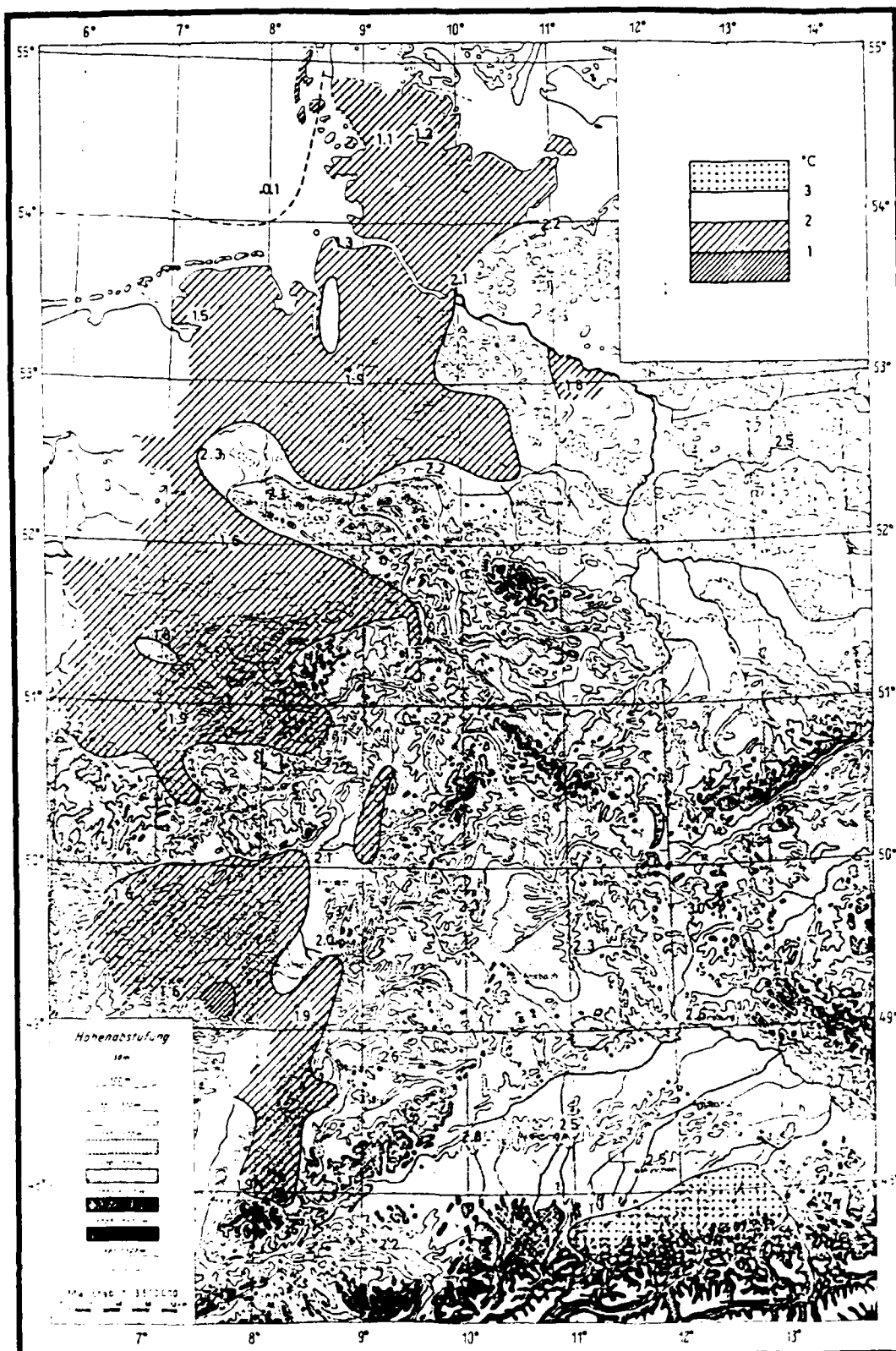


Fig. 9: Deviation of Monthly Mean Air Temperature Values
from 1951-1980 Value in °C
(May 1986, FRG)

