DIGITAL MAPPING AND INFORMATION SYSTEMS [1)]

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1. INTRODUCTION

Among the many expressions of h u m a n e n d e a v o u r s affected by the computer age few are as much in a s t a t e o f t r a n s i t i o n as the mapping sciences. Everything is changing: methods, products, social significance etc. Therefore it is difficult to give a precise and short summary of the current situation, in spite of the fact that some trends are clearly evident. The following is only a p e r s o n a l v i e w , of the transition from classical maps created by artists to computer-based information systems created by t e c h n o l o g i s t s a n d m a c h i n e s . This does represent an improvement and will increase the usefulness of mapping work.

One only needs to inspect one example: the c l a s s i c a l c o n t o u r m a p and the d i g i t a l t e r r a i n m o d e l . Contour line mapping has been a great stride forwards during the second half of this century when compared to the traditional artistic rendering of slopes. However, flexibility of digital techniques are quickly replacing the adolescent contour map by a considerably more useful product, namely the raster digital terrain model. This in turn can be used to obtain various derived results such as slope maps, visibility maps, volume counts etc.

The following will review the short history of digital mapping and the current operational capabilities. This will

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serve as a basis for an outlook into future developments.

2. HISTORICAL DEVELOPMENTS

Digital mapping may have two different roots. Early systems were used in geoscientific work. Limitations of computing power and of appropriate equipment led to the g r i d -c e l l a p p r o a c h to digital mapping. Mapping themes were sampled in cells, often on a kilometer-basis. Presentations were in crude form on available computer output devices. A typical system was SYMAP (Figure 1). Already some data bases of regional extent were created. Today they are obsolete.

Another route to digital mapping led from a set of g i v e n a n a l o g m a p s or other inputs to a n e w a n a l o g m a p . Digital techniques were just a tool to replace manual redrafting. This is still a widely-used approach of diminishing relevance. The technology is characterized by large precision plotters but modest computing power. Given maps, or other analog data sources such as photographs, serve as input to create an analog map. Digital data are a detour, they are not a product in themselves. In photogrammetry this has led to an increase of throughput of a factor of 2 at large mapping scales. All photogrammetric manufacturers today offer working systems that enable one to do this type of work.

Numerous problems have been and are being solved that are of great value also in future applications. The emphasis is on data display to match previous manual redrafting. As an example one has to hach planimetric slope symbols (Figure 2), or must use many different lettering systems (Figure 3).

The result is a c o m p u t e r d r a w n m a p . Its role has been disputed at times; workers in the field have called manually drawn contour maps superior in detail to the computer drawn alternative since morphological detail is poorly represented. However, these were problems of early automated systems. The dispute is not applicable to many of the modern products.

In addition the argumentation seems meaningful only as long as the digital data are not a product and as long as the flexibility of digital techniques are not fully employed.

3. THE CURRENT SITUATION

3.1 Computer-Based Map Information

The flexibility of computerized systems has a decisive role if mapping efforts are not aimed at merely creating a conventional map coverage, but aim at the creation of a c o m p u t e r b a s e d i n f o r m a t i o n s y s t e m . Computing power then becomes a central issue; peripherals are a means for analog-to-digital conversion or vice-versa, and serve for man-machine interfaces.

Why should one employ computers?

Computers allow the user an easy a c c e s s t o d a t a . One sometimes is afraid of this ease when dealing with p e r s o n a l d a t a : income and taxes, traffic rules and violations, passing through customs etc. What is perceived at times as a drawback may be an a d v a n t a g e with mapping efforts: data have in the past just not been sufficiently accessible to users! Computers can alleviate this problem.

Flexibility of digital techniques improves one's capabilities of data retrieval, display and editing. A large variety of maps at different scales and with varying thematic content can be created from one common data base. The type of data can be of graphical, positional, thematic and alphanumeric nature. It is an inherent part of any information system to maintain a level of correctness, to revise and up-date.

The a n a l y s i s of map information is more o b j e c t i v e in a digital environment than in manual processing. The comparison of entities is objective, quantitative measures can be obtained by machine.

These advantages of superior ease of data access, flexibility of data manipulation and objectivity of analysis have led to a nearly universal consensus that the g e o - i n f o r m a t i o n s y s t e m is a more desirable and useful concept than the conventional map.

3.2 Data Capture

In order to obtain a digital map information system one has to capture the relevant data, to analyse and store it, and to display selected parts or all data. Data capture consists of obtaining p o s i t i o n a l and t h e m a t i c information. Positional information relates to points, lines and areas.

One is today fairly familiar with numerous methods of data capture:

- manually in the field;
- manually on a digitizing table;
- manually in a photogrammetric instrument;
- semi-automatically by an aided-track manual digitizer;
- semi-automatically by manually monitored line following;
- semi-automatically be stereo-correlators in photogrammetric instruments to generate digital terrain data;
- automatically by line-following and automated search for starting points for each line;
- automatically by raster scanning and subsequent vectorisation (Figure 4).

These technologies are available today as operational tools, including the automated methods. The wide-spread use for the more advanced techniques may be so far presented by a lack of acceptance by users. This lack is based less on thorough testing of technological capabilities than on adherence to traditional value systems. Data capture in its various forms will need the human operator to attack thematic meaning to the data, correct errors and to introduce relational information.

3.3 Organizing a Data Base

Having captured the data one needs to put it into a data base. This serves for
- storage,
- retrieval,
- selection,
- manipulation,
- change correction,
- data protection,
- verification of data correctness,
- conversion of data into information.

Data of positional or thematic character are stored together with r e l a t i o n s : coordinates relate to points, these form nodes and lines, then regions and thematic elements. Objects relate in turn to one another.

