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MONIKA, A MINICOMPUTER BASED INTERACTIVE LARGE SCALE MAPPING SYSTEM

Abstract

A minicomputer based interactive large scale mapping system has been developed in Monikartta Oy/SOFTMAP.
System utilizes various input sources such as stereoplotting instrument, digitizer, tacheometer. All input data is stored on database which can be created and updated by especially designed management programs. The verification and editing is carried out by graphical display unit. Final map is drawn by a digital flat bed plotter.
On this paper the features of MONIKA, both hardware and software as well as the experiences so far acchieved will be discussed.

1. Introduction

Since the beginning of 1977 the problems concerning the land information systems e.g. the spatial referencing, data management and graphical presentation of landrelated data has been investigated at the Institute of Geodesy, Helsinki University of Technology (HUT) /1,2/. This research project has been granted mainly by the Academy of Finland. It was becoming obvious, that some ideas realized during the project could be applied to the development of an information system for the large scale mapping. On October 1978 started the project "Development of the ADP-system for map production" financed by the Finnish National Fund for Research and Development (SITRA). Monikartta Oy/Softmap, Finnish surveying company, took the main responsibility for the development of the software whereas at the Institute of Geodesy, HUT some special problems were investigated. A board of professional surveyors was appointed by SITRA for the technical supervision of the project. In the beginning of 1980 the first version of the interactive mapping system, called MONIKA, was implemented. The general structure of the MONIKA system is given in Fig.1. The system can be utilized for the large scale mapping and for the mapping of underground utilities.

The map data system, such as MONIKA, is only a part of the municipal information system. When developing MONIKA it has been taken into consideration relationships between map data and other data resources. By now two other systems will utilize the point register of MONIKA. The structure of the integration is given in Fig.2.

2. Data collecting and processing

Raw mapping data must be processed and stored in computer compatible form. The MONIKA system has completed software for the manipulation of data collected by field surveying, photogrammetric plotting and digitizing of graphical material.

The program package for the horizontal and vertical control survey will handle measurements of distances, horizontal and vertical angles as well as levelled differences in heights. All the required corrections and reductions due to eccentric observations, athmosphere, elevation difference of the measured line and map projection system can be computed and inserted in the above mentioned observations. The programs include also a lot of checking procedures. The linear equations of the least squares adjustment of horizontal and levelling networks are solved by the conjugate gradient method. All the Gauss-Krüger grid coordinates can be transformed into geographical coordinates and vice versa. The program for the conversion of coordinates allows the transformation of plane coordinates from one grid to another with a different central meridian.

The MONIKA system includes an interactive program package for the numerical ground surveying. The dialogue language commands are mnemonics in order to help users who are not familiar with computers and programming. The field data may be in tabular or coded form. In the former case field notes are punched on a paper tape or the field records can be given during the interactive computing session. In the case field data has been coded and stored in memory of data collector of electronic tacheometer it can be transferred directly to computer for processing. The software can handle data collected by various methods of terrestrial surveying e.g. intersection of points by angle or distance measurements, orthogonal, polar, extension and traverse method. Further a lot of subprograms take care of some special computations such as section and tangency of lines and circles, coordinates of points located on a survey line, or on a perpendicular distance to a survey line and determining the bearings and distances for the setting out of computed points.

The data collecting of ground details is accomplished nowadays by photogrammetric means. The configuration of the recording system is given in Fig.3. The codes are inserting in x,y-data records of points, lines and areas using menu-keyboard. The keyboard with replaceable code slides (Fig.4) seems to be most suitable for the numerical coding of stereoplotting. The contents of the tape casette is transferred to the computer for data management. MONIKA includes programs for the block adjustment of independent two- or three-dimensional models and for the bundle block adjustment.

Plenty of data for urban mapping are in graphical mode, which must be converted into numerical mode before the processing. The graphical material consists of field sketches of ground surveying and utility surveys, city plans and maps,etc. The menu of digitizing by tablet is analogous to the menu-keyboard of stereoplotting. Digitized coordinates are transformed using four-or-six-parameter model to ground coordinates before the data transfer to the data base.

3. Data base structure

The complexity of handling spatial data is due to the large sets and multipurpose character of various data. The organization of data base for everyday use should meet the demands of economics and reliability of the system.

