ERDWERK®

Hydrogeologie · Geothermie

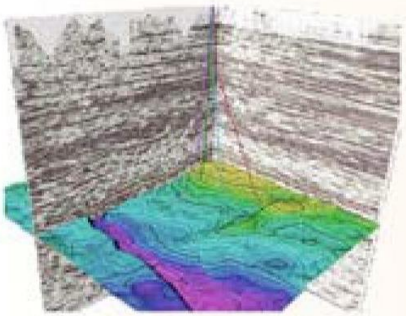
Geothermal Energy in Munich (and beyond) A Geothermal CITY Case Study

With thanks to the Erdwerk Team and
special thanks to Dr. Achim Schubert & Ulrich Steiner

Neil Farquharson

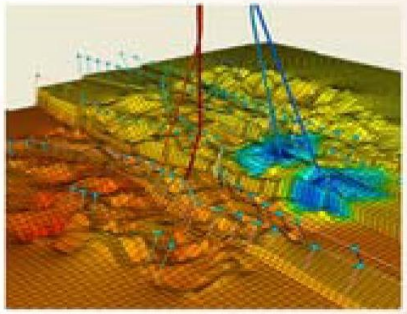
Outline

1. ERDWERK GmbH
2. Munich
3. The Southern German Molasse Basin
4. Geothermal Development in Bavaria
5. Project Optimization
6. SWM – GRAME
7. Beyond Munich
8. Geothermal Worldwide Potential



Geology & Geophysics

Geological Exploration
Geological Models
Well Site Geology
Borehole Geophysics



Reservoir Engineering

Reservoir Models
Simulation & Targeting
Risk Assessment
Well Test Analysis

Drilling Engineering

Well Design and Drilling Program
Well Site Design
Supervision
Drilling Data Analysis & Drilling Performance Analysis

