2. HYDROCHEMICAL MAPS

Jiri Sima

Contents

- Origin of groundwater chemistry
- Method of map compilation
- Standardized legend
- Examples

Origin of gw chemistry

The chemical composition of groundwater is the combined results of the composition of water that infiltrates to soil and rocks to reach groundwater reservoir and its reactions with gases and minerals in the soil and rock

(development of natural composition)

Hydrochemical map

- Basic hydrochemistry – groundwater types (colors)
- Types of water of the system (columns, Stiff and pie graphs)
- groundwater quality (natural, human affected – pollution)

Origin of gw chemistry

The effect of pollution, such as nitrate, acid rain, industrial wastes and others also influences the groundwater chemistry in recent years

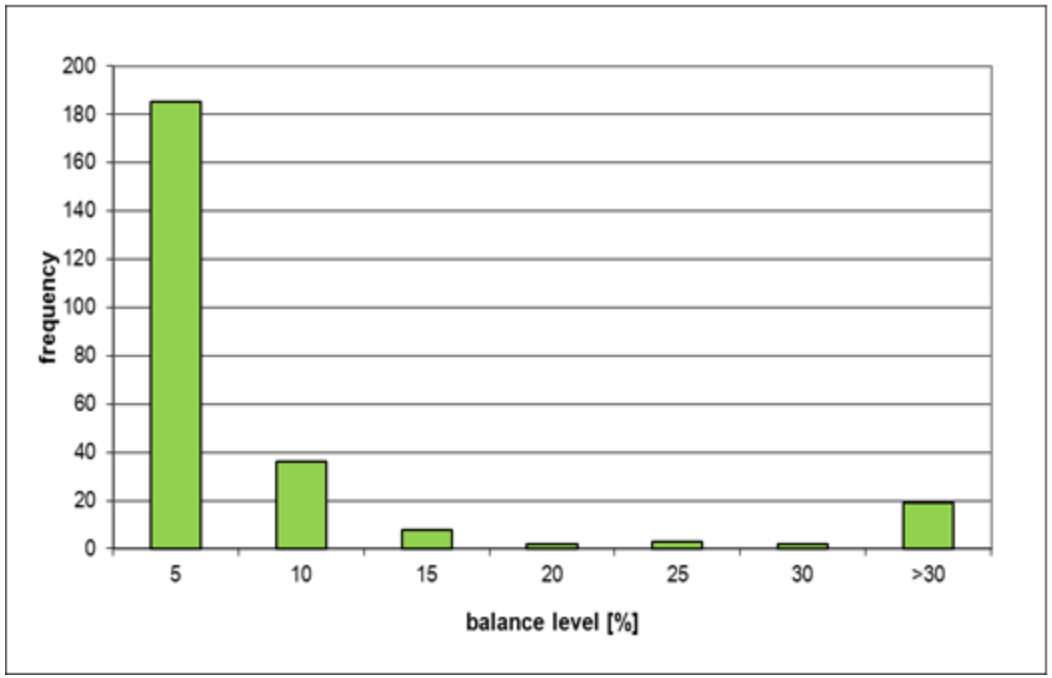
(development of human affected composition)

Origin of gw chemistry

The classical type of water analyses (complete chemical analysis - ions) in hydrogeology is to produce basic information concerning the water composition and quality. Maps are usually compiled to display the regional distribution of water composition and quality.

Reliability of analyses

Reliability of the analyses using the cation-anion balance is at level of 10 %.

