Interreg CENTRAL EUROPE
GeoPLASMA-CE
European Union
European Regional Development Fund

D.T3.5.1 JOINT REPORT ON CALIBRATION OF TRT DEVICES

Annex B: Common evaluation sheets for the benchmark TRT

Version 1
06 2019

Geologische Bundesanstalt
LANDESAMT FÜR UMWELT, LANDWIRTSCHAFT UND GEOLOGIE
Freistaat SACHSEN
CZECH GEOLOGICAL SURVEY
GeoZS Geološki zavod Slovenije
AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY
geoENERGIE Konzept
GiGa infosystems
Bundesverband Geothermie
City of Ljubljana

general information

pilot area	**PA Krakow**
TRT measurement ID	-
location of BHE	-
coodinates	-
reference system	-
drilling company	-
name	-
address	-
owner of the BHE	AGH
name	-
address	-

measurement performed by	TRT#3
name, adress	
email, telefone	
evaluated by	Geologische Bundesansalt
name, adress	Martin Fuchsluger
email, telefone	martin.fuchsluger@geologie.ac.at

sensor accuracy of the TRT device		
TRT device	TRT#3	
max. derivation of temp. sensors	0.1	K
accuracy of flow meter	70	L/h

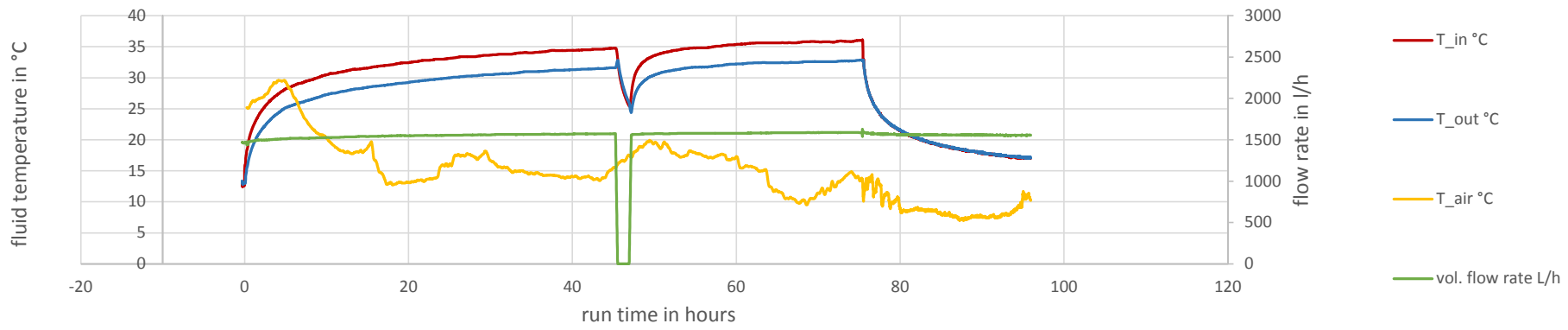
date/time table	**DD.MM.YYYY hh:mm**
BHE drilled and completed	30.08.2017
BHE pipes filled	30.08.2017 00:00
T-profile before TRT	21.09.2018 11:00
start of TRT heater on)	**21.09.2018 11:24**
end of TRT (heater off)	**23.09.2018 08:30**
1st T-profile after TRT	00.01.1900 00:00
2nd T-profile after TRT	00.01.1900 00:00

BHE settings		
drilling length	84.5	m
tubing length	84.5	m
mean drilling diameter	125	mm
type of tubing	simplex 1xU	
diameter of tubes	40	mm
grouting material	TERMOROTAS	
heat carrier fluid	fresh water	
vol. heat capacity of fluid (if not water)		MJ/m³/K

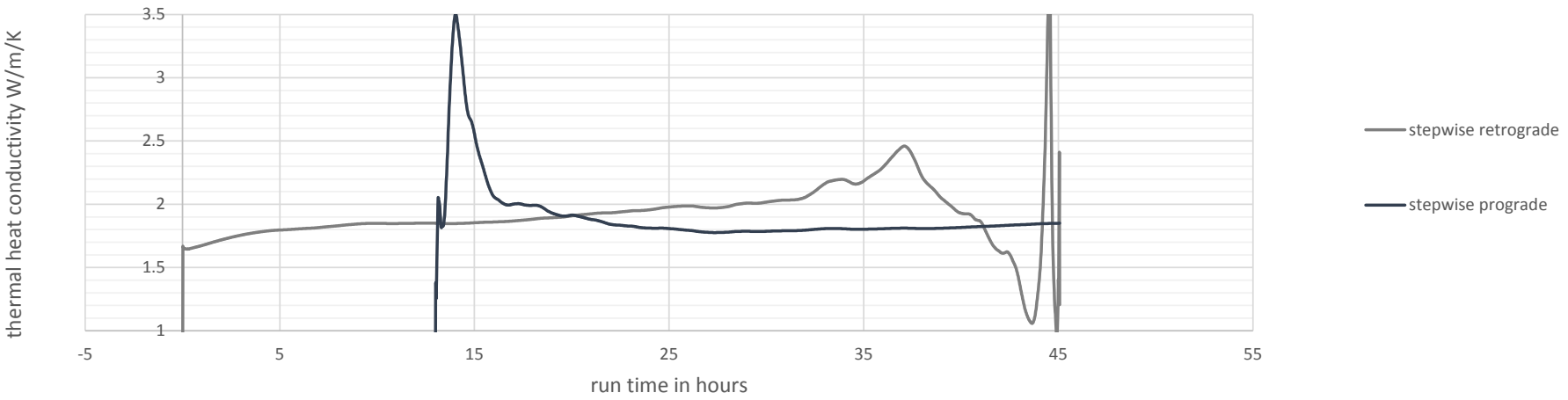
free text comments on incidents during measurements

TRT raw data and stepwise evaluation plot

raw data plots: inlet and outlet fluid temperature, ambient air temperature [°C] and pumping rate [l/h] against time [h]



processed data plot: stepwise evaluation of thermal conductivity (see VDI4640-5)



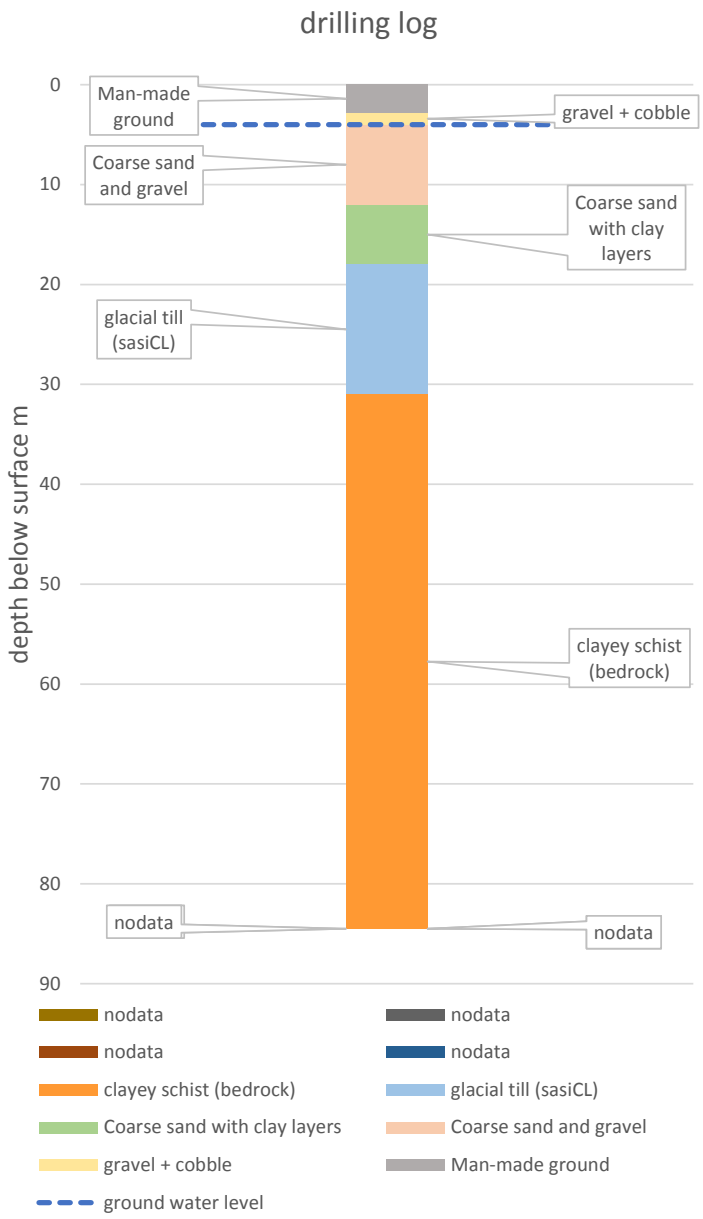
TRT results

data processing		
method applied	line source method harmonized GeoPLASMa-CE approach	
results		
effective thermal conductivity	**1.85**	*W/m/K*
mean underground temperature below 10 m	**12.3**	*°C*
thermal borehole resistance	**0.12**	*K/W/m*