List of Tables

Table 1: Soil Sample Data for the Hammelburg Test Area

Table 2: Daily Precipitation Data for the Nearest Weather Station
Schweinfurt in April 1986

Table 3: Daily Precipitation Data for the Nearest Weather Station
Schweinfurt in May 1986

Table 1: Soil Sample Data for the Hammelburg Test Area

Terrain Unit Sample No.	UTM Grid Coordinates	Recording Date	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	USCS Field Soil Type	Soil Strength (psi)
15	623/455	16/05/86	25.8	30.5	57.8	CL-CH	182
		17/05/86	25.6	30.5	57.8		230
		22/05/86	23.8	30.8	54.6		203
18	626/451	16/05/86	19.5	22.3	38.5	CL-ML	235
		17/05/86	16.2	21.1	35.9		270
68	610/461	16/05/86	31.3	33.1	52.4	CL-CH	170
		17/05/86	24.7	33.1	52.4		232 238
76	609/469	16/05/86	27.5	24.1	37.8	ML	132
		17/05/86	25.5	24.1	37.8		179 169
99	619/471	16/05/86	25.3	24.1	39.8	ML	79
		17/05/86	22.5	22.5	35.9		91
		18/05/86	22.4	22.5	35.9		114
		22/05/86	23.4	24.2	42.1		94

List of Photos

Photos 1-128: Views of Terrain Units No. 1 to 128

Photos 129-130: Consecutive Terrain Conditions of Terrain Units
No. 58/59 and No. 87/88



Photo 1: View of Terrain Unit No. 1



Photo 2: View of Terrain Unit No. 2



Photo 3: View of Terrain Unit No. 3



Photo 4: View of Terrain Unit No. 4



Photo 5: View of Terrain Unit No. 5



Photo 6: View of Terrain Unit No. 6



Photo 7: View of Terrain Unit No. 7

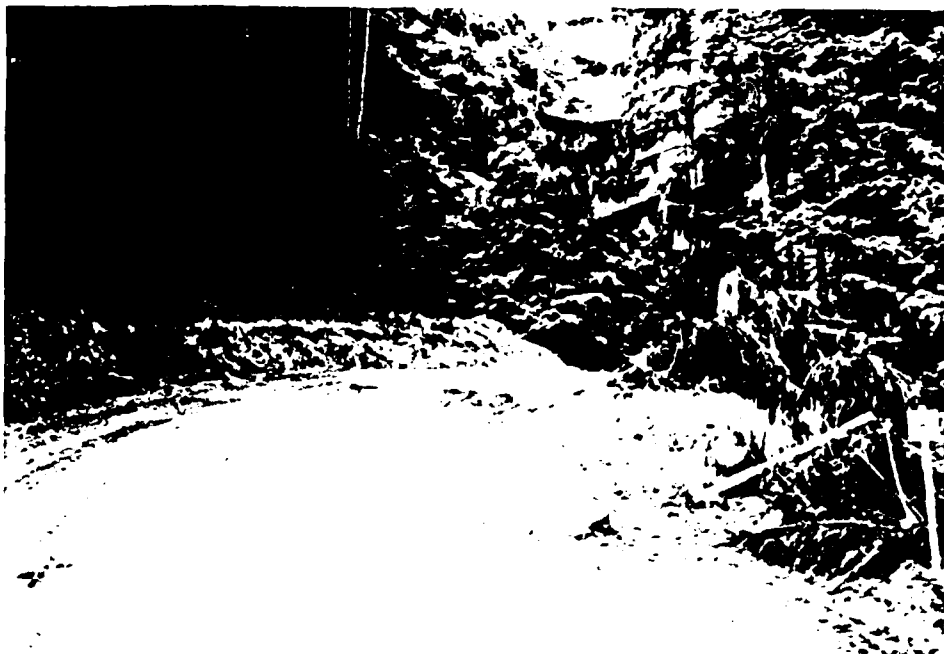


Photo 8: View of Terrain Unit No. 8



FIGURE 11. View of Tunnel Port - N. 1.



