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HYDROGEOLOGICAL MAPPING BY USE OF CYCLOGRAM TECHNIQUE.

PRESENTATION OF THE ADVANCE IN SYSTEMATIC HYDROLOGICAL MAPPING EXEMPLIFIED BY THE FIRST COMPLETE MAPPING OF A COUNTY (VIBORG).

During the last lo years the Geological Survey of Denmark has developed a cartographic method of presentation of geological and hydrological borehole data.

The method has been desribed in DGU. III Series. No. 41 (Lars Jørgen Andersen: Cyclogram technique for geological mapping of borehole data), 1973.

The advantage of the method is that it makes possible an indirect three-dimensional presentation of geological and hydrological data.

Shortly desribed the method implies that information of geological layers, limits of stratification, position of groundwater potential level etc. is placed in a system of concentric, circular rings. In the Danish system each circle ring represents a hundred metre turn. The inner circle ring represents information from loo m above sea level to the sea level, the next ring information from sea level to loo m below sea level etc.

Following this system information deriving from the same level will be placed on the same "hour" in the same circle ring.

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The well record department contains information from about 13o.ooo boreholes carried out for water supply, geotechnical or scientific purposes.

The fundamental idea of the method is that it utilizes one the most sharp human senses - the sense of direction. It is possible, therefore, with a minimum of training to distinguish connections between information from different boreholes - placed on different terrain levels - i.e. groundwater level, occurrence of continuous waterbearing layers (sand, gravel etc.) or raw material deposits.

The cyclogram technique was originally designed for hand construction, but at the time it was decided to establish hydrogeological data base at the EDP centre at Copenhagen university RECKU, it was nearly immediately decided to develop computer programs for direct plotting of the cyclograms on maps.

This work is now brought to a sufficient standard, and maps are systematically produced in co-operation with the Danish counties as a link in the physical planning. The establishment of the EDP base is a natural follow-up of the manual base at DGU.

The base is prepared to receive any information in any "language".

As it several years ago became evident that the main subject of work within a decade would be processing of hydrogeological maps the work was concentrated on the problems around this map production.

The purpose of presenting the method at this conference is the following:

1) Since the method was published in 1973, computer programmes have been developed for automatical processing of geological, hydrological and technical data as cyclograms on maps.

2) It has been decided by law that all the Danish counties as a basis for the physical planning have to produce hydrogeological basis data maps and from these derived special maps after the principles drawn up by D.G.U.

3) The cartographic printing technique has been developed to satisfy the demands of the method.

4) At the conference it is possible to demonstrate (at the exhibition) the first complete hydrogeological basis data map of the Viborg county (north-western Denmark).

The intention with the basis data maps is that the cyclograms contain as many as possible of the existing geological, hydrological and technical data.

The principles of construction of the cyclograms attached to this paper will be demonstrated. The complete legend to the maps can be seen at the exhibition but will as well be shown as diapositive at the oral presentation. Furthermore, the method of processing, examples of single cyclograms, mapsections illustrating representative problems within physical planning and special maps showing single parameters extracted from the basis data maps will be given.

The information contained in the basis data map is.

1) Site of well
2) Well numbers (D.G.U. file number and local number)
3) Year of drilling
4) Screened interval(s)
5) Bottom of casing
6) Groundwater level
7) Limits of stratification (geological boundary)
8) Geological symbols. An amount of 150 symbols including geological and popular names of rocks and soils.

(Examples ML: clayey till, DS. meltwater sand SK: White chalk, R: shale).

9) Yield in $m^3/h/m$ drawdown

10) Information of existing geological description

11) Well diametre

12) Geological interpretation, given by use of a 24 colour scale.

It should be noticed that the method is open for changing of the scale of a circle turn. If the purpose is to illustrate superficial problems, the turn may be fixed to 10, 12 or 40 m. If the material concerns many very deep boreholes, the turn may be 400 or 1000 m. In case of big variations in terrain levels a possibility is open for changing of the reference level.

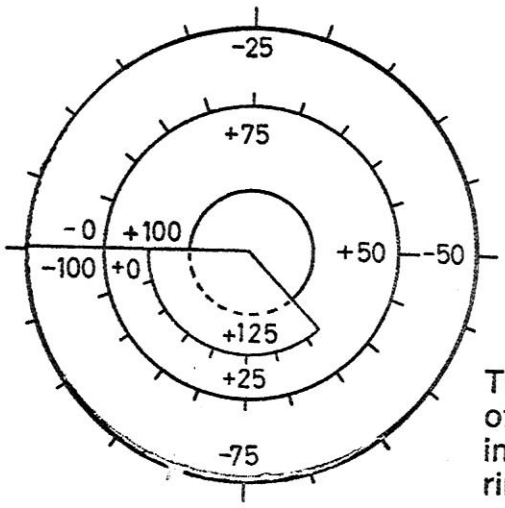
List of diapositives

1) Example of cyclogram
2) Legend of cyclogram (enclosed)
3) Legend of geological symbols (enclosed)
4) Legend of colour scale
5-6) Flow chart of EDP processing (enclosed)
7) Coordinate table (D-Mac)
8-17) The processing of the maps by use of D-Mac
18-19) Geological interpretation by use of colours
2o-24) Details from the cyclogram map from the Viborg county
25-26) Detail and total cyclogram map from the SKIBSØL area (Sealand)
27) Flow chart of the EDP processing of groundwater chemical maps (enclosed)
28) Groundwater chemical map from the SKIBSØL area
29-3o) Groundwater chemical maps from the NORDVAND area (Sealand)
31) Transmissivity map from the SKIBSØL area