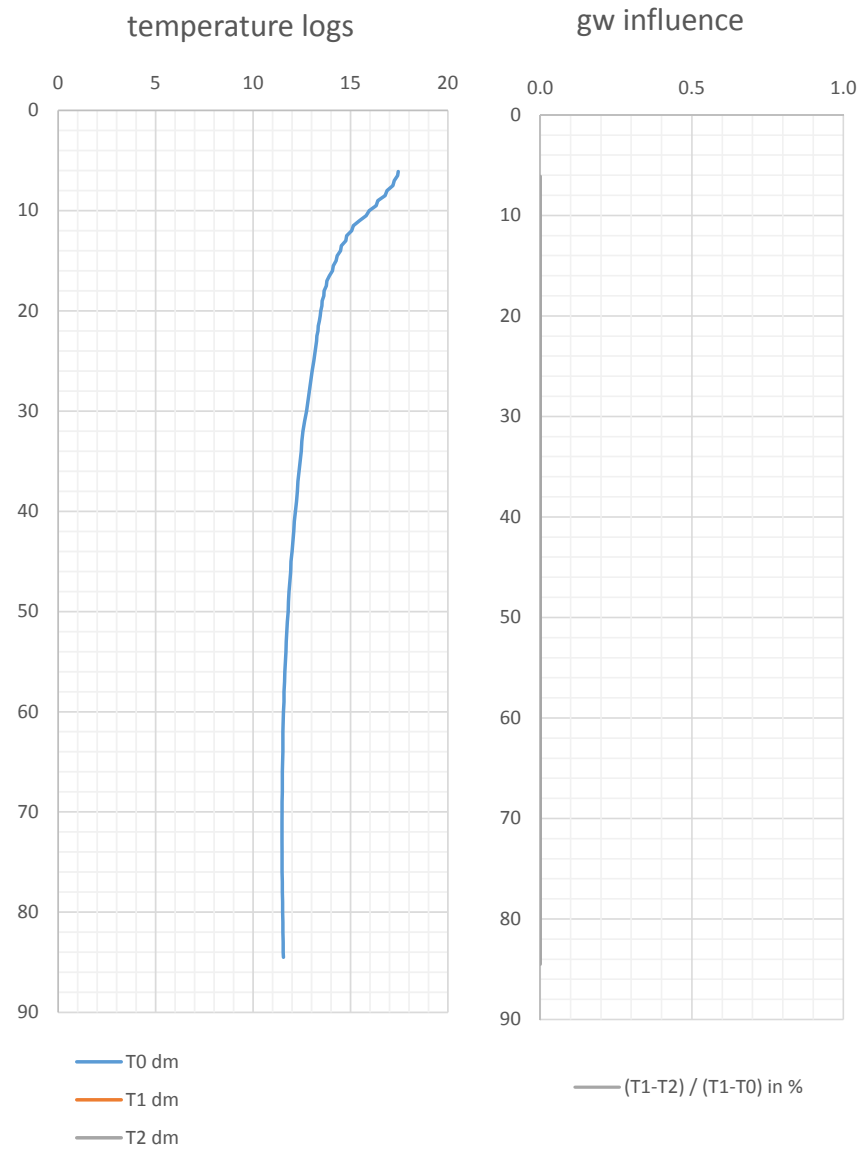
t_{min} suggest	13.5	h
t_{min} minimum time criterion	**13**	h
estimated total error	**10.3**	**%**
	0.19	**W/m/K**
slope stability	0.13	W/m/K
device error	0.14	W/m/K
line source approximation error	0.10	W/m/K

drilling log and temperature profile measurements

geological profile incldluing an estimation of the first groundwater level



temperature profiles: baseline measurement (before start of TRT), additional measurements after TRT



GeoPLASMA-CE criterion check

criterion title	target value	actual value	criterion fullfilled
waiting time after drilling	7	387	OK
waiting time after filling the pipes	1	387.5	OK
length of the BHE	25	84.5	OK
duration of the TRT test	61.491	45.09	test duration should be higher
specific power load	30	67	OK
turbulent flow	3000	13070	OK
sampling interval	2	1.0	OK
temperature profile before TRT	1	1	OK
temperature profile after TRT with delay 12-24h	12	0.0	waiting time should be higher

comments

Power interruption at run time 45; evaluation considers only the first run.
no temperature log after TRT available

general information

pilot area	**PA Krakow**
TRT measurement ID	-
location of BHE	-
coodinates	-
reference system	-
drilling company	-
name	-
address	-
owner of the BHE	AGH
name	-
address	-

measurement performed by	TRT#2
name, adress	
email, telefone	
evaluated by	Geologische Bundesansalt
name, adress	Martin Fuchsluger
email, telefone	martin.fuchsluger@geologie.ac.at

sensor accuracy of the TRT device		
TRT device	TRT#2	
max. derivation of temp. sensors	0.05	K
accuracy of flow meter	50	L/h

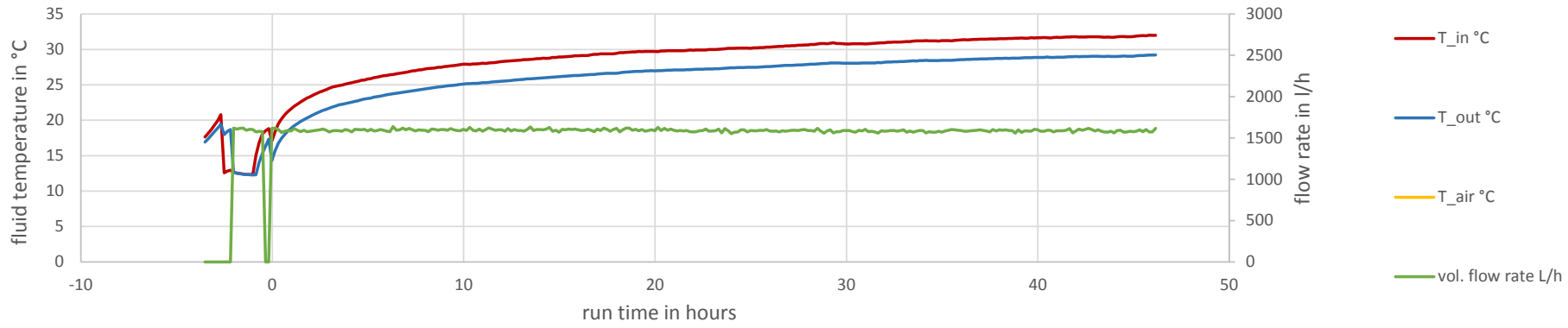
date/time table	**DD.MM.YYYY hh:mm**
BHE drilled and completed	30.08.2017
BHE pipes filled	30.08.2017 00:00
T-profile before TRT	24.04.2018 10:12
start of TRT heater on)	**24.04.2018 13:11**
end of TRT (heater off)	**26.04.2018 11:30**
1st T-profile after TRT	26.04.2018 12:30
2nd T-profile after TRT	26.04.2018 14:23

BHE settings		
drilling length	84.5	m
tubing length	84.5	m
mean drilling diameter	125	mm
type of tubing	simplex 1xU	
diameter of tubes	40	mm
grouting material	TERMOROTAS	
heat carrier fluid	fresh water	
vol. heat capacity of fluid (if not water)		MJ/m³/K

