

Interreg



CENTRAL EUROPE

European Union
European Regional
Development Fund

GeoPLASMA-CE

TAKING
COOPERATION
FORWARD



Knowledge Exchange Workshop, Essen, 29 November 2018



Activities of the Polish Geological Institute - National Research Institute in mapping and monitoring of shallow geothermal energy



Maciej Kłonowski, Wiesław Kozdrój, Grzegorz Ryżyński, PP8, Polish Geological Institute - NRI

PLAN OF THE PRESENTATION

Discussion and further actions:

- ✓ Activities in TransGeoTherm project;
- ✓ Activities in Geothermal4PL project;
- ✓ Activities in SGE under the GeoPLASMA-CE project;
 - measurements of thermal conductivity of soils;
 - TRT measurements;
- ✓ Activities under the national SGE project:
 - database on SGE instalations in Poland;
 - temperature monitoring;
- ✓ Activities in RockStore project;



TransGeoTherm – Geothermal Energy for Transboundary development of the Neisse Region. Pilot Project

- It was carried out jointly by the PGI-NRI and LfULG between Oct 2012 – Dec 2014
- It was funded by the co-operational Programme for Transboundary Co-operation Poland-Saxony 2007-2013



**POLISH GEOLOGICAL INSTITUTE – NATIONAL RESEARCH INSTITUTE
LOWER SILESIAN BRANCH**

LANDESAMT FÜR UMWELT,
LANDWIRTSCHAFT
UND GEOLOGIE



Freistaat
SACHSEN

TAKING COOPERATION FORWARD



SERIES OF 12 GEOTHERMAL MAPS:

Public version:

8 maps showing average heat extraction rate [W/m]

1 800 [whpy] of GSHP
operation in the heating
mode only, depth ranges of:

0 - 40 m

0 - 70 m

0 - 100 m

0 - 130 m

2 400 [whpy] of GSHP
operation in the mode of
heating and warm water
production, depth ranges of:

0 - 40 m

0 - 70 m

0 - 100 m

0 - 130 m

Professional version:

4 maps showing
thermal conductivity
[W/m*K]
for depth ranges of:

0 - 40 m

0 - 70 m

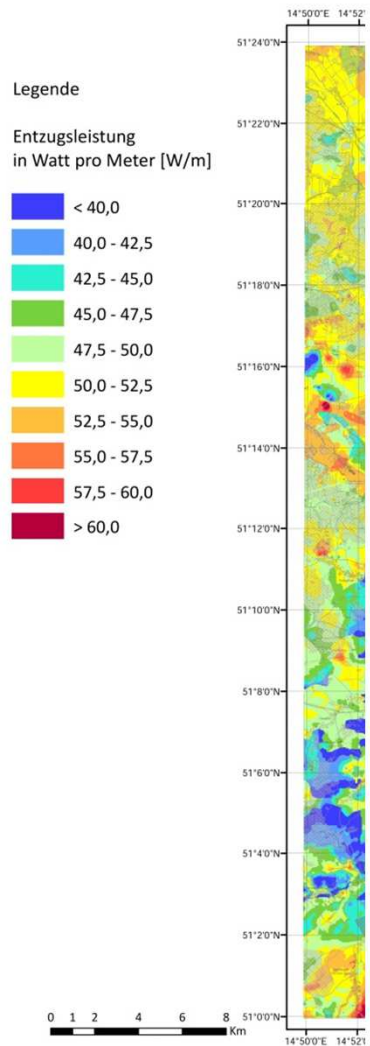
0 - 100 m

0 - 130 m

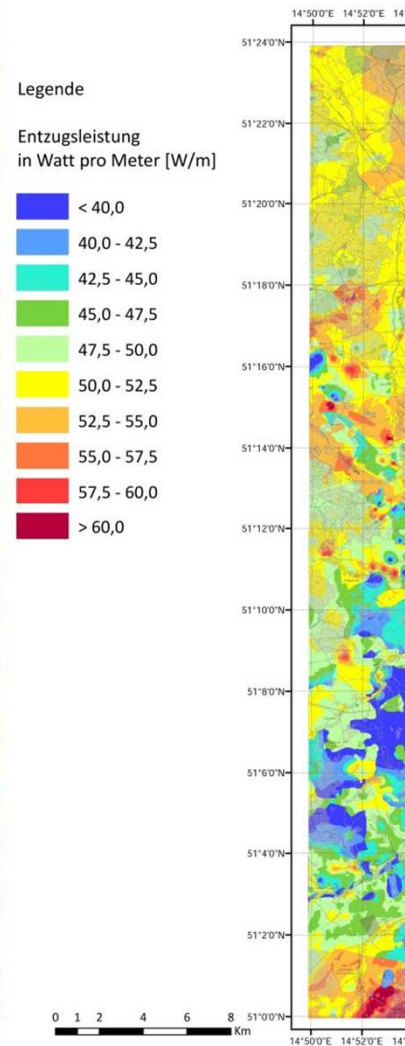


SELECTED GEOTHERMAL MAPS

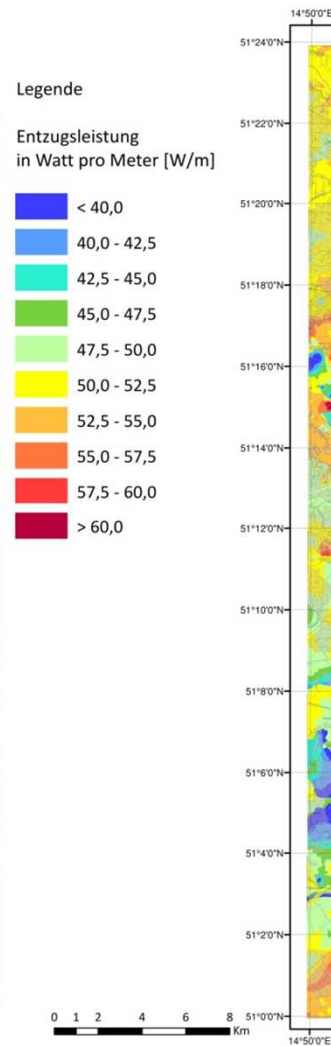
Entzugsleistung
für 1800 Jahresbetrie
- bis



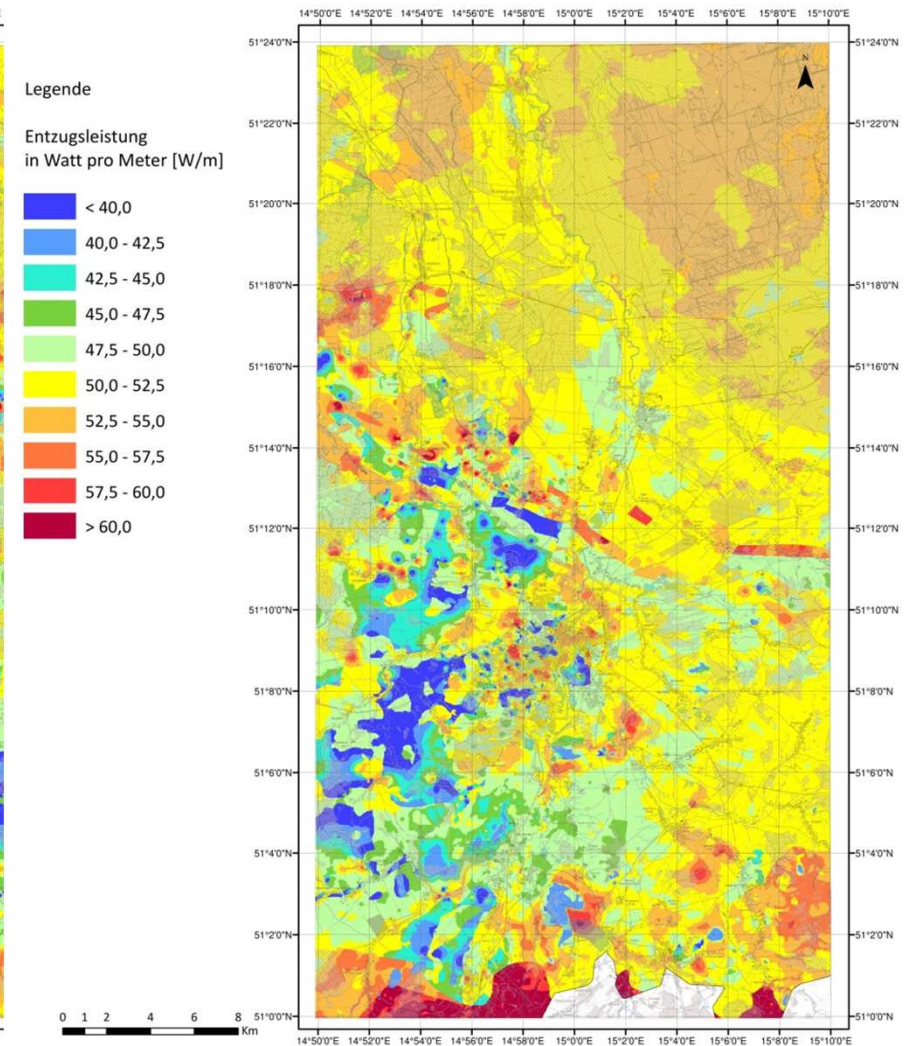
Entzugsleistung ir
für 1800 Jahresbetrie:
- bis 7



Entzugsleist
für 1800 Jahresbe
-



Entzugsleistung in Watt pro Meter [W/m]
für 1800 Jahresbetriebsstunden einer Wärmepumpe
- bis 130m Bohrtiefe



Geothermal4PL Support for the sustainable development and use of shallow geothermal energy in the areas covered by the Mieszkanie Plus programme in Poland

- It was carried out jointly by the PGI-NRI and CMR in 2017
- It was financed by the EEA Financial Mechanism 2009–2014, Bilateral Cooperation Fund







SELECTED GEOTHERMAL MAPS


A series of maps: geological, hydrogeological and maps of geothermal potential for 6 selected sites in Poland