Production Engineering

Completion Design
Well Test Design
Artificial Lift Systems
Stimulation Design

Project Management, Permits and Tenders

Project Management
Bidding Procedures
Approval Procedures

Clients

BMW Group

aspo

HOCHTIEF

Federal Ministry
for Economic Affairs
and Energy

MACQUARIE

SW//M

Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

RWE

RWE Innogy

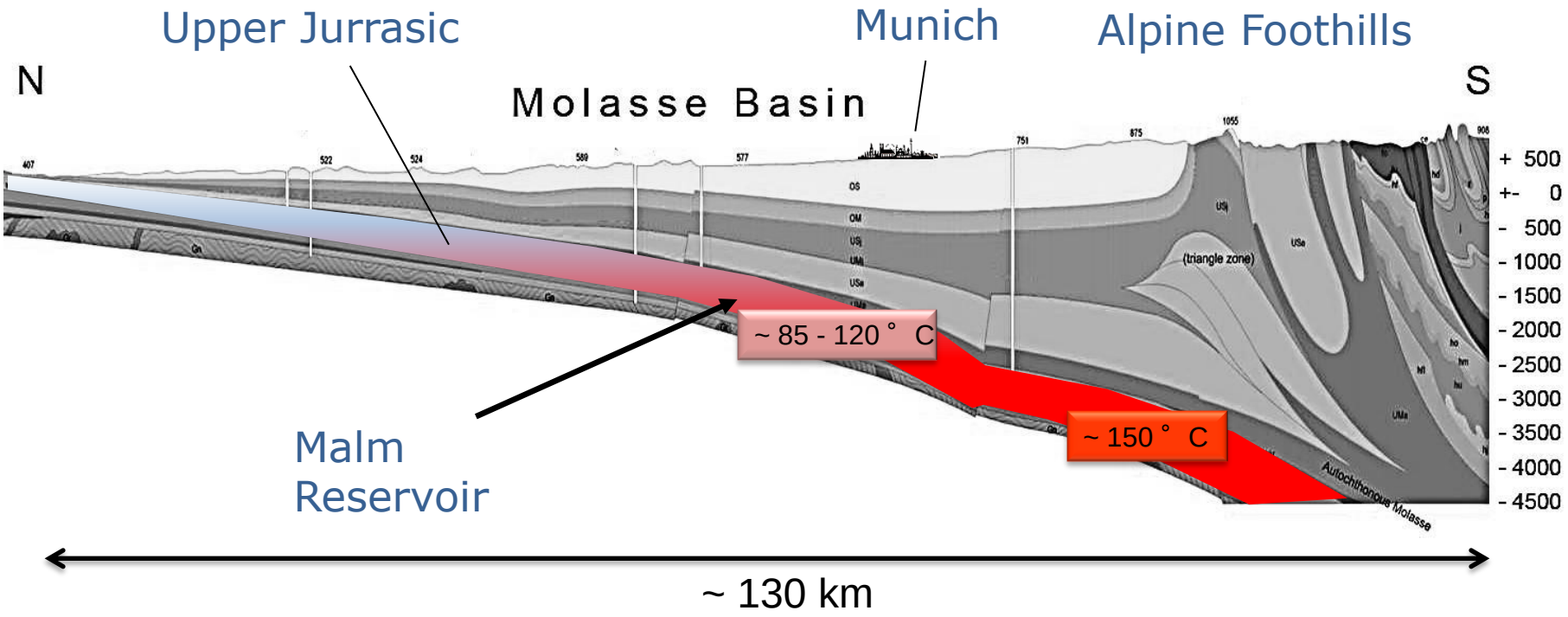
Munich RE

e·on

RAG


Reykjavik
Island
Färöer-Inseln
Tórshavn
Norwegen
Oslo
Schweden
Finnland
Bottnischer Meerbusen
Åland
Helsinki
Tallinn
Estland
Stockholm
Ostsee
Saaremaa
Rigaischer Meerbusen
Lettland
Riga
Skagerrak
Kattegat
Dänemark
Kopenhagen
Nordsee
Vesterhavet
Syl
Irland
Irish Sea
Dublin
Großbritannien
St.-Georgs-Kanal
Muir Cheilteach
London
Niederlande
Belgien
Deutschland
Ärmelkanal
Keltische See
Paris
Frankreich
Biskaya
Berlin
Polen
Warschau
Litauen
Wilna
Minsk
Oblast Kaliningrad
Prag
Tschechien
Slowakei
Wien
Budapest
Ungarn
München
Österreich
Bern
Schweiz
Slowenien
Ljubljana
Kroatien
Belgrad
Serbien
Sarajevo
Montenegro
Podgorica
Prishtina
Skopje
Albanien
Tirana
Italien
Rom
Isola d'Elba
Corse (Corsica)
Isola Maddalena
Isola d'Ischia
Sardegna (Sardinia)
Tyrrhenisches Meer
Adriatisches Meer
Balearic Sea
Mallorca
Eivissa (Ibiza)
Portugal
Lissabon
Spanien
Golf von Cádiz
Rumänien
Bukarest
Bulgarien
Sofia
Schwarzes Meer
Ukraine
Kiew
Republik Moldau
Kischinau
Asowsches Meer
Taganrog Bay
Karatschai-Tscherkessien
Region Krasnodar
Marmarameer
Türkei
Ankara
Griechenland
Athen
Kerkyra
Kos
Zypern
Nikosia
Republik Karelien
Onegasee
Ladogasee
Oblast Archangelsk
Oblast Wologda
Oblast Kostroma
Oblast Kirow
Oblast Leningrad
St. Petersburg
Oblast Jaroslawl
Oblast Nowgorod
Oblast Twer
Oblast Moskau
Moskau
Oblast Wladimir
Oblast Iwanowo
Oblast Uljanowsk
Mordwinien
Oblast Rjasan
Oblast Pensa
Oblast Tula
Oblast Kaluga
Oblast Smolensk
Tambow
Oblast Orjol
Oblast Kursk
Oblast Belgorod
Oblast Woronesch
Mari El
Udmurtien
Region
Google Earth 2016