One of the most important uses of a data base is in specific data selection. In the current context this is either with positional or thematic criteria: one may select data in a given area or adjacent to defined elements; or one may want to access certain themes. 3.4 Working with the Data

Work with the data is interactive on a work-station. There is rapid hardware development for interactive displays and to produce vector-, raster- or mixed hardcopies, on printers, plotters or on film. Two examples on a film writer and on an inexpensive color raster printer are shown on Figures 5 and 6.

The discussion of current technology will be illustrated by three examples: Figures 7 and 8 show artesian fountains, with and without positional reference data. Another example is shown is Figure 9, presenting a map at scale 1:50 000. The third example illustrates in Figures 10 and 11 the flexibility of digital systems by comparing two types of displays.

4. OUTLOOK TO FUTURE DEVELOPMENTS

One may expect that the pure map information system will be combined with readily available other data in pictorial form, e.g. satellite images, leading to a pictorial information system. The concept is illustrated as follows: Contents of a map data base can be selected and projected into and over an image. This can be done automatically but is not a trival task, particularly since high geometric accuracy is needed. Once this is achieved a number of applications come to mind; for example one now can detect discrepancies between the data base and the image. Figure 12 shows one LANDSAT-satellite image combined with the forest boundaries taken from a map 1:50 000 and stored in a data base. The example indicates that discrepancies exist between image and map: the satellite data clearly show various types of ground cover whereas the map data indicate uniform forest cover.

We see that the new technologies promise to lead one into new approaches to data manipulation.

Products will become available that are unfamiliar today. Figure 13 is an example from Graz: a digital elevation model is presented in a perspective view with some land-use themes from a data base.

5. CONCLUSION

It has been argued that the digital information system offers many advantages over an analog map, enumerating flexibility, data access and objectivity of analysis. Evidence has been presented that the field is going to be further developed from pure map data to pictorial information systems, with a wealth of new possibilities of data manipulation, synergistic analysis and display.

FIGURE CAPTIONS;

Figure 1: Example of the grid cell approach to digital mapping obtained through program SYMAP,

Figure 2: Solving the problem of haching a planimetric slope symbol, typical for creating a new analog map from existing analog maps.

Figure 3: Various types of lettering used to create analog maps by computer (Courtesy R. Huetter).

Figure 4: Operational cartographic raster scanner KARTOSCAN.

Figure 5: Raster hard-copy produced on a film writer (Courtesy H. Ranzinger).

Figure 6: Raster hard-copy produced on an inexpensive color printer (Courtesy W. Kainz and M. Manowarda).

Figure 7: Plot of artesian fountains from a digital data base (Courtesy M. Ranzinger and R. Huetter).

Figure 8: Same as Figure 7 but with linear features to serve as a positional reference.

Figure 9: Example of a plot showing features of the map 1:50 000 (Courtesy M. Ranzinger, R. Huetter and W. Kainz).

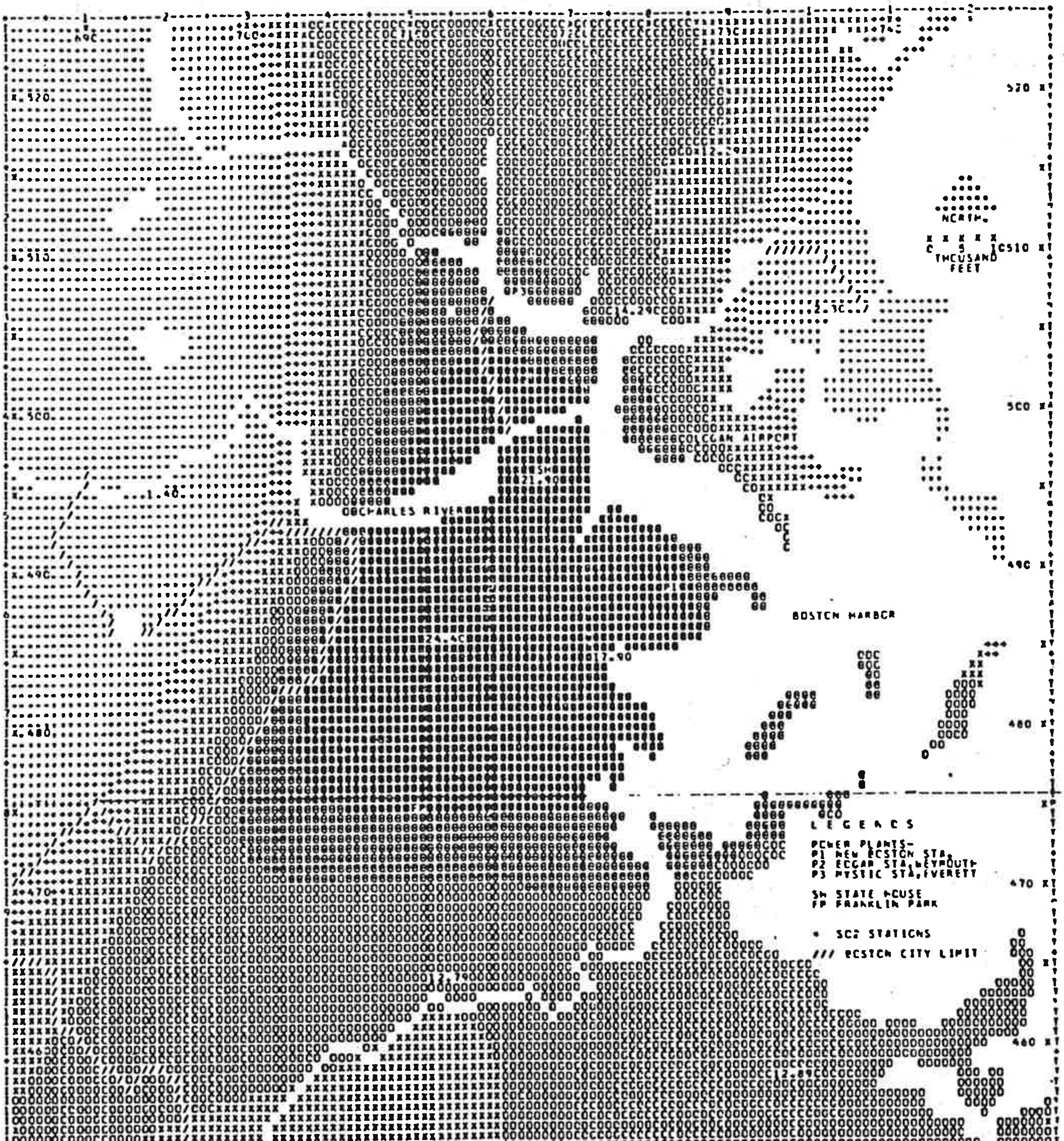
Figure 10: Display of height information in the form of an axonometric view of profiles (Courtesy H. Raetzsch).