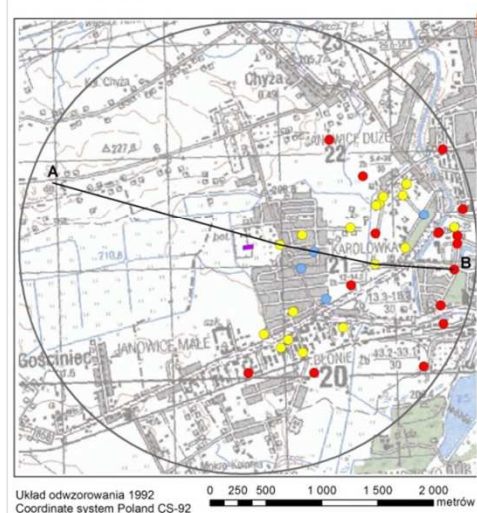
POTENCJAŁ GEOTERMALNY OBSZARÓW WYZNACZONYCH DO REALIZACJI INWESTYCJI W RAMACH PROGRAMU "MIESZKANIE +" (ZAMOŚĆ) Załącznik 6.4 Appendix 6.4

Geothermal potential for selected areas of MIESZKANIE+ investment program

Wartości średnie współczynnika przewodzenia ciepła gruntu (λ) na głębokości 40 m
Average values of thermal conductivity coefficient (λ) at the depth of 40 m




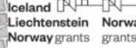
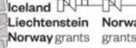


Liczba otworów - 45
Amount of boreholes

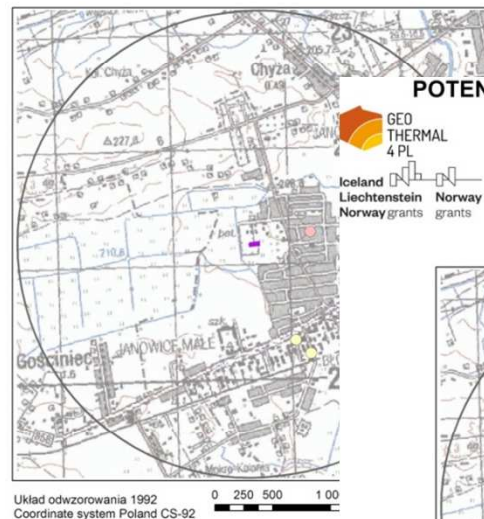
POTENCJAŁ GEOTERMALNY OBSZARÓW WYZNACZONYCH DO REALIZACJI INWESTYCJI W RAMACH PROGRAMU "MIESZKANIE +" (ZAMOŚĆ) Załącznik 6.5 Appendix 6.5

Geothermal potential for selected areas of MIESZKANIE+ investment program

Wartości średnie współczynnika przewodzenia ciepła gruntu (λ) na głębokości 70 m
Average values of thermal conductivity coefficient (λ) at the depth of 70 m










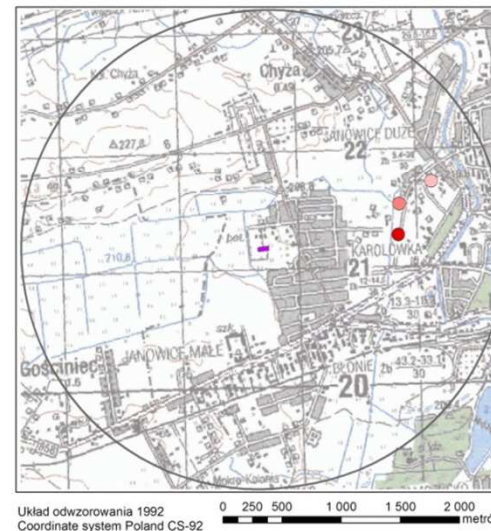
POTENCJAŁ GEOTERMALNY OBSZARÓW WYZNACZONYCH DO REALIZACJI INWESTYCJI W RAMACH PROGRAMU "MIESZKANIE +" (ZAMOŚĆ) Załącznik 6.6 Appendix 6.6

Geothermal potential for selected areas of MIESZKANIE+ investment program




Wartości średnie współczynnika przewodzenia ciepła gruntu (λ) na głębokości 100 m
Average values of thermal conductivity coefficient (λ) at the depth of 100 m



   





Wartości współczynnika λ w otworach wiertniczych

-  2,13
-  2,13 - 2,20
-  2,20 - 2,22

-  Teren inwestycyjny MIESZKANIE+
MIESZKANIE+ investment area
-  Obszar badań
Research area

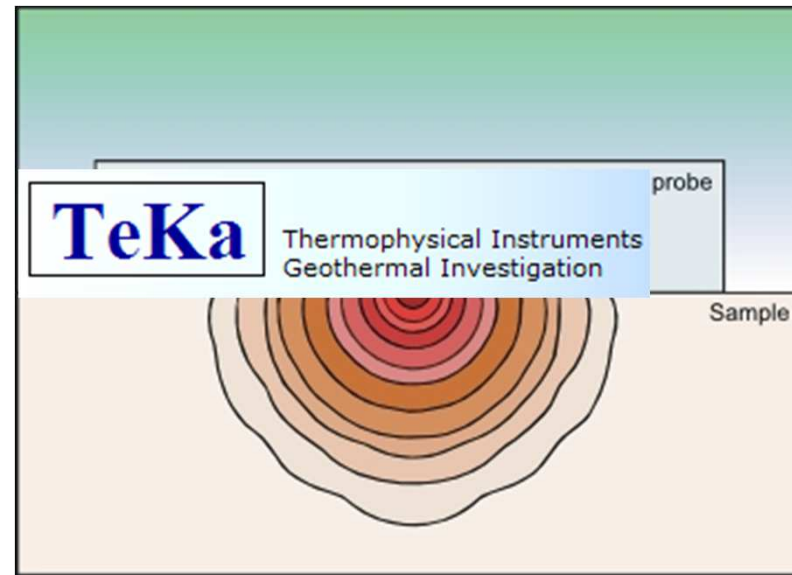
Liczba otworów - 3
Amount of boreholes



Basic equipment for thermal parameters determination (thermal conductivity) – devices were implemented in PGI-NRI Laboratory in 2015.



KD2PRO- Thermal Needle



TK04 – Thermal conductivity meter equipped with half space probe



Basic equipment for thermal parameters determination (thermal conductivity)



Measurement of thermal conductivity of BHE backfill materials

Basic equipment for thermal parameters determination of soils and rocks (thermal conductivity)



Soil samples Pilot Aarea Kraków

12 soil samples were gathered for PA Kraków.

36 TC measurements with needle probe were made.

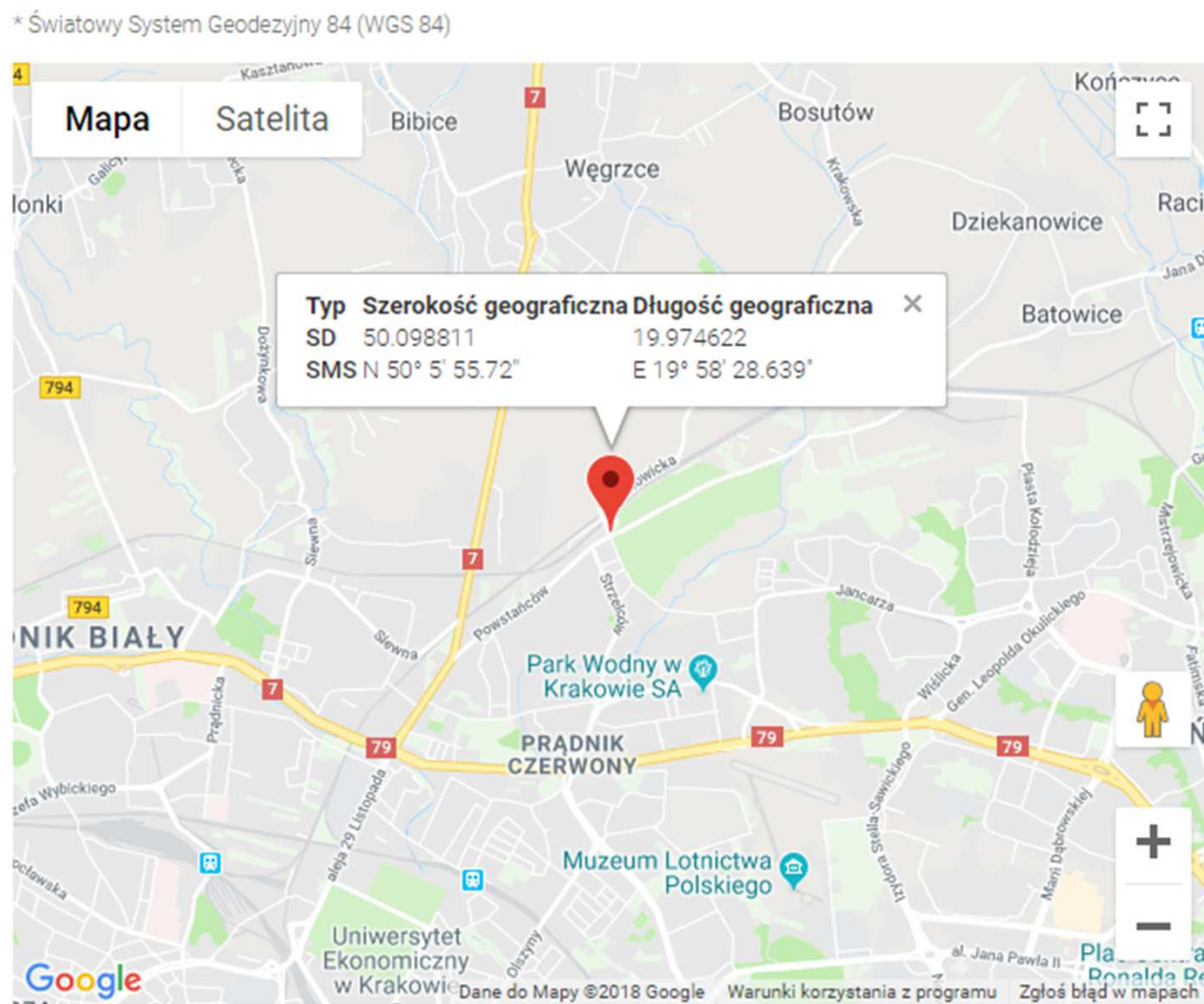
15 samples for PA Wałbrzych are in testing.