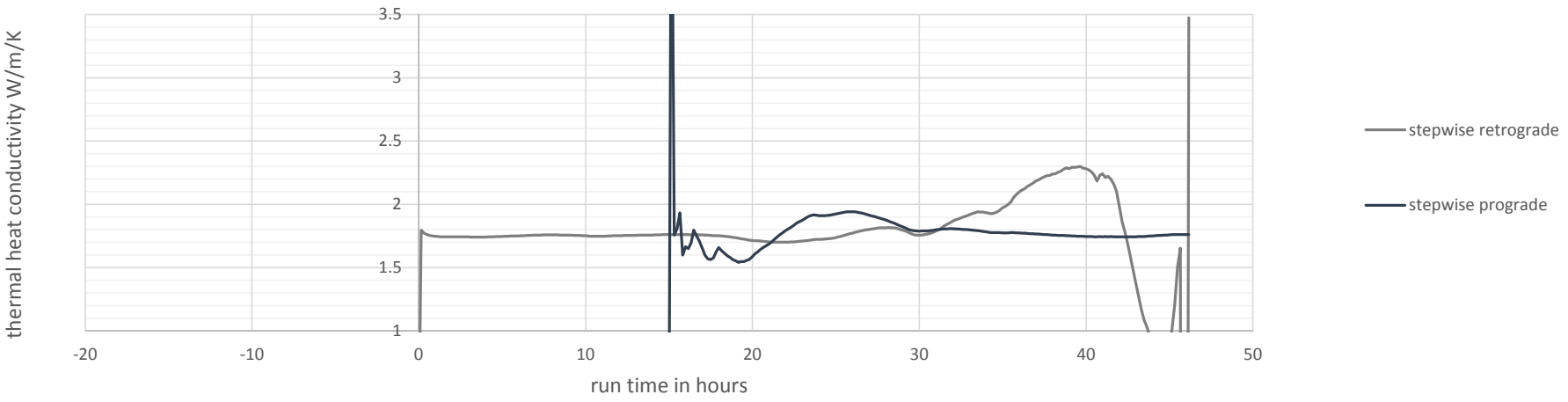
free text comments on incidents during measurements

TRT raw data and stepwise evaluation plot

raw data plots: inlet and outlet fluid temperature, ambient air temperature [°C] and pumping rate [l/h] against time [h]



processed data plot: stepwise evaluation of thermal conductivity (see VDI4640-5)



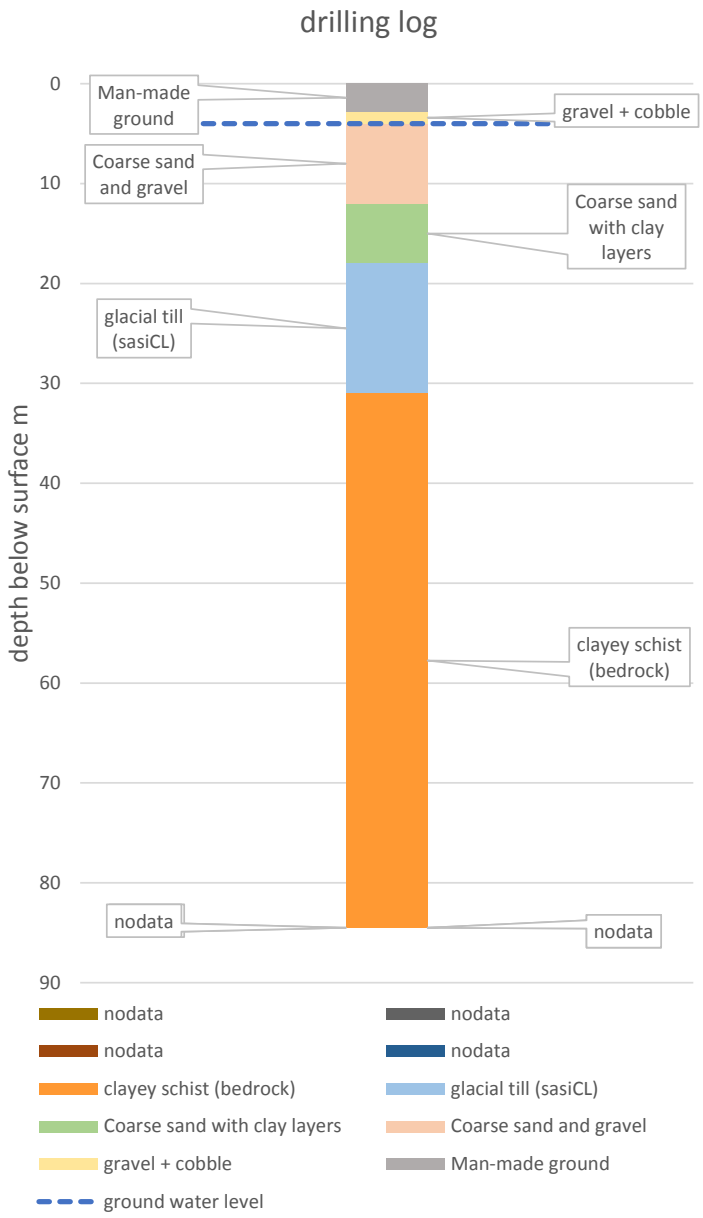
TRT results

data processing		
method applied	line source method harmonized GeoPLASMa-CE approach	
results		
effective thermal conductivity	**1.76**	*W/m/K*
mean underground temperature below 10 m	**11.5**	*°C*
thermal borehole resistance	**0.13**	*K/W/m*

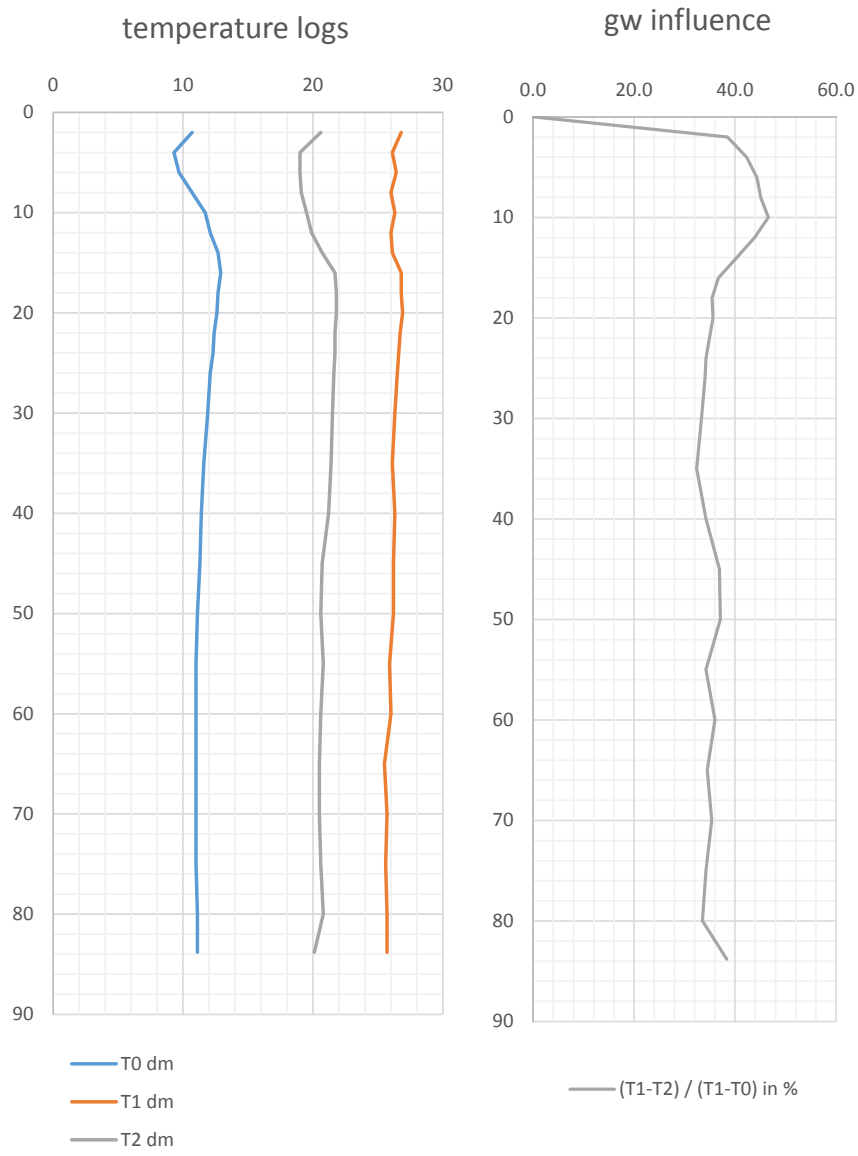
t_{min} suggest	14.2	h
t_{min} minimum time criterion	**15**	h
estimated total error	**6.0**	**%**
	0.11	**W/m/K**
slope stability	0.06	W/m/K
device error	0.09	W/m/K
line source approximation error	0.09	W/m/K

drilling log and temperature profile measurements

geological profile incldluing an estimation of the first groundwater level



temperature profiles: baseline measurement (before start of TRT), additional measurements after TRT