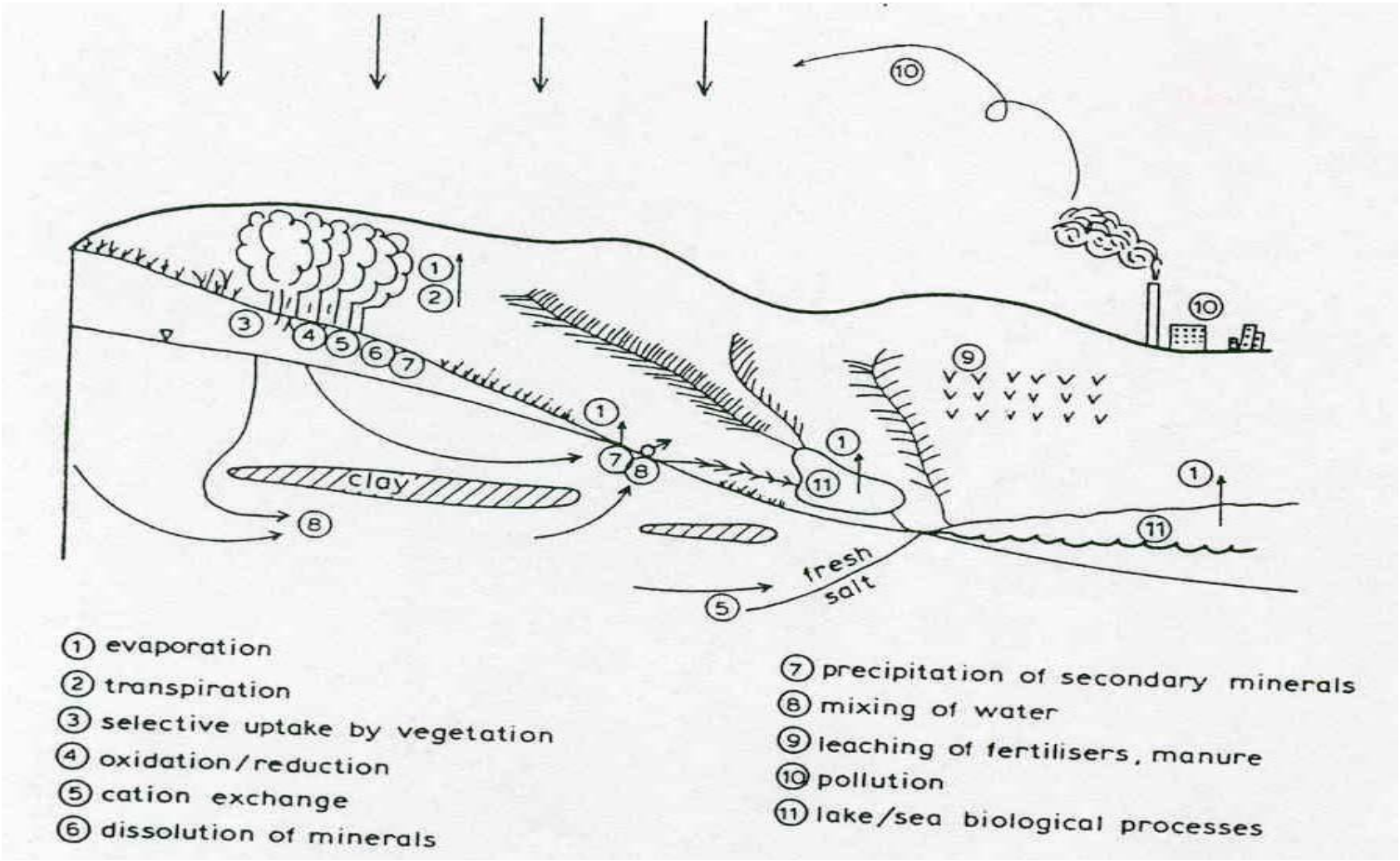


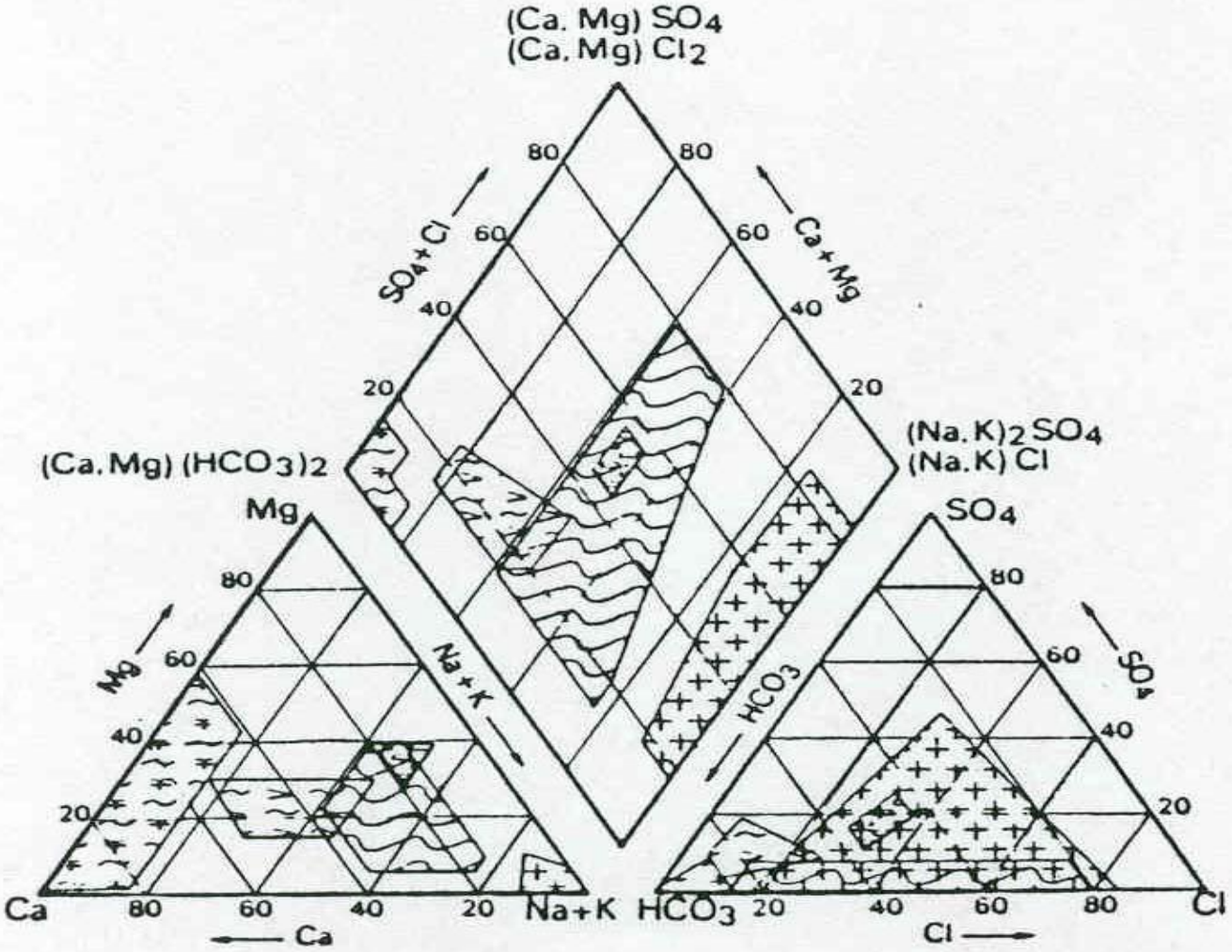
Hosaina 255 samples 87% balance error less than 10%

Origin of gw chemistry

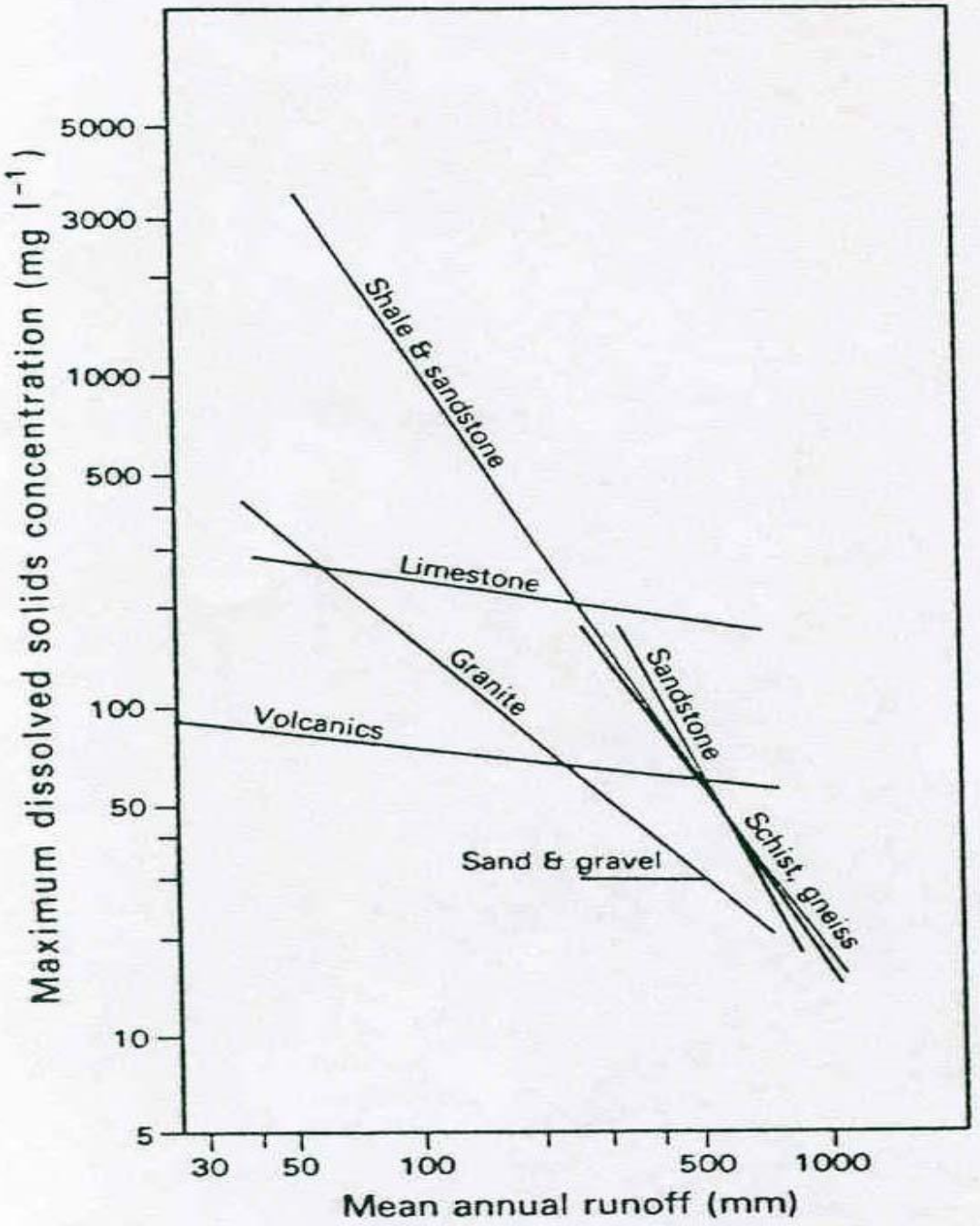
Groundwater chemistry is an important toll for hydrogeologists for tracing the origins and the history of water within the water cycle. Water composition change through reaction with the rocks, and water chemistry provides information about the processes and environments through which the water has circulated.