sample	latitude	longitude	altitude
WT-1	50.099476	19.975124	236.6
WT-2	50.099298	19.974824	236.2
WT-3	50.099070	19.974798	236.2
WT-4	50.098811	19.974622	235.7
WT-5	50.051543	20.019262	198.9
WT-6	50.051442	20.019094	198.5
WT-7	50.051650	20.019751	199.9
WT-8	50.051407	20.019347	199.3
WT-9	50.103812	19.986238	241.3
WT-10	50.103938	19.985887	240.2
WT-11	50.104373	19.986389	238.3
WT-12	50.104097	19.986827	238.2

Sample	Type of soil	Water content [%]	Thermal conductivity λ [W/k xm]	Sample temperature [°C]	Average thermal conductivity λ [W/k xm]	PORT PC Guidelines category
WT-1	Medium sand	12,30	0,94	19,48	0,966	3
			1,014	19,34		
			0,944	19,33		
WT-2	Medium sand	20,68	2,202	18,86	2,209	4
			2,194	18,86		
			2,231	18,88		
WT-3	Fine sand	17,37	2,195	19,57	2,186	4
			2,192	19,5		
			2,17	19,48		
WT-4	Sandy silt	16,02	1,443	20,83	1,442	8
			1,443	20,95		
			1,441	21,09		
WT-5	Silt	19,43	2,076	21,2	2,076	8
			2,079	21,35		
			2,074	21,49		
WT-6	Silt	17,95	1,929	22,06	1,929	8
			1,929	22,15		
			1,93	22,24		
WT-7	Silt	22,72	1,992	23,39	1,991	8
			1,991	23,45		
			1,991	23,51		
WT-8	Silt	16,96	1,423	22,49	1,419	8
			1,414	22,61		
			1,42	22,76		
WT-9	Silt	23,29	1,94	22,91	1,940	8
			1,946	23,05		
			1,934	23,19		
WT-10	Silty clay	25,41	2,104	23,71	2,107	10
			2,105	23,7		
			2,112	23,68		
WT-11	Silty clay	25,34	2,075	23,57	2,078	10
			2,09	23,61		
			2,07	23,66		
WT-12	Silty clay	23,61	2,026	23,55	2,030	10
			2,028	23,61		
			2,035	23,66		



Localisation of samples Project Pilot Aarea Kraków

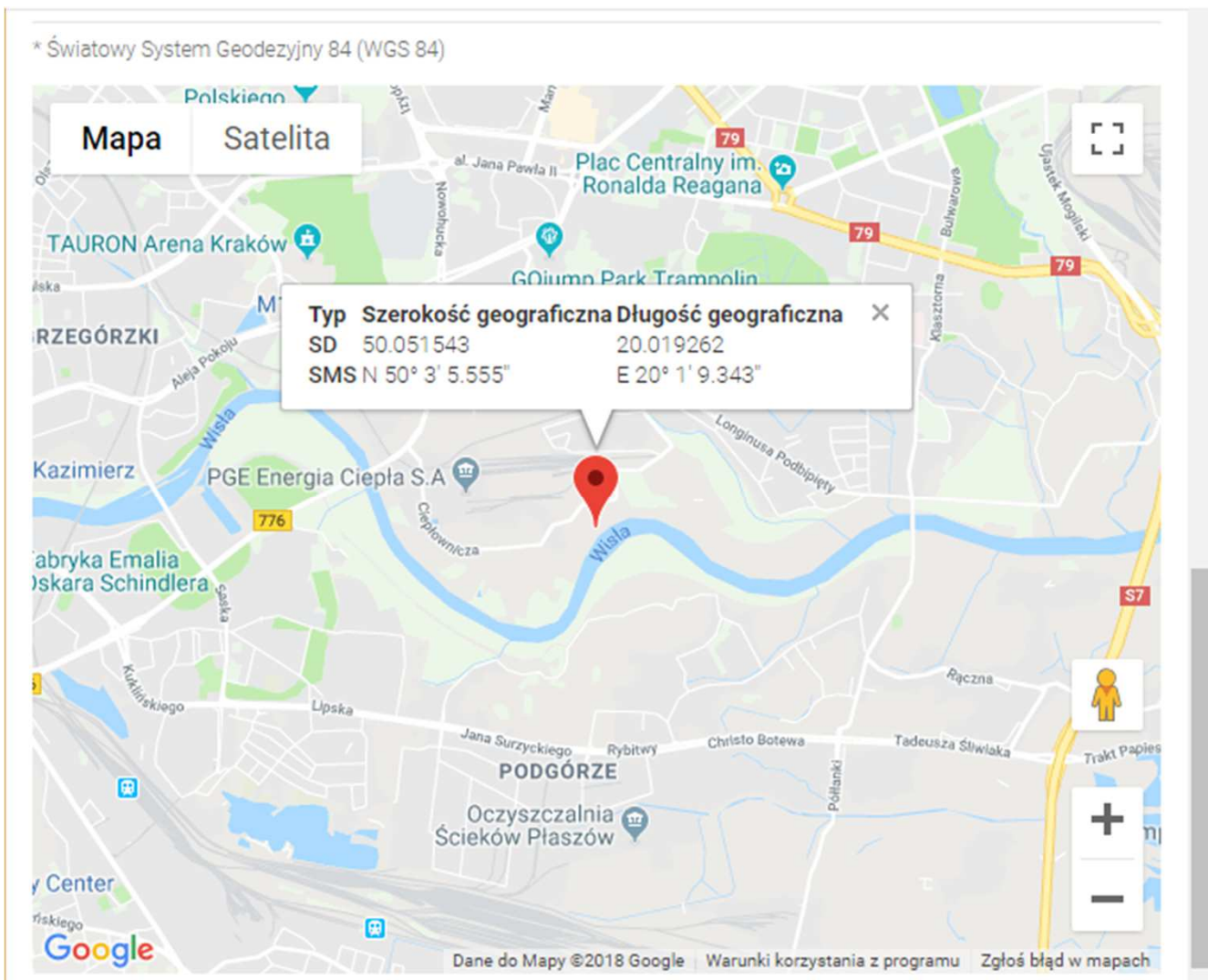


WT-1 ÷ WT-4 fluvioglacial sands

Sample	Type of soil	Water content [%]
WT-1	Medium sand	12,30
WT-2	Medium sand	20,68
WT-3	Fine sand	17,37
WT-4	Sandy silt	16,02



Localisation of samples Project Pilot Aarea Kraków



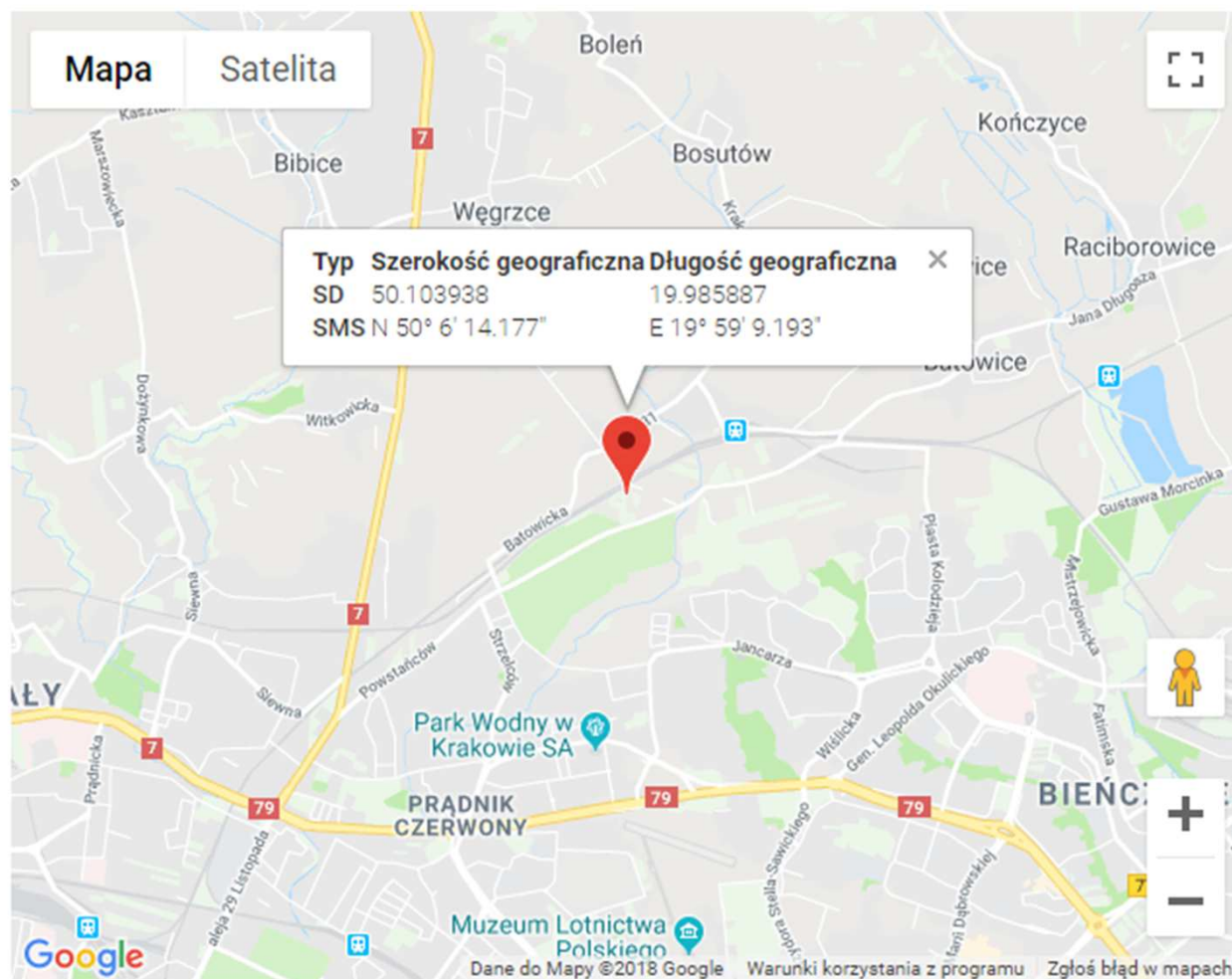
WT5 ÷ WT8 river clays

Sample	Type of soil	Water content [%]
WT-5	Silt	19,43
WT-6	Silt	17,95
WT-7	Silt	22,72
WT-8	Silt	16,96