GEOLOGICAL BASISDATA MAP

LEGEND

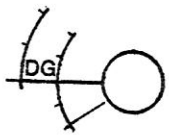
CYCLOGRAMS



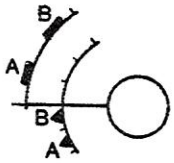
The position of the levels in the circle rings (m)

Site of well

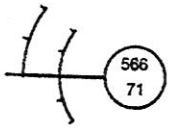
3.7/5.8 Specific yield in m³/h/m drawdown



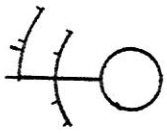
Geological symbol



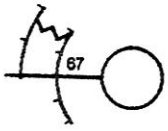
Screened intervals A.B . . .
A Groundwater level
B for screen A.B . . .



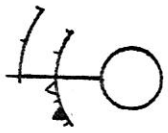
Well number
Upper: D.G.U. file No.
Lower: Waterworks's No.



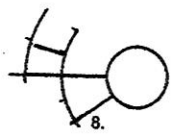
Bottom of casing



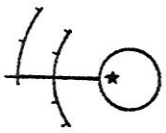
Uncertain boundary
Year of drilling
(1967)



Groundwater level in year
◂ of drilling
◃ at later sounding



Well diameter (8″)
Terrain (level +10)
Geological boundary
(level –4)



D.G.U. – geological description available

GEOLOGICAL SYMBOLS

B	Dug well
BK	Bryozoan limestone
C	Brown coal
CP	Brown coal (redeposited)
D	Diatomite, kieselguhr, diatomaceous gyttja
DG	Meltwater gravel Meltwater sand and -gravel
DI	Meltwater silt
DL	Meltwater clay
DS	Meltwater sand
DV	Alternating meltwater deposits
E	Vulcanic ash
ED	Marine diatomite (moler)
ES	Eolian sand
FG	Postglacial limnic gravel
FI	Postglacial limnic silt
FL	Postglacial limnic clay
FP	Postglacial limnic gyttja
FS	Postglacial limnic sand
FV	Alternating postglacial limnic deposits
G	Gravel, gravel and stone, stone and gravel
GI	Micaceous silt
GL	Micaceous clay
GP	Gyttja
GS	Micaceous sand
GV	Alternating miocene deposits
HG	Postglacial marine gravel
HI	Postglacial marine silt
HL	Postglacial marine clay
HP	Postglacial marine gyttja
HS	Postglacial marine sand
HV	Alternating postglacial marine deposits
I	Silt
IG	Interglacial gravel
II	Interglacial silt
IL	Interglacial clay Cyprina clay
IP	Interglacial gyttja
IS	Interglacial sand
IV	Alternating interglacial deposits
K	Limestone, chalk
KG	Quartzose gravel
KK	Arenaceous limestone
KS	Quartzose sand
L	Clay, marl
LK	Argillaceous limestone
LL	Lillebælt clay, plastic clay, eocene clay
M	Mould
MG	Till gravelly
MI	Till silty
ML	Till clayey
MS	Till sandy
MV	Alternating till deposits
O	Filling
OI	Oligocene silt
OL	Oligocene clay
OQ	Oligocene sandstone Øksenrade sandstone
OS	Oligocene sand
OV	Alternating oligocene deposits
P	Mud
PI	Paleocene silt
PK	Glauconitic limestone, Paleocene clay
PL	Kerteminde clay, -marl Glauconitic clay, -marl
PQ	Paleocene glauconitic sandstone
PR	Paleocene shale
PS	Paleocene glauconitic sand
PV	Alternating paleocene deposits
Q	Sandstone
R	Shale, slate clay
RL	Røsnæs clay
S	Sand
SK	Chalk
SL	Søvind marl
SP	Septarian clay
T	Peat
TG	Lateglacial limnic gravel
TI	Lateglacial limnic silt
TL	Lateglacial limnic clay
TP	Lateglacial limnic gyttja
TS	Lateglacial limnic sand
TV	Alternating lateglacial limnic deposits
U	Clay and sand, clay and stone, clay and gravel
V	Alternating thin layers
VL	Viborg clay, Branden clay
X	Unknown layers
YG	Lateglacial marine gravel
YI	Lateglacial marine silt
YL	Lateglacial marine clay
YP	Lateglacial marine gyttja
YS	Lateglacial marine sand
YV	Alternating lateglacial marine deposits
Z	Flint
ZK	Limestone and flint