The data structure of the MONIKA system was designed to manage data for large scale mapping. Points, lines and areas are the necessary topological elements to compile all features of base maps. The MONIKA system can deal with these elements and attribute data relating to them /3, 5/. Points and lines have a specified list of plotting parameters including common text and symbolism. The location of elements can be expressed by reference to a geographic label or to a geometric location. The general structure of MONIKA is given in Fig. 5.

Primary data identifier consists of two integer codes T1 and T2. The identifier T1 may have values from 1 to 999 and T2 value between 1 and 9999. For example geographic labelling can be defined using these identifiers in which case T1 may indicate a district number and T2 may have a quarter number. Further classification will be accomplished by means of identifier T3 ranging in value from 1 to 999. Within a class a single data item may have an individual identification number T4. Thus in the MONIKA structure an object may have four identifiers and it makes a whole of 15 numeric digits. That will be enough for the majority of practical applications.

The data base includes four data groups i.e. points, lines, areas and attributes. Points are devided into two subgroups. The first one is termed register of calculated points and points are identified by primary identifiers (T1, T2), class identifier (T3) and by an individual number (T4). Points of the second subgroup termed register of graphical points, are identified by T1, T2 and T3 only. Coordinate data of points is a list of x,y,z coordinates. Lines are subgrouped and identified identically with points. A line in the first subgroup is defined by reference to points of register of calculated points. Lines of second type are defined by a string of x,y,z coordinates. Areas are composed so that lines are linked together. Nodes are furnished with a proper code for the exact matching of lines. Attribute data can be assigned to each completely defined point, line and area. That approach makes possible to select the contents of maps according to needs of users.

4. Application in mapping process

The configuration of hardware used for the development of the MONIKA system is given in Fig.6. The mainframe is a PDP 11/34 processor with 64 Kwords of 16-bit core memory. Peripheral equipment consists of a double disk RK05 with 2x2,5 Mbytes, alphanumeric terminal Tally 1612, paper tape reader, vector refresh graphical system Megraphic 7000 and flatbed plotter CIL 4/74. The stereoplotting instrument Topocart C is connected to the installation via the photorecording device. Software written in Fortran IV is run under the operating system RSX-11M.

The mapping process using the MONIKA system can be described as follows.

Phase 1: Field surveying and computations necessary to prepare data for data base.

Phase 2: Encoding photographs on a stereoplotting instrument and digitizing graphical material on a tablet.

Phase 3: Verification and interactive edition of the content of data base on a graphic display.
Phase 4: Drawing map sheets on a flatbed plotter.
Phase 5: Inspection of map sheets and if necessary manual edition.
Phases 1 and 2 are descripted in the chapter 2. Some details dealing with the other phases will be outlined.

During editing session data are displayed in the user definable order according to identifier T3. The unremovable data will take priority over the data that can be edited unrestricted. For example property boundaries have priority over natural features, point numbers and text. The manipulation of the map image utilize the software based on Megatek-subroutines /4/. One screen image can be outputted directly by the flatbed plotter or the picture may be stored on a disk file for drawing afterwards. Data base files are updated according to the corrections made on the display file.

The symbology and text of the MONIKA system is completely user definable. Symbols may be associated with each identified point, line and area.Symbol definition language allows the user to generate any kind of symbols, that can be stored on the symbol register.

Examples of produced maps are shown in Figures 7 and 8.

5. Conclusions

The project for the developing the MONIKA system demonstrated that a mini-computer based interactive graphic system provides an effective instrument for the production of city maps at large scale. Standardization of data collecting and recording as well as of the symbology could be a great help for the users and for the organisations that are developing computer supported mapping systems. In the near future standardization will become very important for the reason that numerical maps stored on a data carrier will substitute plastic sheets as orginal evidence.

Even if the project was completed in the spring of 1980 the MONIKA system is under continuing development and major object is to improve the editing facilities.