Origin of gw chemistry





	Ec-range
Shale. sandstone. greywacke. quartzite. schist. gneiss	150. – 350.
Marl + $CaSO_4$ / MSO_4 (magmatic rock)	800. – 1300.
Limestone. marl (magmatic rock)	1200. – 2000.
Magmatic rock	1500. – 1700.
Schist. quartzite. granite.sandstone (+FeS_2)...	1300. – 2100.


Maximum dissolved solids concentration (mg l⁻¹)
5000
3000
1000
500
100
50
10
5
30
50
100
500
1000
Mean annual runoff (mm)
Shale & sandstone
Limestone
Granite
Volcanics
Sandstone
Schist, gneiss
Sand & gravel

Hydrochemical map

The groundwater chemistry is shown in form of hydrochemical types of water using standard classification scheme.

Hydrochemical types of groundwater are expressed in solid color and /or using screens.

Classification scheme

Composition of groundwater is expressed as percentage of concentration of main cations and anions

Concentration of main ions is presented in miliequivalents per liter of sample (meq/l)

Hydrochemical types

There are three hydrochemical types defined based on the concentration of individual dissolved solids:

- **Basic**
- **Transitional**
- **Mixed**

Basic hydrochemical type

– solid color
– the concentration of the main cation and anion is higher than 50 Meq%,

Transitional type

- horizontal strips
- the concentrations of the main cation and anion range between 35 and 50 Meq%, or exceed 50 Meq% for one ion only, a dominant ion combination is expressed by relevant color strips (screen) in the horizontal position, the second ion is expressed by index (e.g. Mg)

Mixed hydrochemical types

– vertical strips

– the concentrations of cation and anion are not over 50 Meq%, and only one ion has its concentration over 35 Meq%, this type is expressed by relevant color strips (screen) in the vertical position.

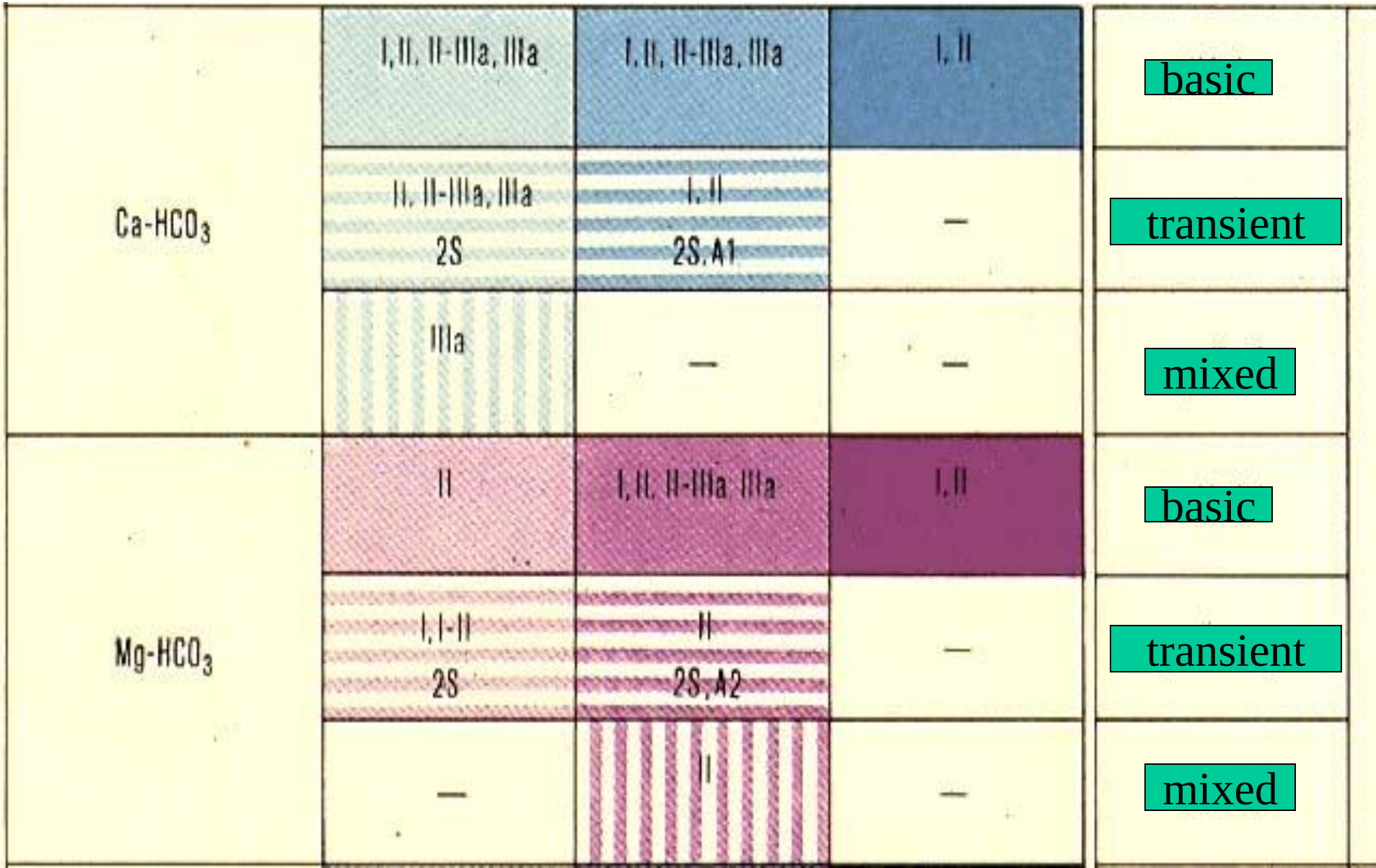
Hydrochemical types

There are seven hydrochemical types defined based on the concentration of dominant cations and anions

Hydrochemical types

No.	Color	Hydrochemical type of groundwater
1	light blue	$Ca\text{-}HCO_3$
2	violet	$Mg\text{-}HCO_3$
3	dark blue	$Na\text{-}HCO_3$
4	yellow	$Ca\text{-}SO_4$
5	brown	$Mg\text{-}SO_4$
6	red	$Na\text{-}SO_4$
7	green	Na-Cl

T.D.S.