Figure 11: Same as Figure 10, but presented as a simulated image with artificial illumination and superimposed contour lines (Courtesy H. Raetzsch, H. Oswald).

Figure 12: Super imposed LANDSAT-satellite image and forest theme from a map 1:50 000 to show discrepancies. Darker parts are forest, brighter image parts are other ground cover, probably agriculture.

Figure 13: Perspective display of a digital elevation model and land use themes of the area around Graz, Austria.

FIG 1

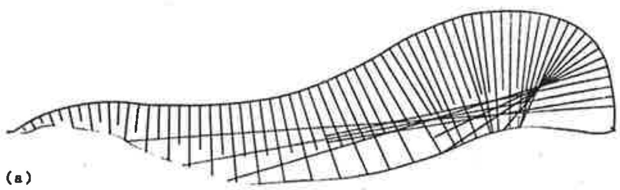


SYMAP

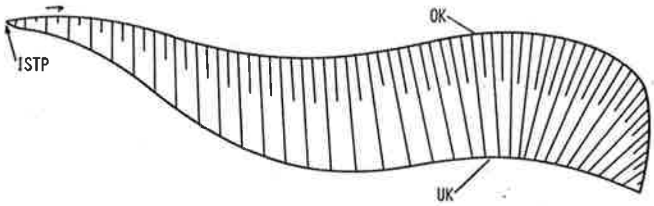
0.8 MINUTES FOR MAP

TIME = 586.2

Fig. 2



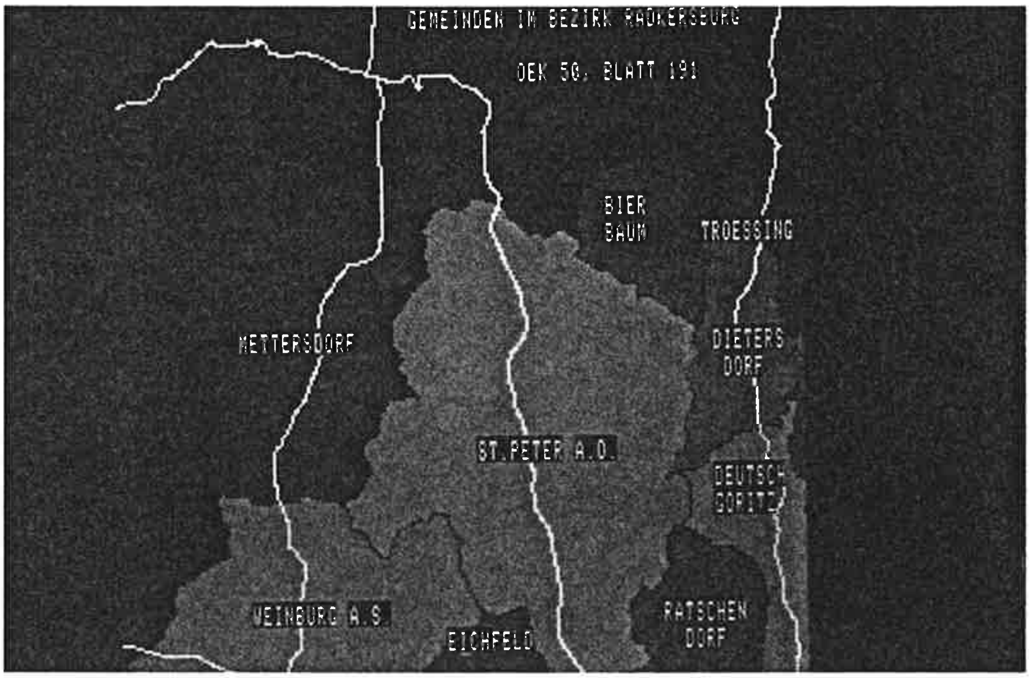
(a)

