



MINERAL WATERS AND HYDROGEO THERMAL RESOURCES IN BULGARIA

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OUTLINES:

- ➔ Introduction
- ➔ General Geological setting
- ➔ Geothermal Potential areas & Resources
- ➔ Pattern of Heat regim & Configuration of Hydrothermal flow
- ➔ Conseptual model of Thermo-aquifer System in non-stratified granitic-metamorphic complex
- ➔ Cases:
 - Natural spring Sapareva Banya
 - Sofia Neogene graben (Hydrothermal basin)
- ➔ Concusions



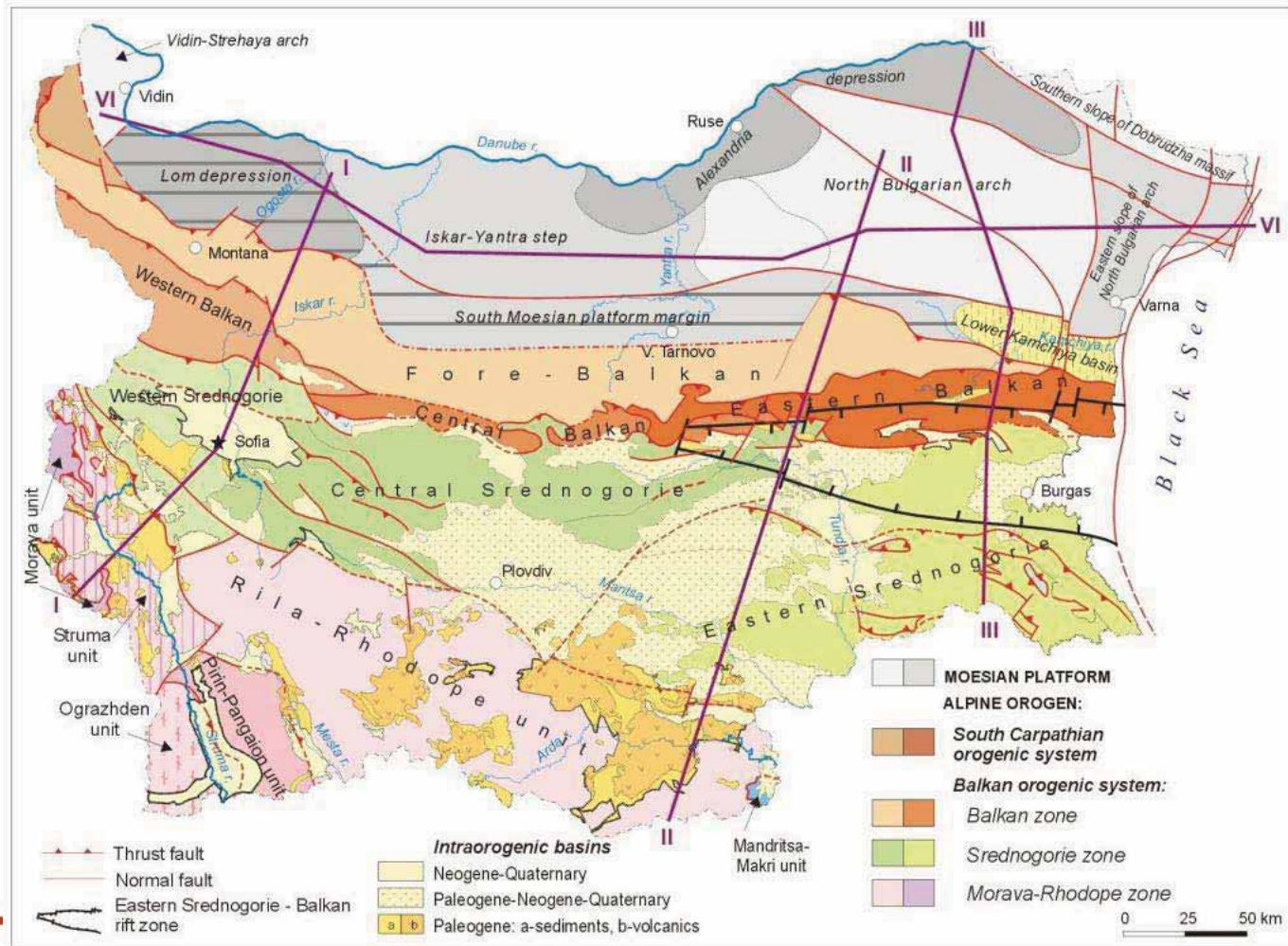
Introduction

- ➔ Bulgaria is very rich of Natural springs of mineral and geothermal water
- ➔ In Bulgaria there are large geothermal aquifers



General Geological setting

Major Tectonic units

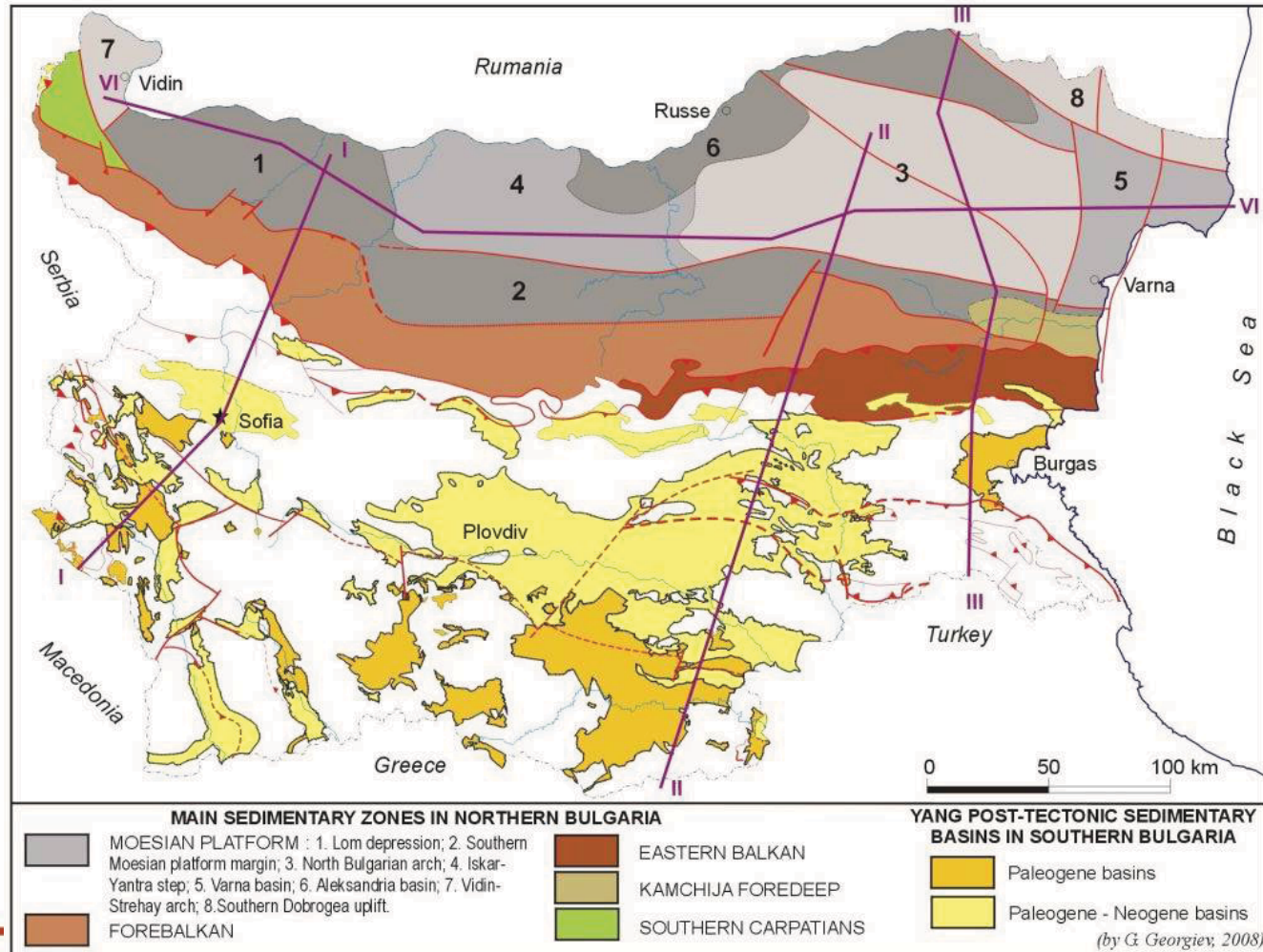


(by Georgiev & Dabovski, 1997 ; Dabovski et al., 2002; modified)