Ca-HCO3
I, II, II-IIIa, IIIa
I, II, II-IIIa, IIIa
I, II
basic
II, II-IIIa, IIIa
2S
I, II
2S, A1
—
transient
IIIa
—
—
mixed
Mg-HCO3
II
I, II, II-IIIa IIIa
I, II
basic
I, I-II
2S
II
2S, A2
—
transient
—
II
—
mixed

Other feature of the map

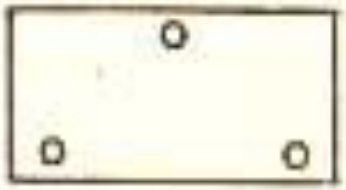
Aquifer types (porous, fissured)

Vertical hydrochemical column (zonal sampling)

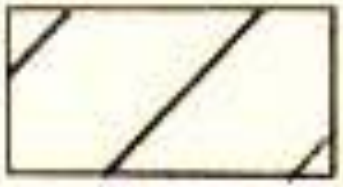
Hydrochemical points (sampled)

Boundaries (type, mineral waters)

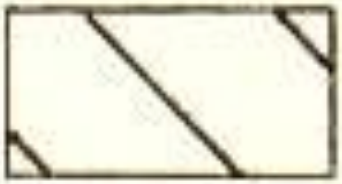
Inset maps



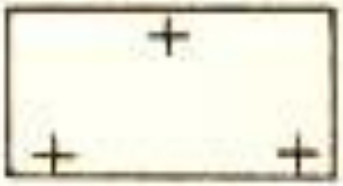
Porous aquifer in alluvial sediments



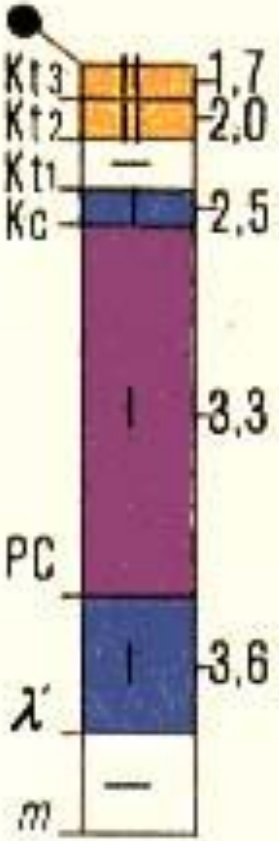
Porous-fissured aquifers in Neogene, Cretaceous and Carboniferous sedimantary rocks



Fissured aquifers in Neogene and Cretaceous sedimantary rocks and groundwater of aquitards



Fissured aquifers in crystaline rocks of Basement and paleo- and neovolcanics



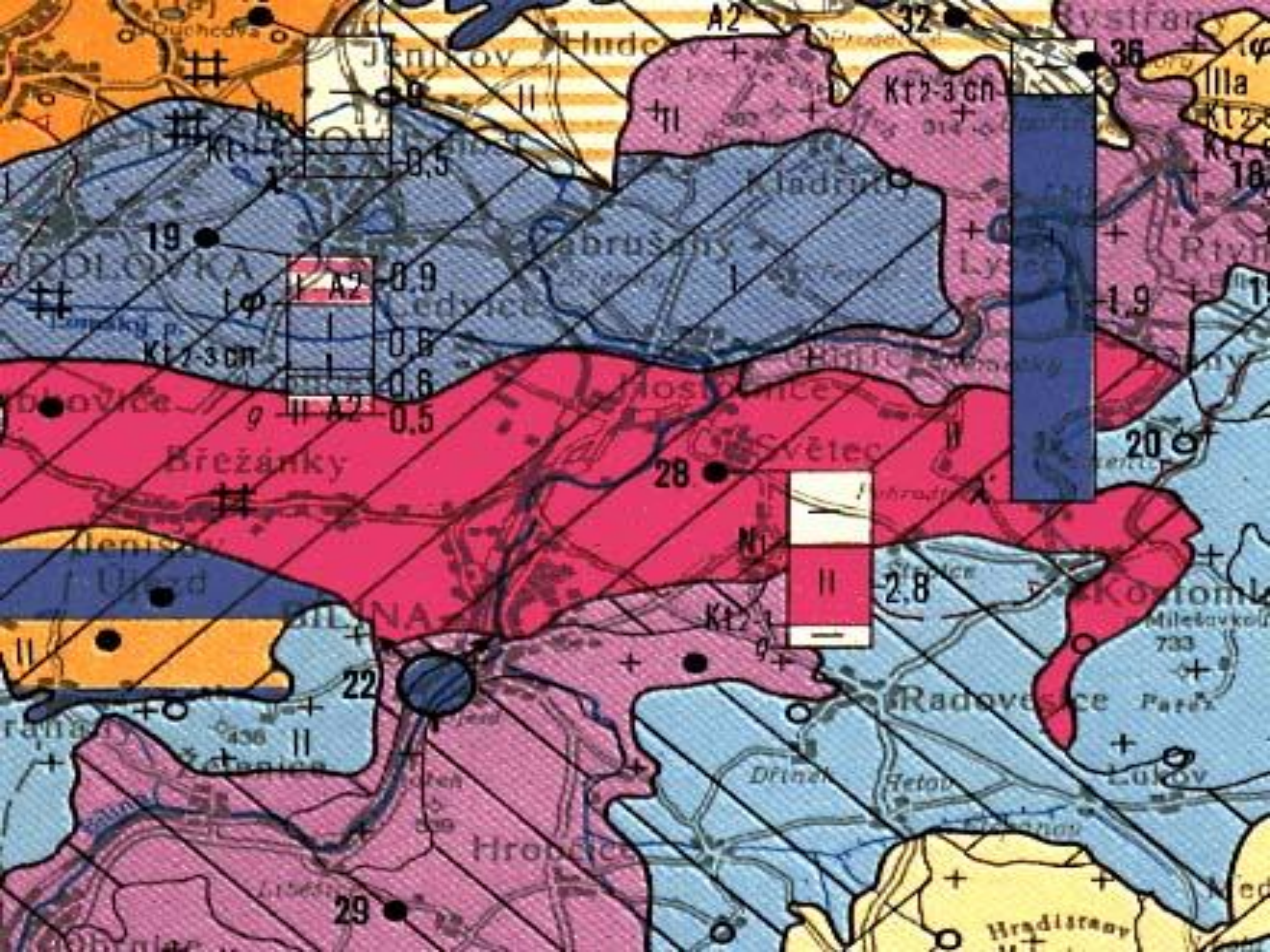
Legend

Stratigraphical index (left)

