

1. Hydrogeological mapping

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Aim of HG map

- Groundwater and rocks – qualitative – permeability and quantitative potential of rock units – aquifers / aquitards / aquiclides
- Water points (spatial distribution and type)
- Supporting information (surface water network and divide, gw flow direction, river discharge, etc.)

Stakeholders

The map, database and Explanations are addressed to:

- hydrogeologists, geochemists, balneologists, and balneo-technicians, whose study and exploit mineral water.
- all geologists, geographers and university students dealing with mineral waters, as well as to technological public interested in this natural heritage.
- informed publik

History

1940 – various scale and purpose

1959 – Commission for Hg. Maps (IAH)

1961 – Helsinki (IAHS) – exhibition 200 (IAH)
survey of map techniques

1963 – UNESCO /Anon – draft legend

1970 – UNESCO /Anon – new legend

1974 – UNESCO /Anon – legend for
geohydrochemical maps (Anon 1975)

1995 – IAH /Struckmaier – hydrogeological map

Concept

From geology-oriented map to visualization of groundwater related features map

Basic types of hydrogeological maps:

1. Hydrogeological regional mapping project (nation basic maps – map sheets/ basins)
2. Thematic synthesis of existing data and reports to answer specific question – water management - protection, pollution
3. Parametric maps – baseflow, aquifer thickness, T , S