General Geological setting

Main Sedimentary basins & zones



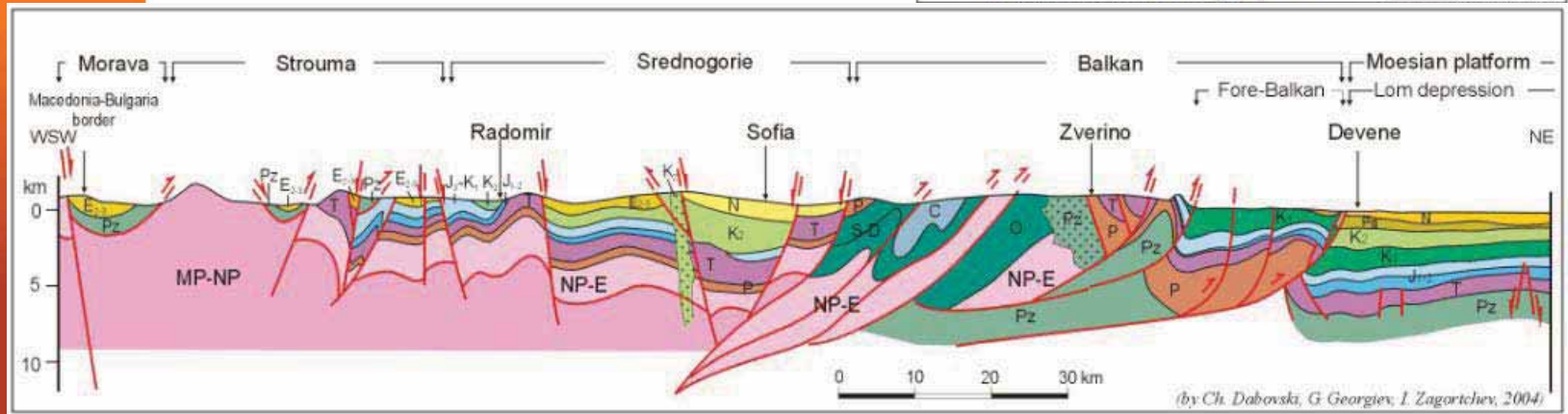
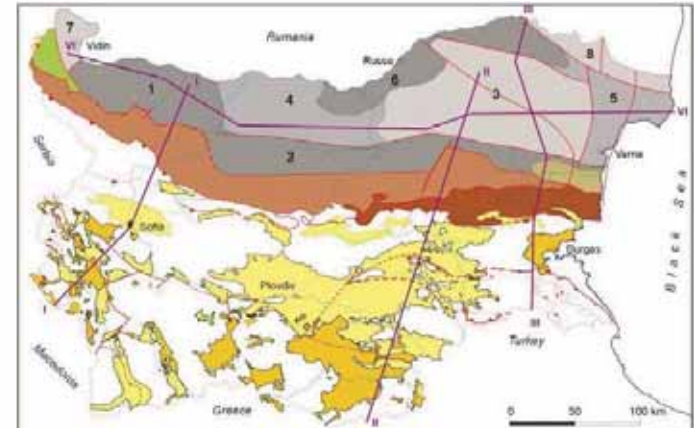
(Georgiev & Dabovski, 2008)



General Geological setting

Regional Geological cross-sections

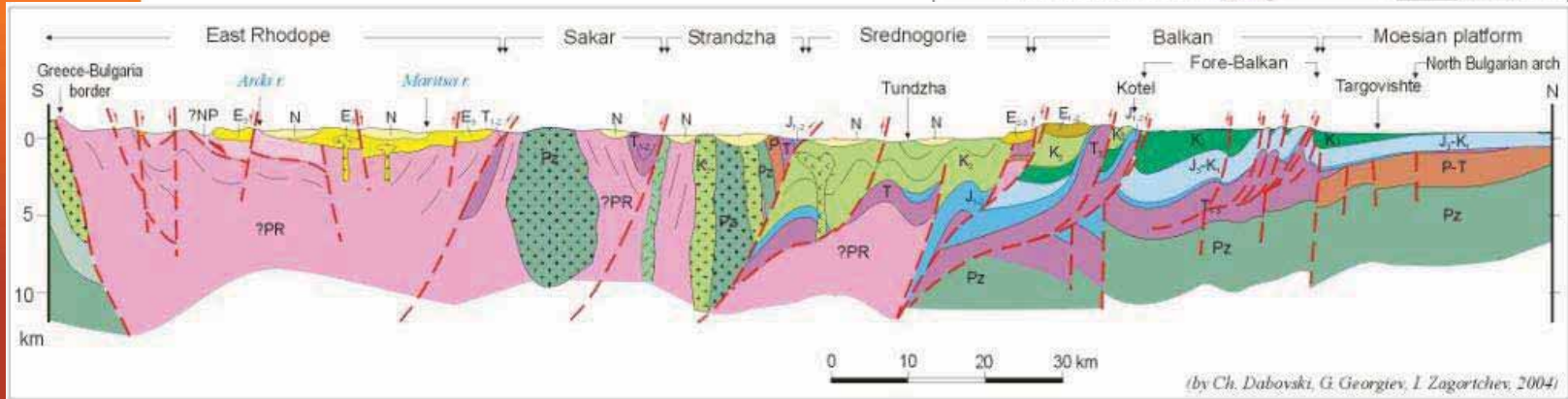
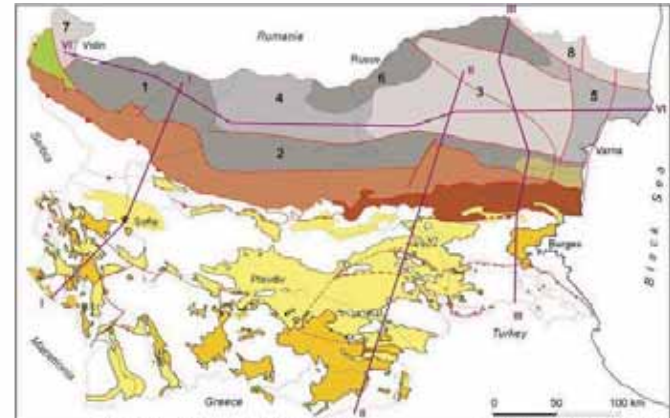
Geological cross-section I-I' across Western Bulgaria



General Geological setting

Regional Geological cross-sections

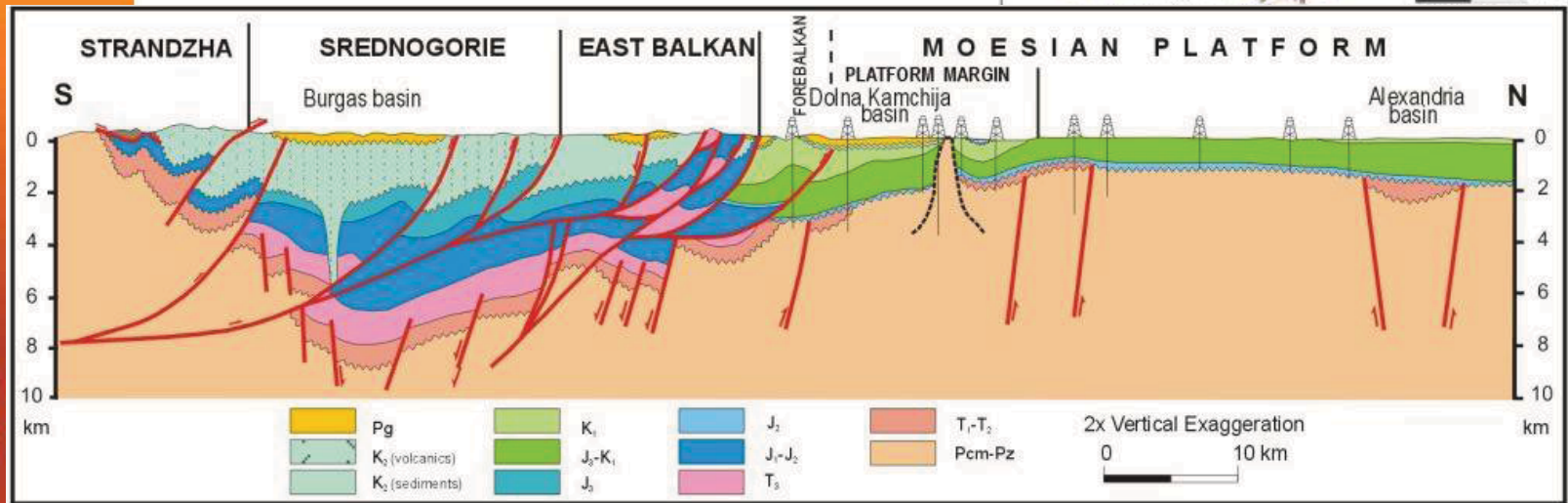
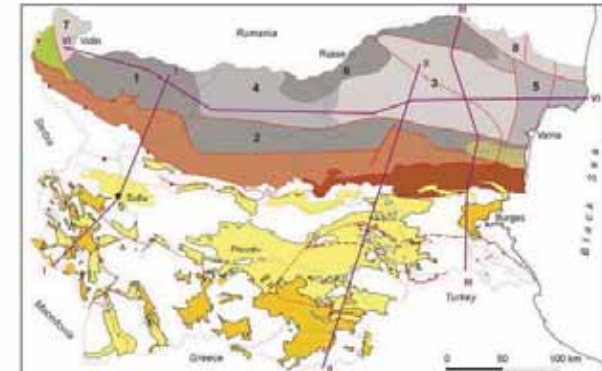
Geological cross-section II-II across Eastern Bulgaria