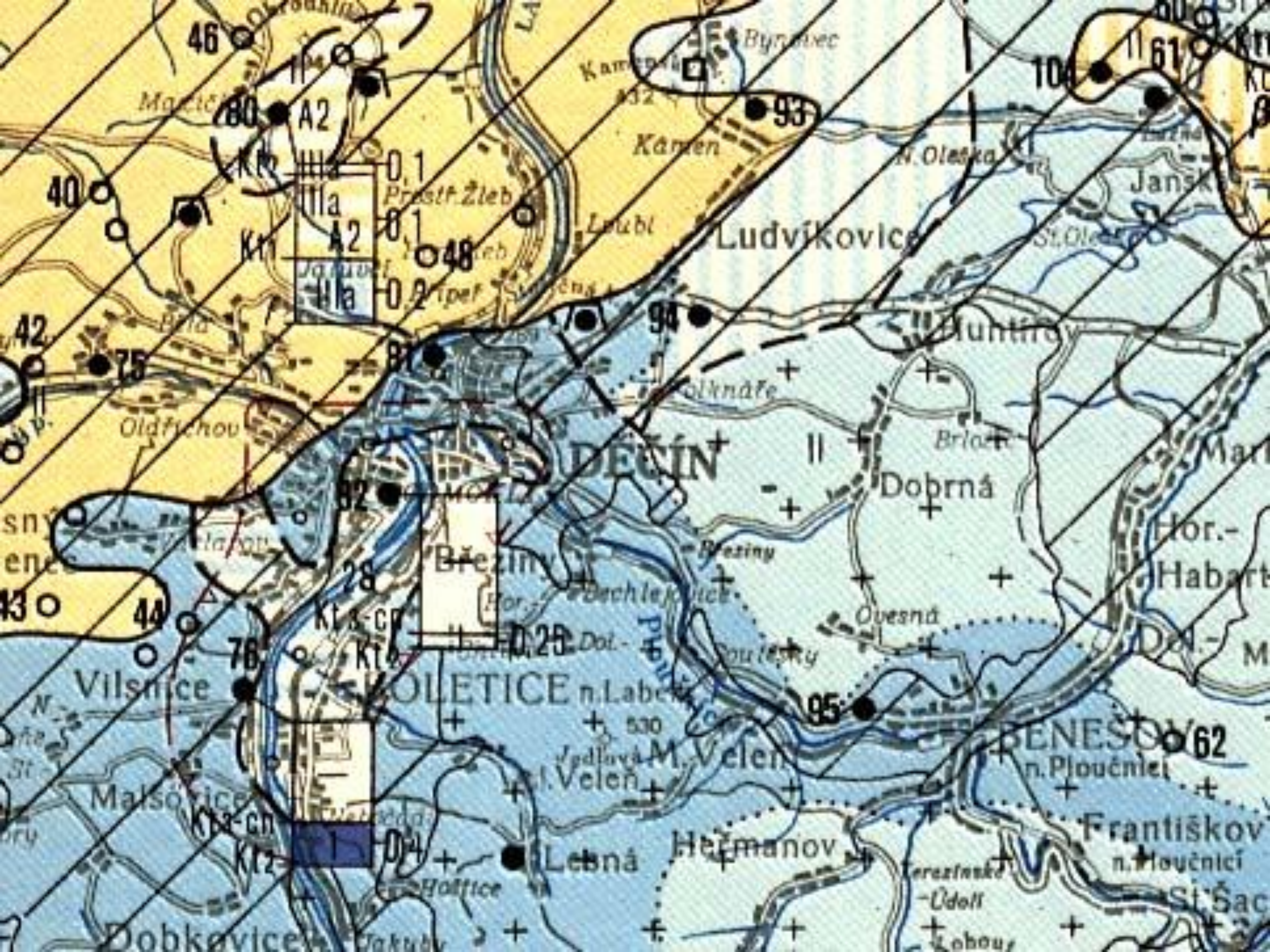
Hydrochemical type (center)

T.D.S. (right)

Vertical scale 1 : 2 0 0 0 0



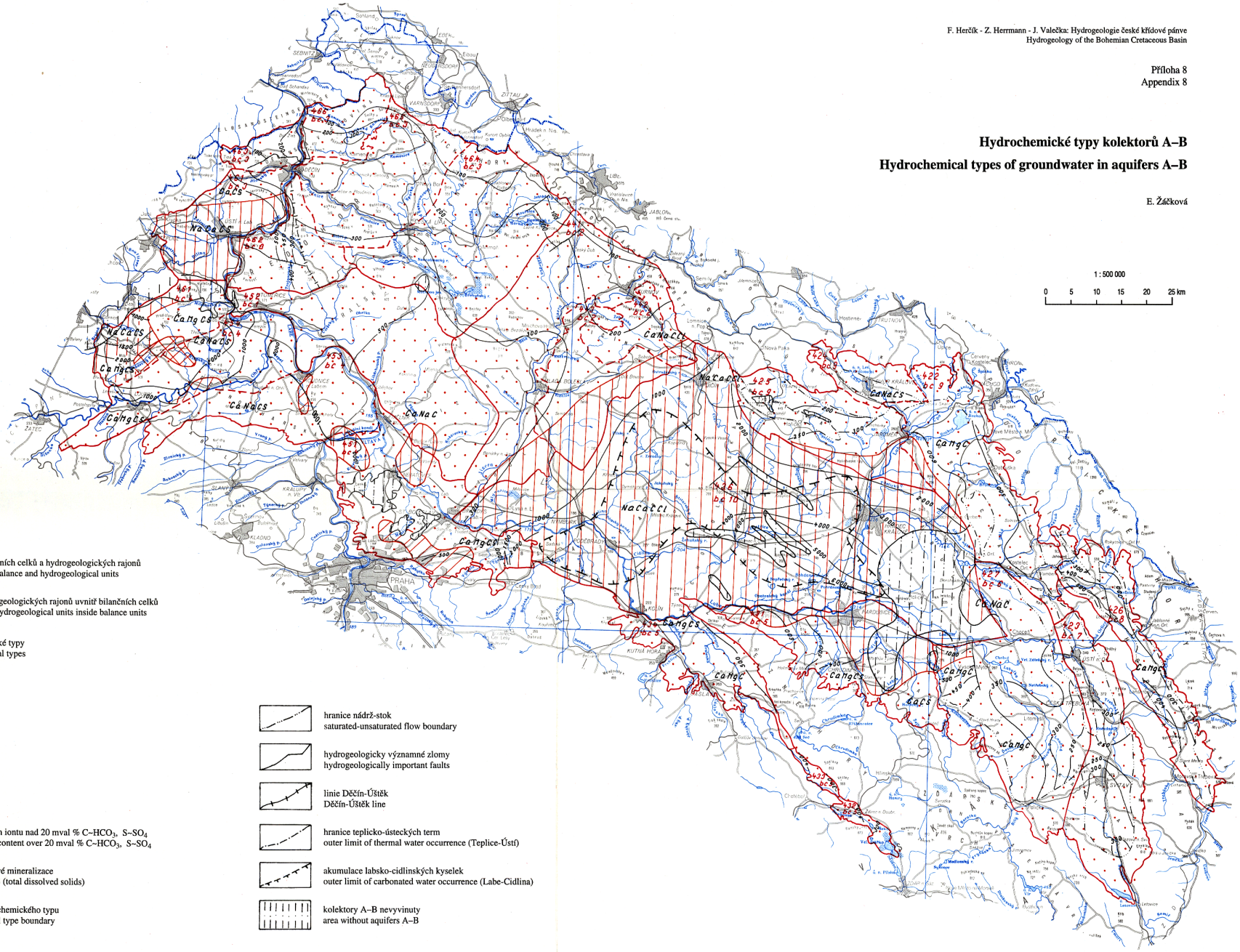
A2
32
36
Kt2-3 cn
IIIa
0.5
19
A2
0.9
Ledvice
Kt2-3 cn
0.8
0.6
0.5
Hostomice
Březánky
28
Světec
1.9
20
N1
2.8
Kt2-1
BÍLINA
22
Radovesice
Milešovka
733
Lukov
Hrobčice
29
Hradišťany