EARTH SCIENCE

Geoscience

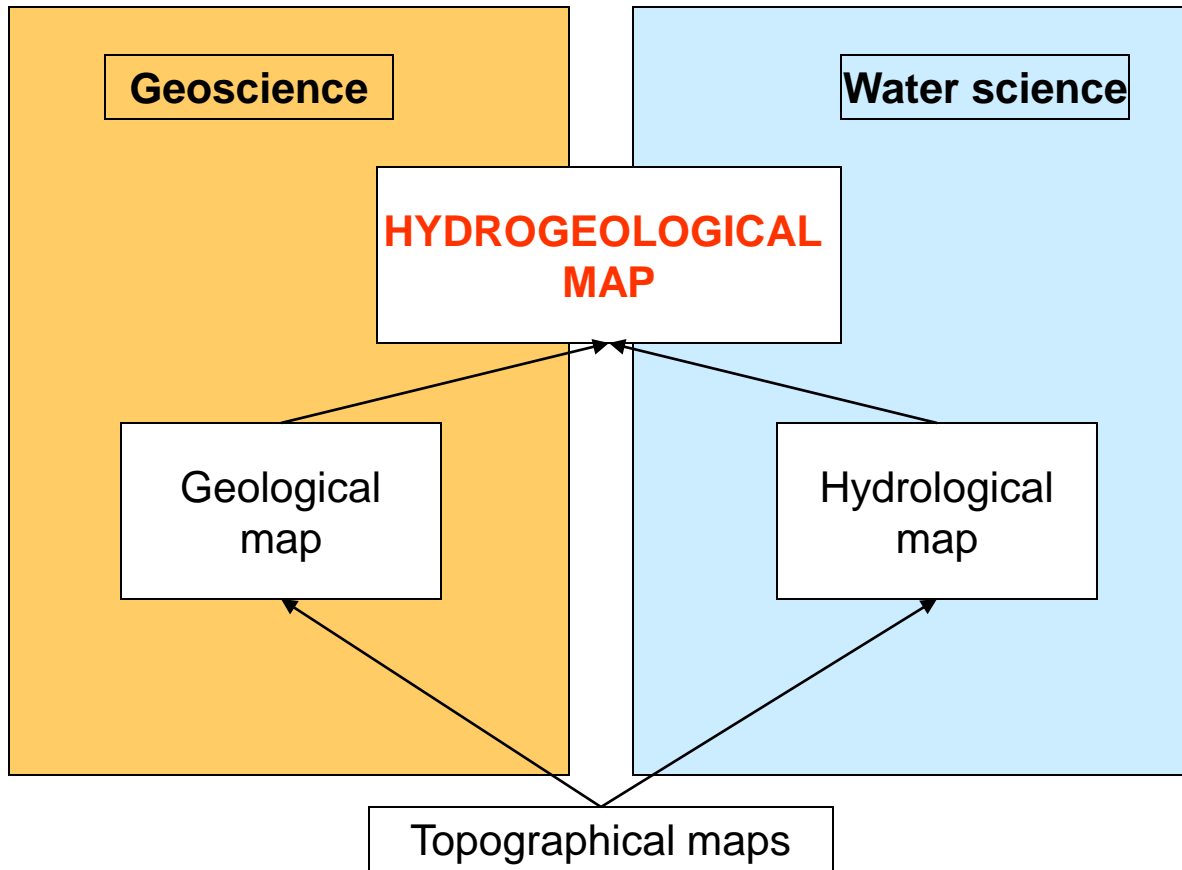
Water science

**HYDROGEOLOGICAL
MAP**

Geological
map

Hydrological
map

Topographical maps

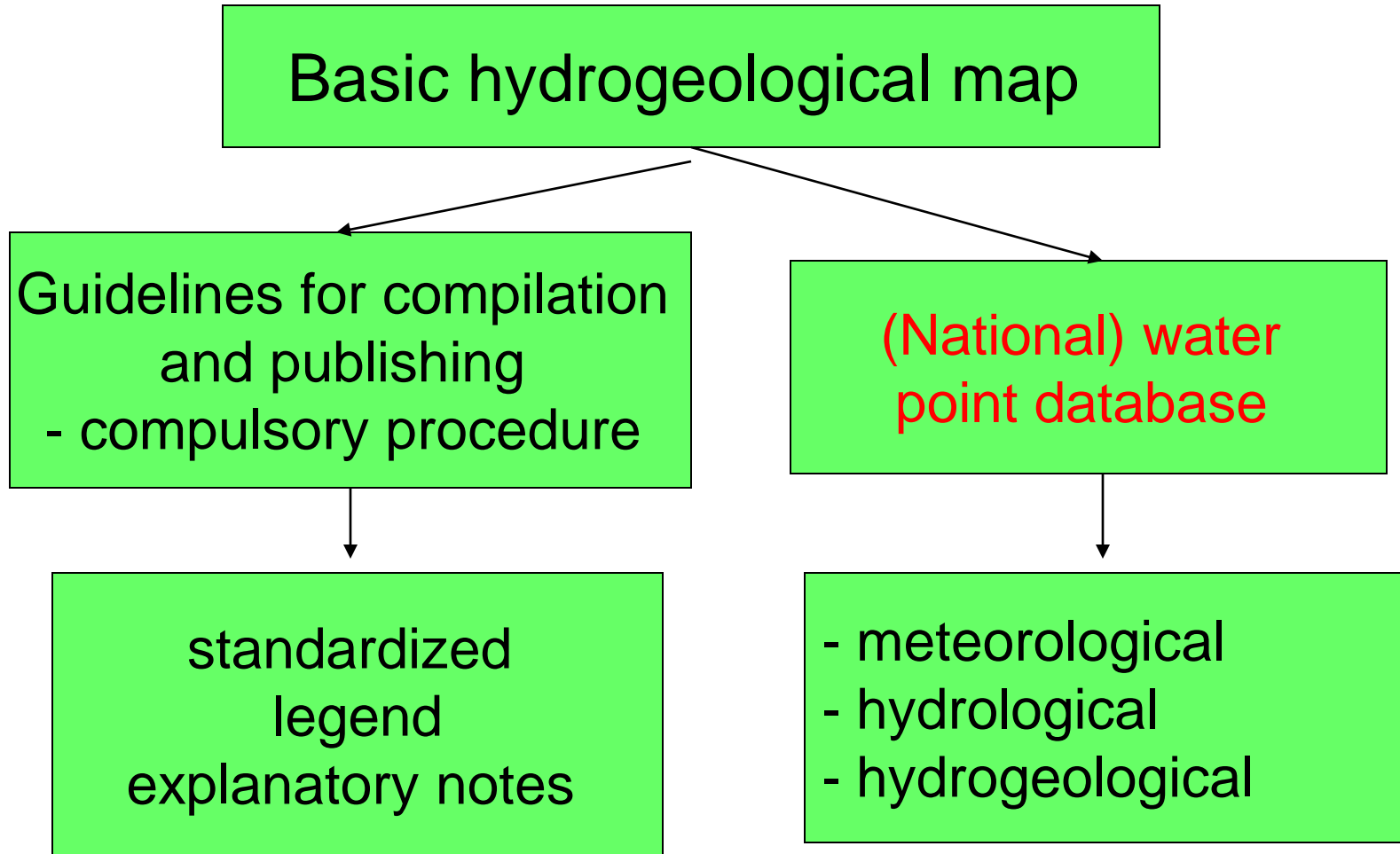


Edition of hydrogeological map – geological survey

National edition of basic hydrogeological maps 1 : 250 000

- Compulsory guidelines - methodology
- Trained manpower
- Vehicle (tool) GIS

General elements



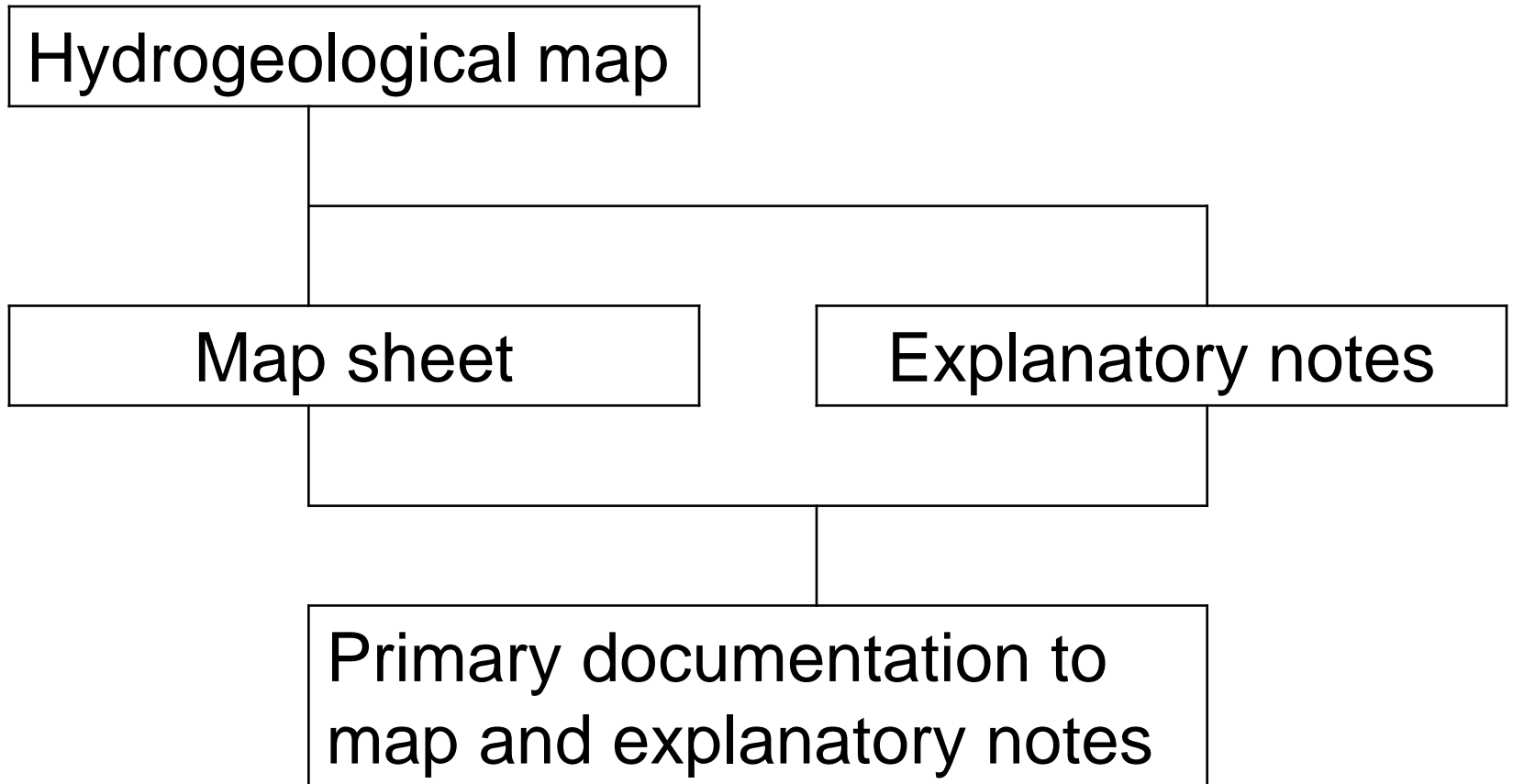
Compulsory guidelines

- General principles for compilation and publishing (1 : 250 000)
 - General legend to hydrogeological map
 - Contents of explanatory note
- (Provided by editor to sheet author/project manager/chief compiler)

General principles of Guidelines

- Validity of guidelines / basic provisions
- Primary documentation of the basic hydrogeological map
- Content of the hydrogeological map (layout and legend)
- Explanatory notes to the basic hydrogeological map