FIGURE 12. View of Tunnel Port - N. 2.



Photo 11: View of Terrain Unit No. 11



Photo 12: View of Terrain Unit No. 12



FIGURE 13. View of Limestone Quarry, No. 13.



FIGURE 14. View of Limestone Quarry, No. 14.





Figure 17. View of Terrain Unit No. 17





Fig. 1.4: View of Terrain Unit No. 19



Fig. 2.0: View of Terrain Unit No. 20



Photos 21 - 22 : View of Terrain Units No. 21 to 22



Photo 23 : View of Terrain Unit No. 23



Photo 24: View of Terrain Unit No. 24



Photo 25: View of Terrain Unit No. 25



Photo 26: View of Terrain Unit No. 26



Photo 27: View of Terrain Unit No. 27



Photo 28: View of Terrain Unit No. 28



Photo 29: View of Terrain Unit No. 29



Photo 30: View of Terrain Unit No. 30



Photo 31: View of Terrain Unit No. 31



Photo 32: View of Terrain Unit No. 32



Photo 33: View of Terrain Unit No. 33



Fig. 34: View of Terrain Part N. 34

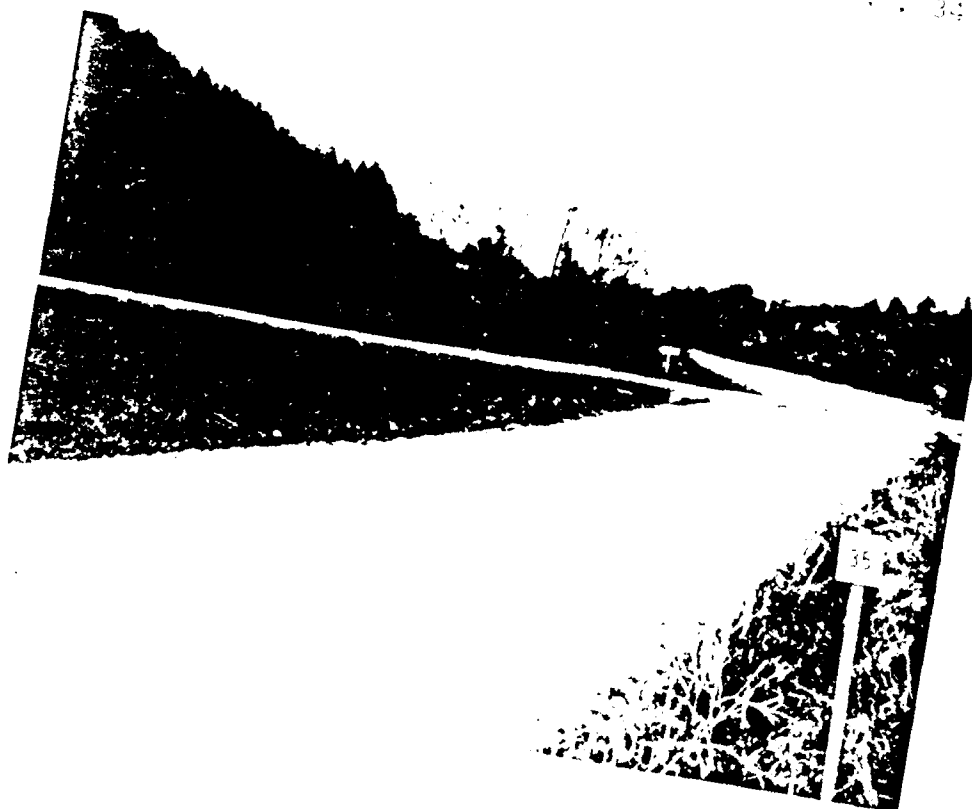


Fig. 35: View of Terrain Part N. 35



Photo 36: View of Terrain Unit No. 36



Photo 37: View of Terrain Unit No. 37



Photo 38: View of Terrain Unit No. 38



Photo 39: View of Terrain Unit No. 39



Photo 40: View of Terrain Unit No. 40



Photo 41: View of Terrain Unit No. 41



Photo 42: View of Terrain Unit No. 42



Photo 43: View of Terrain Unit No. 43



Bild 44: View of Terrain Unit No. 44

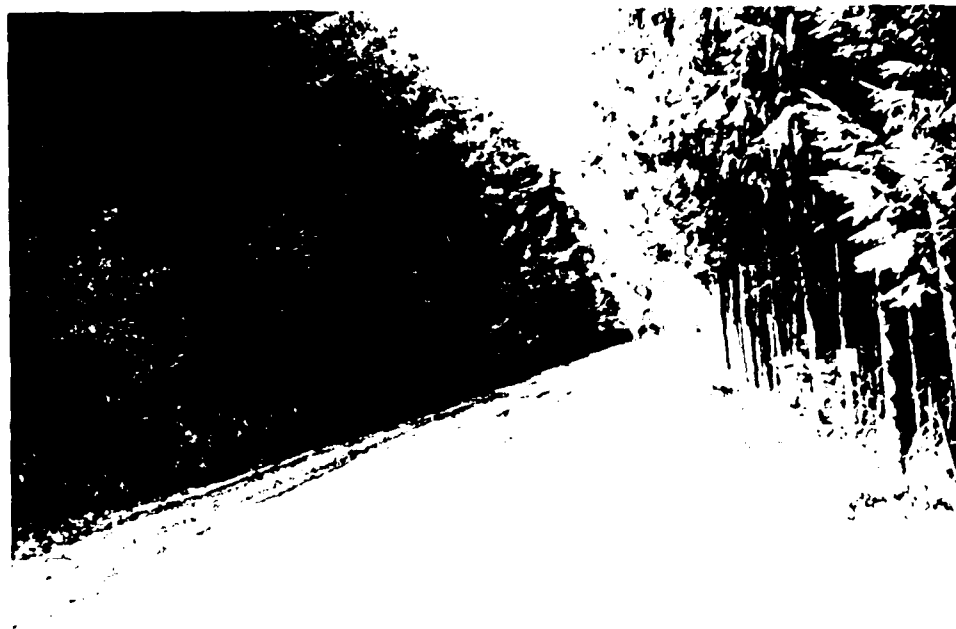


Bild 45: View of Terrain Unit No. 45



Fig. 1. View of Terrain Unit N. 40



Fig. 2. View of Terrain Unit N. 41



Fig. 48: View of Terrain Unit No. 48



Fig. 49: View of Terrain Unit No. 49



Photo 50: View of Terrain Unit No. 50



Photo 51: View of Terrain Unit No. 51



Photo 52: View of Terrain Unit No. 52

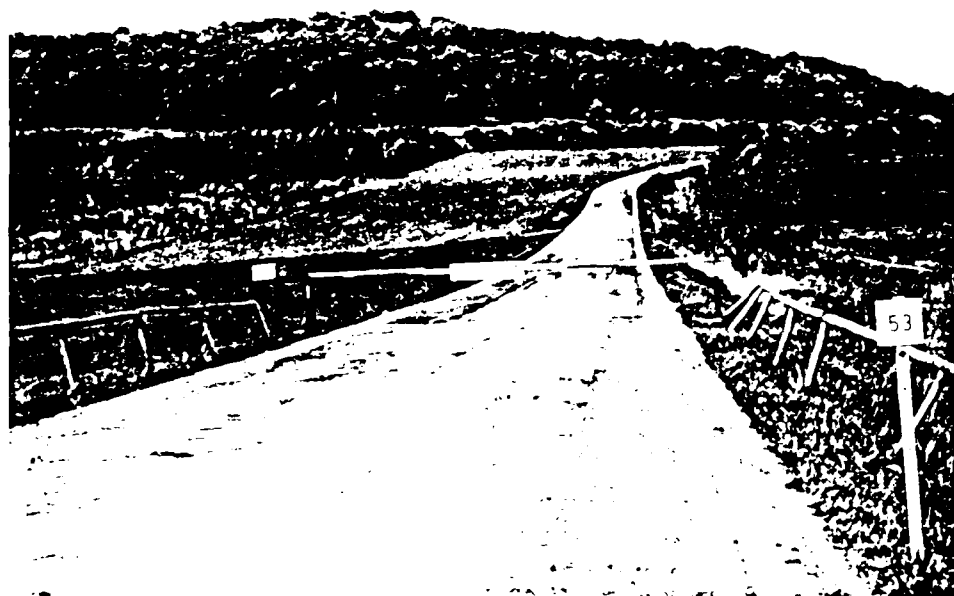