GeoPLASMA-CE criterion check

criterion title	target value	actual value	criterion fullfilled
waiting time after drilling	7	238	OK
waiting time after filling the pipes	1	237.5	OK
length of the BHE	25	84.5	OK
duration of the TRT test	62.174	46.32	test duration should be higher
specific power load	30	60	OK
turbulent flow	3000	13962	OK
sampling interval	2	10.0	sampling rate should be higher
temperature profile before TRT	1	1	OK
temperature profile after TRT with delay 12-24h	12	1.9	waiting time should be higher

comments

general information

pilot area	**PA Vienna**
TRT measurement ID	Benchmark Vienna #3
location of BHE	1220 Wien, Stadlauerstraße 64-66
coodinates	608472 5343047
reference system	UTM 33N
drilling company	Porr Umwelttechnik GmbH
name	-
address	1100 Wien, Absberggasse 47
owner of the BHE	MG immo GmbH
name	Heribert Fruhauf
address	1021 Wien, Messeplatz 1

measurement performed by	TRT#1
name, adress	
email, telefone	
evaluated by	Geologische Bundesansalt
name, adress	Martin Fuchsluger
email, telefone	martin.fuchsluger@geologie.ac.at

sensor accuracy of the TRT device		
TRT device	TRT#1	
max. derivation of temp. sensors	0.05	K
accuracy of flow meter	10	L/h

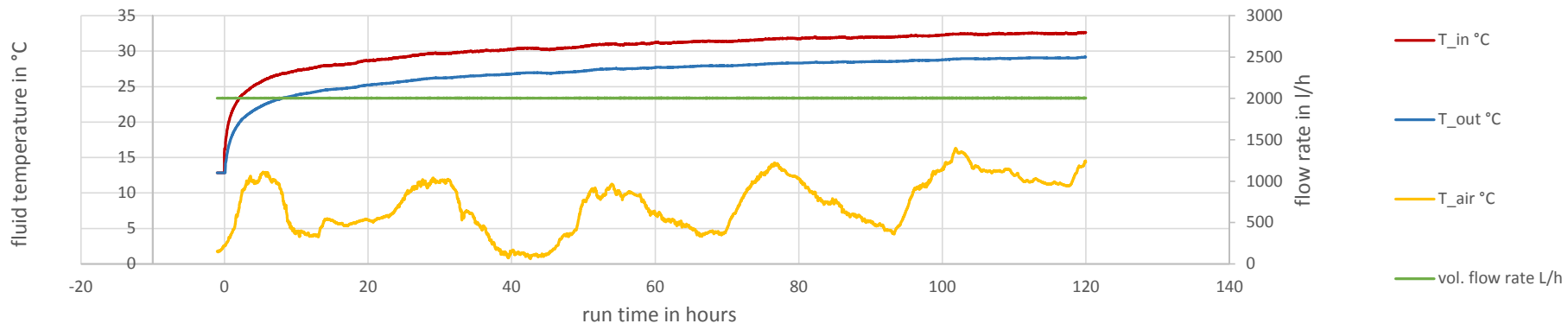
date/time table	**DD.MM.YYYY hh:mm**
BHE drilled and completed	08.02.2017
BHE pipes filled	08.02.2017 18:00
T-profile before TRT	05.03.2018 12:10
start of TRT heater on)	**07.03.2018 09:37**
end of TRT (heater off)	**12.03.2018 09:37**
1st T-profile after TRT	12.03.2018 10:20
2nd T-profile after TRT	12.03.2018 15:10

BHE settings		
drilling length	150	m
tubing length	150	m
mean drilling diameter	133	mm
type of tubing	simplex 1xU	
diameter of tubes	40	mm
grouting material	Röfix CC856	
heat carrier fluid	fresh water	
vol. heat capacity of fluid (if not water)		MJ/m³/K

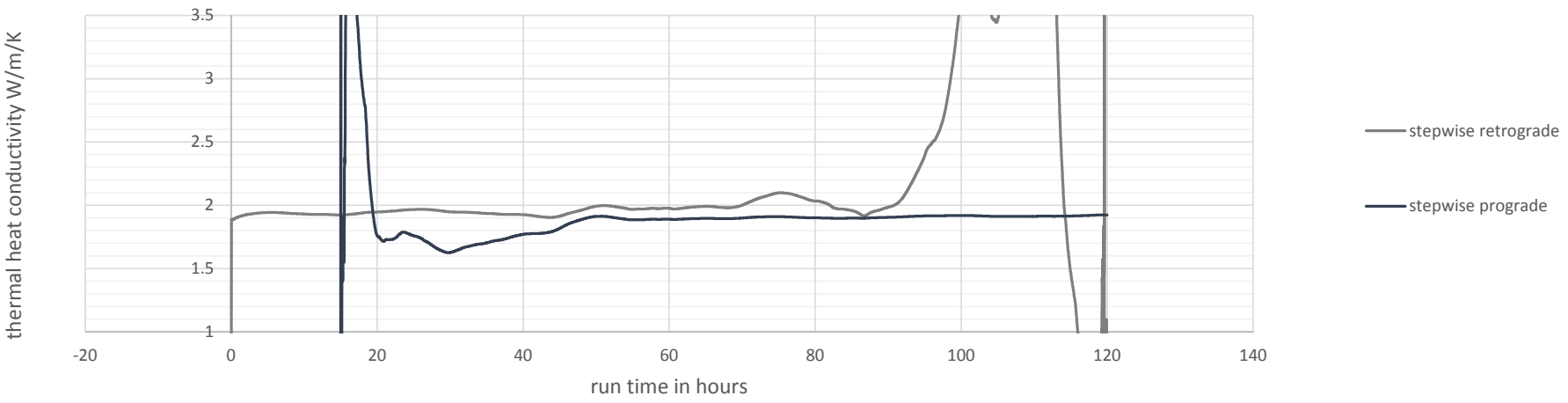
free text comments on incidents during measurements

TRT raw data and stepwise evaluation plot

raw data plots: inlet and outlet fluid temperature, ambient air temperature [°C] and pumping rate [l/h] against time [h]



processed data plot: stepwise evaluation of thermal conductivity (see VDI4640-5)