Integral parts of hydrogeological map



Hydrogeological map

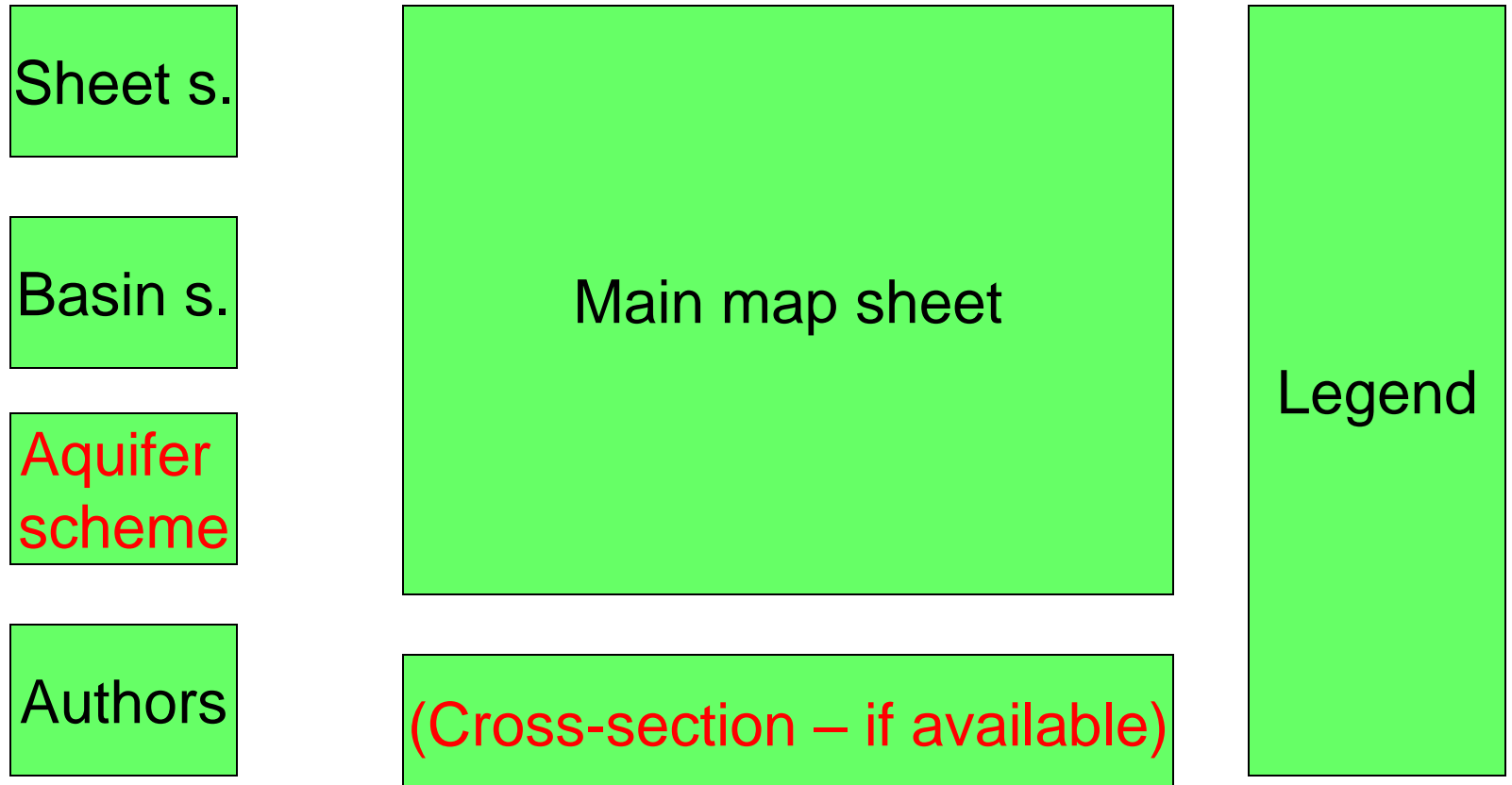
Compulsory data

- ***Original map***
- Legend
- Aquifer scheme
- (*Cross-section*
- *Authors scheme*)
- Sheets scheme
- Basin scheme
- ***Explanatory note***
- ***Primary data***

Voluntary data

- Water quality data
(hydrochemical map)
- Geophysical exploration
- Physiography
- Rainfall, temperature
- Regional aquifers
- Soil cover
- Quaternary cover

Layout of map sheet



General legend to map

- extent of aquifers and their types, and lithology with tectonic features
- basic structural and topographical settings
- all-important hydrogeological features (natural, man made)
- water quality, thermal water, and mineral water provinces

Aquifer system – color

The basic hydrogeological map is compiled as color maps

Qualitative type of permeability (porous, fissured, karst, formation with low or without permeability - gw resources)