General Geological setting

Regional Geological cross-sections

Geological cross-section III-III across Eastern Bulgaria

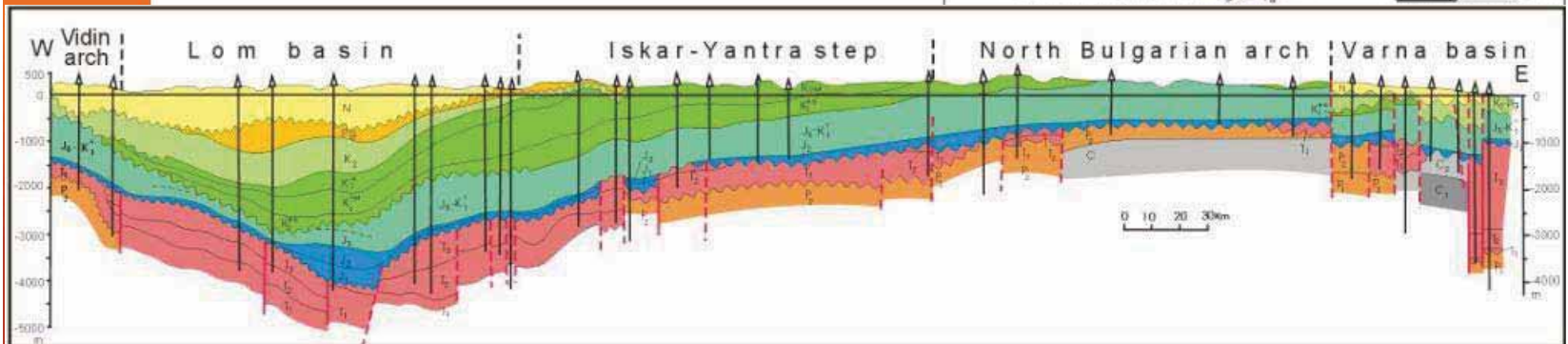
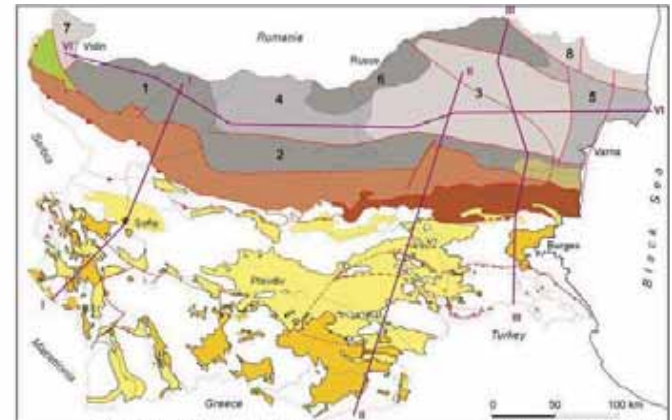


(Georgiev et al., 2001)

General Geological setting

Regional Geological cross-sections

Geological cross-section IV-VI across Northern Bulgaria



(by Kalinko – ed., 1976 - updated)

Geothermal Potential Areas and Resources

I. **Northern Bulgaria** - *Regional Geothermal Aquifers in Carbonate Fms:*

- ➔ Middle-Upper Devonian
- ➔ Middle-Upper Triassic
- ➔ Upper Jurassic – Valanginian

II. **Southern Bulgaria** - *Reproductive Hydrothermal Systems with Meteoric Thermal waters:*

- ➔ Mesozoic fragmentary carbonate bodies & Rhodope marbles
- ➔ Tertiary grabens – clastic aquifers
- ➔ Granites, Schists & Gneisses
- ➔ Volcanic & Volcano-Sedimentary Fms



Northern Bulgaria

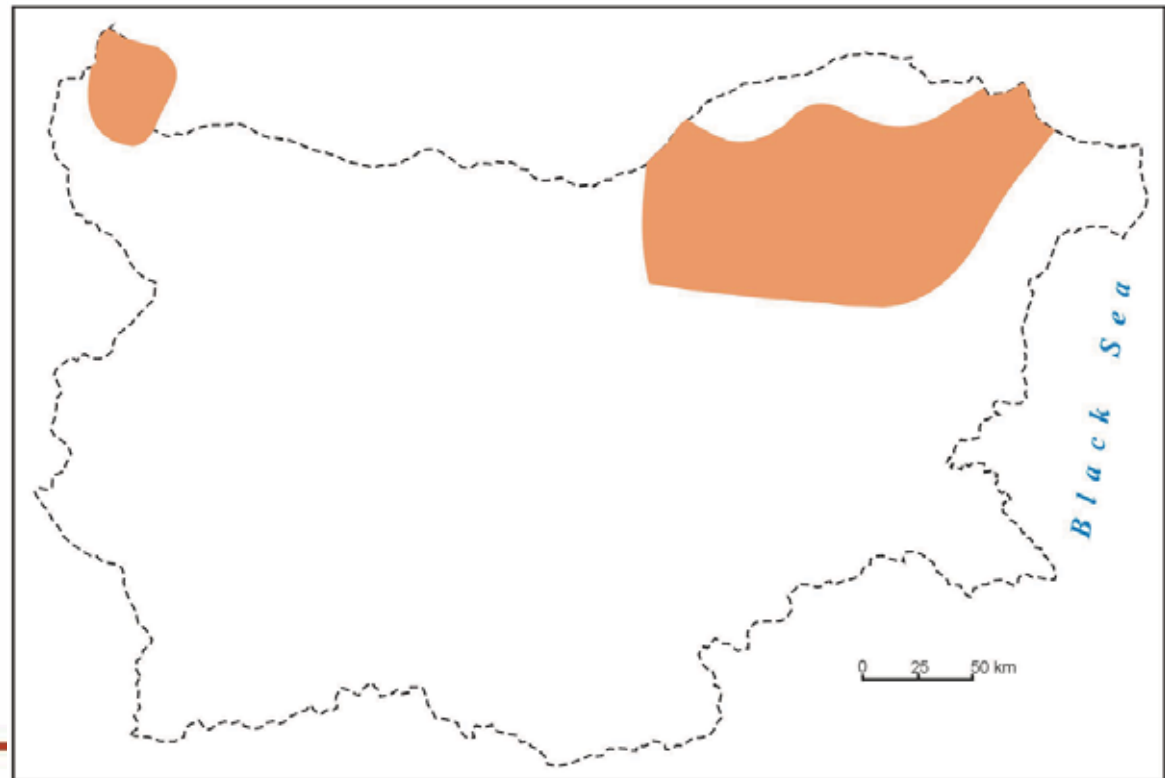
Middle-Upper Devonian carbonate aquifers

Depth – 2000 – 5000 (6000) m

Saline waters & brines

Temperature – 50-150°C

Recovery energy – 5-25 (30) GJ/sq.m



(Shterev 1996)

Northern Bulgaria

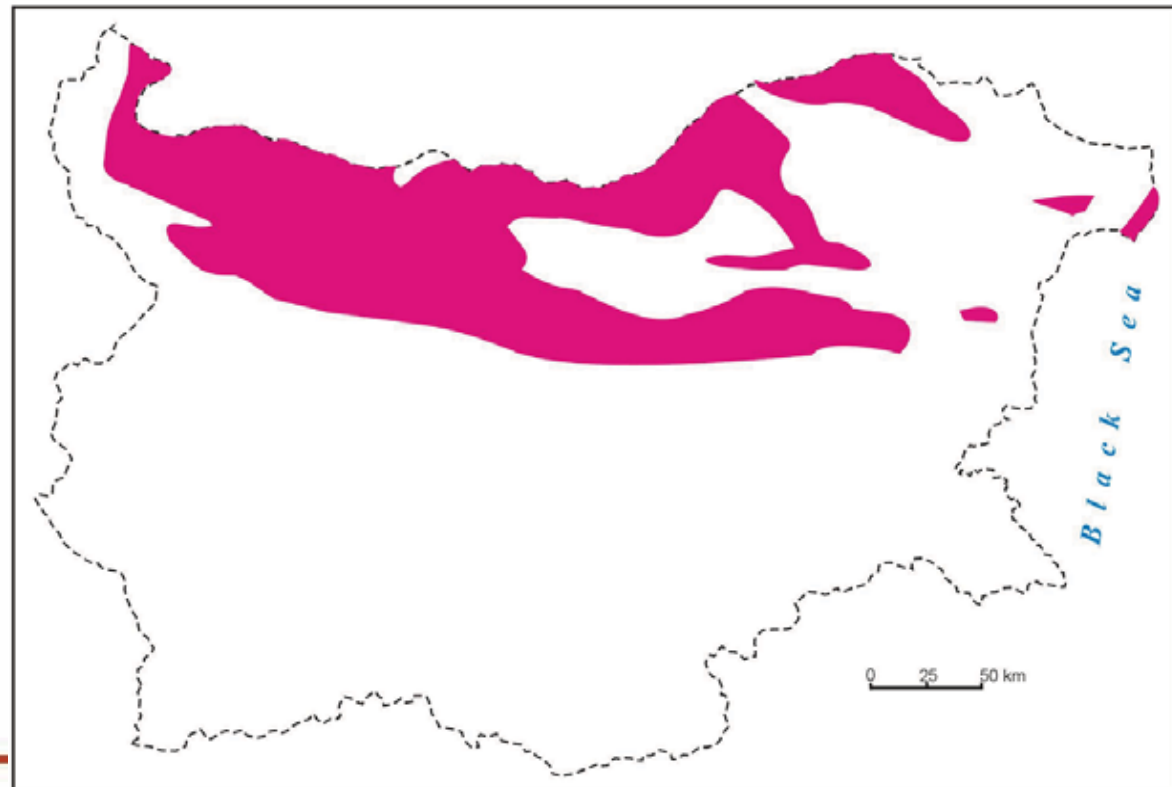
Middle-Upper Triassic carbonate aquifers

Depth – 1500-4000 m

Saline waters & brines

Temperature – 40-140°C

Recovery energy – 1-10 GJ/sq.m



(Shterev 1996)