Localisation of samples Project Pilot Aarea Kraków

* Światowy System Geodezyjny 84 (WGS 84)



WT10 ÷ WT12 glacial tills

Sample	Type of soil	Water content [%]
WT-9	Silt	23,29
WT-10	Silty clay	25,41
WT-11	Silty clay	25,34
WT-12	Silty clay	23,61



Preparation of soil samples for thermal conductivity testing (cohesive and non-cohesive soils)

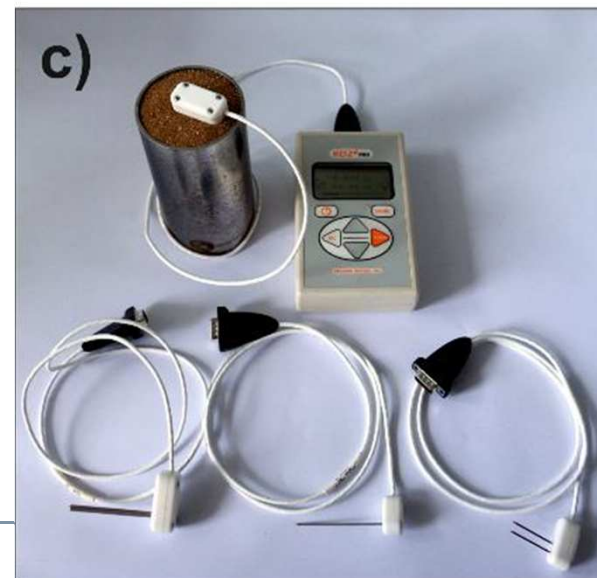
a) steel cylinder for max and min volume density testing + vibrating rods (for non-cohesive soils)



b) 2 piece steel cylinder with compactor (for cohesive soils)



c) KD2Pro thermal needle probes and logger



d) TC testing of recompacted samples of clays



Correlation of results with archival data (PORT PC Guidelines – EED database)

PORT PC Category	Soil type
1	sand, dry
2	sand (compacted), dry
3	sand, wet
4	sand, saturated
5	gravel, dry
6	gravel, saturated
7	silt, dry
8	silt, wet
9	clay, till, dry
10	clay, till, wet

Sample	Type of soil	Water content [%]	Average thermal conductivity λ [W/k xm]	PORT PC Guidelines category
WT-1	Medium sand	12,30	0,966	3
WT-2	Medium sand	20,68	2,209	4
WT-3	Fine sand	17,37	2,186	4
WT-4	Sandy silt	16,02	1,442	8
WT-5	Silt	19,43	2,076	8
WT-6	Silt	17,95	1,929	8
WT-7	Silt	22,72	1,991	8
WT-8	Silt	16,96	1,419	8
WT-9	Silt	23,29	1,940	8
WT-10	Silty clay	25,41	2,107	10
WT-11	Silty clay	25,34	2,078	10
WT-12	Silty clay	23,61	2,030	10



Correlation of results with archival data (PORT PC Guidelines – EED database)

PORT PC Category	Soil type
1	sand, dry
2	sand (compacted), dry
3	sand, wet
4	sand, saturated
5	gravel, dry
6	gravel, saturated
7	silt, dry
8	silt, wet
9	clay, till, dry
10	clay, till, wet

Sample	Type of soil	Water content [%]	Average thermal conductivity λ [W/k xm]	PORT PC Guidelines category
WT-1	Medium sand	12,30	0,966	3
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WT-12	Silty clay	23,61	2,030	10

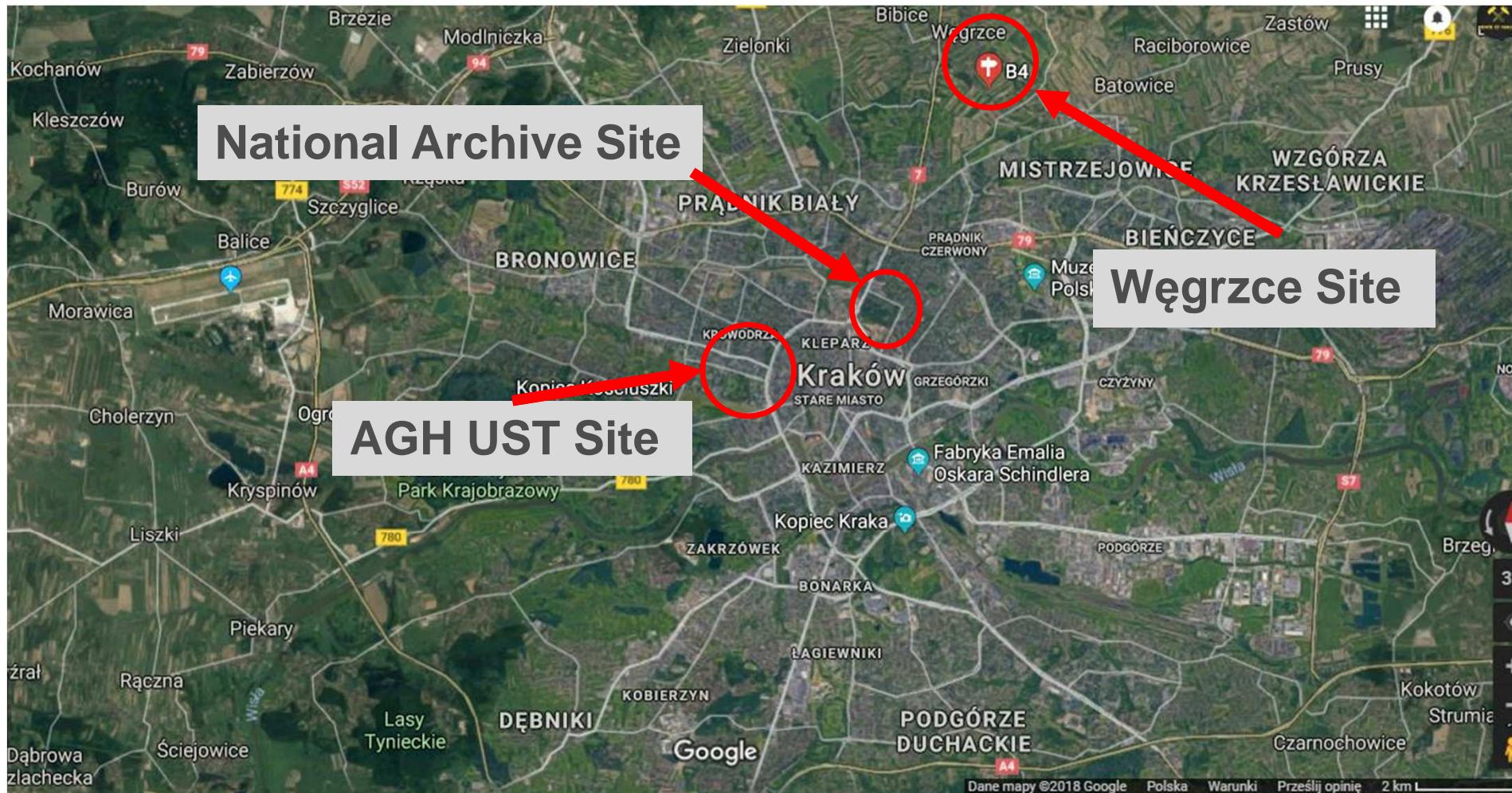


Performed TRTs - general information

No.	Localisation	Start of TRT test	TRT duration	Depth	BHE construction	TRT test	Temperature profile	Circulation fluid	TRT status
1	Kraków AGH UST	24.04.2018	48	83,8	single U	+	+	water	Benchmark
2	Kraków National Archive	20.08.2018	49	100	single U	+	+	water	
3	Kraków Węgrzce	05.09.2017	49	72	single U	+		glycol	Benchmark
4	Wałbrzych Dobromierz	23.08.2018	43	92	single U	+	+	glycol	
5	Wałbrzych Boguszów-Gorce	31.07.2018	49	100	single U	+		glycol	
6	Vienna OASE 22+	26.01.2018	68	150	single U	+	+	water	Benchmark



PA KRAKÓW - TRT localisation



TRT RESULTS Kraków AGH UST

Benchmark

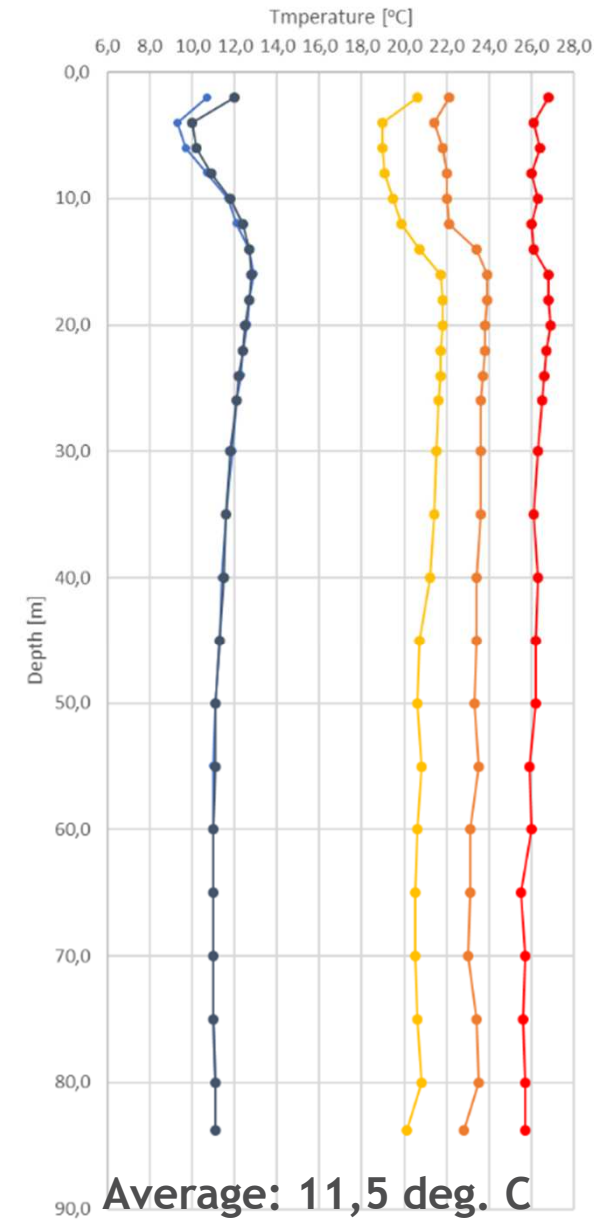


No.	Localisation	Start of TRT test	TRT duration	Depth	BHE construction
1	Kraków AGH UST	24.04.2018	48	83,8	single U