DĚČÍN
Ludvíkovice
Dobrná
Březiny
KOLETICE
n.Labem
BENEŠOV
n.Ploučnicí
Františkov
n.Ploučnicí
Heřmanov
Lesná
M.Veleň
Vilsnice
Malšovice
Oldřichov
Kámen
Prostř.Žleb
Byňovec
Dobkovice
Hor.-
Habart
Dol.-
Ovesná
Bechlejovice
Huntířov
Jedlová
Janská
St.Oleška
N.Oleška
Terezínské
Údolí
0,1
0,1
0,2
0,25
0,4
IIIa
IIIa
IIIa
A2
A2
Kt1
Kt2
Kt3-cn
Kt3-cn
46
80
40
48
42
75
81
70
94
93
104
61
92
28
43
44
76
95
62
530

Příloha 8
Appendix 8

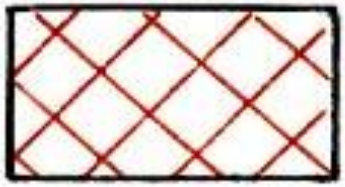
Hydrochemické typy kolektorů A–B
Hydrochemical types of groundwater in aquifers A–B

E. Žáčková

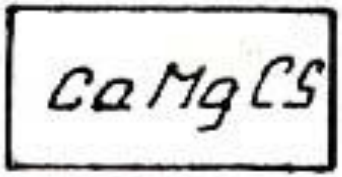


Na-HCO_3
Na-HCO_3

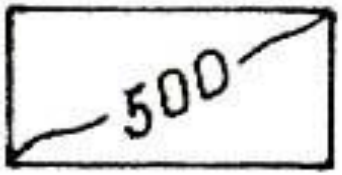
Ca-SO_4
Ca-SO_4



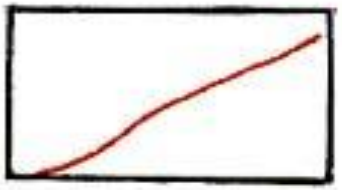
Mg-SO_4
Mg-SO_4



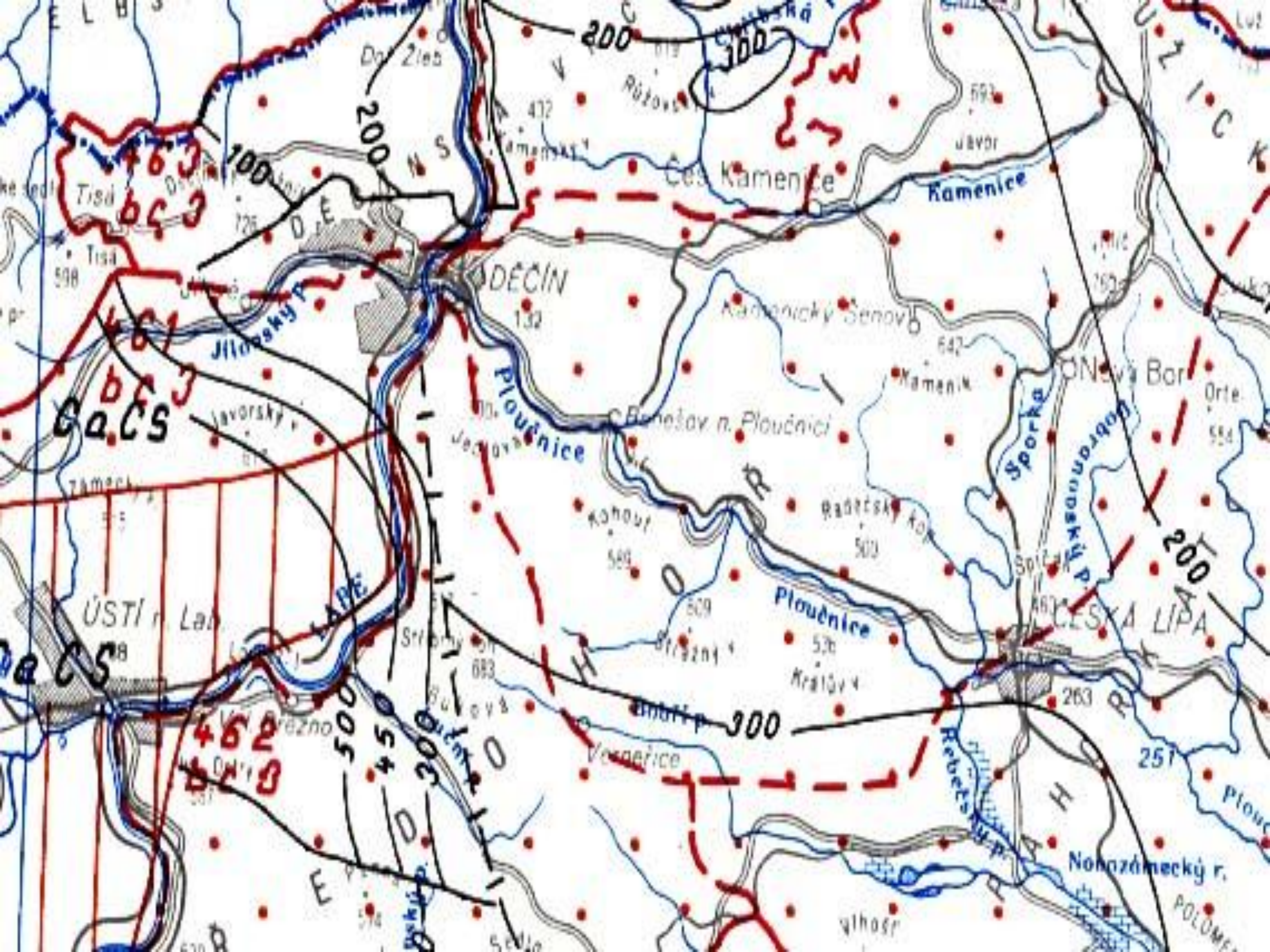
typ s výskytem iontu nad 20 mval % C~HCO_3, S~SO_4
type with ion content over 20 mval % C~HCO_3, S~SO_4



izolinie celkové mineralizace
isoline of TDS (total dissolved solids)



hranice hydrochemického typu
hydrochemical type boundary



DĚČÍN
Čes. Kamenice
Kamenice
Tisá
Benešov n. Ploučnicí
Ploučnice
Nový Bor
Javor
Kamenický Šenov
Kameník
Sporka
ČESKÁ LÍPA
ÚSTÍ n. Lab.
LABE
Jílovský p.
Ploučnice
Bukový
Ryžoviště
Radečský kop
Kralův v.
Stříbrný v.
Verneřice
Velké Březno
Orle
Rebečský p.
Novozámecký r.
Dobranovský p.
200
300
100
500
450
300
463
bc3
461
bc3
GaCS
aCS
462
bc3