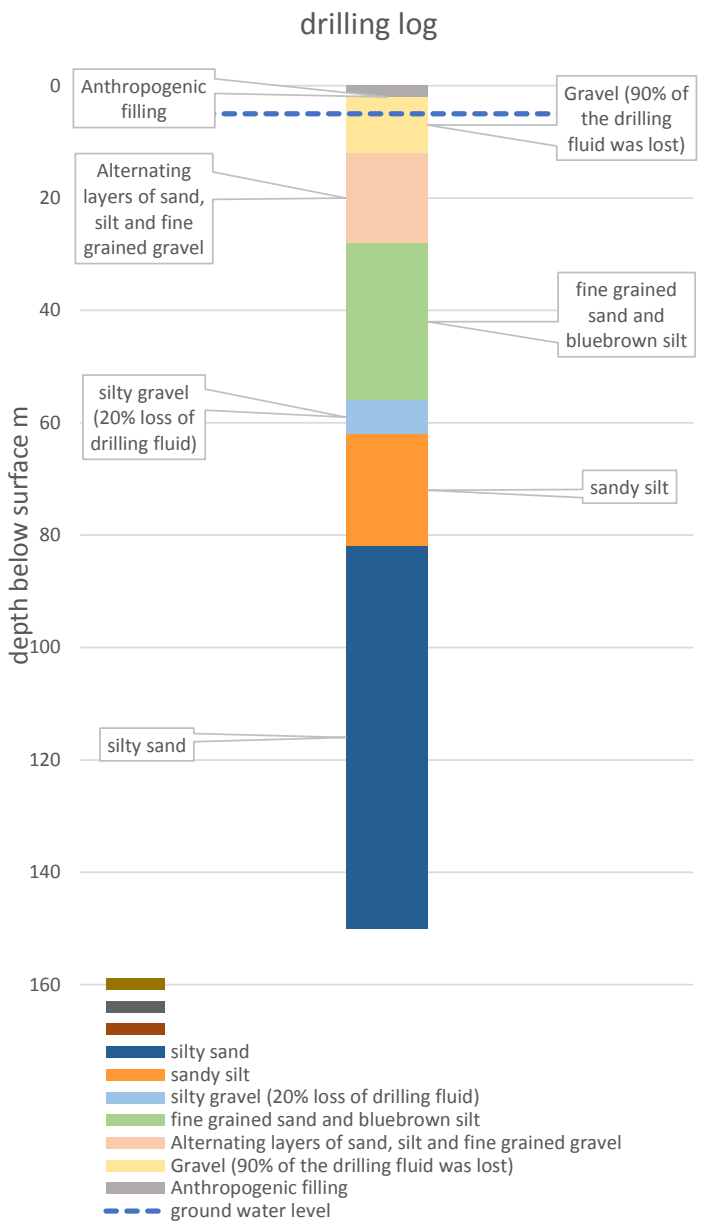
TRT results

data processing				
method applied	line source method harmonized GeoPLASMa-CE approach			
results				
	effective thermal conductivity	**1.92** *W/m/K*		
	mean underground temperature below 10 m	**12.8** *°C*		
	thermal borehole resistance	**0.12** *K/W/m*		

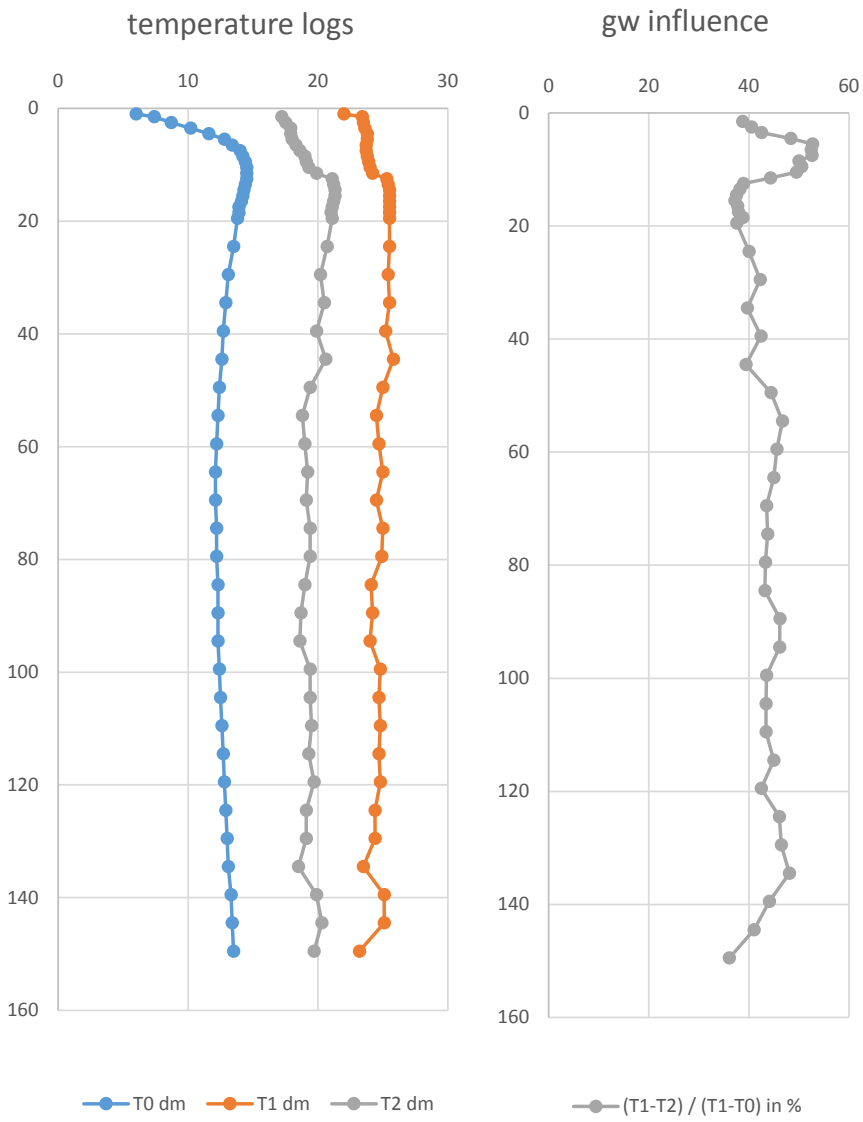
t_{min} suggest	13.0	h
t_{min} minimum time criterion	**15**	h
estimated total error	**5.2**	**%**
	0.10	**W/m/K**
slope stability	0.04	W/m/K
device error	0.04	W/m/K
line source approximation error	0.10	W/m/K

drilling log and temperature profile measurements

geological profile incldluing an estimation of the first groundwater level



temperature profiles: baseline measurement (before start of TRT), additional measurements after TRT



GeoPLASMA-CE criterion check

criterion title	target value	actual value	criterion fullfilled
waiting time after drilling	7	392	OK
waiting time after filling the pipes	1	391.7	OK
length of the BHE	25	150	OK
duration of the TRT test	60.966	120.00	OK
specific power load	30	53	OK
turbulent flow	3000	16958	OK
sampling interval	1	1	OK
temperature profile before TRT	1	1	OK
temperature profile after TRT with delay 12-24h	12	4.8	waiting time should be higher

comments

1st run was started on 5.3.2018 15:08 with
power interuption on 6.3.2018 19:49
circulation restart on 7.3.2018
wait until temperature of BHEin and BHEout was stable at 12.85 °C
Restart on 7.3.2018 9:37

general information

pilot area	**PA Vienna**
TRT measurement ID	Benchmark Vienna #1
location of BHE	1220 Wien, Stadlauerstraße 64-66
coodinates	608472 5343047
reference system	UTM 33N
drilling company	Porr Umwelttechnik GmbH
name	-
address	1100 Wien, Absberggasse 47
owner of the BHE	MG immo GmbH
name	Heribert Fruhauf
address	1021 Wien, Messeplatz 1

measurement performed by	TRT#3
name, adress	
email, telefone	
evaluated by	Geologische Bundesansalt
name, adress	Martin Fuchsluger
email, telefone	martin.fuchsluger@geologie.ac.at

sensor accuracy of the TRT device		
TRT device	TRT#3	
max. derivation of temp. sensors	0.2	K
accuracy of flow meter	70	L/h

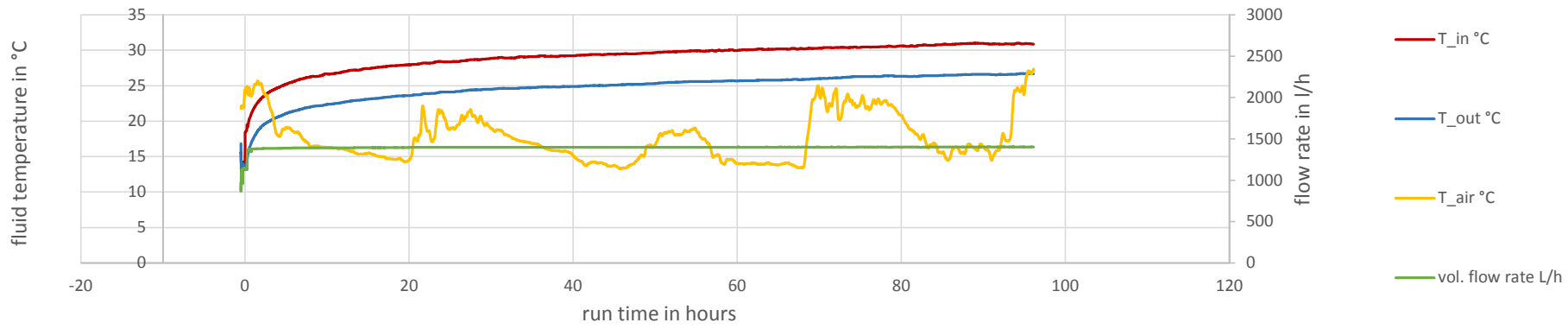
date/time table	**DD.MM.YYYY hh:mm**
BHE drilled and completed	08.02.2017
BHE pipes filled	08.02.2017 18:00
T-profile before TRT	01.09.2017 09:00
start of TRT heater on)	**01.09.2017 10:38**
end of TRT (heater off)	**05.09.2017 10:47**
1st T-profile after TRT	05.09.2017 11:15
2nd T-profile after TRT	05.09.2017 13:15