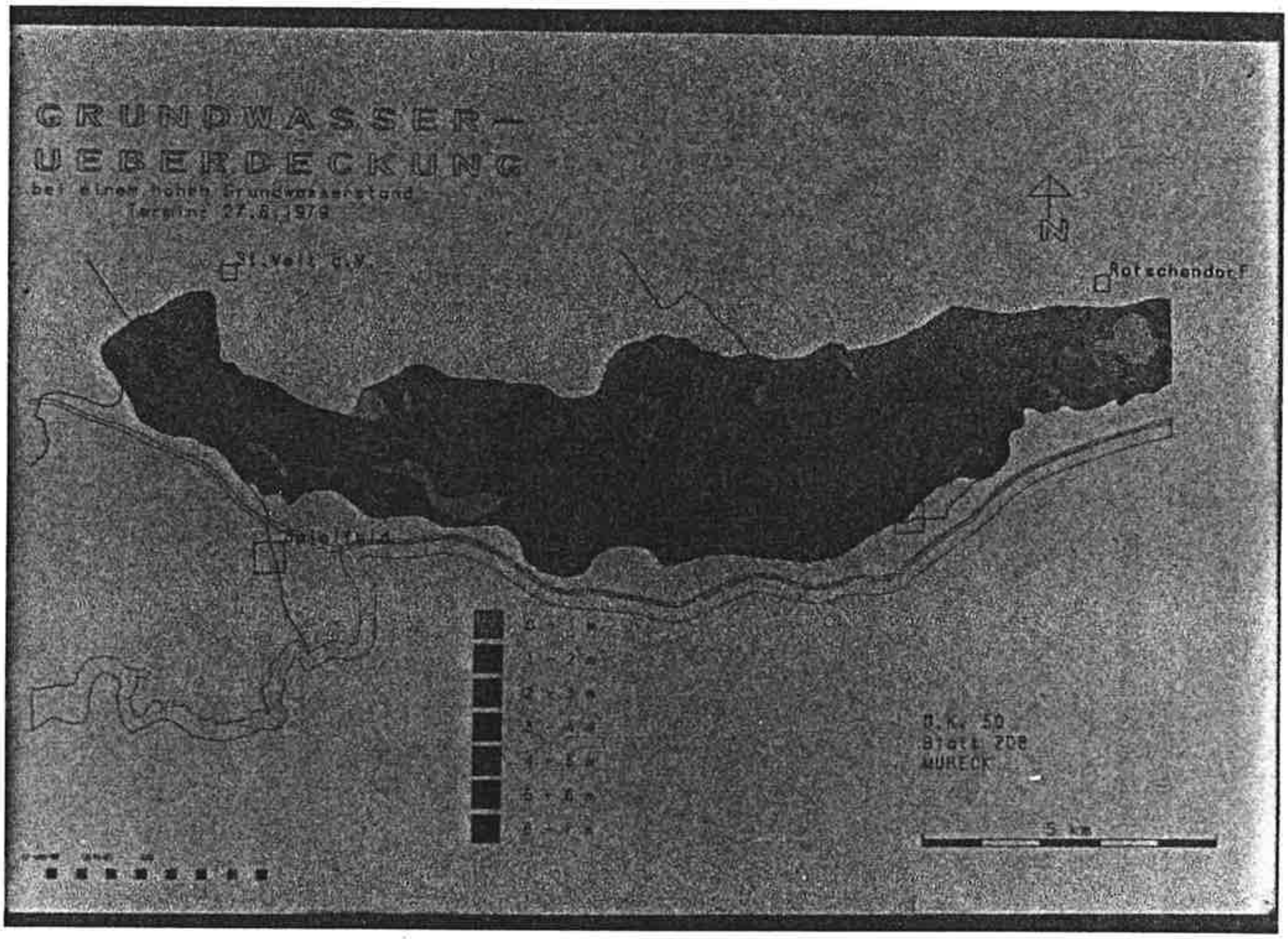


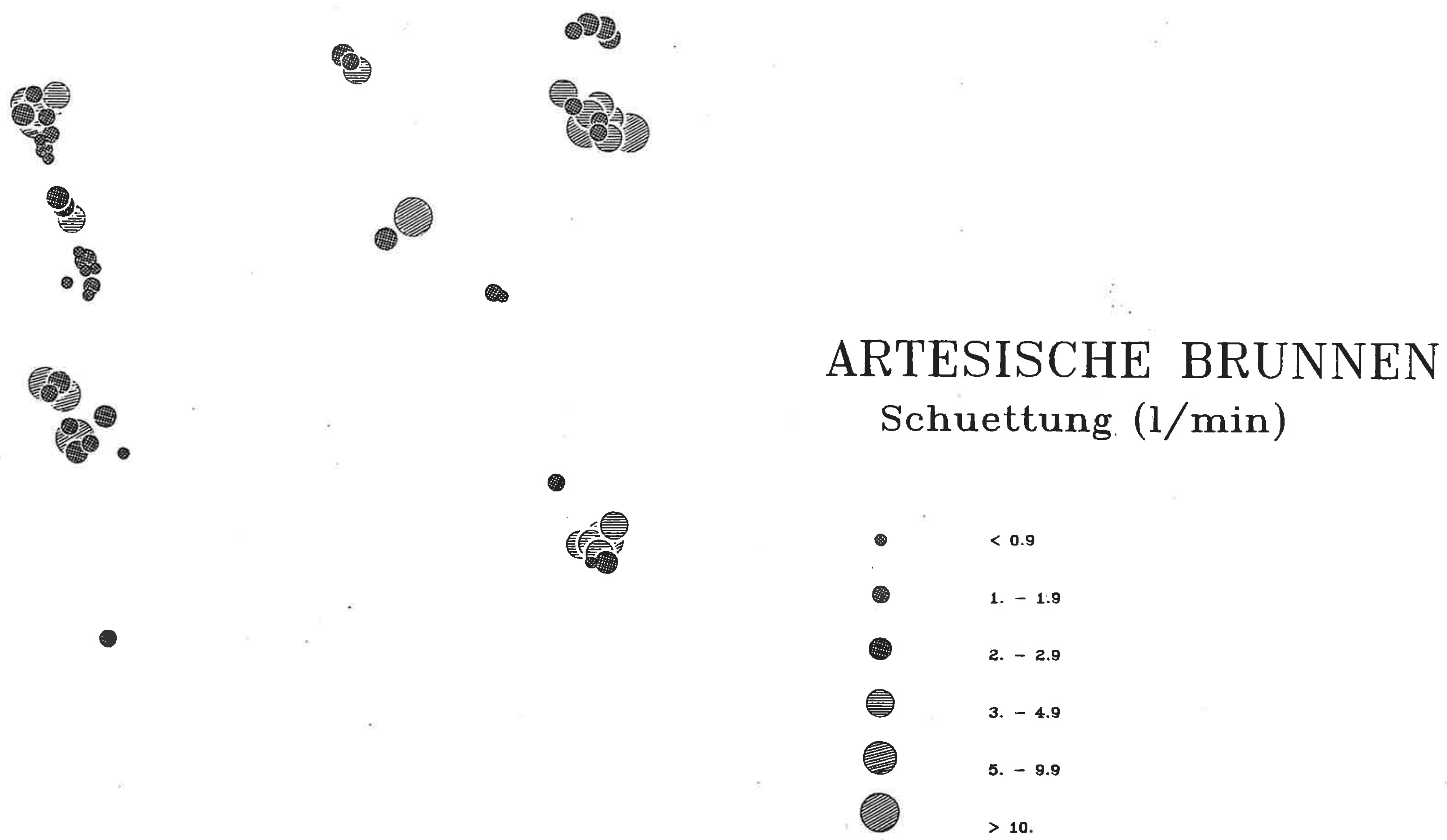
(a)