Map of groundwater quality

Groundwater quality is depicted from the view of point of its utilization for water supply and according to the indices of the national standard (Drinking Water Standard) by orange hatching

Groundwater quality types

There are four water quality types defined based on requirements for processing (treatment) before it is supply as a drinking water

(category I) good quality, (category II and III) less suitable, (category IV) unsuitable groundwater quality

Category I - good quality

Groundwater requires only disinfections and/or filtration by a simple sand filter, and chemical or mechanical deacidification and/or deaeration

Category II - less suitable

Groundwater requires a simple water treatment technology e.g. coagulation. filtration or the first step of treatment of iron or manganese or longer time filtration on sand filters and disinfections

Category III - less suitable

Groundwater requires multi steps treatment e.g. clarification, sorption, oxidation, iron and manganese removal and/or combination of physical and chemical and microbiological water treatment processes.

Category IV – unsuitable

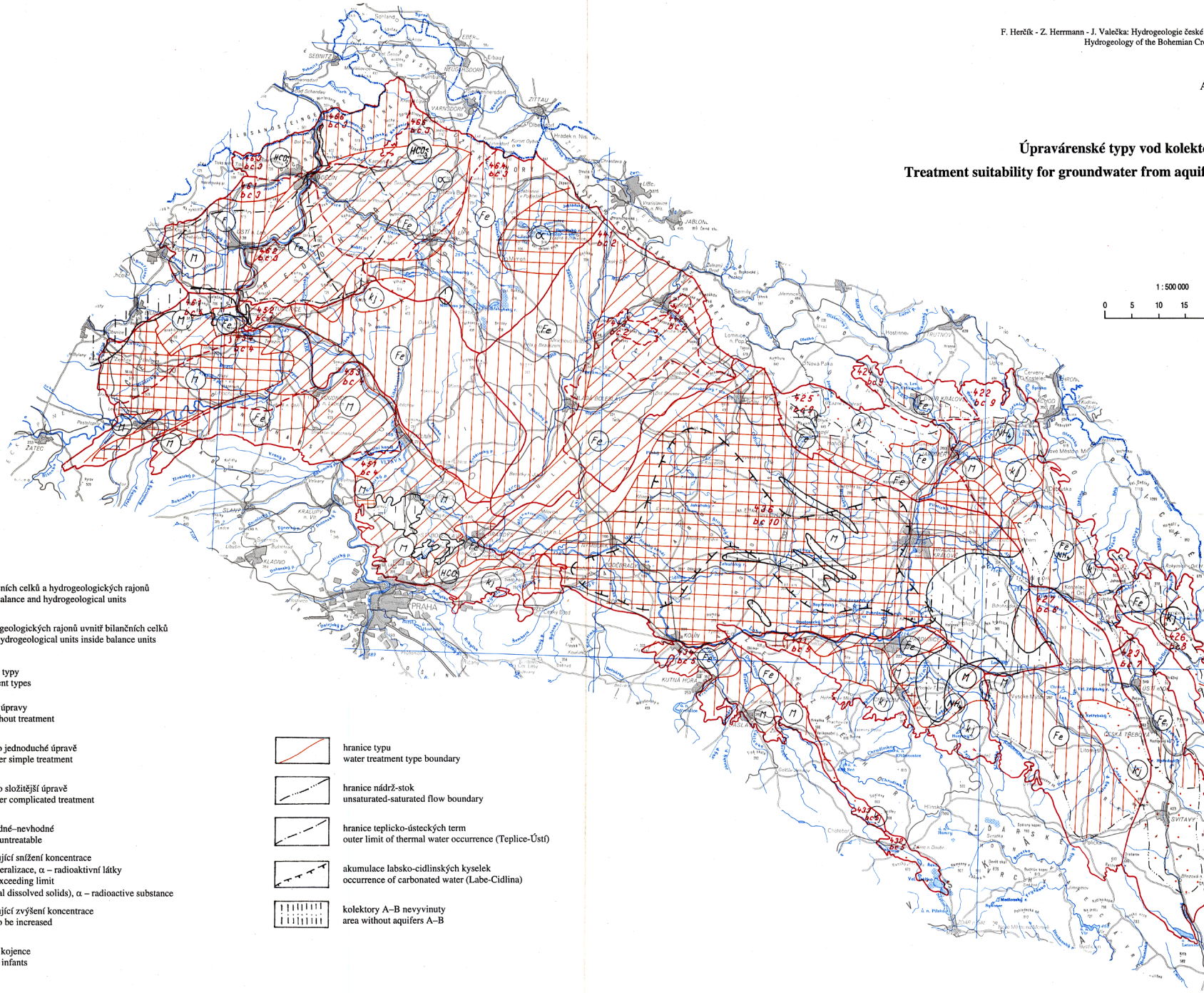
Groundwater is not suitable for water treatment to be used for water supply. Such water can be only used exceptionally for water supply. The water treatment is expensive and will not secure quality that is required by the national drinking water standards

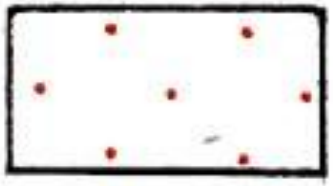
Classification limits

Component	Symbol	Unit	Groundwater treatment category					
			I.		II.		III.	
			Value					
			Standard	Max.	Standard	Max.	Standard	Max.
Microbiological and biological analysis								
Coli (37 ^{o}C)		CFU.100ml	10	50	100	5000	1000	50000
Microorganisms		num. 1ml	*[1)]	50	3000	*	10000	*
Physical and chemical analysis								
Ammonium	NH_4^-	$mg.l^{-1}$	0.05	0.5	0.5	1	1	3
Arsenic	As	$mg.l^{-1}$	0.01	0.05	*	0.05	0.05	0.1
Color	Col	$mg.l^{-1}$	10	20	20	50	*	200
Biochemical Oxygen Demand	BOD	$mg.l^{-1}$	*	3	4	5	5	7
Total Organic Carbon	TOC	$mg.l^{-1}$	2	3	5	7	8	10
Nitrates	NO_3	$mg.l^{-1}$	15	50	*	50	*	100
Phenols	FN	$mg.l^{-1}$	*	0.001	0.001	0.003	0.05	0.1
Fluoride	F^-	$mg.l^{-1}$	0,7-1,0	1.5	*	1.5	*	1.5
Manganese	Mn	$mg.l^{-1}$	0.05	0.1	0.1	3	1	5