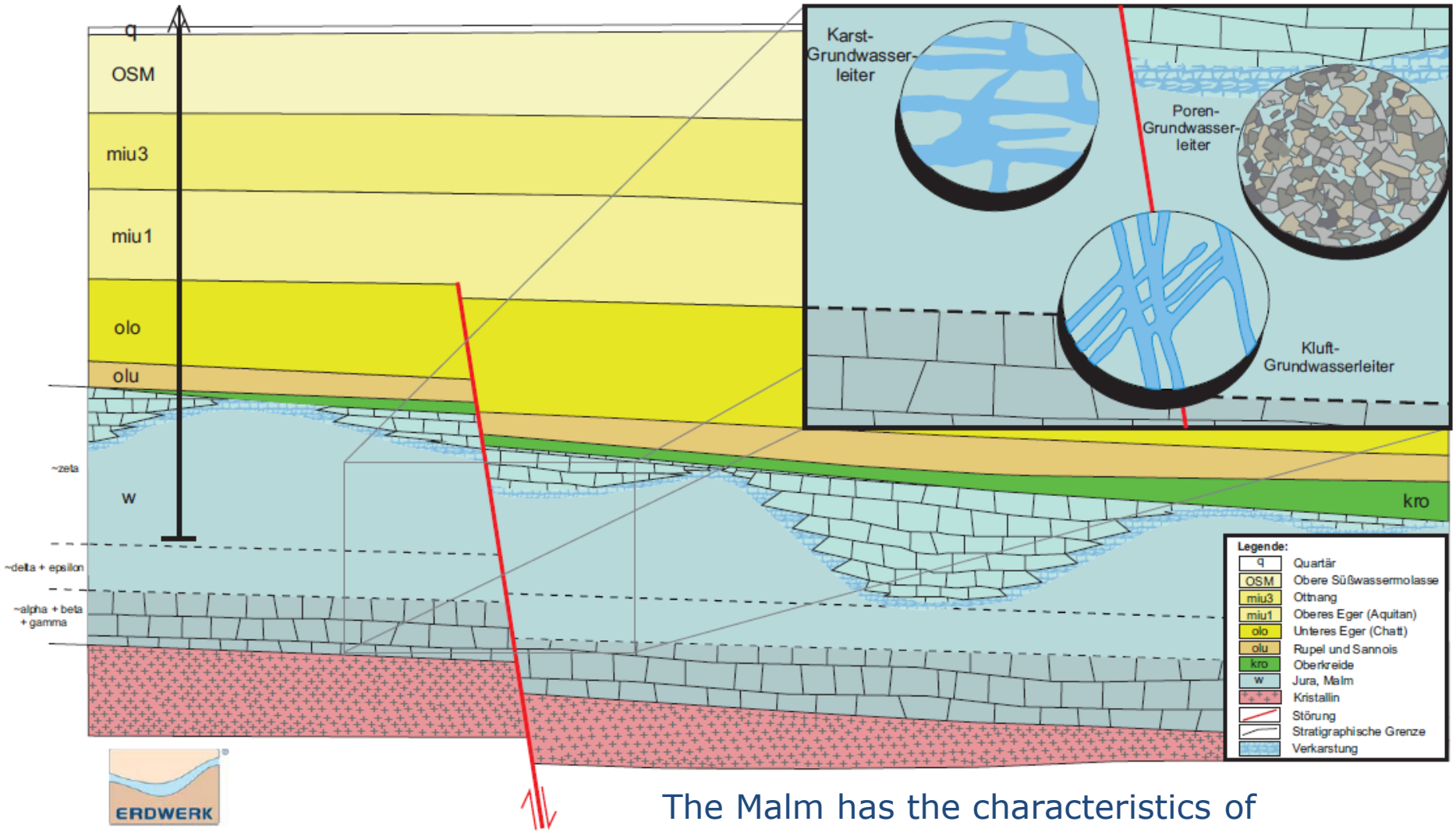
The Southern German Molasse Basin



Adapted from 'Geologische Karte von Bayern 1:500000', Bayerisches Geologisches Landesamt, 1996