Kraków - AGH UST Campus

Temperature profile

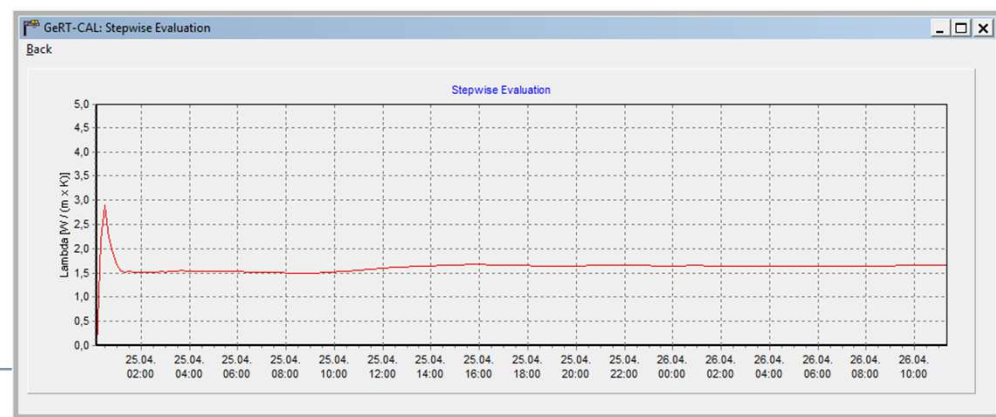
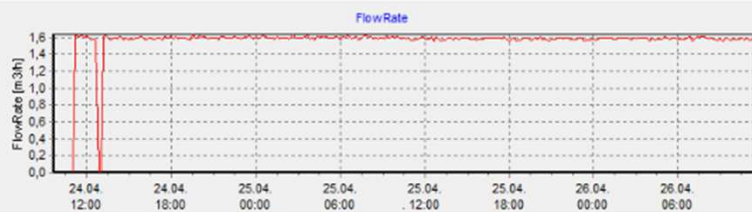
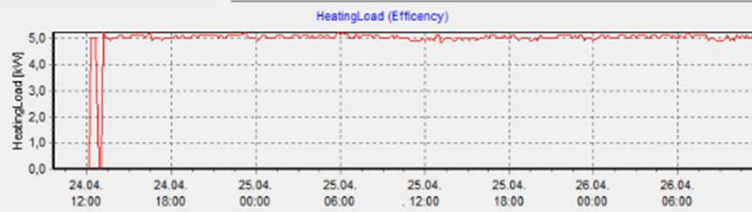
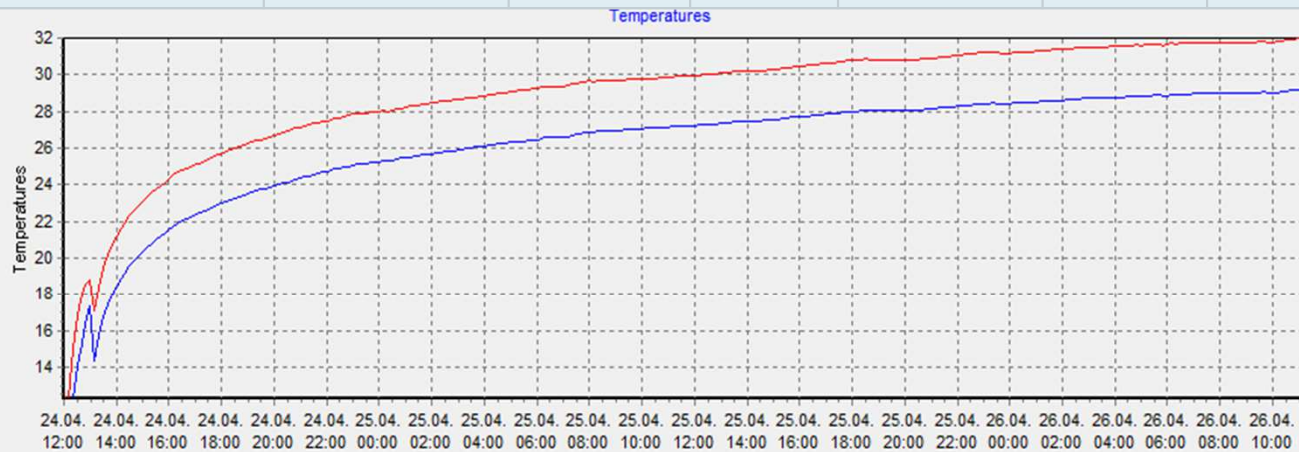
(1 x u-pipe, $\phi 32$ mm, 83,8 m depth)



TRT RESULTS Kraków AGH UST

Benchmark

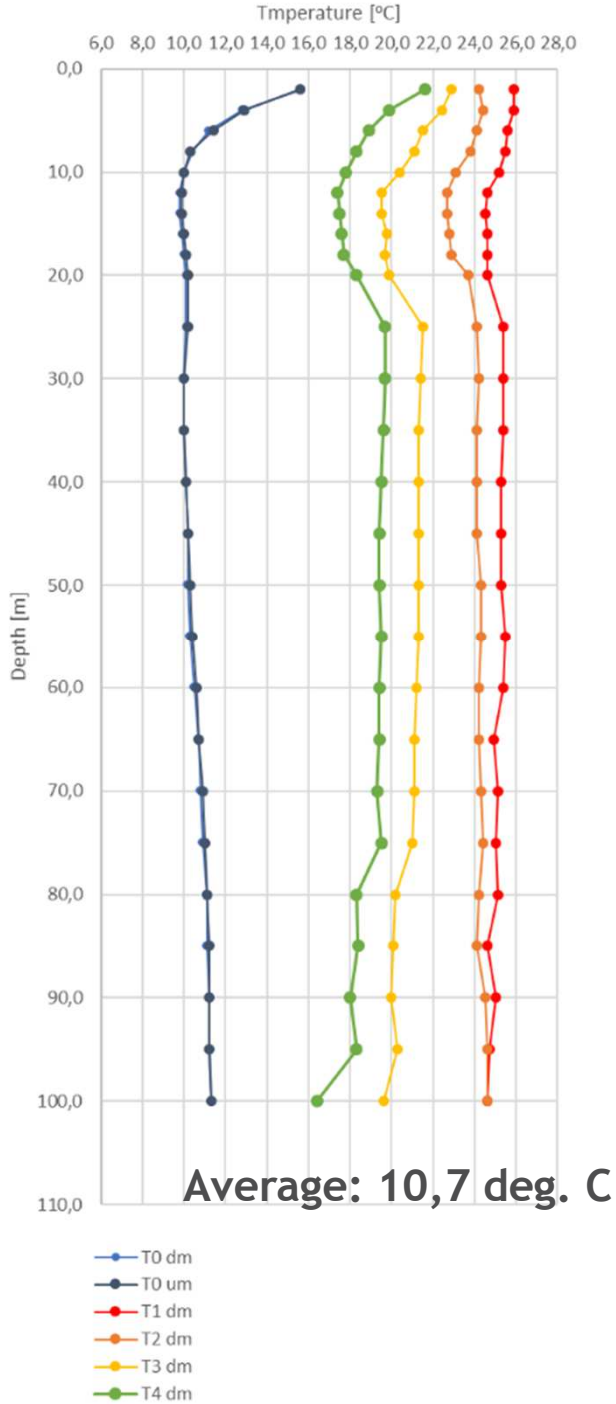
No.	Localisation	Start of TRT test	TRT duration	Depth	BHE construction	λ [W/m x K]	average t_0 (temperature profile) [°C]	t_0 (TRT test) [°C]
1	Kraków AGH UST	24.04.2018	48	83,8	single U	1,66	11,5	12,3