Photo 53: View of Terrain Unit No. 53



Photo 54: View of Terrain Unit No. 54



Photo 55: View of Terrain Unit No. 55



Photo 56: View of Terrain Unit No. 56



Photo 57: View of Terrain Unit No. 57

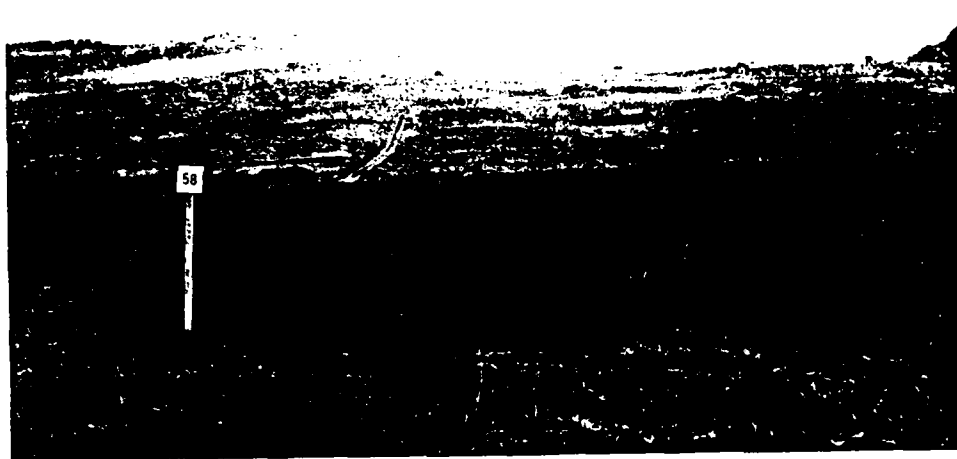


Photo 58: View of Terrain Unit No. 58

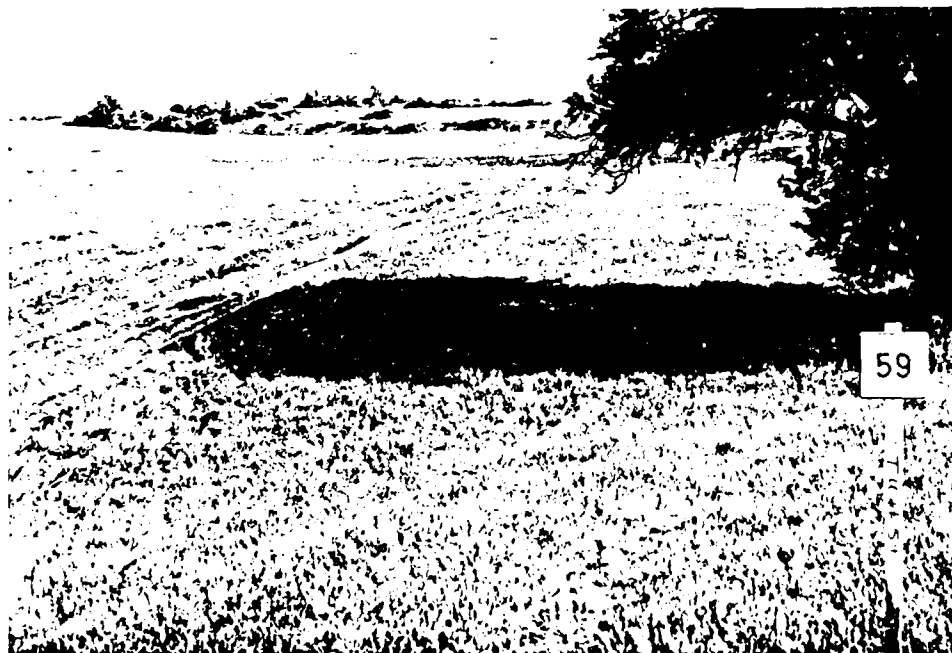


Photo 59: View of Terrain Unit No. 59



Photo 60: View of Terrain Unit No. 60



Photo 61: View of Terrain Unit No. 61



Photo 62: View of Terrain Unit No. 62

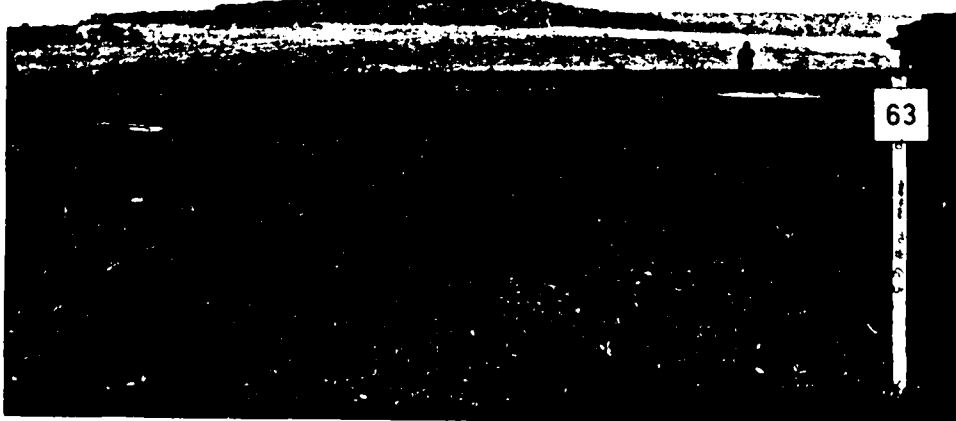


Photo 63: View of Terrain Unit No. 63



Photo 64: View of Terrain Unit No. 64



Photo 65: View of Terrain Unit No. 65



Photo 66: View of Terrain Unit No. 66



Photo 67: View of Terrain Unit No. 67



Photo 68: View of Terrain Unit No. 68



Photo 69: View of Terrain Unit No. 69



Photo 70: View of Terrain Unit No. 70