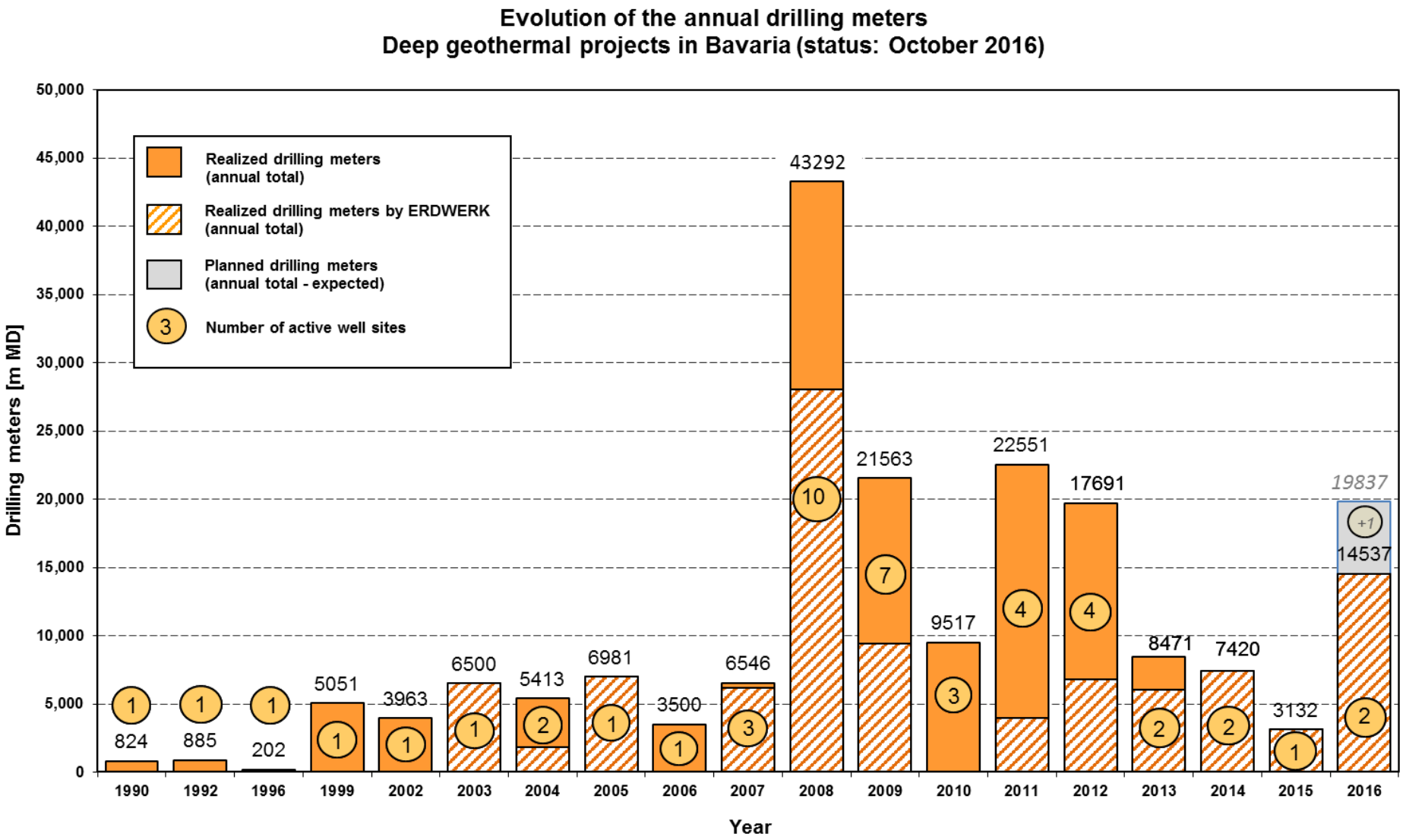
The Southern German Molasse Basin

The Southern German Molasse Basin

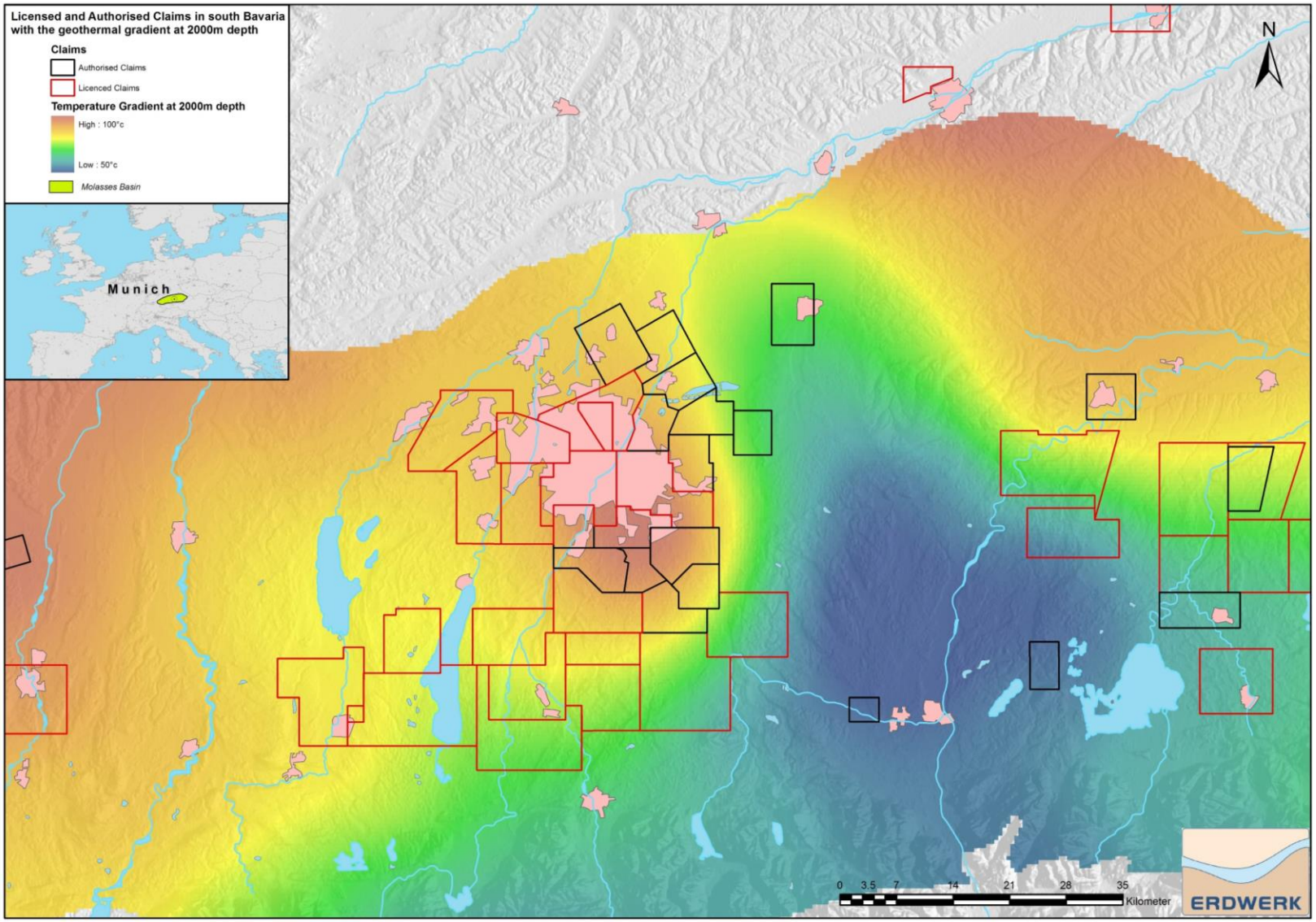