BHE settings		
drilling length	150	m
tubing length	150	m
mean drilling diameter	133	mm
type of tubing	simplex 1xU	
diameter of tubes	40	mm
grouting material	Röfix CC856	
heat carrier fluid	fresh water	
vol. heat capacity of fluid (if not water)		MJ/m³/K

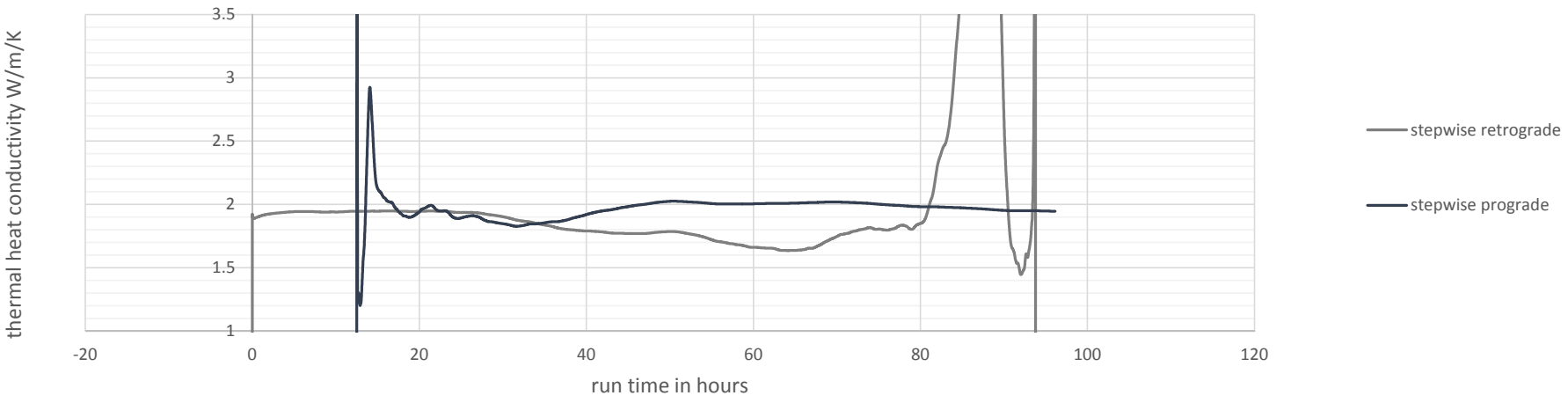
free text comments on incidents during measurements

TRT raw data and stepwise evaluation plot

raw data plots: inlet and outlet fluid temperature, ambient air temperature [°C] and pumping rate [l/h] against time [h]



processed data plot: stepwise evaluation of thermal conductivity (see VDI4640-5)



TRT results

data processing

method applied line source method
harmonized GeoPLASMa-CE approach

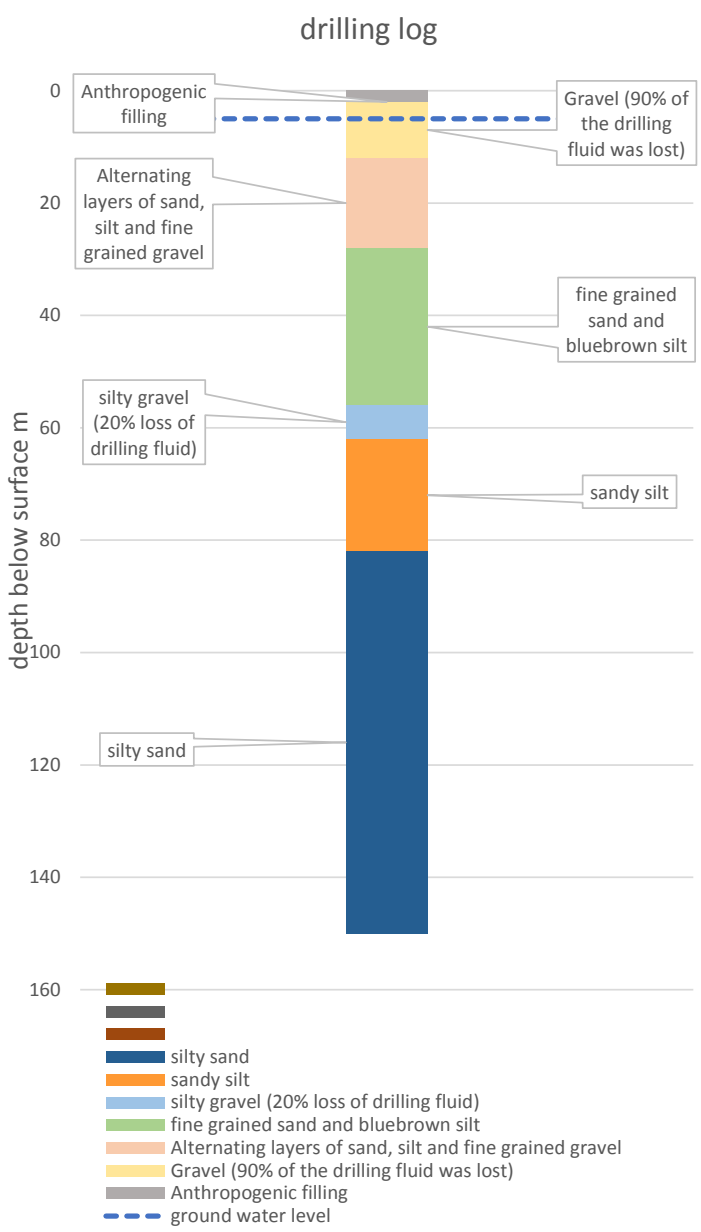
results

effective thermal conductivity	**1.95**	*W/m/K*
mean underground temperature below 10 m	**12.9**	*°C*
thermal borehole resistance	**0.13**	*K/W/m*