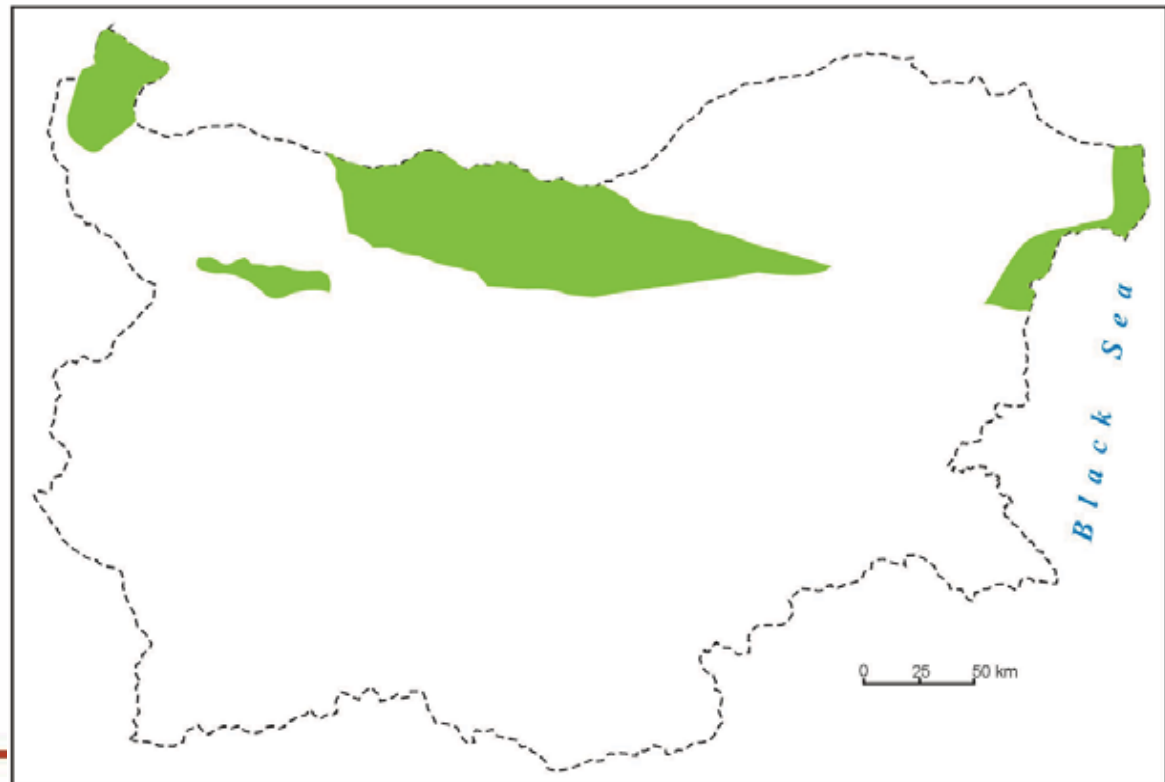
Northern Bulgaria

Malm (J3) – Valanginian (K1) carbonate aquifers

Depth – 800-2500 (3000) m

- a. Low mineralized meteoric waters - 25-55°C
- b. Saline waters & brines - 40-90 (100) °C)

Recovery energy – 0.5-20 GJ/sq.m

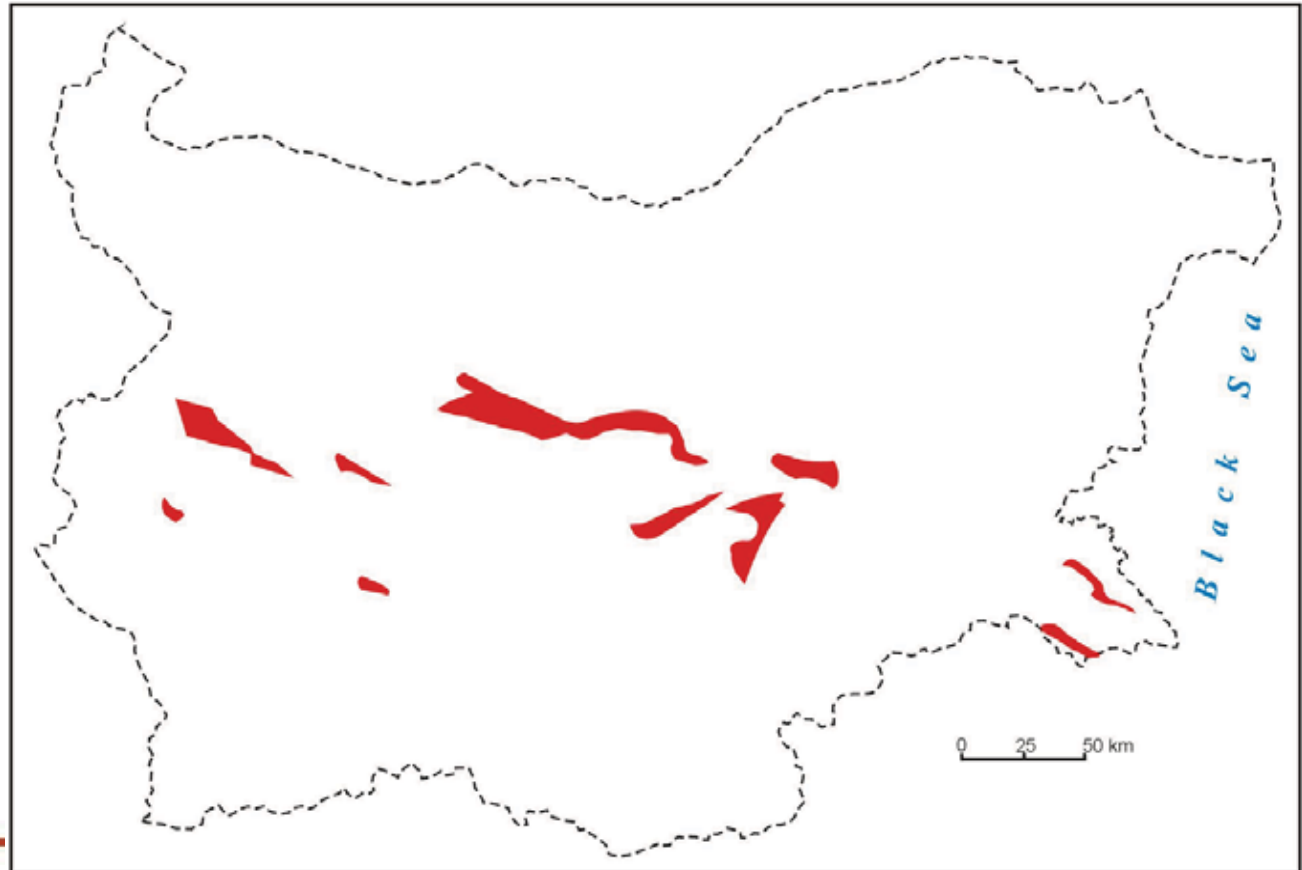


(Shterev 1996)

Southern Bulgaria

Mesozoic fragmentary carbonate bodies & Rhodope marbles

Temperature – 25-80°C

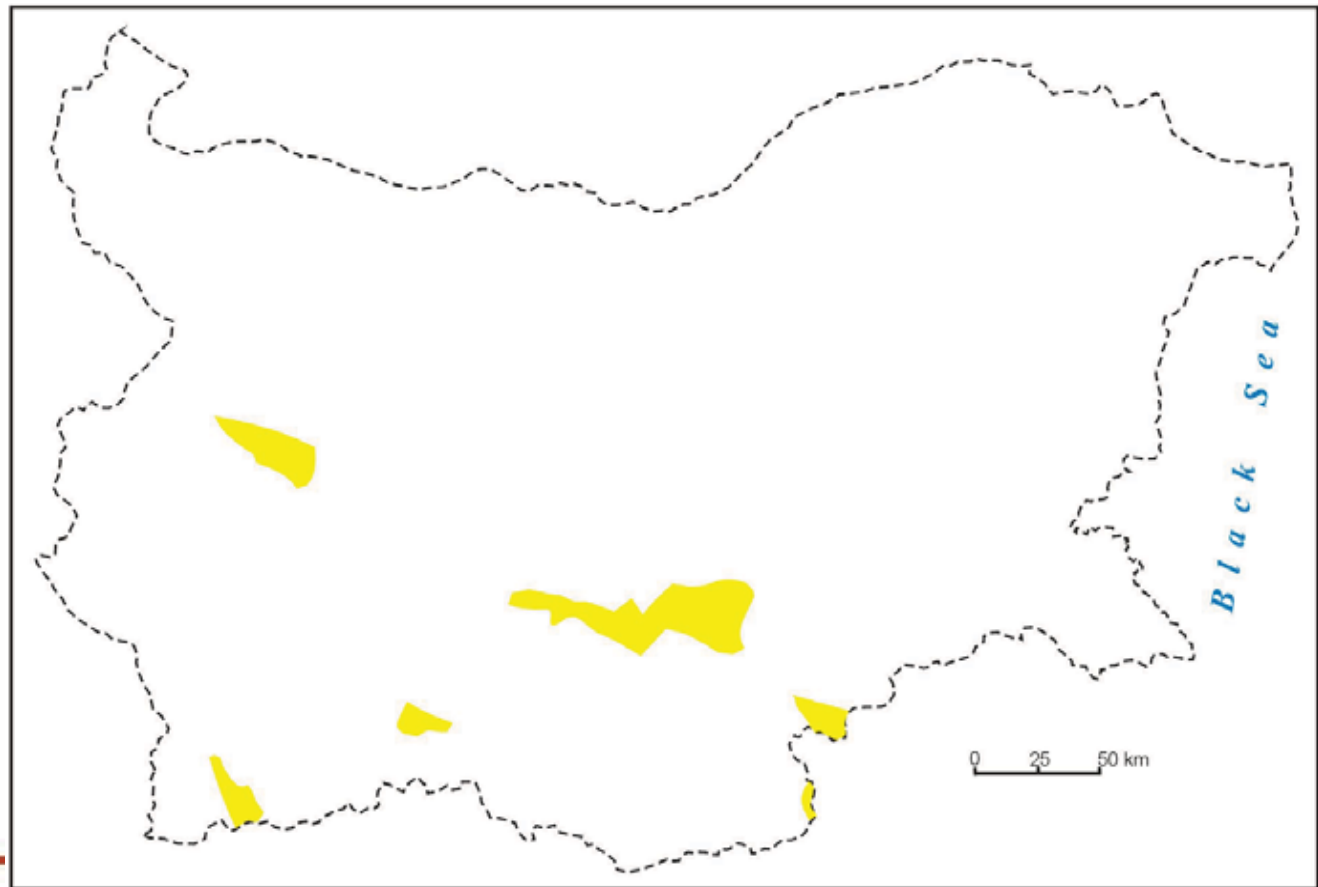


(Shterev 1996)