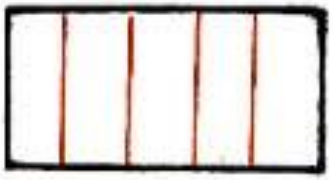
A

Úpravárenské typy vod kolekt
Treatment suitability for groundwater from aquif

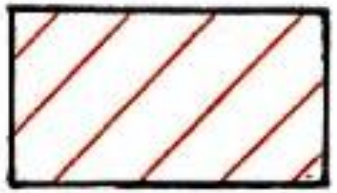




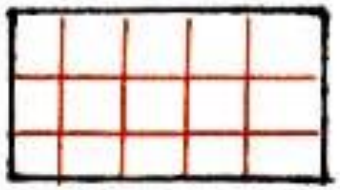
I. vhodné bez úpravy
I. suitable without treatment



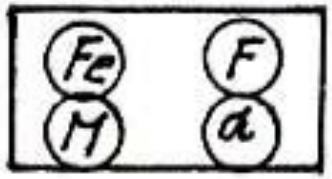
II.a vhodné po jednoduché úpravě
II.a usable after simple treatment



II.b vhodné po složitější úpravě
II.b usable after complicated treatment

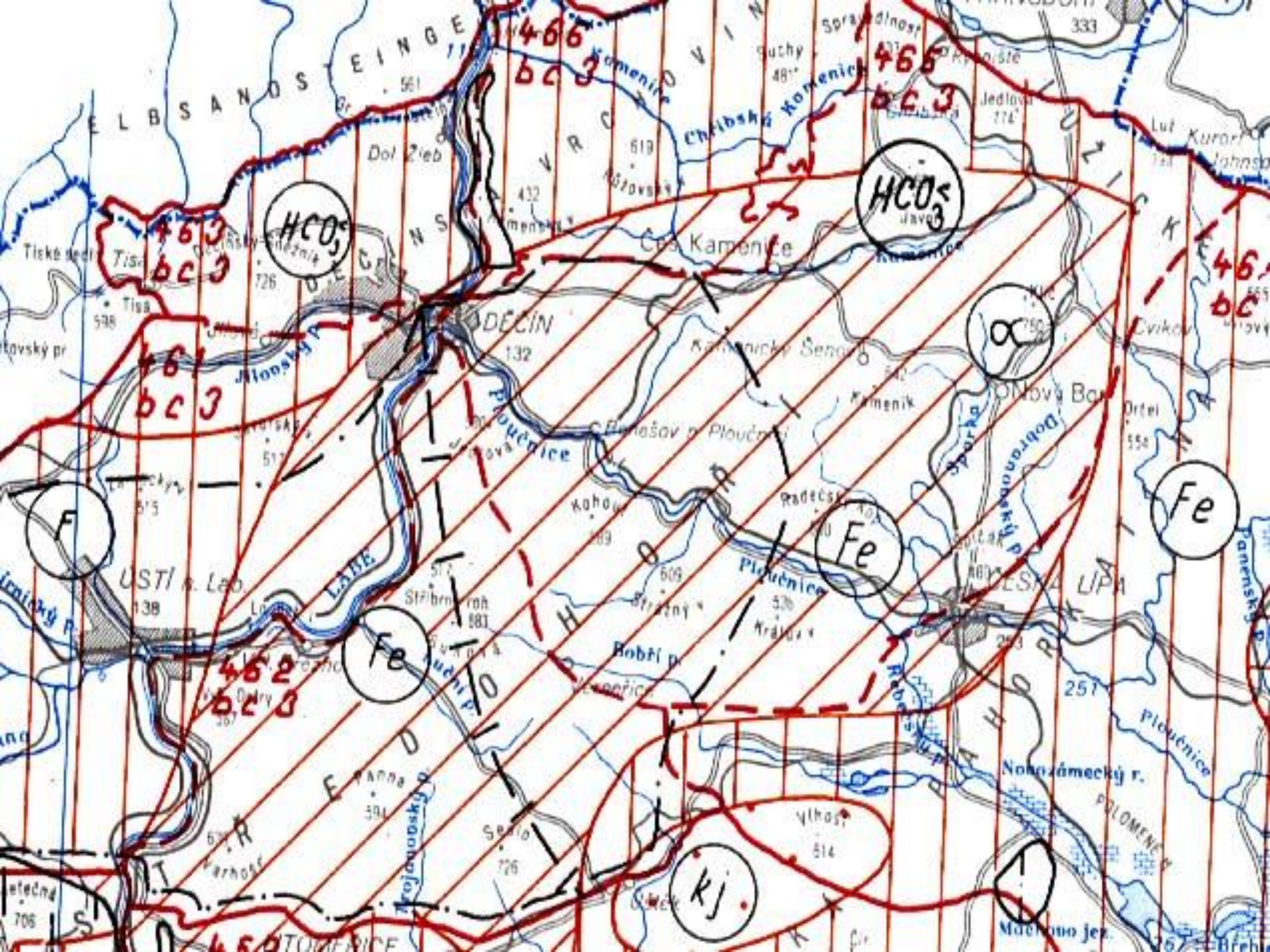


III. méně vhodné–nevhodné
III. unusable–untreatable



složky vyžadující snížení koncentrace
M – celk. mineralizace, α – radioaktivní látky
components exceeding limit
M – TDS (total dissolved solids), α – radioactive substance

složky vyžadující zvýšení koncentrace
components to be increased



DĚČÍN
132
ÚSTÍ n. Lab.
138
LABE
Ploučnice
Čes. Kamenice
Benešov n. Ploučnicí
Kamenice
Chřibská Kamenice
Jílovský p.
Bobří p.
Nohozámecký r.
Dobranovský p.
Tiské stěny
Tisá
Dol. Žleb
Stříbrný roh
Radečský
Kamenik
Vlhošť
Sedlo
Kohout
Cvikov
Suchý
Jedlová
Spravedlnost
Vrchovany
466
bc3
463
bc3
461
bc3
462
bc3
HCO_3^-
Fe
F
kj
α

Explanatory to the map

- Sampling and Analysis
- Classification of Natural Waters
  - Rain Water
  - Surface Water (rivers and lakes)
  - Groundwater in Volcanic Rocks
  - Groundwater in Mesozoic Sediments
  - Groundwater in Quaternary Sediments
  - Groundwater in Basement Rocks
- Water Quality
  - Domestic Use
  - Irrigation Use
  - Industrial Use
- Mineral and Thermal Water

Thank you for your attantion