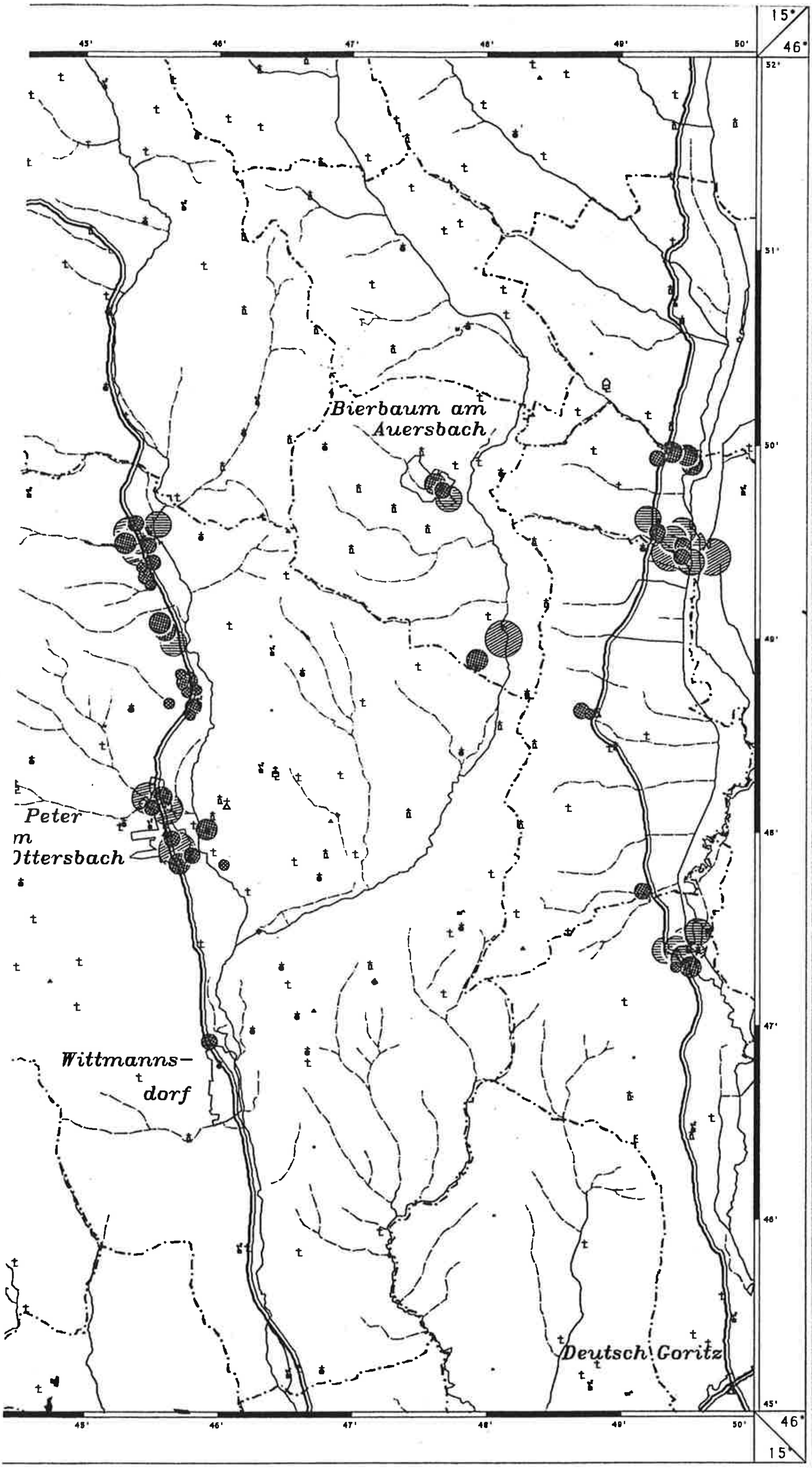
0	CARTOGRAPHIC SIMPLEX
1	ROMAN-SIMPLEX-PRIN
2	ROMAN-COMPLEX-PRIN
3	ROMAN-COMPLEX-INDEX
4	ROMAN-DUPLEX-PRIN
5	ROMAN-TRIPLEX-PRIN
6	*ITALIC-COMPLEX-PRIN*
7	*ITALIC-COMPLEX-INDEX*
8	***ITALIC-TRIPLEX-PRIN***
9	*SCRIPT-SIMPLEX-PRIN*
10	*SCRIPT-COMPLEX-PRIN*
11	GOTHIC-GERMAN-PRIN
12	GOTHIC-ENGLISH-PRIN
13	GOTHIC-ITALIAN-PRIN
14	SPECIAL-SIMPLEX-PRIN (1)
15	SPECIAL-SIMPLEX-PRIN (2)
16	SPECIAL-COMPLEX-PRIN (1)
17	SPECIAL-COMPLEX-PRIN (2)
18	SPECIAL-COMPLEX-INDEX (1)
19	SPECIAL-COMPLEX-INDEX (2)
20	ROMAN-CARTOGRAPHIC