Quantification of (amount) permeability

- Yield of water points (specific yield of well)
- transmissivity

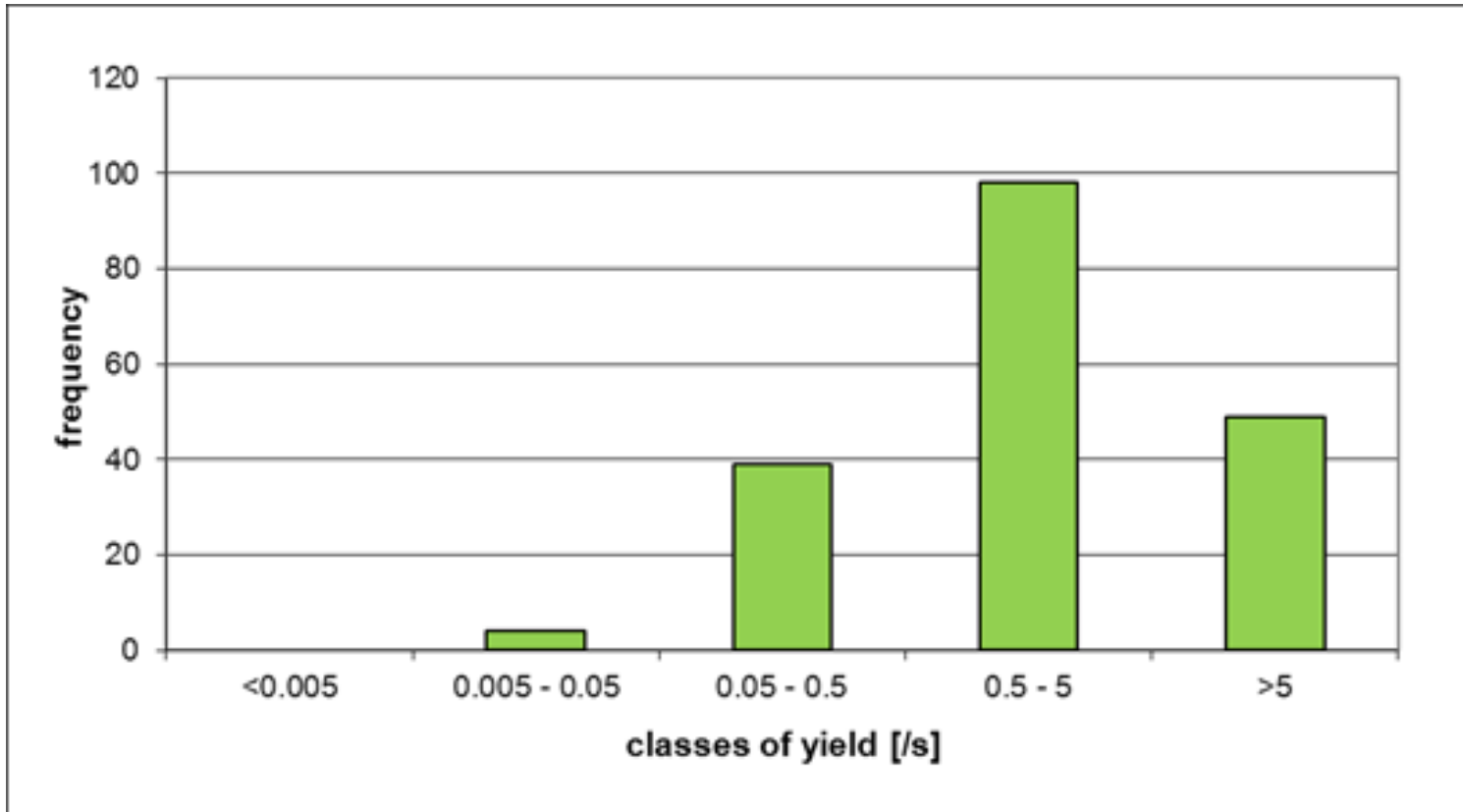
Type of permeability

Aquifer	Color	Rock example
Porous	Blue	Alluvial
Fissured	Green	Sandstone/basalt
Fissured/karstic	Green (dark)	Limestone
Basement	Brown-red	Granite/gneiss
Aquiclude	Brown	Marlstone
Aquitard	Brown (dark)	Claystone
Mixed	Blue/green strips	Volcanic/sedimentary

Quantification of permeability

Aquifer class	T (m ² /d)	q (l/sm)	Yield (l/s)
Extra high	500	5	More 25
High	100	1	5.1-25
Moderate	1.11-10	0.011-0.1	0.51-5
Low	0.11 - 1	0.01	0.051-0.5
Extra low	0.1	0.001	0.005-0.05
Neglegible /seepage			Less 0.005

Quantification volcanic Rift



Number of data	Max	Min	Median	Average
190	70	0.035	3	4.67

Permeability

k (m/s)	1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}	10^{-12}
gravel - sand	-----X-												
loess – silt -clay						-X-----							
lava - basalt	-----X-----												
limestone	-----X-----												
snadstone					-----X-----								

Background information

- Simplified topography – dark gray (60% black): towns, names, international and administrative boundaries
- Drainage – blue: stream or rivers
- Grids or lines of longitude and latitude – black
- Additional information: inset maps, explanatory notes (separate better)

Groundwater and rocks 1

Intergranular permeability - blue

- Extensive ($>100 \text{ Km}^2$) and highly productive $T = 10.1\text{-}100 \text{ m}^2/\text{d}$, $q = 0.11\text{-}1 \text{ l/sm}$, $Q = 5.1\text{-}25 \text{ l/s}$ productive aquifers (dark blue)
- Local or discontinuous highly productive aquifers, or extensive but only moderately productive aquifers ($T = 1.1\text{-}10 \text{ m}^2/\text{d}$, $q = 0.011\text{-}0.1 \text{ l/s.m}$, with spring and well yield $Q = 0.51\text{-}5 \text{ l/s}$) (light blue)

Groundwater and rocks 2

Fissured (karst) aquifers - green

- Extensive ($>100 \text{ Km}^2$) and highly productive $T = 10.1-100 \text{ m}^2/\text{d}$, $q = 0.11-1 \text{ l/sm}$, $Q = 5.1-25 \text{ l/s}$ productive aquifers (dark green)
- Local or discontinuous highly productive aquifers, or extensive but only moderately productive aquifers ($T = 1.1-10 \text{ m}^2/\text{d}$, $q = 0.011-0.1 \text{ l/s.m}$, with spring and well yield $Q = 0.51-5 \text{ l/s}$) (light green)

Groundwater and rocks 3

**Basement rocks forming aquifers
with local and limited
groundwater resources – brown-
red**

($T = 0.11-1 \text{ m}^2/\text{d}$, $q = 0.0011-0.01 \text{ l/s.m}$,
with spring and well yield $Q = 0.051-0.5$
 l/s).

Groundwater and rocks 4

Rocks with fissured porosity and with essentially no groundwater resources - brown

- Strata (sediments) with limited groundwater resources - light brown for $T = 1\text{m}^2/\text{d}$, $q = 0.01\text{ l/sm}$, $Q = 0.05 - 0.5\text{ l/s}$
- Strata with essentially no groundwater resources - dark brown for $T = 0.1\text{m}^2/\text{d}$, $q = 0.001\text{ l/sm}$, $Q = 0.05$

Groundwater and rocks 5

Covered / confined aquifers

- Where there is an extensive aquifer immediately underlying a thin impermeable cover, the appropriate aquifer color should be used crossed by brown stripes (1 mm wide and 3 mm separation) - Adigrad sandstone – Humara area

Lithology

Ornament in gray

The orientation of the ornament indicates the type of bedding

- Horizontal = unfolded, horizontal or gently inclined strata (less than 20°)
- Vertical = folded strata