Southern Bulgaria

Tertiary grabens – clastic aquifers

Temperature – 25-65°C



(Shterev 1996)

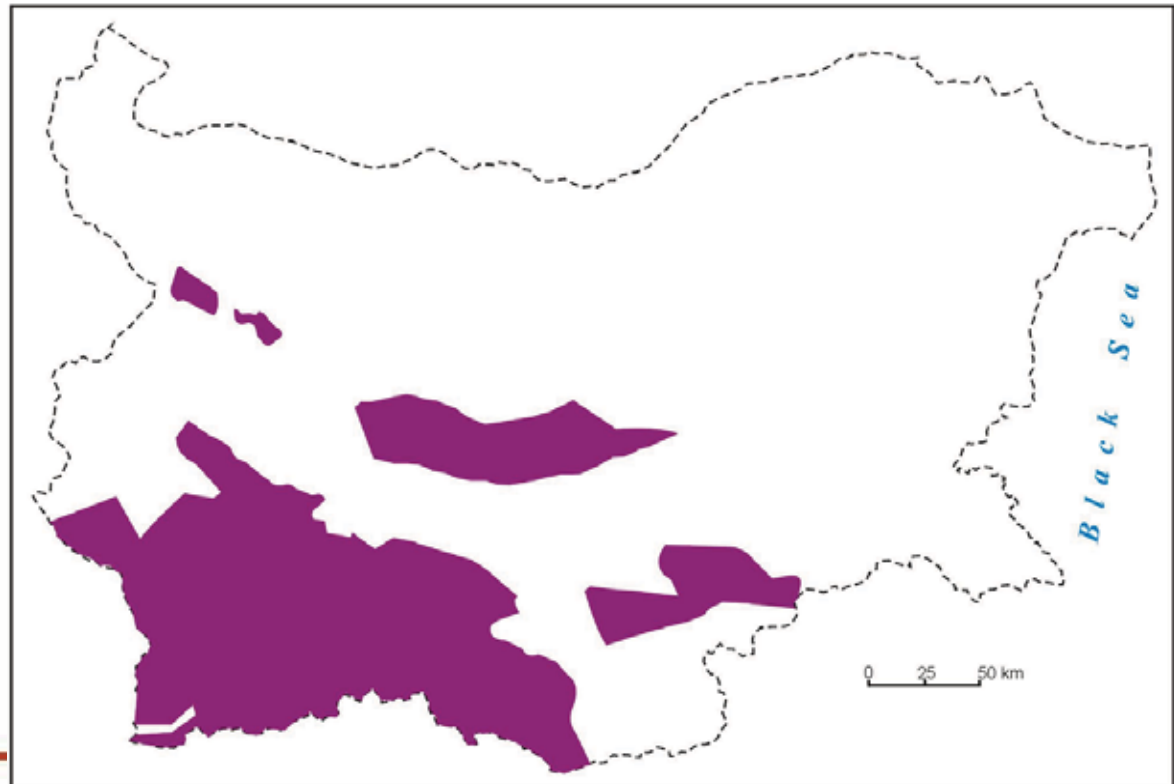
Southern Bulgaria Granites, Schists & Gneisses

Non-stratified (fault bounded)

Thermal waters - 30-120°C

Hydrogeothermal reproduction per 1 sq. km of recharge area – 0.2 l/s

Geothermal energy – 45 KW/t



(Shterev 1996)

Southern Bulgaria

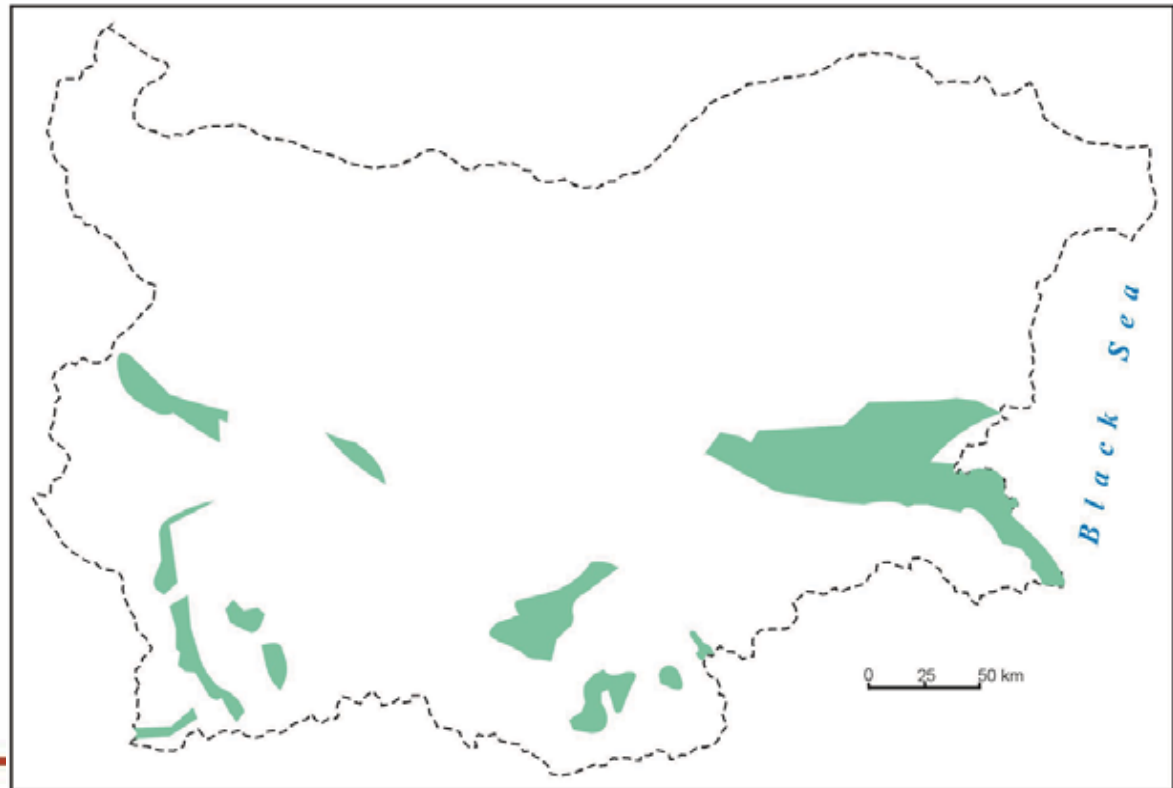
Volcanic & Volcano-Sedimentary Fms

Non-stratified (fault bounded)

Thermal waters - 30-120°C

Hydrogeothermal reproduction per 1 sq. km of recharge area – 0.2 l/s

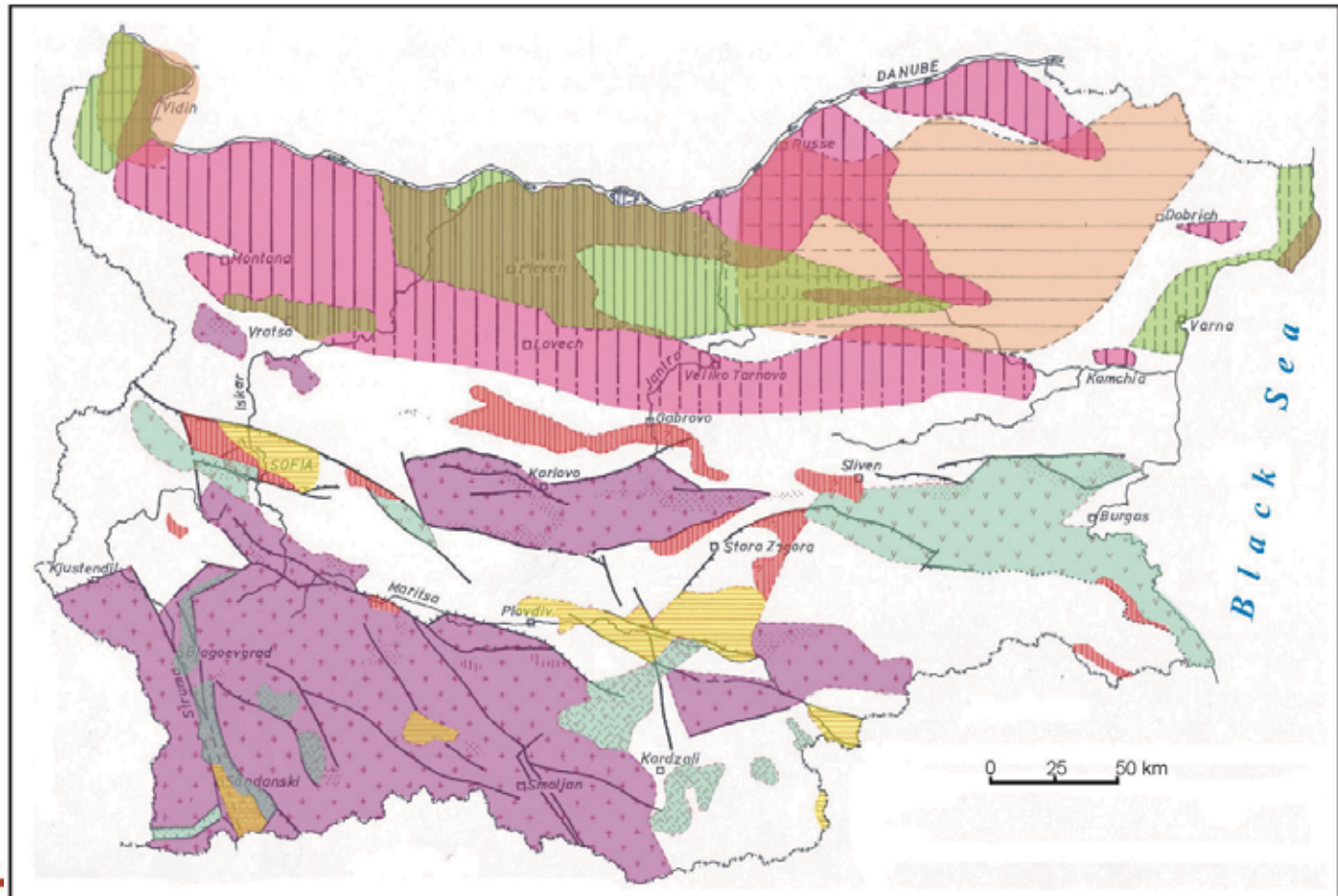
Geothermal energy – 45 KW/t



(Shterev 1996)