References

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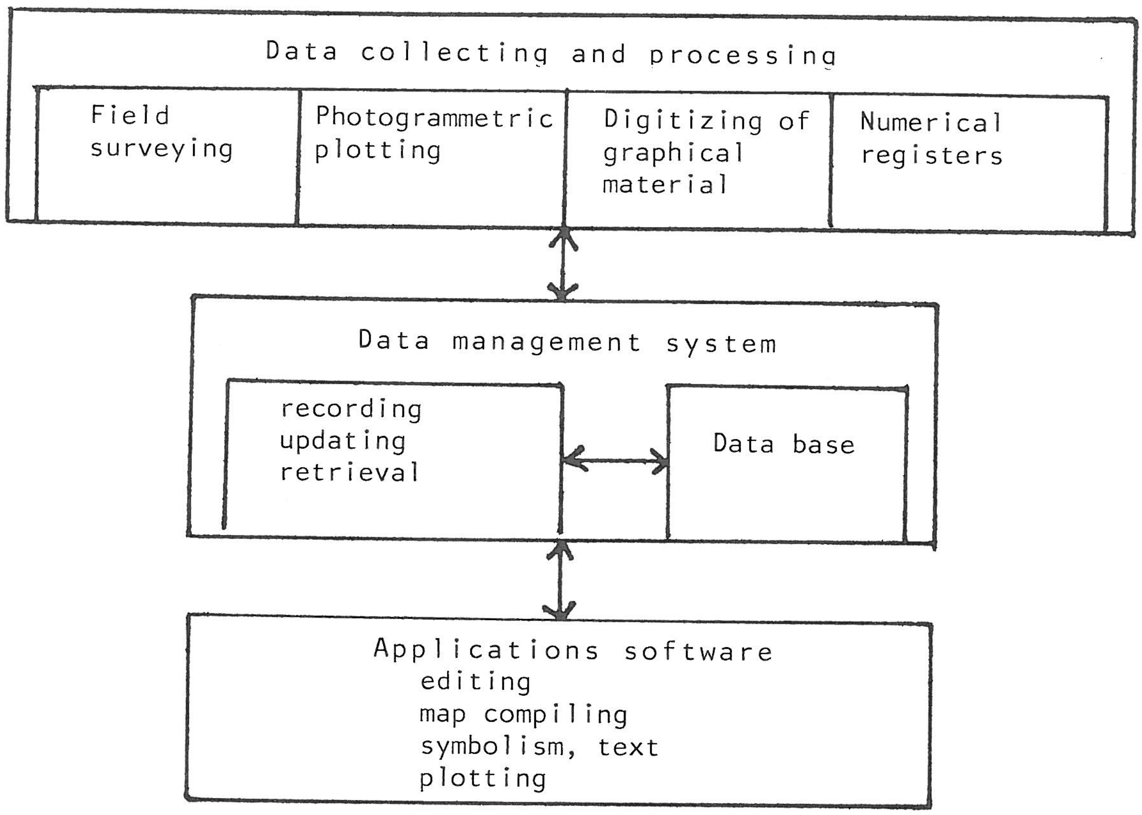

Figure 1. General structure of MONIKA.

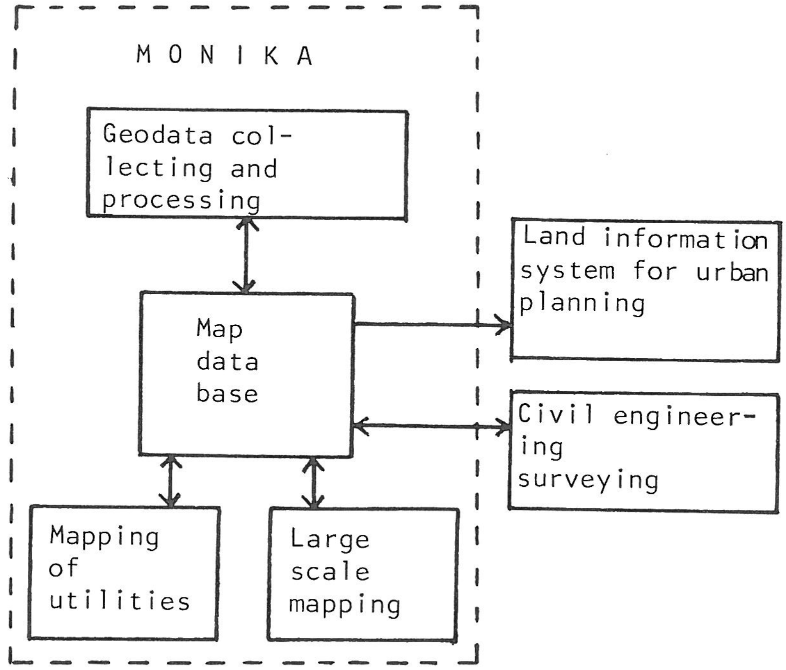

Figure 2. Integration of MONIKA.