TRT RESULTS Kraków National Archive



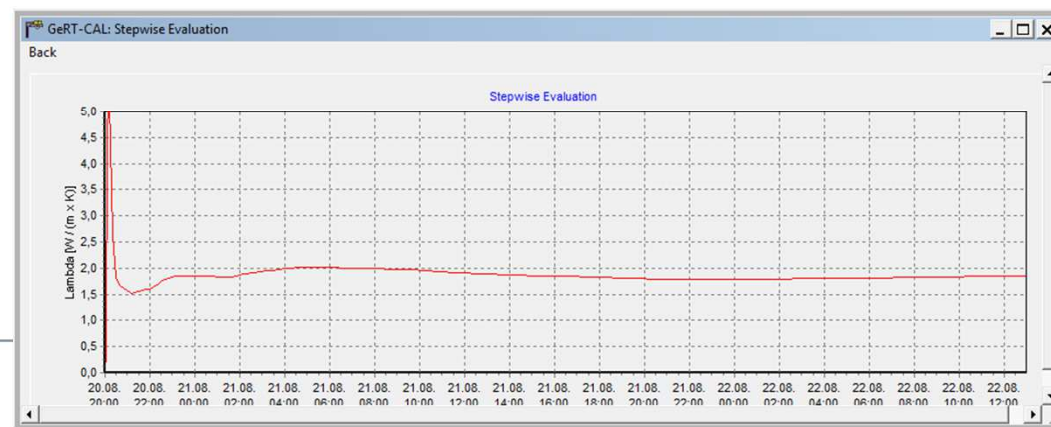
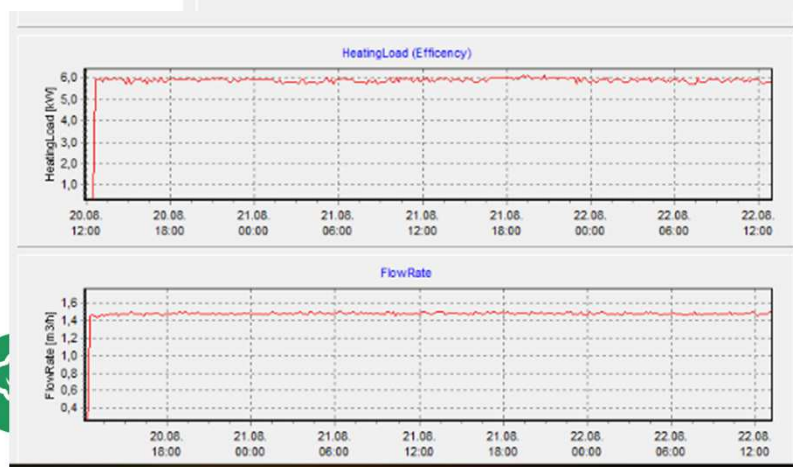
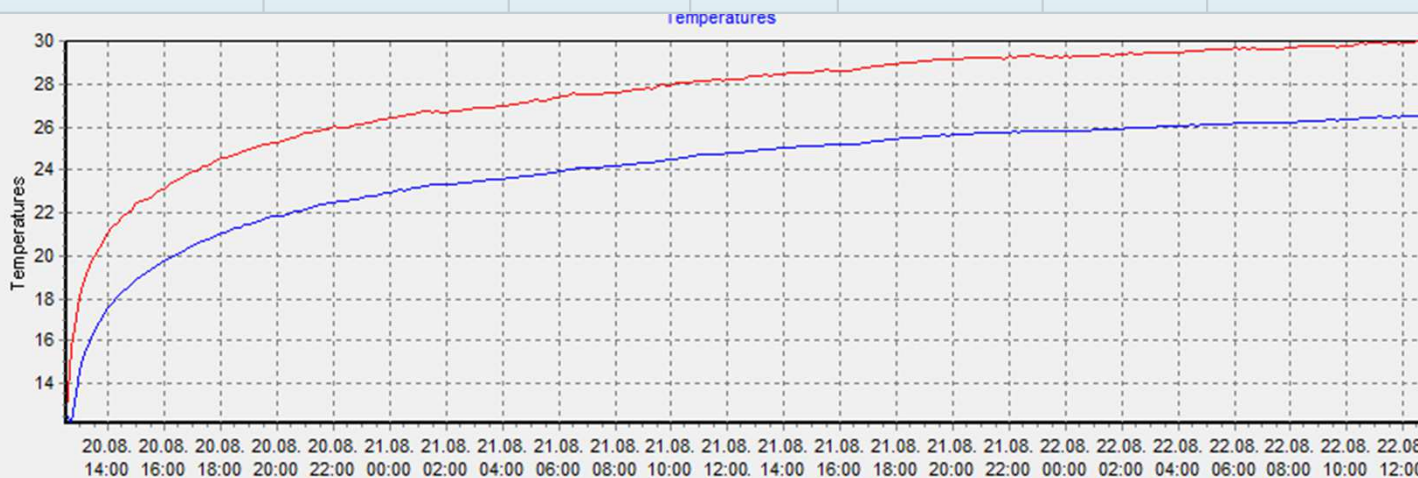
Kraków - National Archive
 Temperature profile
 (1 x u-pipe, $\phi 32$ mm 100 m depth)



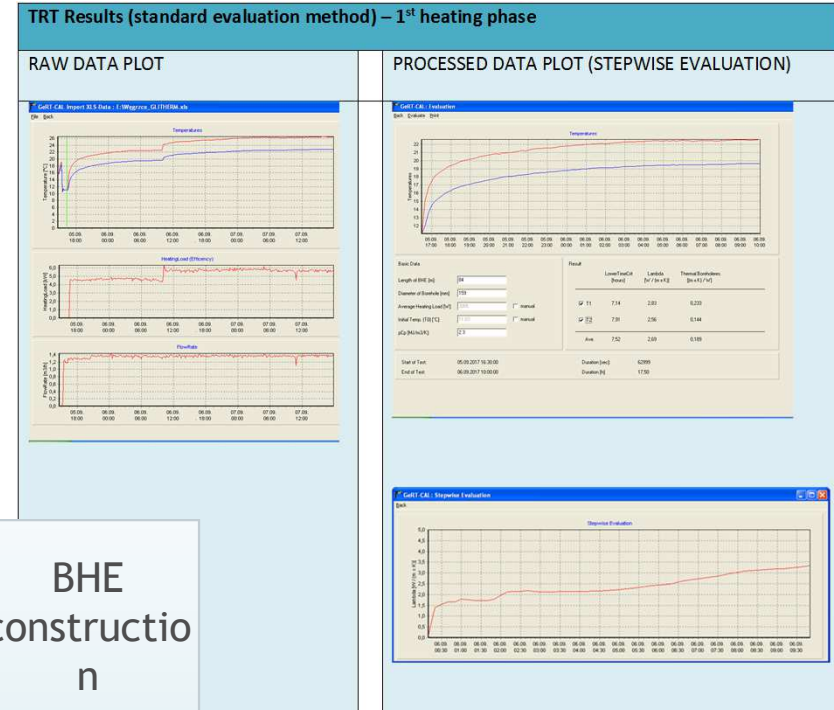
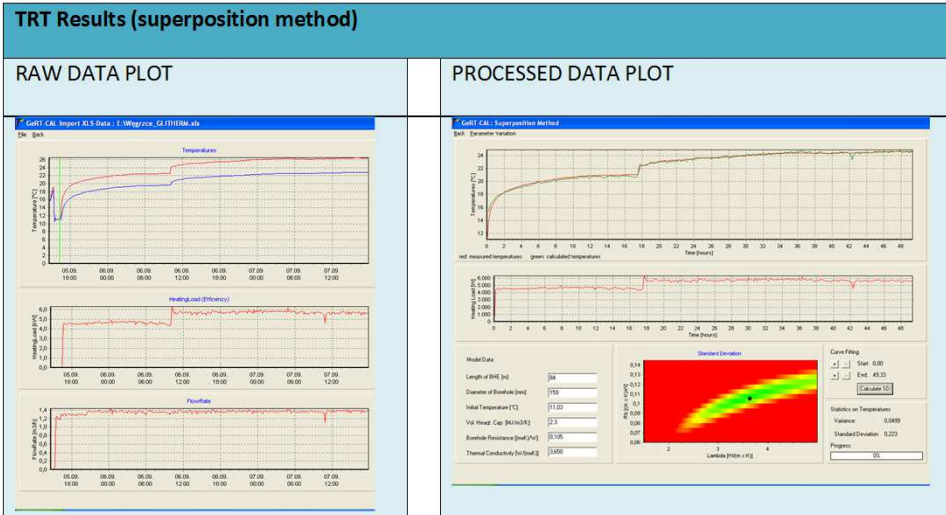
No.	Localisation	Start of TRT test	TRT duration	Depth	BHE construction
2	Kraków National Archive	20.08.2018	49	100	single U

TRT RESULTS Kraków National Archive

No.	Localisation	Start of TRT test	TRT duration	Depth	BHE construction	λ [W/m x K]	average t_0 (temperature profile) [°C]	t_0 (TRT test) [°C]
2	Kraków National Archive	20.08.2018	49	100	single U	1,84	10,7	12,6



TRT RESULTS Kraków – Węgrzce benchmark



No.	Localisation	Start of TRT test	TRT duration	Depth	BHE construction
3	Kraków Węgrzce	05.09.2017	49	72	single U

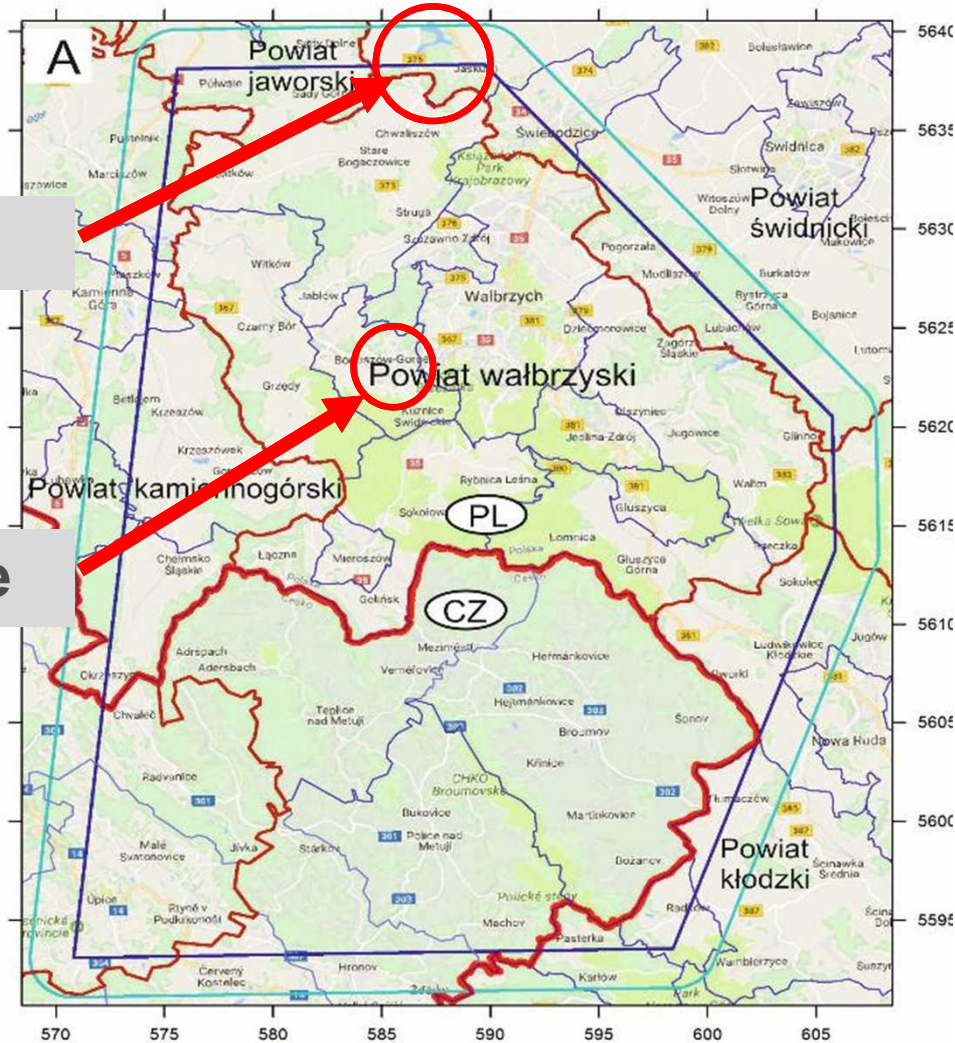
No.	Localisation	λ [W/m x K]	average t_0 (temperature profile) [°C]	t_0 (TRT test) [°C]
3	Kraków Węgrzce	2,64 ÷ 3,65 (2 phases)	no data	11,1