Photo 71: View of Terrain Unit No. 71



Photo 72: View of Terrain Unit No. 72



Photo 73: View of Terrain Unit No. 73



Photo 74: View of Terrain Unit No. 74



Photo 74: View of Terrain Unit No. 74



Photo 76: View of Terrain Unit No. 76



Photo 77: View of Terrain Unit No. 77



Photo 78: View of Terrain Unit No. 78



Photo 79: View of Terrain Unit No. 79

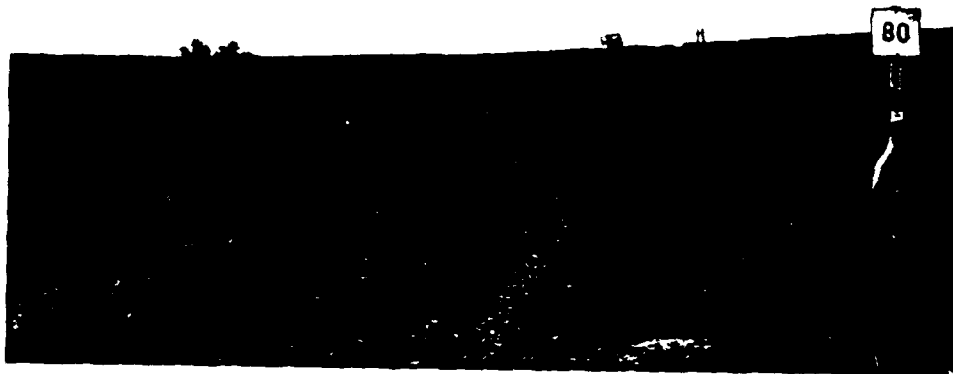


Photo 80: View of Terrain Unit No. 80



Photo 81: View of Terrain Unit No. 81



Photo 82: View of Terrain Unit No. 82



Photo 83: View of Terrain Unit No. 83



Photo 84: View of Terrain Unit No. 84



Photo 85: View of Terrain Unit No. 85



Photo 86: View of Terrain Unit No. 86



Photo 87: View of Terrain Unit No. 87



Photo 88: View of Terrain Unit No. 88



Photo 89: View of Terrain Unit No. 89



Photo 90: View of Terrain Unit No. 90