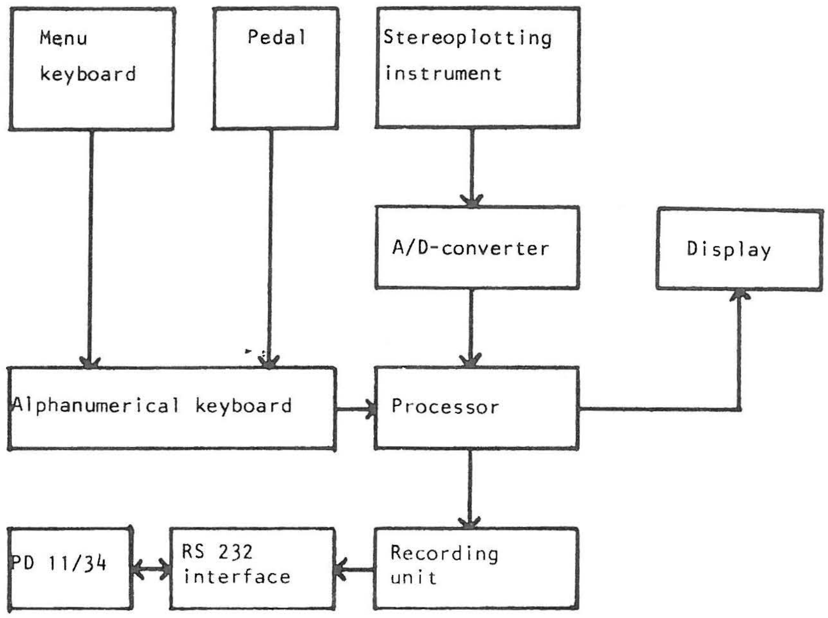

Figure 3. Configuration of photorecording.

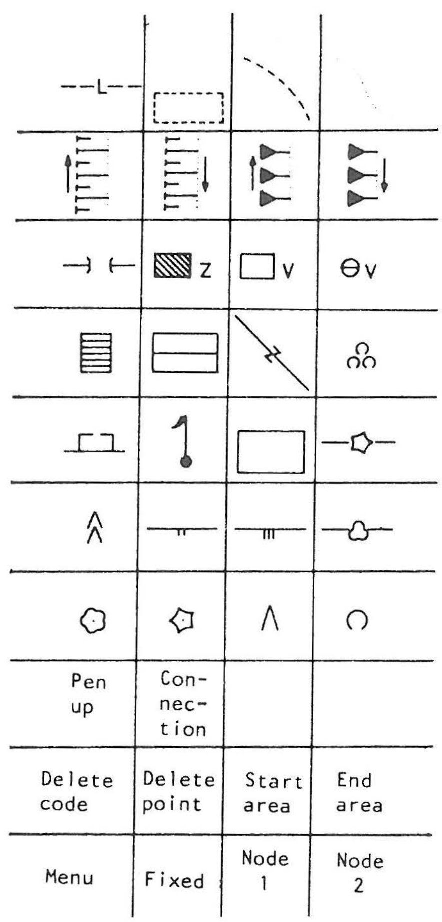

Figure 4. Menu-keyboard.