The Malm has the characteristics of many different aquifer types

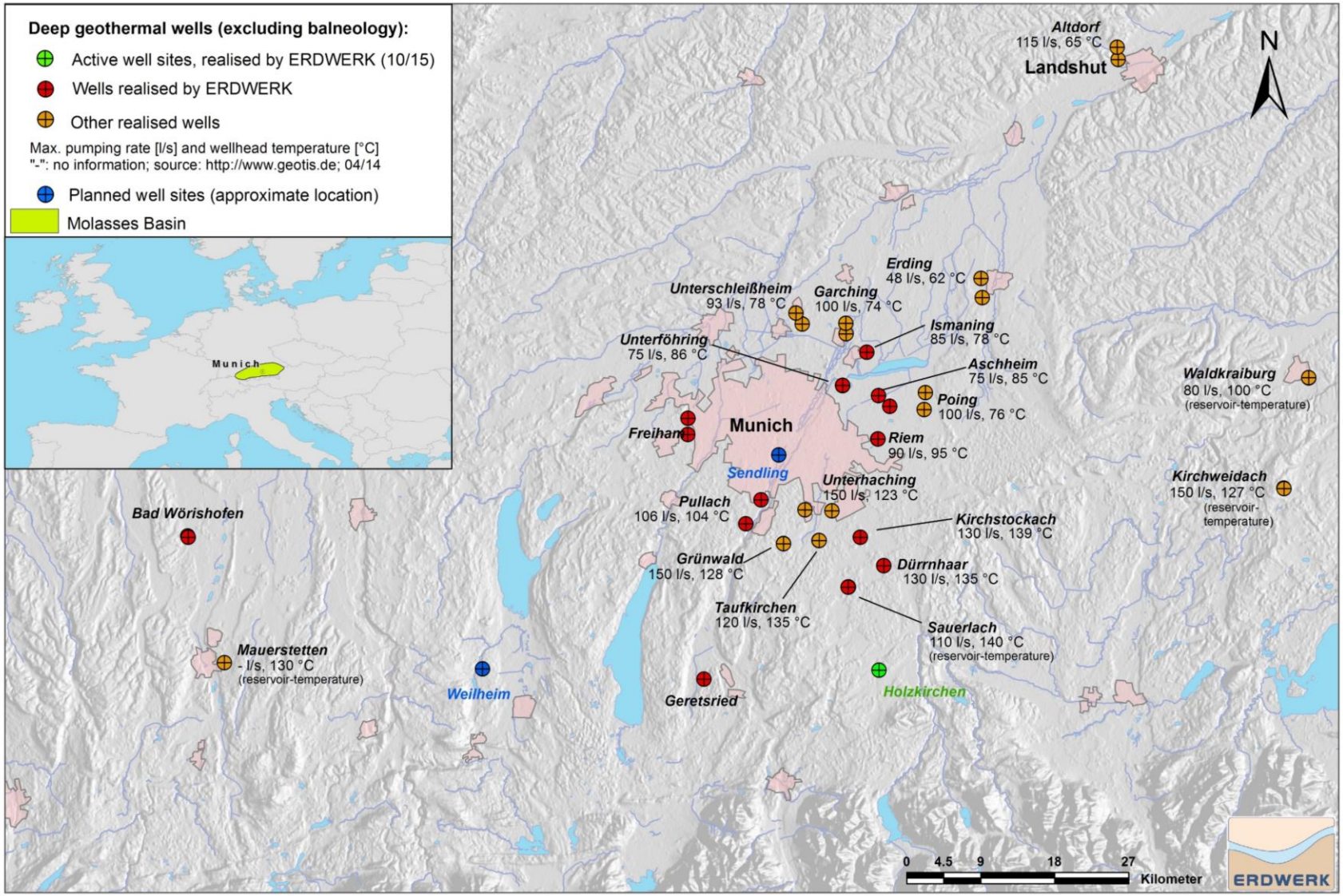
Geothermal Development in Bavaria



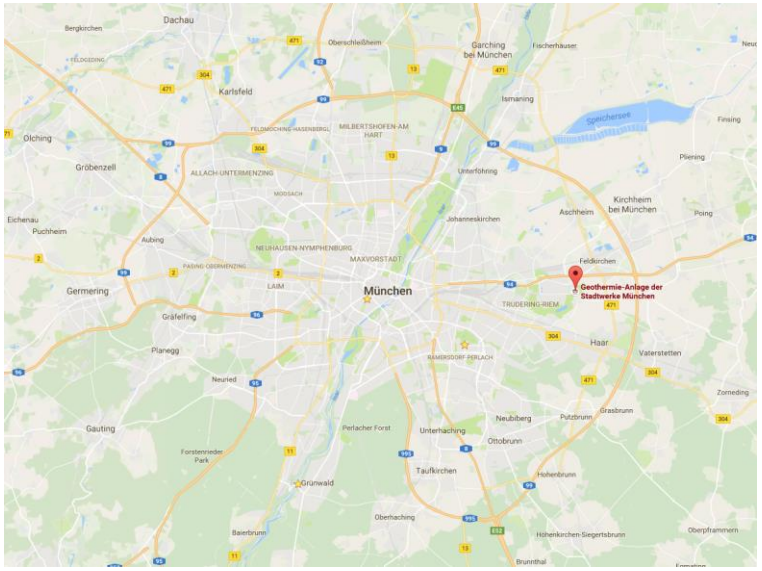