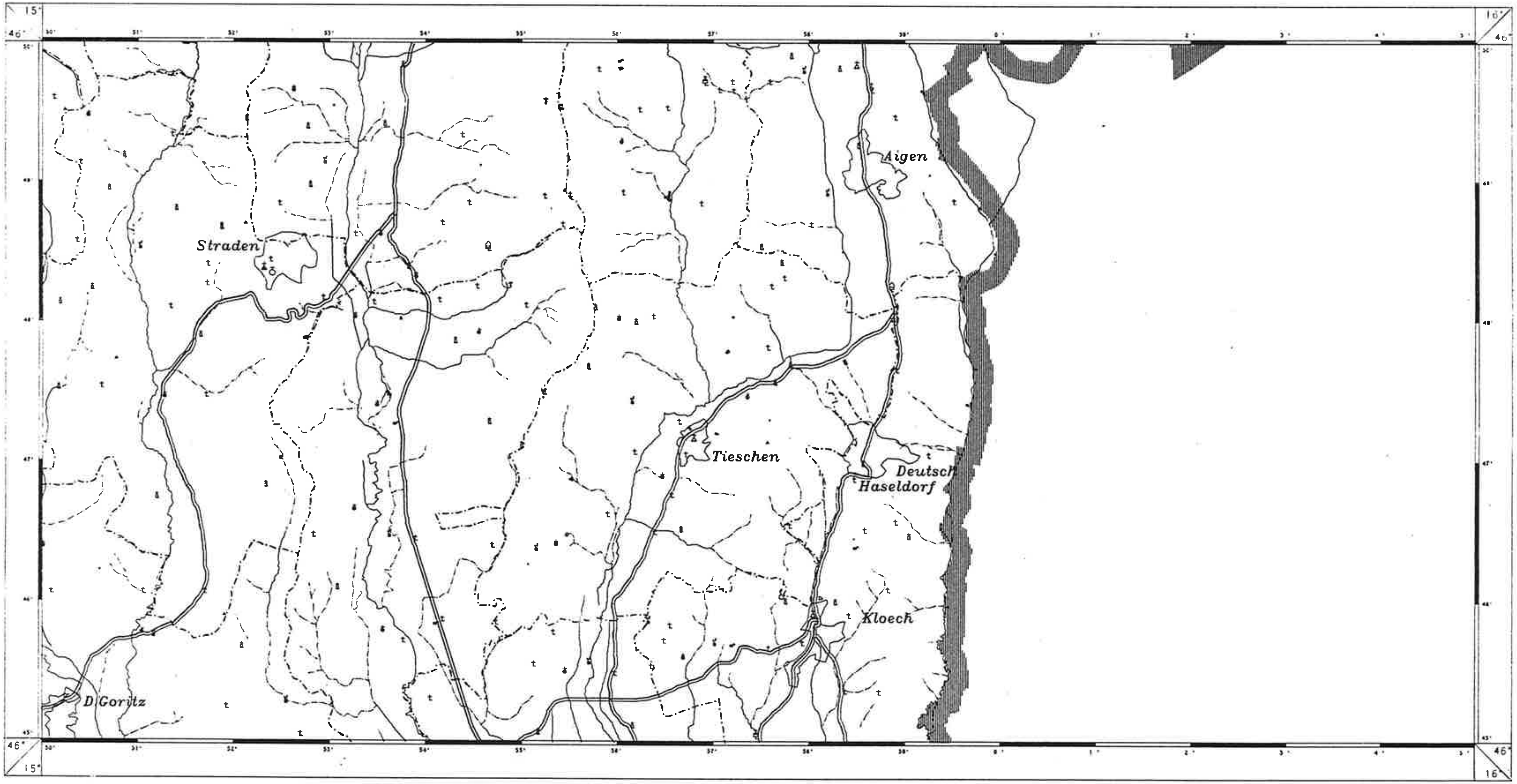
Fig. 4


GEMEINDEN IM BEZIRK RADKERSBURG
OEK 50, BLATT 191
BIER
BAUM
TROESSING
METTERSDORF
DIETERS
DORF
ST.PETER A.O.
DEUTSCH
GORITZ
WEINBURG A.S.
EICHFELD
RATSCHEN
DORF


GRUNDWASSER-
UEBERDECKUNG
bei einem hohen Grundwasserstand
Termin: 27.8.1979
Rotschendorf
Blatt 208
MURECK
5 km


ARTESISCHE BRUNNEN
Schuettung (l/min)
< 0.9
1. - 1.9
2. - 2.9
3. - 4.9
5. - 9.9
> 10.