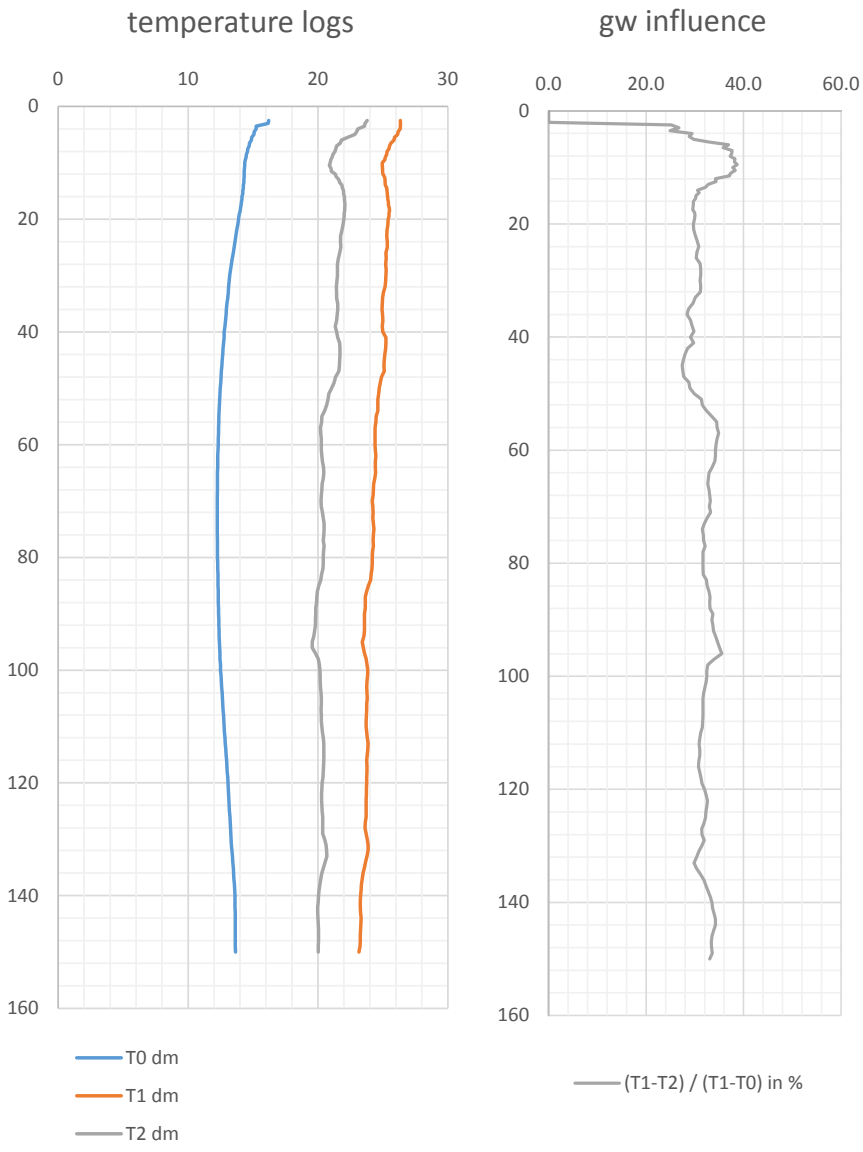
t_{min} suggest	12.8	h
t_{min} minimum time criterion	**12.5**	h
estimated total error	**9.8**	**%**
	0.19	**W/m/K**
slope stability	0.03	W/m/K
device error	0.19	W/m/K
line source approximation error	0.12	W/m/K

drilling log and temperature profile measurements

geological profile incldluing an estimation of the first groundwater level



temperature profiles: baseline measurement (before start of TRT), additional measurements after TRT

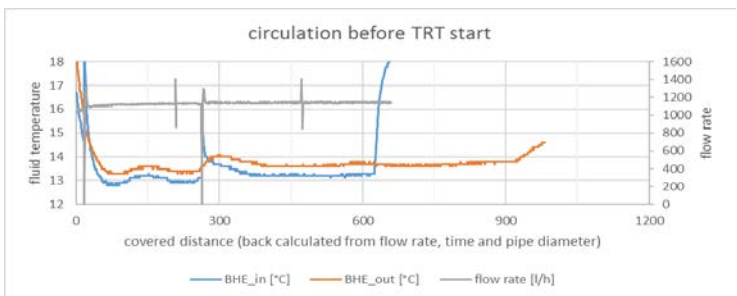


GeoPLASMA-CE criterion check

criterion title	target value	actual value	criterion fullfilled
waiting time after drilling	7	205	OK
waiting time after filling the pipes	1	204.7	OK
length of the BHE	25	150	OK
duration of the TRT test	60.819	96.14	OK
specific power load	30	47	OK
turbulent flow	3000	11601	OK
sampling interval	2	1.0	OK
temperature profile before TRT	1	1	OK
temperature profile after TRT with delay 12-24h	12	2.0	waiting time should be higher

comments

It seems, that temperature sensors at this device between BHE inlet and outlet are not calibrated to each other: temperature difference is -0.4 K at circulation test before heater is switched on.



general information

pilot area	**PA Vienna**
TRT measurement ID	Benchmark Vienna #2
location of BHE	1220 Wien, Stadlauerstraße 64-66
coodinates	608472 5343047
reference system	UTM 33N
drilling company	Porr Umwelttechnik GmbH
name	-
address	1100 Wien, Absberggasse 47
owner of the BHE	MG immo GmbH
name	Heribert Fruhauf
address	1021 Wien, Messeplatz 1

measurement performed by	TRT#2
name, adress	
email, telefone	
evaluated by	Geologische Bundesansalt
name, adress	Martin Fuchsluger
email, telefone	martin.fuchsluger@geologie.ac.at

sensor accuracy of the TRT device		
TRT device	TRT#2	
max. derivation of temp. sensors	0.05	K
accuracy of flow meter	50	L/h

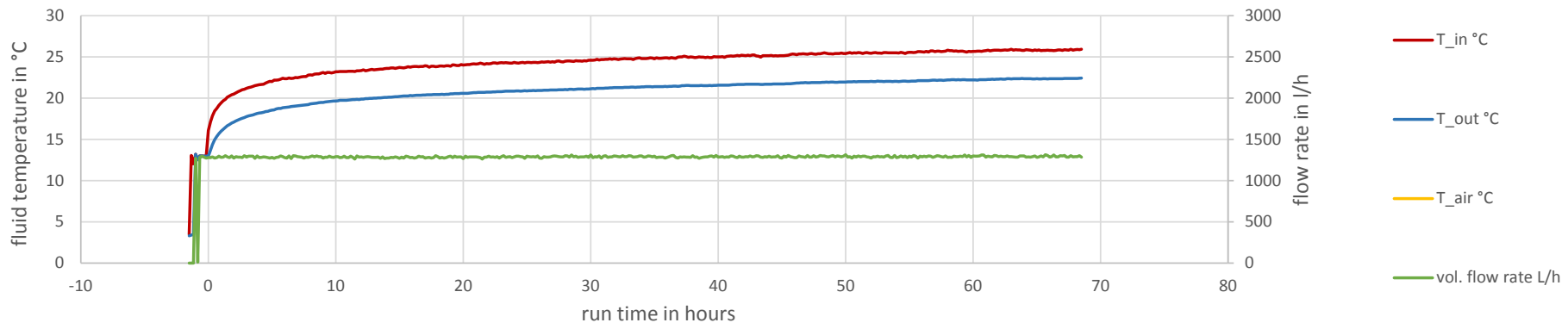
date/time table	**DD.MM.YYYY hh:mm**
BHE drilled and completed	08.02.2017
BHE pipes filled	08.02.2017 18:00
T-profile before TRT	26.01.2018 10:32
start of TRT heater on)	**26.01.2018 13:10**
end of TRT (heater off)	**29.01.2018 09:50**
1st T-profile after TRT	29.01.2018 09:46
2nd T-profile after TRT	29.01.2018 11:45

BHE settings		
drilling length	150	m
tubing length	150	m
mean drilling diameter	133	mm
type of tubing	simplex 1xU	
diameter of tubes	40	mm
grouting material	Röfix CC856	
heat carrier fluid	fresh water	
vol. heat capacity of fluid (if not water)		MJ/m³/K

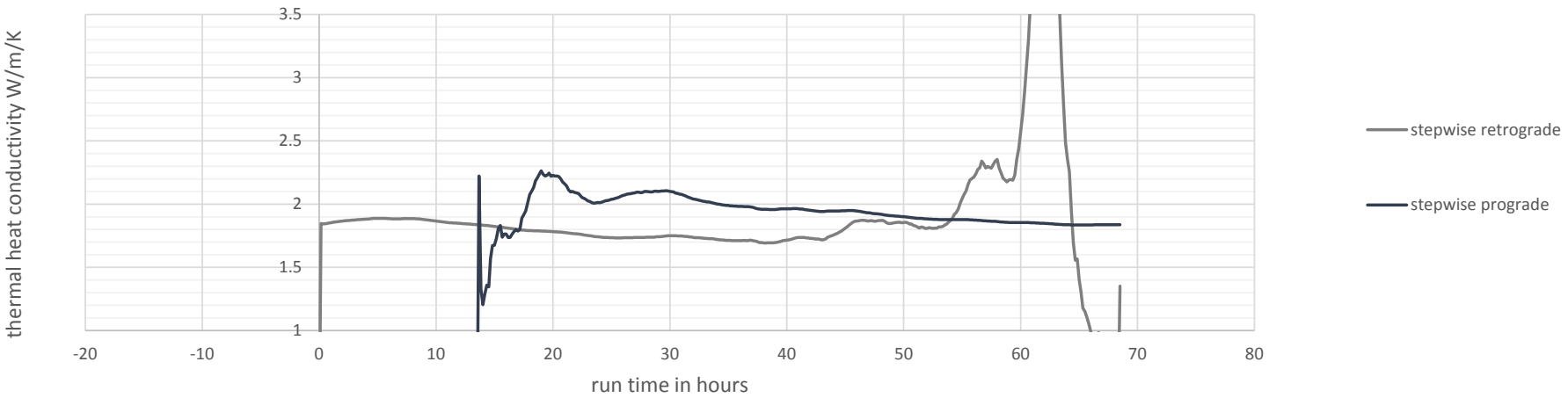
free text comments on incidents during measurements