Bulgaria

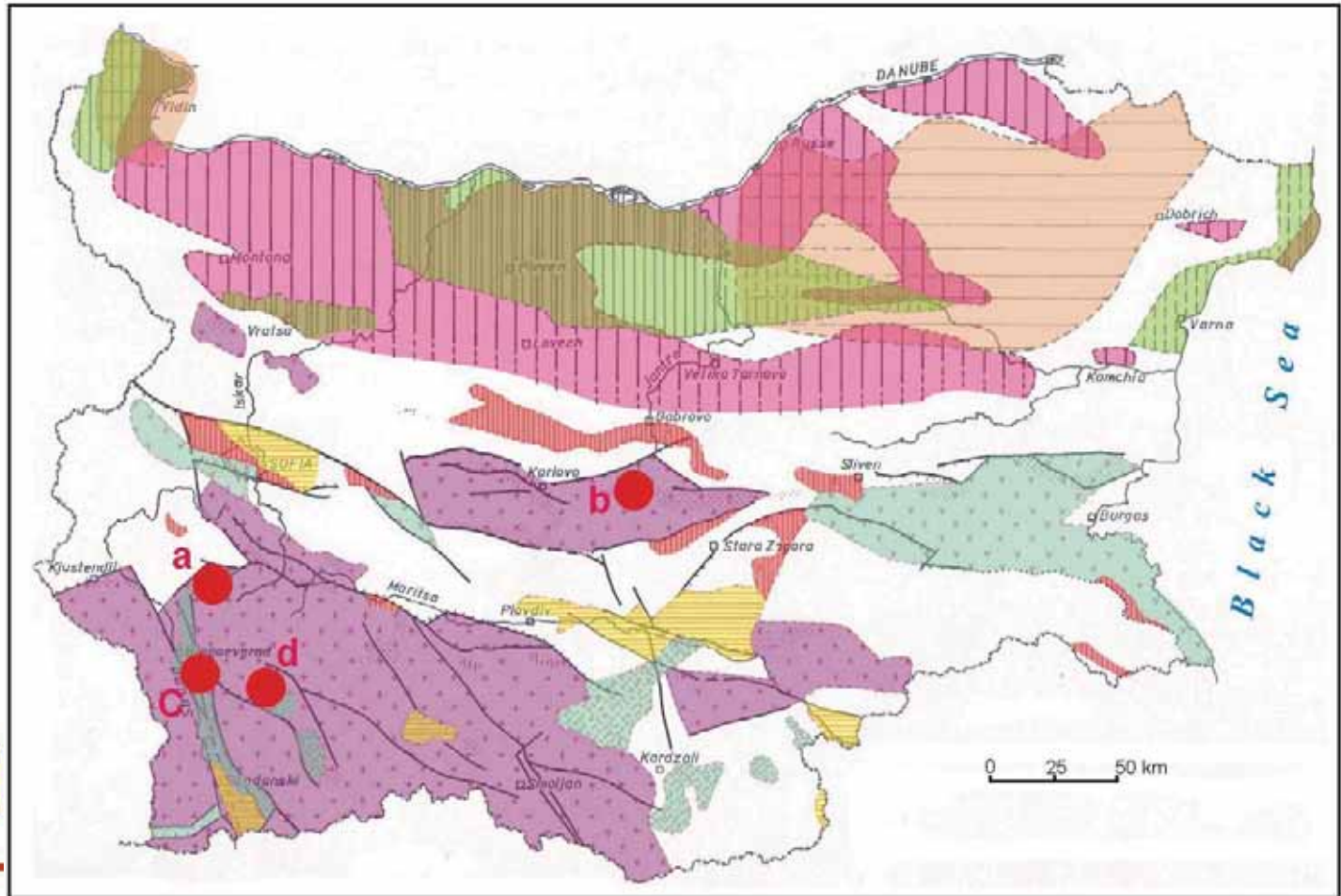
Geothermal Potential area & Resources



(Shterev 1996, 2004)

Bulgaria

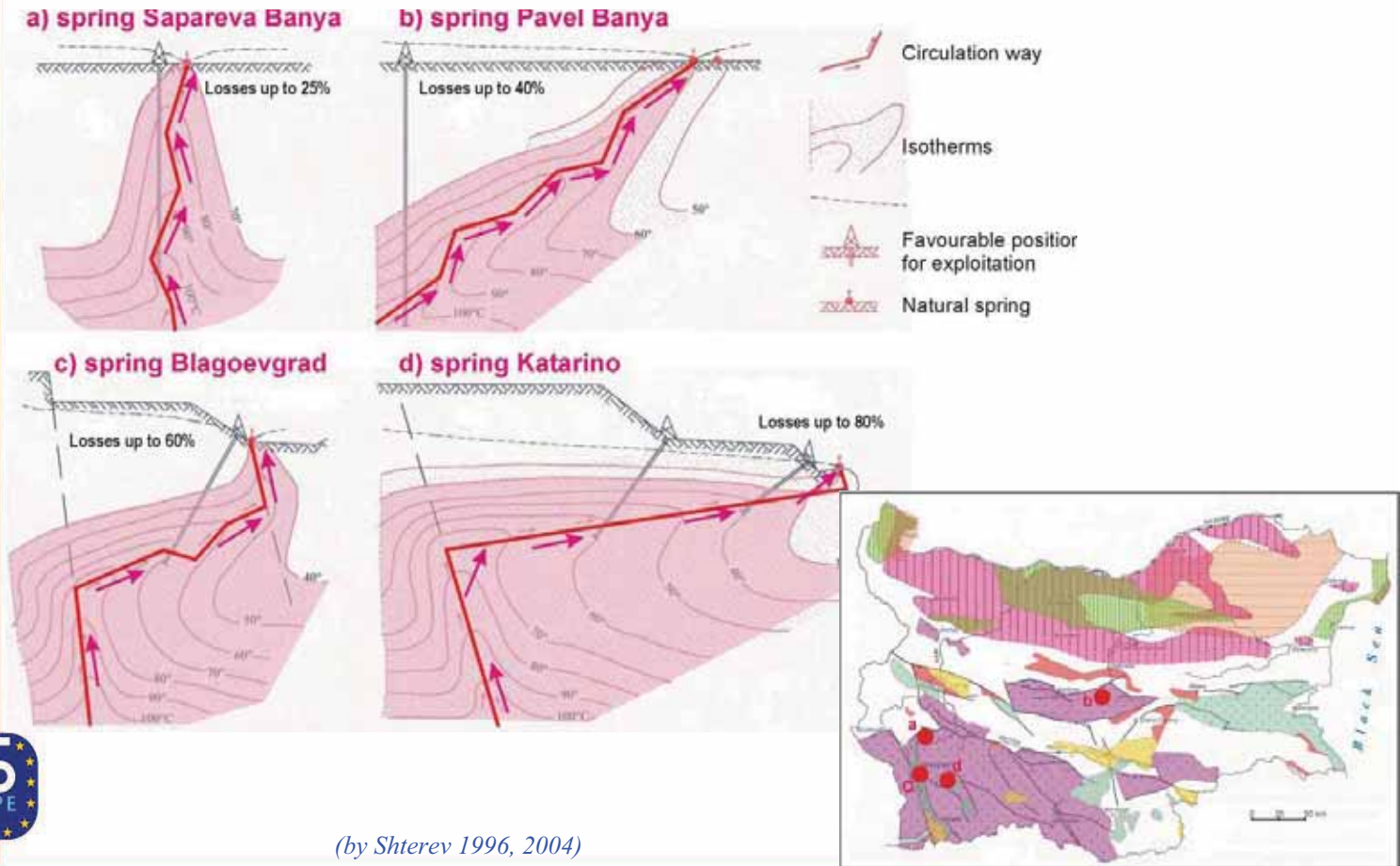
Patterns of Heat regime & Configuration of Hydrothermal flow



(Shterev 1996, 2004)