15°
46°
Bierbaum am
Auersbach
Peter
m
)ttersbach
Wittmanns-
dorf
Deutsch Goritz


15°
46°
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46°
Straden
Aigen
Tieschen
Deutsch
Haseldorf
Kloech
D Goritz

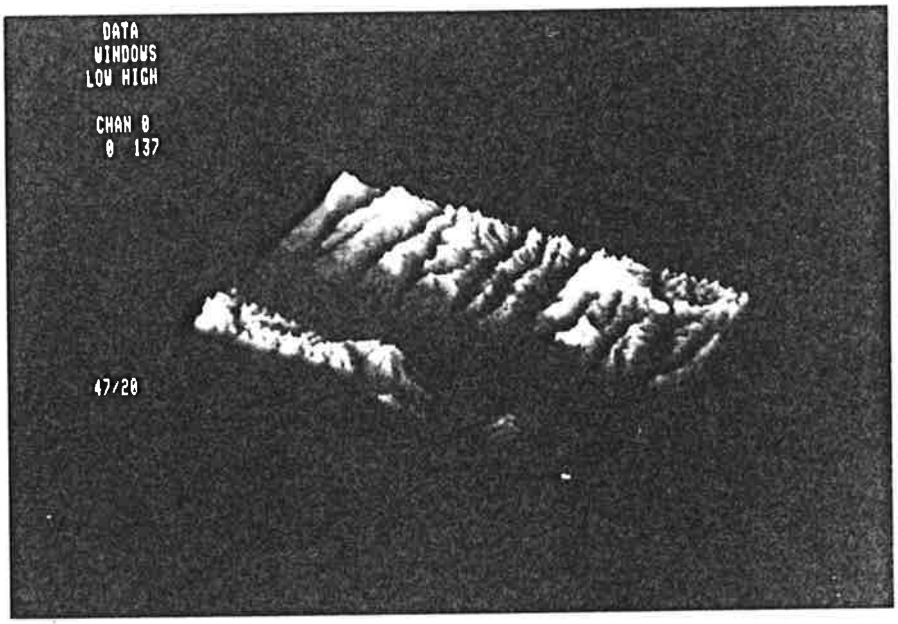
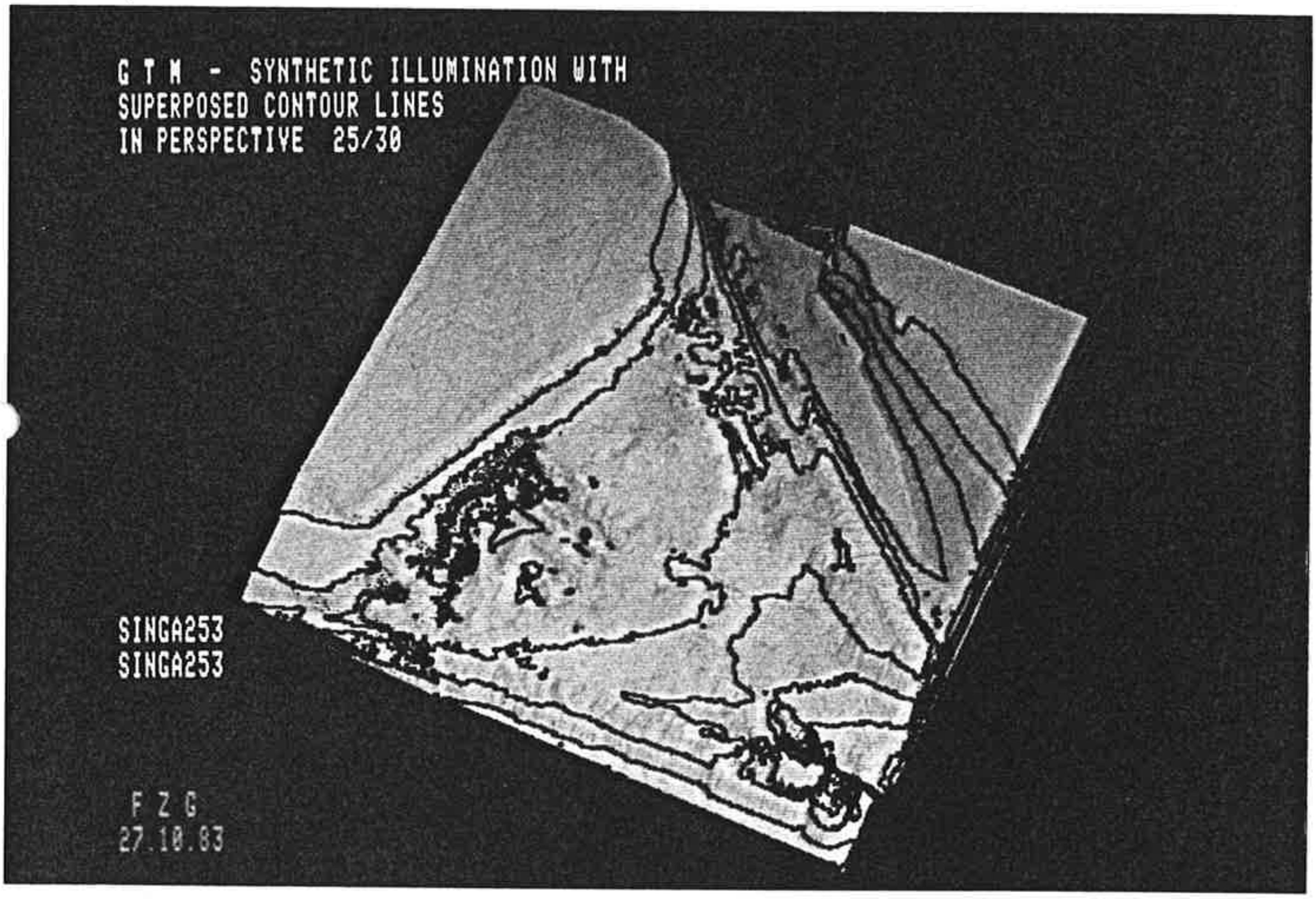
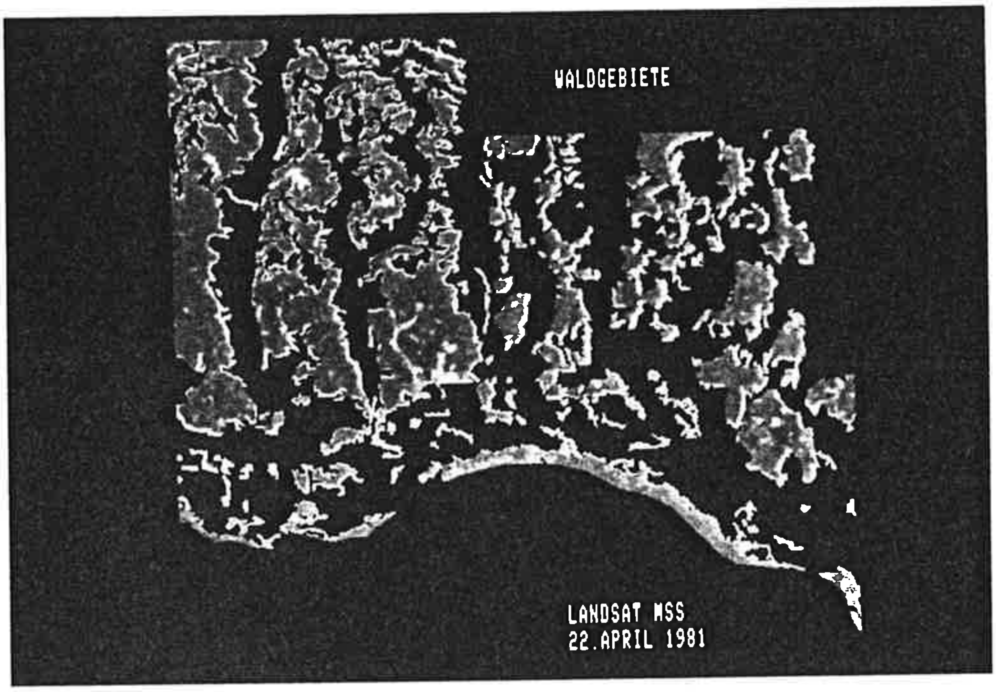