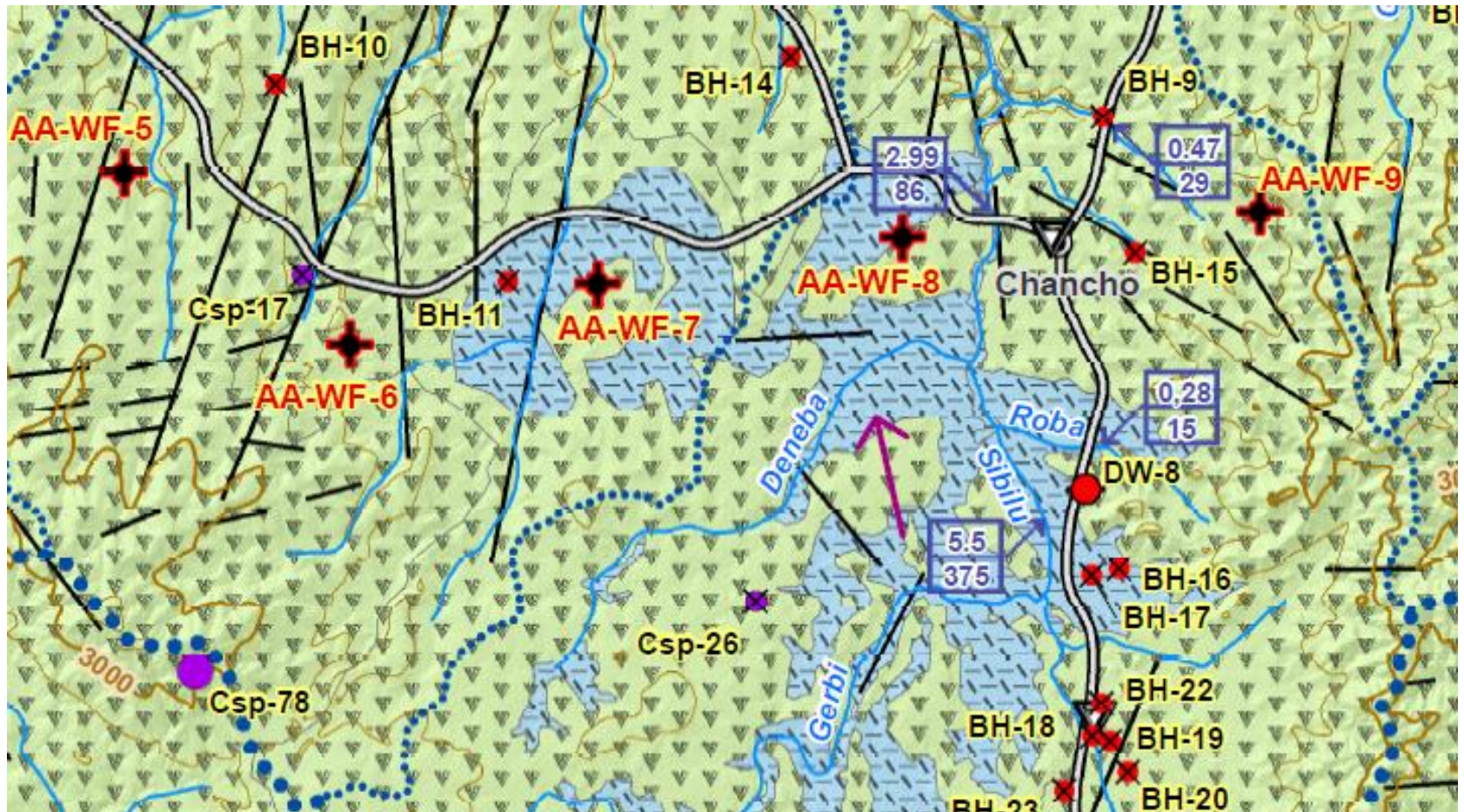
Representation of detailed data 1

- Violet: groundwater and springs
- Orange: physical and chemical characteristics of groundwater quality and temperature
- Blue: surface water and karst hydrography
- Red: man-made features and alterations to the natural groundwater regime

Representation of detailed data 2

- Dark green: horizon contours (isopachytes) and limits of certain features
- Black: geological information (fault, volcanic cone)

Hydrogeological map (AA)