Photo 91: View of Terrain Unit No. 91



Photo 92: View of Terrain Unit No. 92



Photo 93: View of Terrain Unit No. 93



Bild 94: View of Terrain Unit No. 94

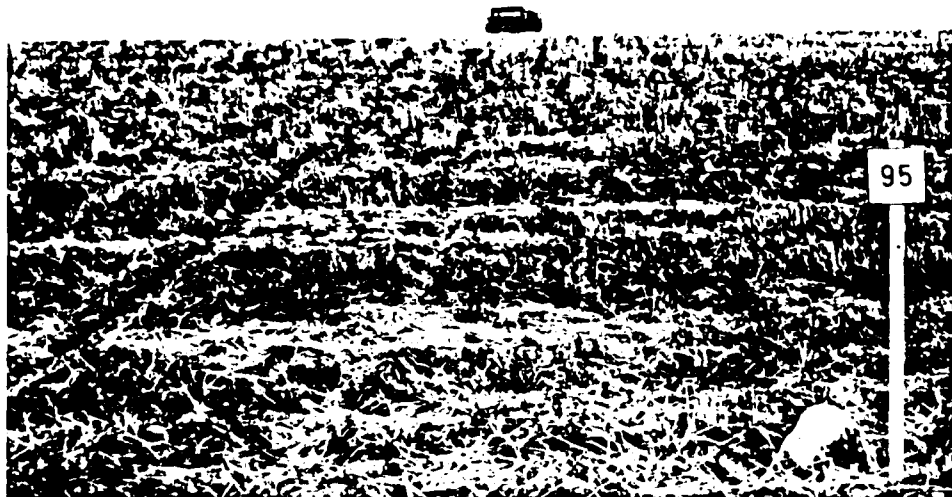


Bild 95: View of Terrain Unit No. 95



Photo 96: View of Terrain Unit No. 96



Photo 97: View of Terrain Unit No. 97



Photo 98: View of Terrain Unit No. 98



Photo 99: View of Terrain Unit No. 99

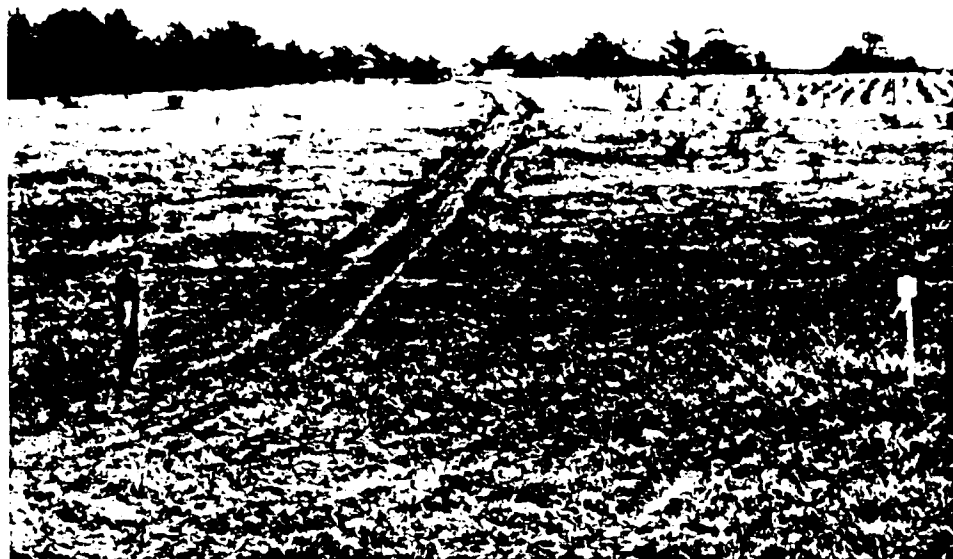


Fig. 10-1-10: View of Terrain Unit No. 100





Photo 102: View of Terrain Unit No. 102



Photo 103: View of Terrain Unit No. 103



104 104 View of Portals Gate Nov. 194



105 105 View of Portals Gate Nov. 194



106: View of Terrain Unit No. 106



107: View of Terrain Unit No. 107



Location: View of Terrain from S. 1. S.





Photo 110: View of Terrain Unit No. 110



Photo 111: View of Terrain Unit No. 111