Bulgaria

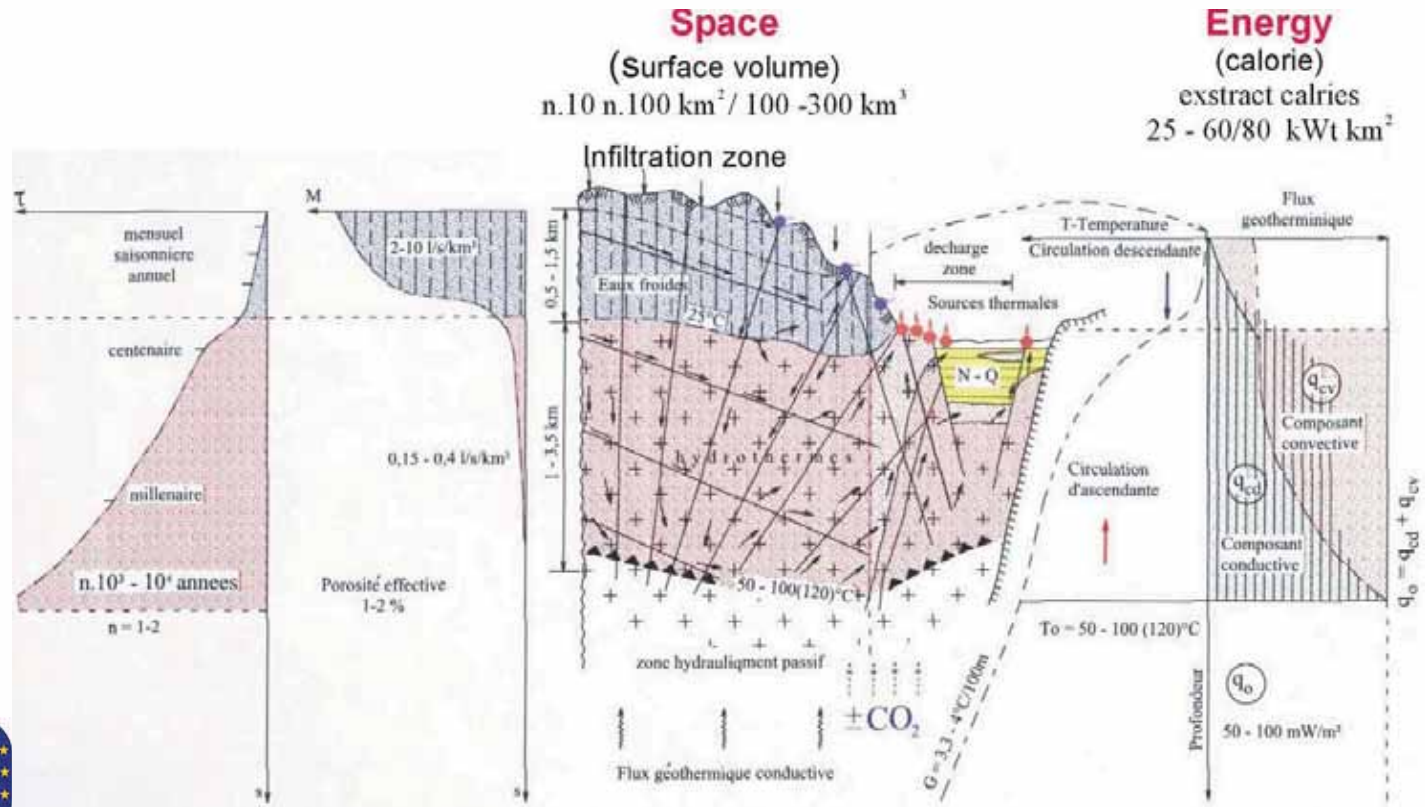
Patterns of Heat regime & Configuration of Hydrothermal flow



(by Shterev 1996, 2004)

Bulgaria

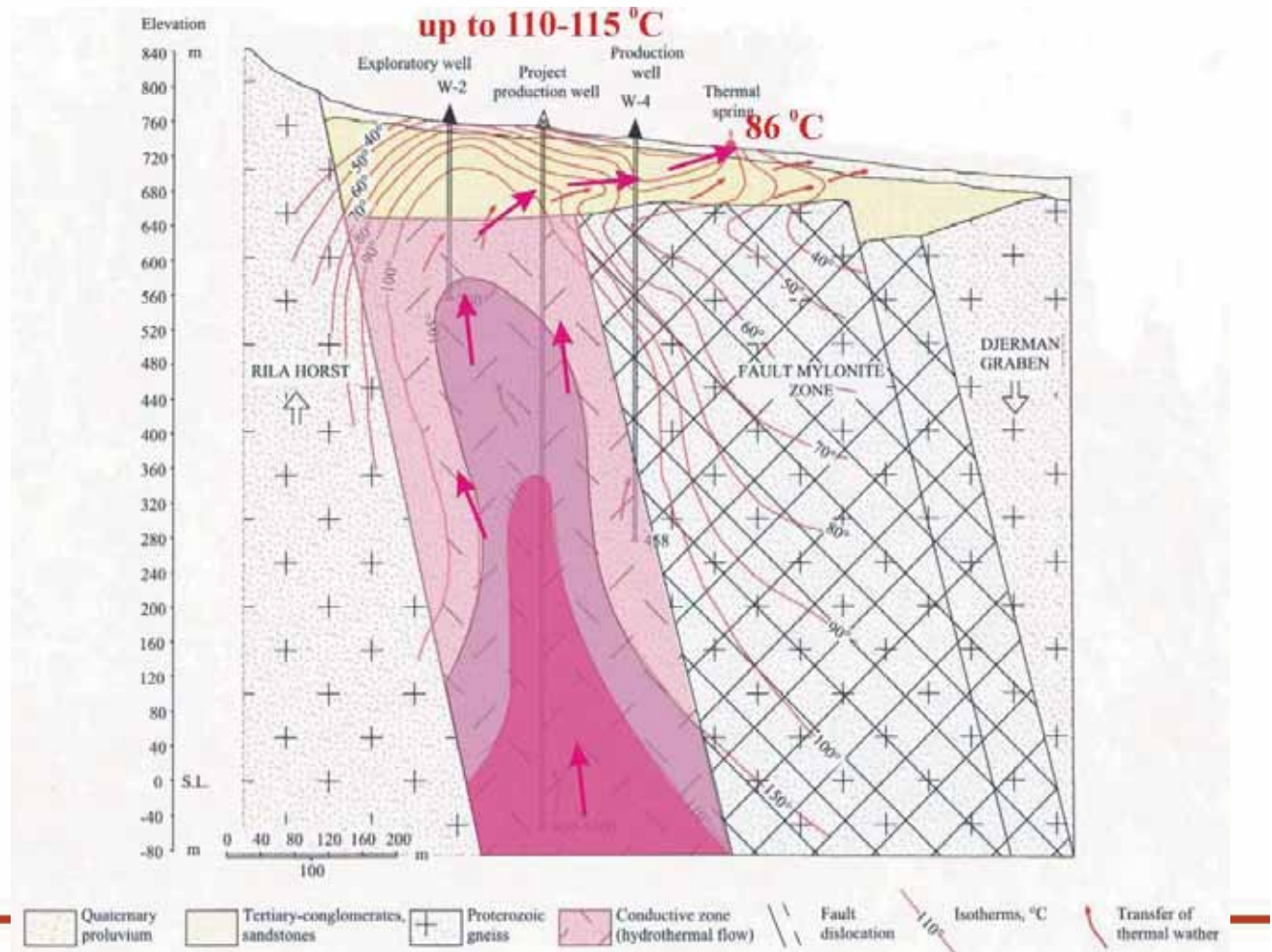
Conceptual model for Thermo-aquifer System in non-stratified granitic-metamorphic complex



(by Shterev 1996, 2004)

Bulgaria

Case: Natural spring Sapareva Banya



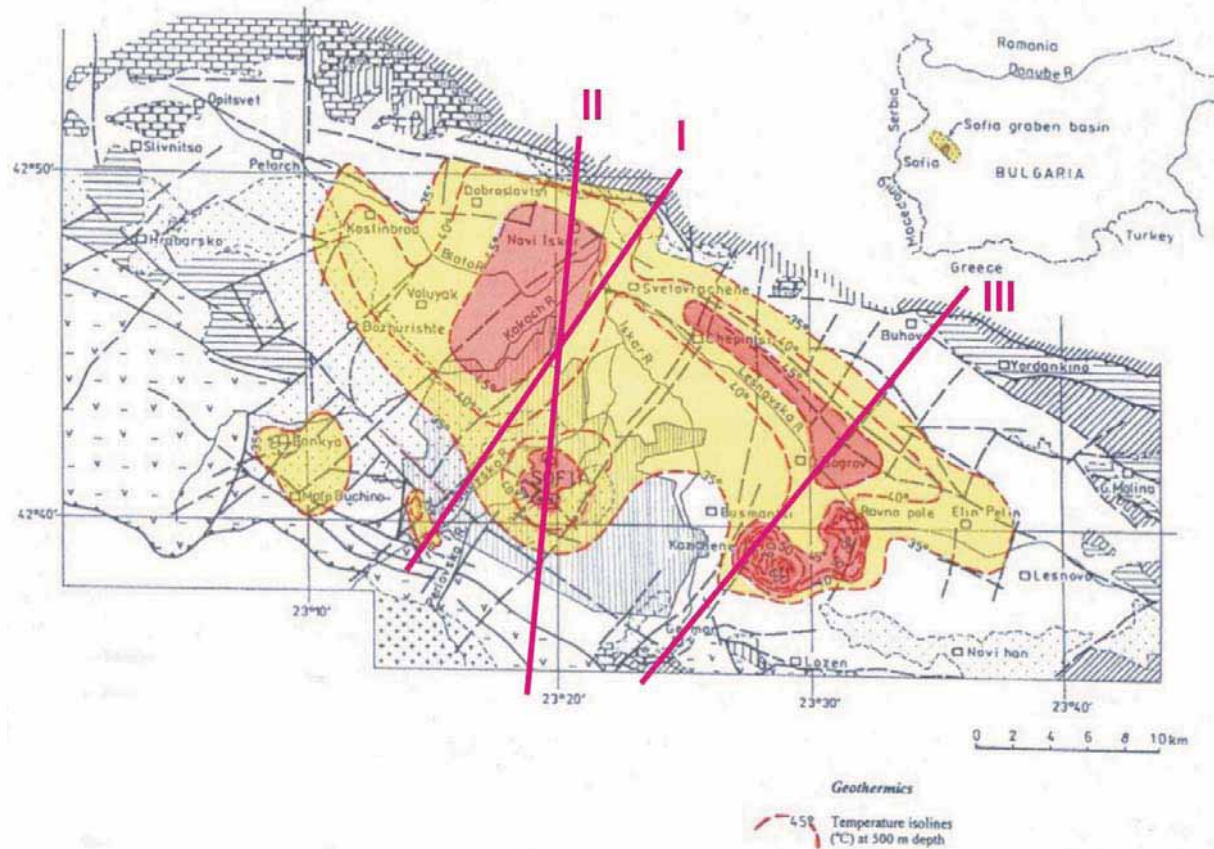
(Shterev 1996, 2004)