Content of explanatory note

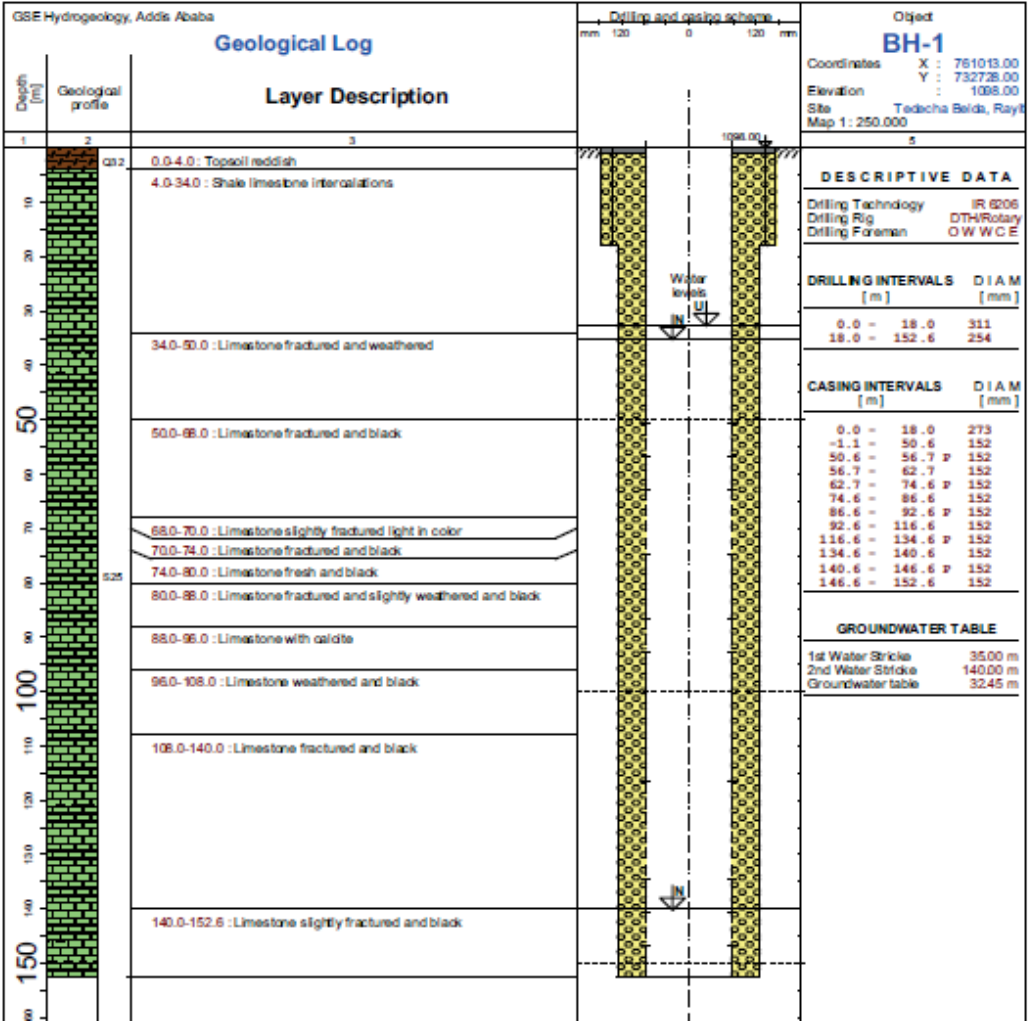
1. Basic characteristic of the area
2. Selected physical and geographical settings
3. Geological settings
4. Hydrogeological settings (aquifer system definition)
5. Hydrochemistry (of natural waters)
6. Natural resources of the area

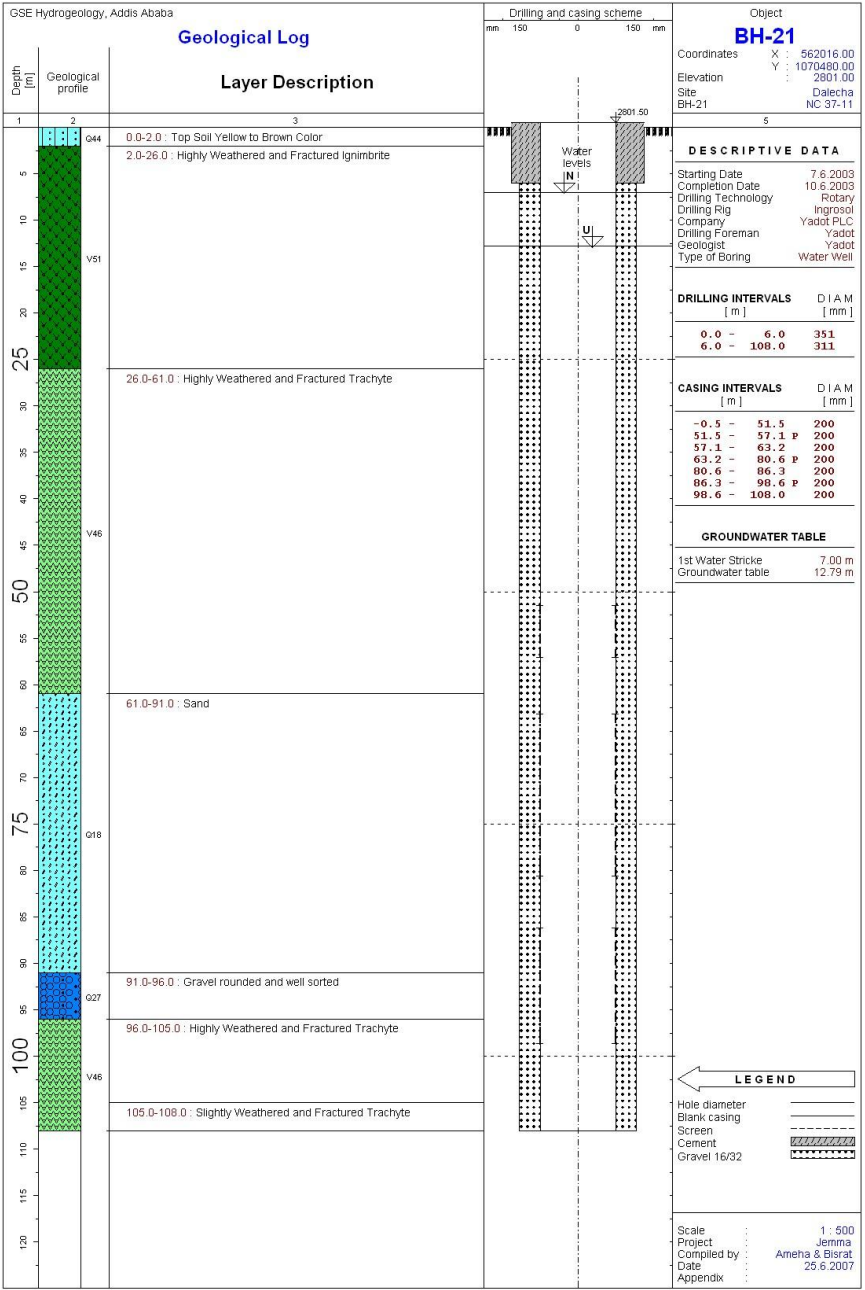
Annexes (WP inventory, chemical analyses, well logs)