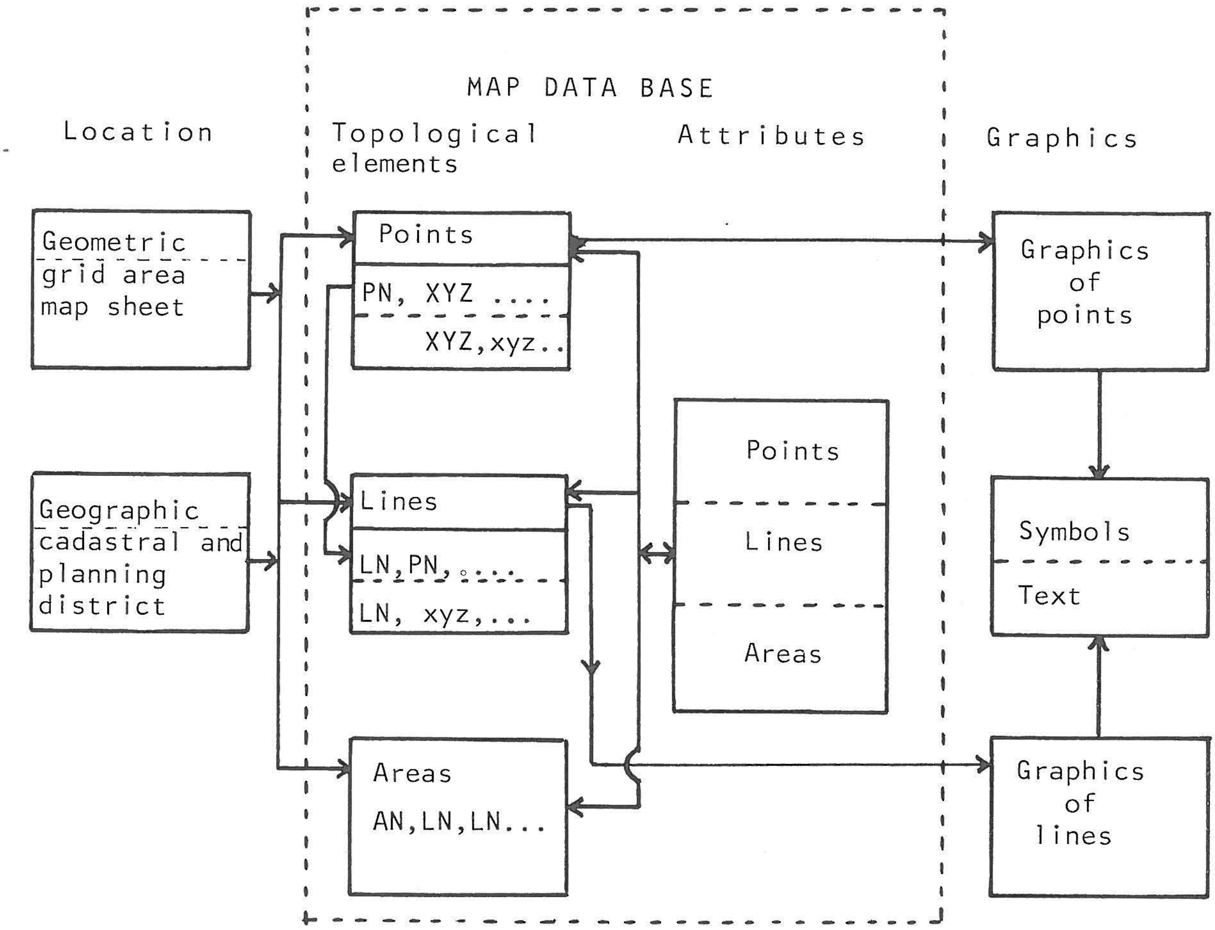

Figure 5. Data structure of MONIKA.

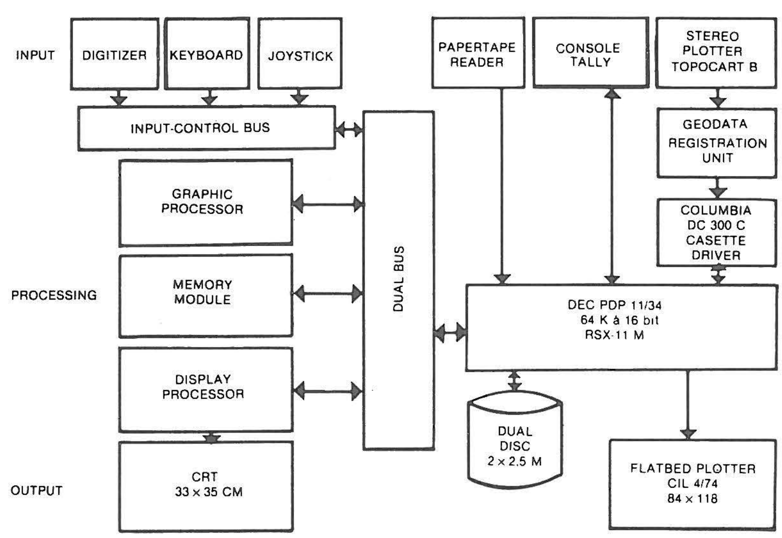

Figure 6. Configuration of hardware.