Photo 112: View of Terrain Unit No. 112



Photo 113: View of Terrain Unit No. 113



Photos 114-115: View of Terrain Units No.114 to 115



Photo 116: View of Terrain Unit No. 116



Photo 117: View of Terrain Unit No. 117



Photo 118: View of Terrain Unit No. 118



Photo 119: View of Terrain Unit No. 119



Photo 120: View of Terrain Unit No. 120



Photo 121: View of Terrain Unit No. 121



Photo 122: View of Terrain Unit No. 122



Photo 123: View of Terrain Unit No. 123



Photo 124: View of Terrain Unit No. 124



Photo 125: View of Terrain Unit N. 1.5



Photo 126: View of Terrain Unit N. 1.5

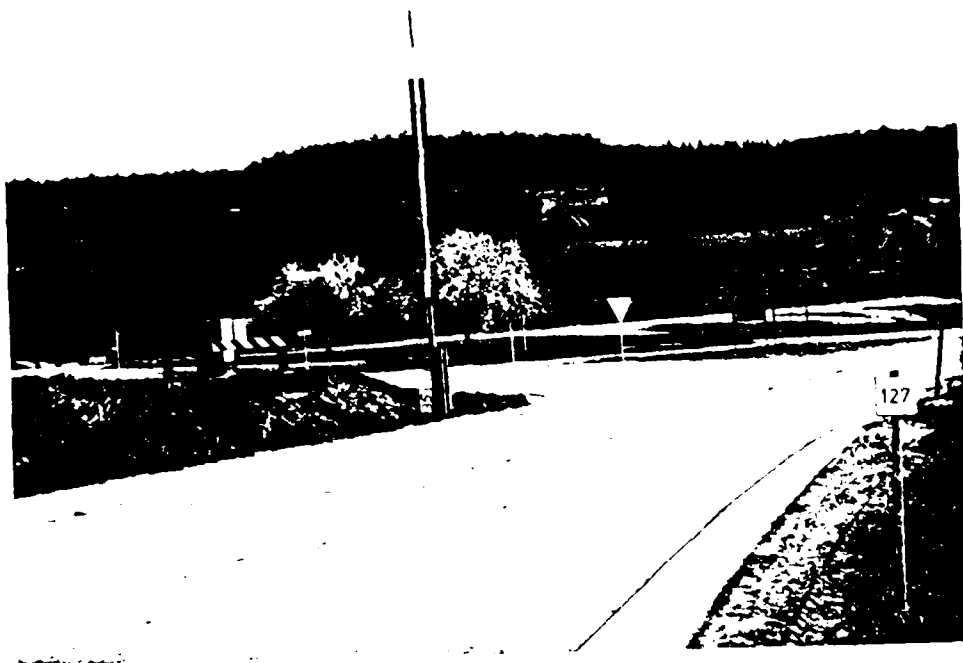


Bild 127: View of Terrain Chair No. 127



Bild 128: View of Terrain Chair No. 128



Abb. 144. Querschnitt durch Terrain-Untereinheiten
 der Terrain-Units Nr. 5a-5c



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