Bulgaria

Case: Sofia Neogene graben (Hydrogeothermal basin)

Geological & Geothermal map

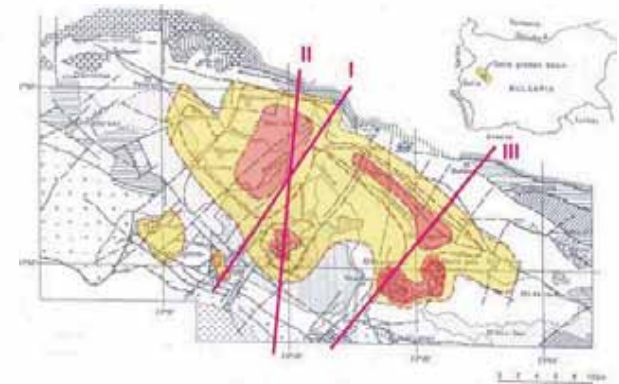
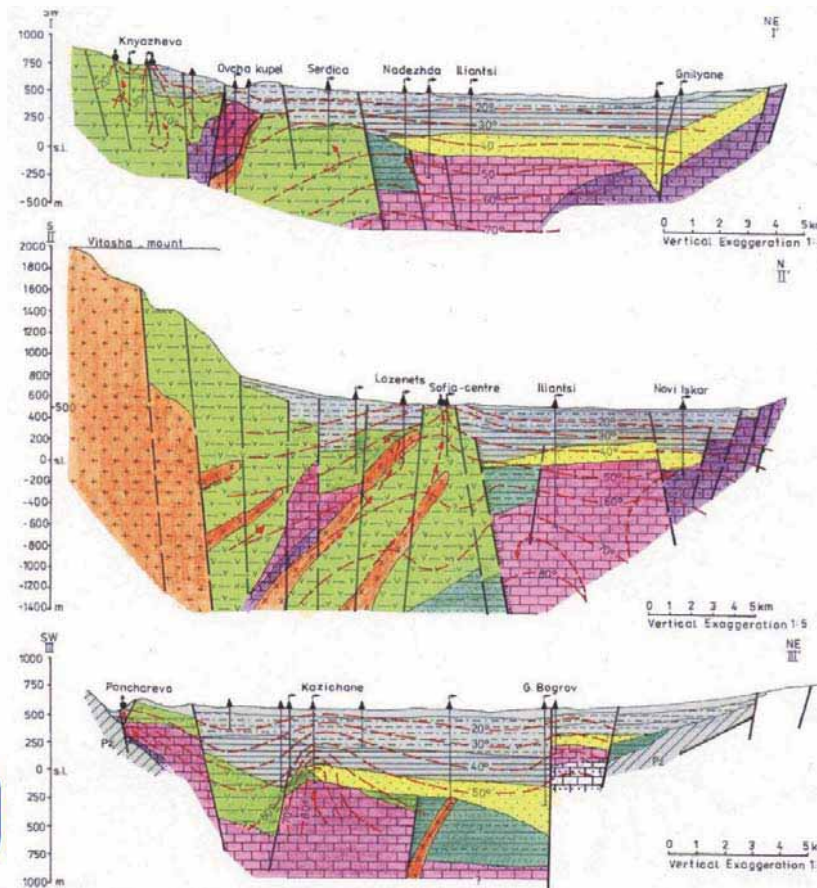


(by Shterev, 2004)

Bulgaria

Case: Sofia Neogene graben (Hydrogeothermal basin)

Geological cross-sections

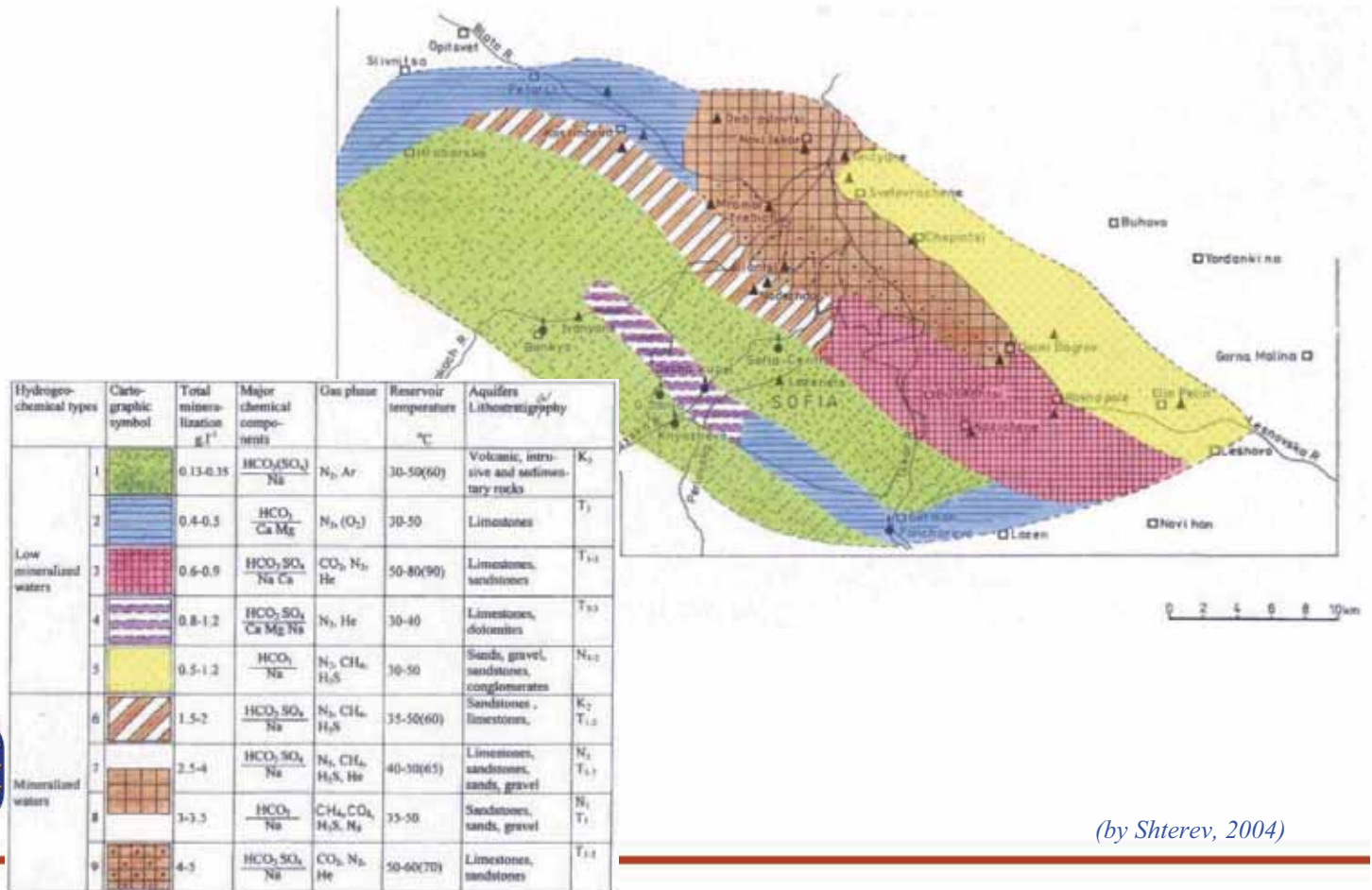


(by Shterev, 2004)

Bulgaria

Case: Sofia Neogene graben (Hydrogeothermal basin)

Distribution of different types thermal waters (by chemical composition)



(by Shterev, 2004)



Bulgaria

Case: Sofia Neogene graben (Hydrogeothermal basin)

Approximate assessment of the Hydrogeothermal potential

Reservoir (aquifer)	Area km ²	Mean hydro-geothermal reproduction or permissible yield l/(s.km ²)	Total yield l/s	Water temperature oC			Total thermal power MWt
				min.	max.	mean	
Neogene-Losenets Form.	120	0.5	60	20	50	25	1
Neogene-Gnilyane-Terr. Form.	240	0.5	120	30	50	42	11
Late Cretaceous complex	600	0.3	180	30	55	42	16
Triasso-Jurassic	400	0.35	140	30	80	55	20
Total for the basin	1360		500				48

Main Conclusions

- ➔ Geothermal potential of Bulgaria is promising as a energy source
- ➔ Utilisation of geothermal energy in Bulgaria is poor for the time being