PA WAŁBRZYCH - TRT localisation

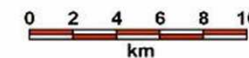
Dobromierz Site

Boguszów Gorce Site

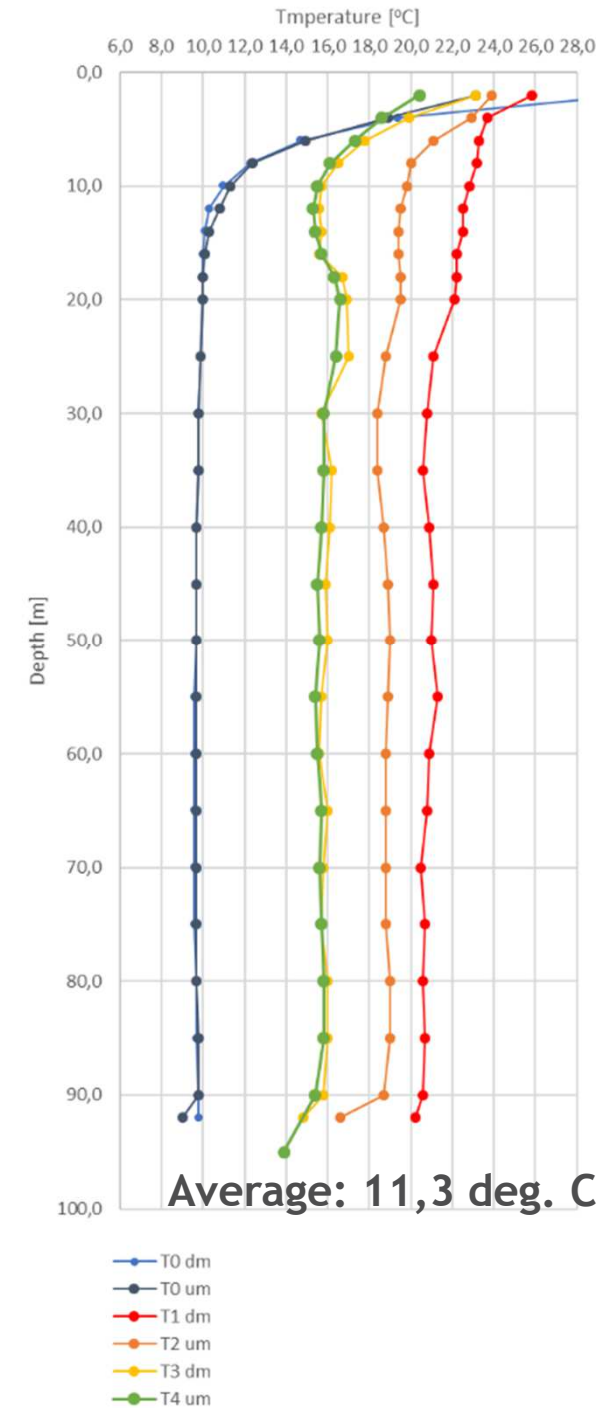


Legenda

-  Obszar pilotażowy Wałbrzych / Broumov
-  Obszar pilotażowy Wałbrzych / Broumov pilot ze strefą buforową
-  granica państw (PL/CZ)
-  granice powiatów
-  granice gmin



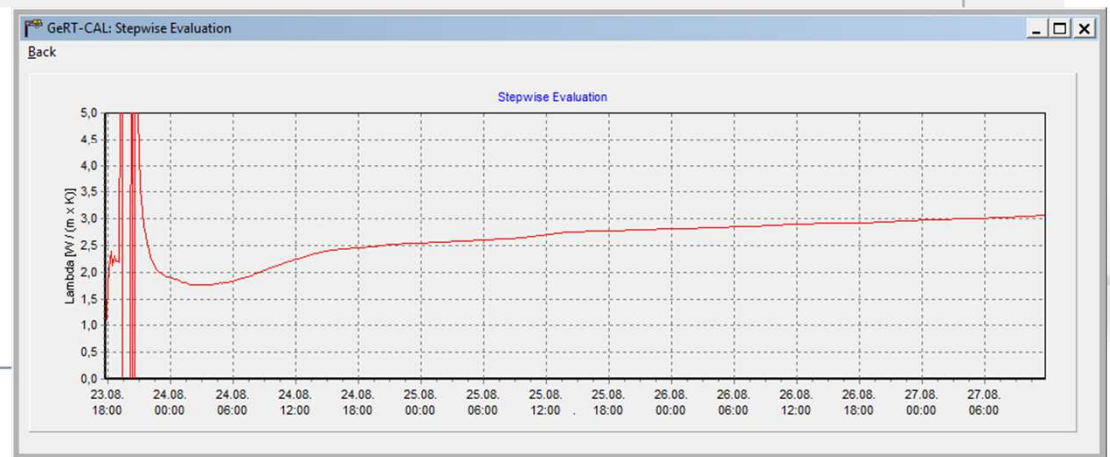
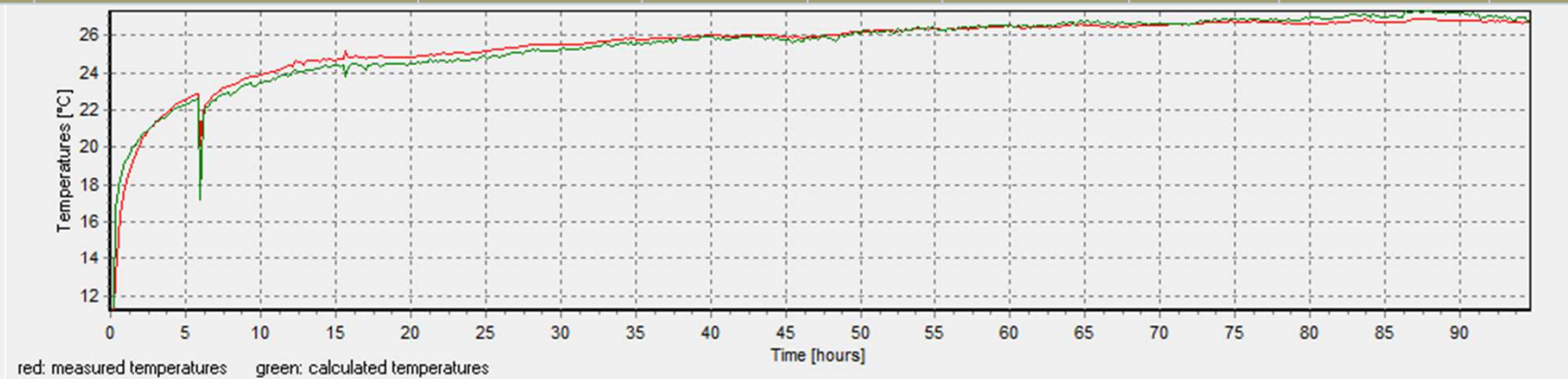
TRT RESULTS Wałbrzych - Dobromierz



No.	Localisation	Start of TRT test	TRT duration	Depth	BHE construction
4	Wałbrzych Dobromierz	23.08.2018	43	92	single U

