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

The method has been described 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 described 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 100 m above sea level to the sea level, the next ring information from sea level to 100 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 130.000 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.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that this is crucial for the company's financial health and for providing reliable information to stakeholders.

2. The second part of the document outlines the specific procedures for recording transactions. It details the steps from initial receipt to final entry in the accounting system, ensuring that all necessary information is captured and verified.

3. The third part of the document addresses the role of the accounting department in monitoring and controlling the company's financial resources. It discusses how accurate records enable the department to identify areas of inefficiency and implement corrective measures.

4. The fourth part of the document focuses on the importance of regular audits and reconciliations. It explains how these processes help to detect and prevent errors, ensuring that the financial statements are accurate and trustworthy.

5. The fifth part of the document discusses the impact of accurate financial records on the company's overall performance and growth. It highlights how reliable financial data is essential for making informed strategic decisions and for attracting investment.

6. The sixth part of the document provides a summary of the key points discussed and offers recommendations for improving the company's financial record-keeping practices. It stresses the need for ongoing training and attention to detail to maintain the highest standards of accuracy.

- 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.

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(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.

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## 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
- 20-24) 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
- 29-30) Groundwater chemical maps from the NORDVAND area (Sealand)
- 31) Transmissivity map from the SKIBSØL area

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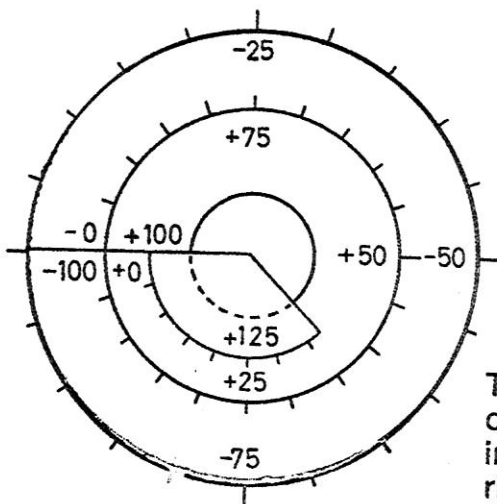
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# GEOLOGICAL BASIS DATA MAP

## LEGEND

### CYCLOGRAMS



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

● Site of well  
3.7/5.8 Specific yield in m<sup>3</sup>/h/m drawdown

Geological symbol

■ Screened intervals A.B ...  
▲ Groundwater level 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

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## GEOLOGICAL SYMBOLS

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