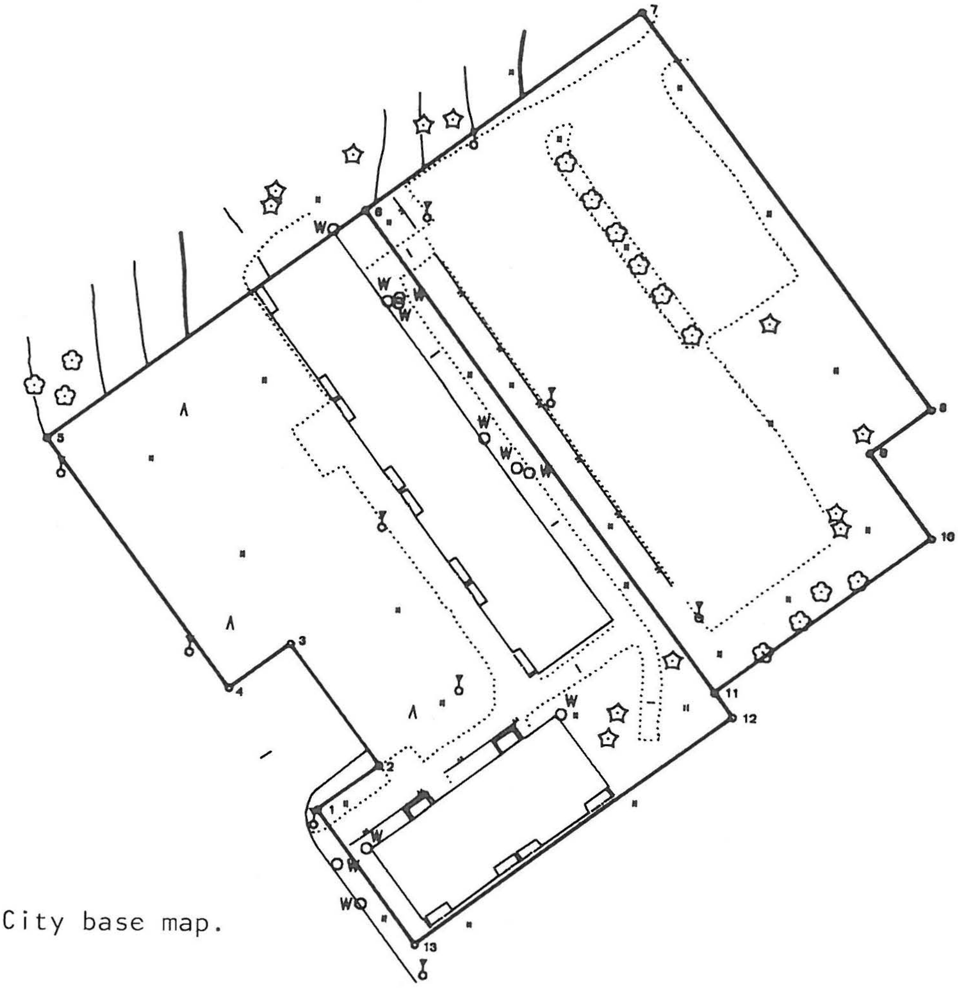

Figure 7. City base map.

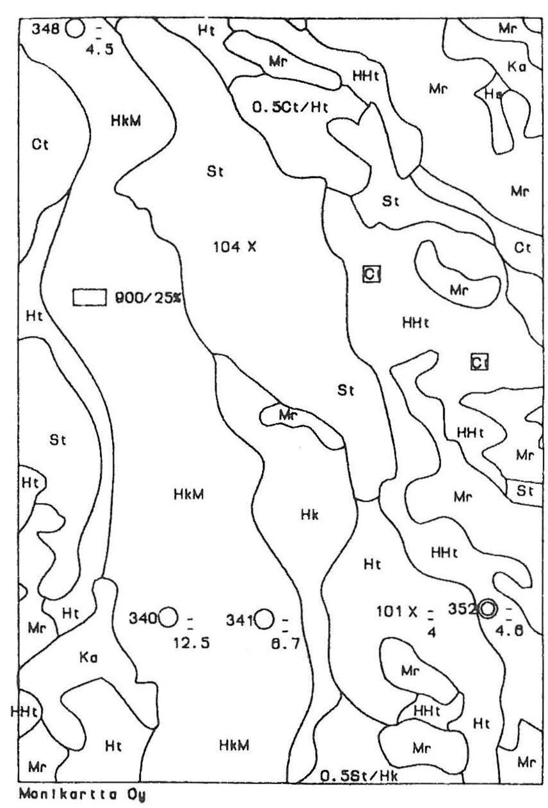

Figure 8. Soil map.