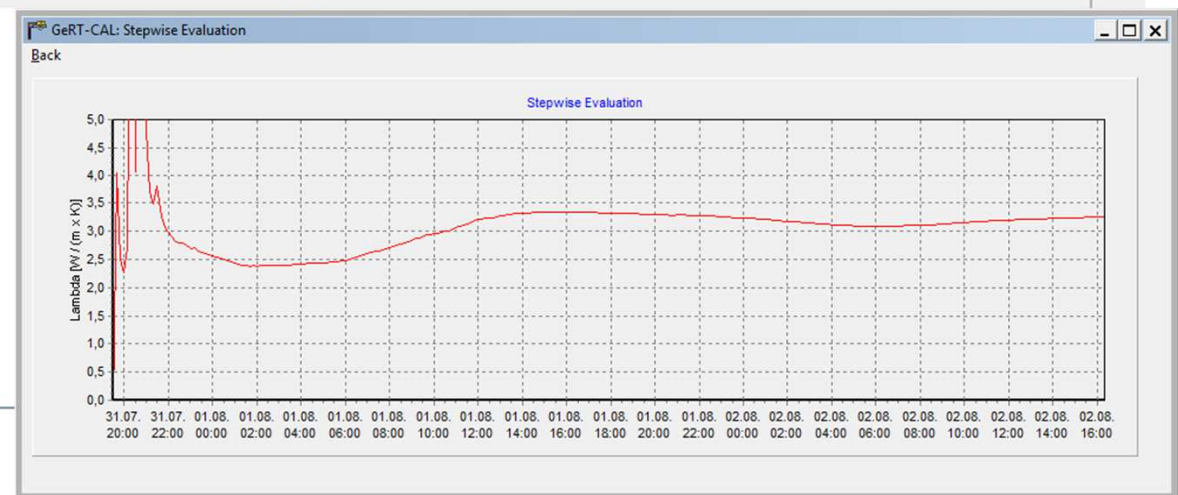
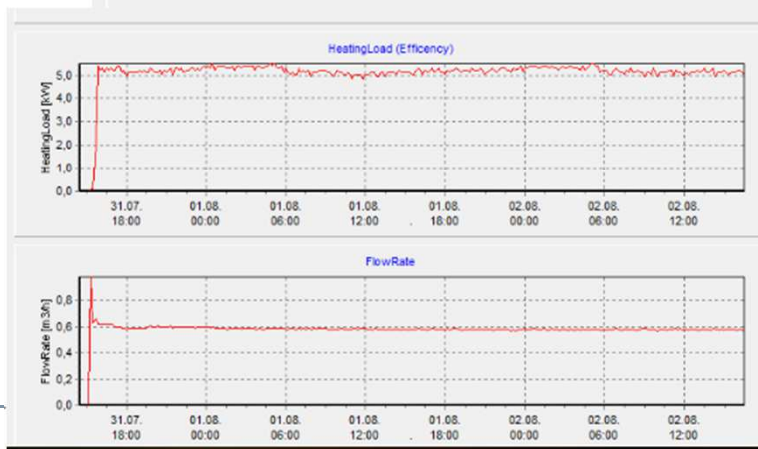
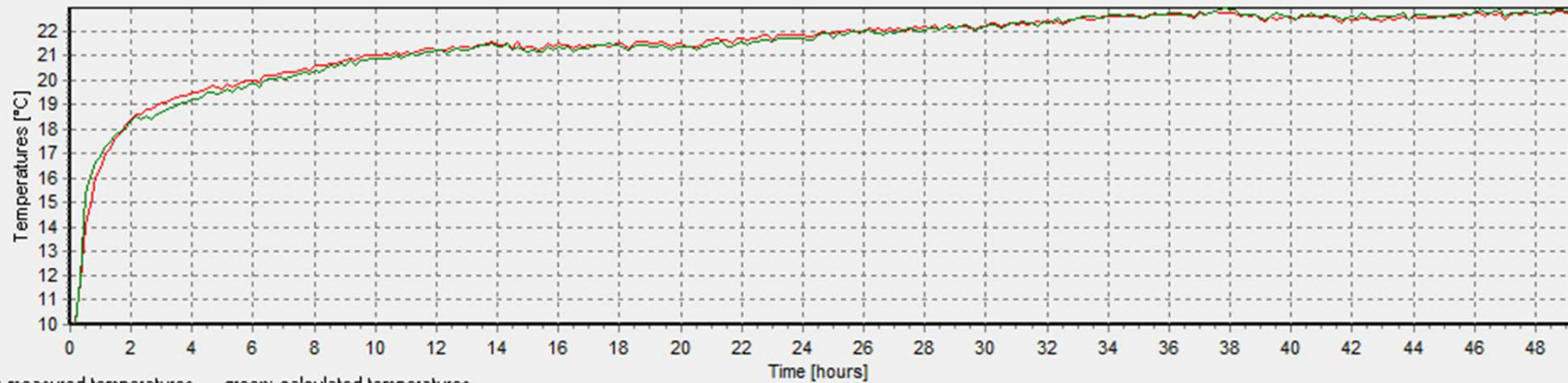
TRT RESULTS Wałbrzych - Dobromierz

No.	Localisation	Start of TRT test	TRT duration	Depth	BHE construction	λ [W/m x K]	average t_0 (temperature profile) [°C]	t_0 (TRT test) [°C]
4	Wałbrzych Dobromierz	23.08.2018	43	92	single U	2,60	11,3	11,3



TRT RESULTS Wałbrzych Boguszów - Gorce

No.	Localisation	Start of TRT test	TRT duration	Depth	BHE construction	λ [W/m x K]	average t_0 (temperature profile) [°C]	t_0 (TRT test) [°C]
5	Wałbrzych Boguszów-Gorce	31.07.2018	49	100	single U	2,85	no data	9,9

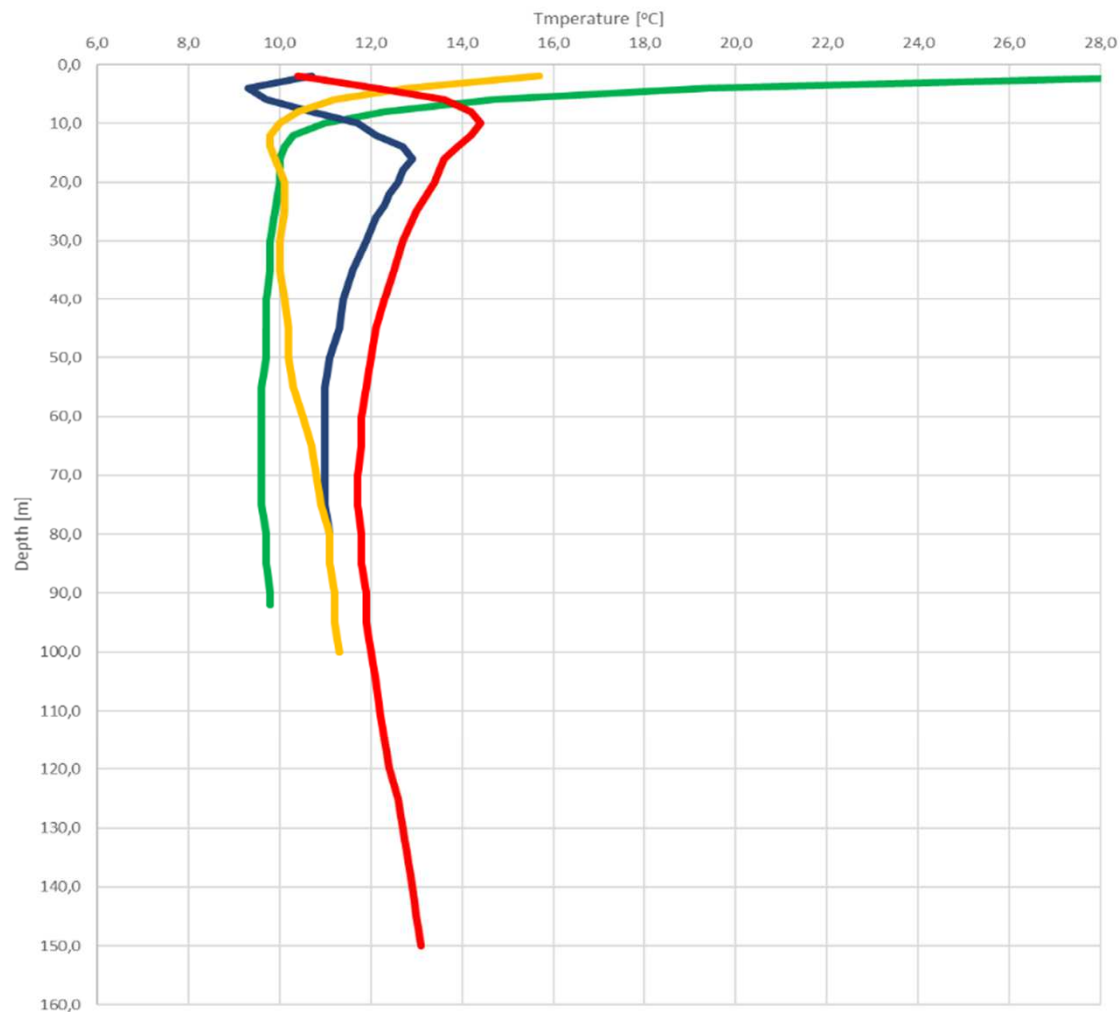


Performed TRTs - Results summary

No.	Localisation	Start of TRT test	TRT duration	Depth	BHE construction	λ [W/m x K]	average t_0 (temperature profile) [°C]	t_0 (TRT test) [°C]
1	Kraków AGH UST	24.04.2018	48	83,8	single U	1,66	11,5	12,3
2	Kraków National Archive	20.08.2018	49	100	single U	1,84	10,7	12,6
3	Kraków Węgrzce	05.09.2017	49	72	single U	2,64 ÷ 3,65 (2 phases)	<i>no data</i>	11,1
4	Wałbrzych Dobromierz	23.08.2018	43	92	single U	2,60	11,3	11,3
5	Wałbrzych Boguszów-Gorce	31.07.2018	49	100	single U	2,85	<i>no data</i>	9,9
6	Vienna OASE 22+	26.01.2018	68	150	single U	1,83	12,6	12,5



All TRT sites Temperature profiles



— DOBR_TO
11,3

Wałbrzych
Dobromierz
23.08.2018

— AGH_TO
11,5

Kraków
AGH UST
24.04.2018

— ARCH_TO
10,7

Kraków
Archiwum
Narodowe
20.08.2018

— VIENNA_TO
12,6

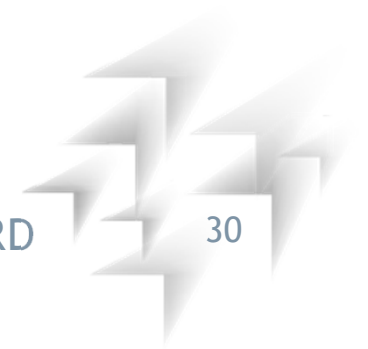
Vienna
OASE 22+
26.01.2018

Performed temperature profiling - SUMMARY



Main objectives:

- mapping SGE resources for Warsaw agglomeration;
- database on SGE installations (so far about 1 200 identified);
- database on SGE installers (so far about 110 major ones identified);
- drilling 5 borehals equipped with BHE for T monitoring i different geological and climatic settings.



Main objectives:

- international project financed by the Research Council of Norway;
- distributed temperature sensing (DTS) in 4 boreholes at the installation nearby Warsaw;



Thank you for your attention



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