DATA
WINDOWS
LOW HIGH
CHAN 0
0 137
47/20

Fig. 11



G T M - SYNTHETIC ILLUMINATION WITH
SUPERPOSED CONTOUR LINES
IN PERSPECTIVE 25/30
SINGA253
SINGA253
F Z G
27.10.83


WALDGEBIETE
LANDSAT MSS
22.APRIL 1981

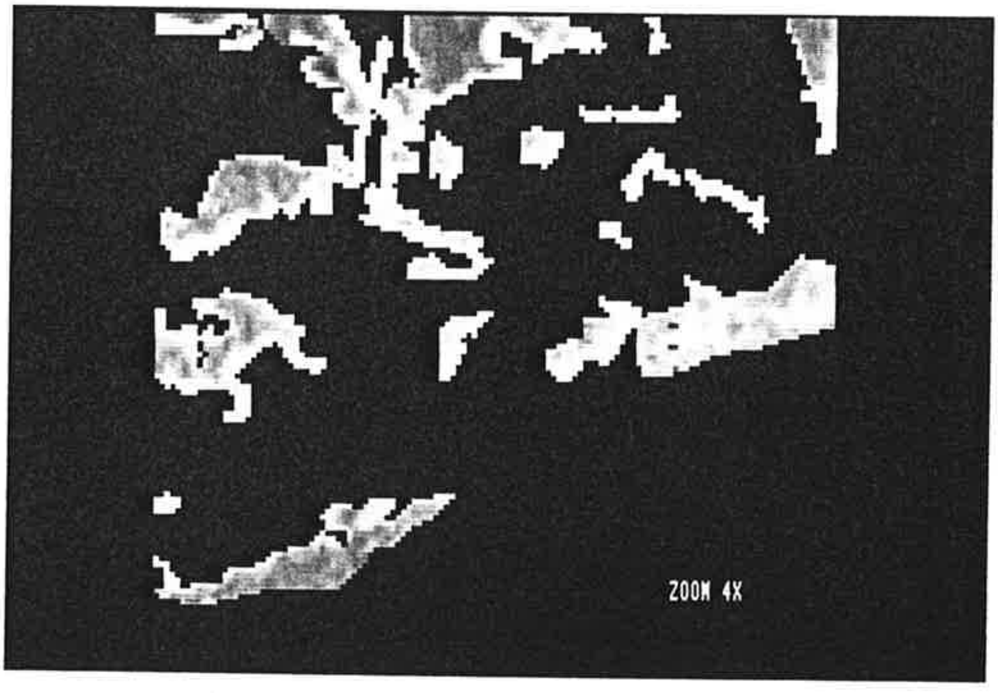

ZOOM 4X

FIG. 13