TRT raw data and stepwise evaluation plot

raw data plots: inlet and outlet fluid temperature, ambient air temperature [°C] and pumping rate [l/h] against time [h]



processed data plot: stepwise evaluation of thermal conductivity (see VDI4640-5)



TRT results

data processing

method applied	line source method harmonized GeoPLASMa-CE approach

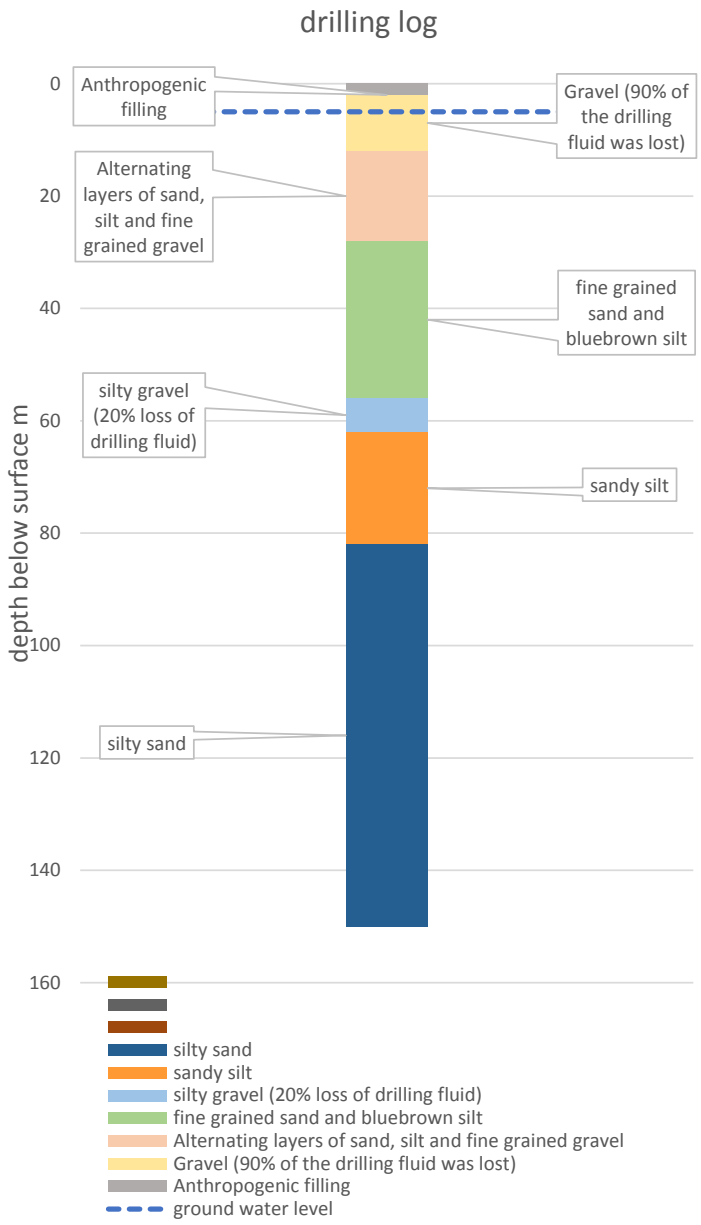
results

effective thermal conductivity	**1.84**	*W/m/K*
mean underground temperature below 10 m	**12.4**	*°C*
thermal borehole resistance	**0.14**	*K/W/m*

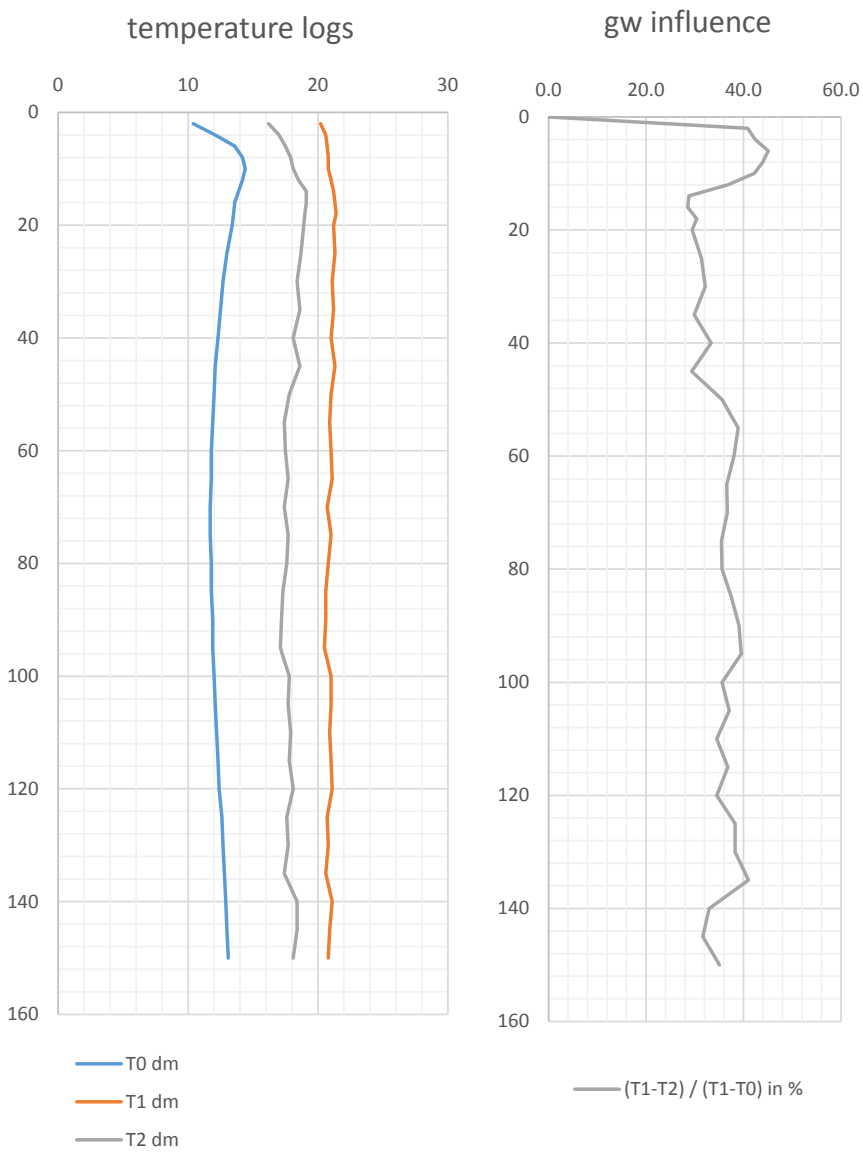
t_{min} suggest	13.6	h
t_{min} minimum time criterion	**13.6**	h
estimated total error	**9.6**	**%**
	0.18	**W/m/K**
slope stability	0.15	W/m/K
device error	0.10	W/m/K
line source approximation error	0.11	W/m/K

drilling log and temperature profile measurements

geological profile incldluing an estimation of the first groundwater level



temperature profiles: baseline measurement (before start of TRT), additional measurements after TRT



GeoPLASMA-CE criterion check

criterion title	target value	actual value	criterion fullfilled
waiting time after drilling	7	353	OK
waiting time after filling the pipes	1	351.8	OK
length of the BHE	25	150	OK
duration of the TRT test	61.583	68.67	OK
specific power load	30	35	OK
turbulent flow	3000	10995	OK
sampling interval	2	10.0	sampling rate should be higher
temperature profile before TRT	1	1	OK
temperature profile after TRT with delay 12-24h	12	2.0	waiting time should be higher

comments

large error, due to slope instability