Annexes

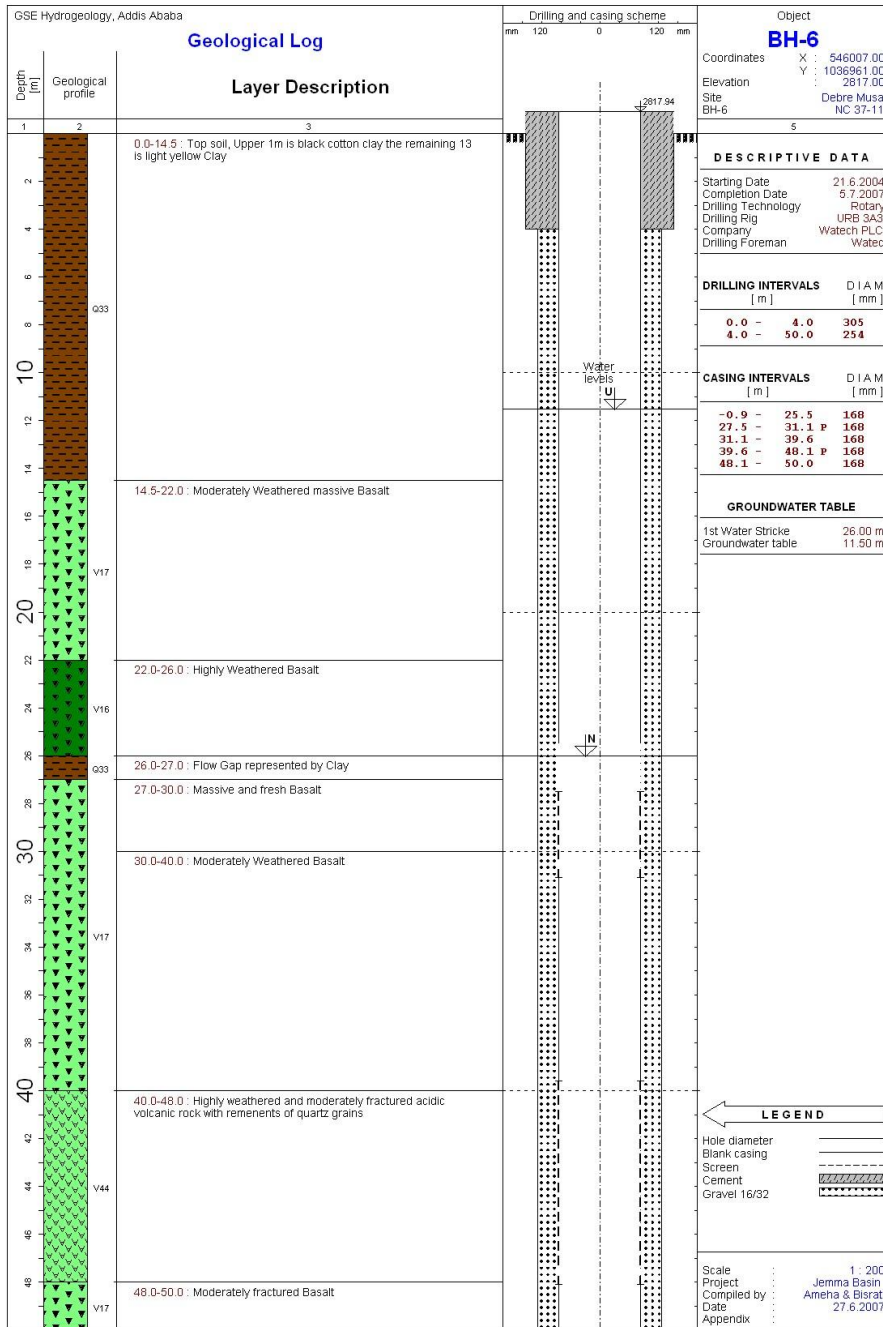
- Water point inventory (bore holes, dug wells, springs, water holes, rivers)
- Chemistry (results of chemical analysis - used for compilation of hydrochemical map and assessment of water quality)
- Well logs (essence of drilling reports – information for next drilling) - **same color and ornaments used in map for geology**

Well log





Ignimbrite - mixed aquifers



Artesian mixed aquifer

Conclusions

Systematical use of digital data, including GIS

- Accelerate the process
- More flexibility in data analysis
- Easy to update
- Presentation an any time (always actual)
- More universal - can serve to more (various) users
- Possibility of internet presentation

Recommendations

Prepare methodology – adopt international – everybody be able to understand

Legend to hydrogeological map – documenting all map features / colors

Contents to explanatory notes

Develop, update, publish water database

Use appropriate tools for your work