Geothermal Development in Bavaria



Geothermal Development in Bavaria



Geothermal Development Riem

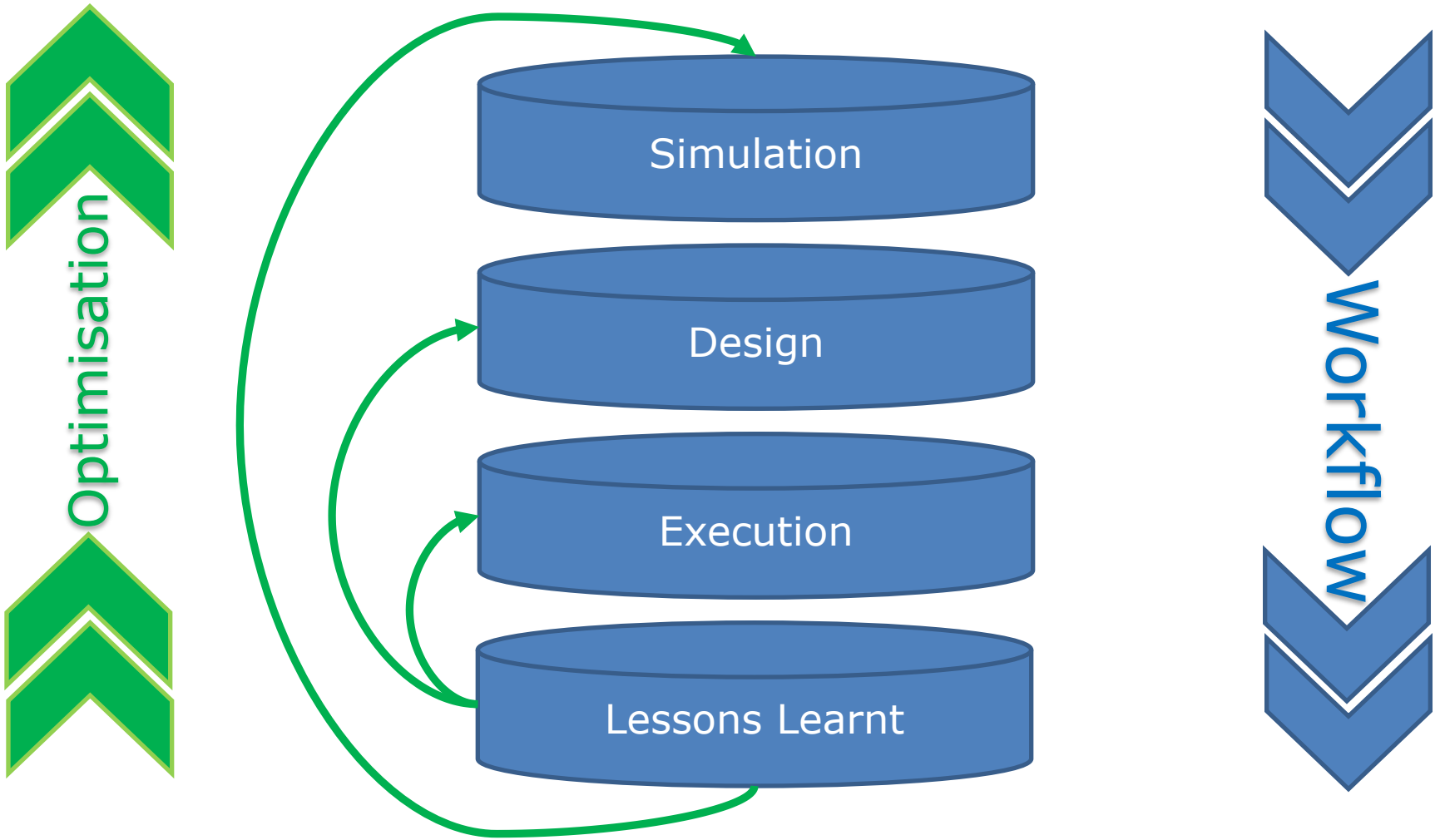


	Riem Th. 1	Riem Th.2
Depth	3,275 m MD 3,020 m TVD	3,400 m MD 2,900 m TVD
Water Temperature	94 ° C	
Production Rate	75l/s	
Maximum available heat	8 MW	

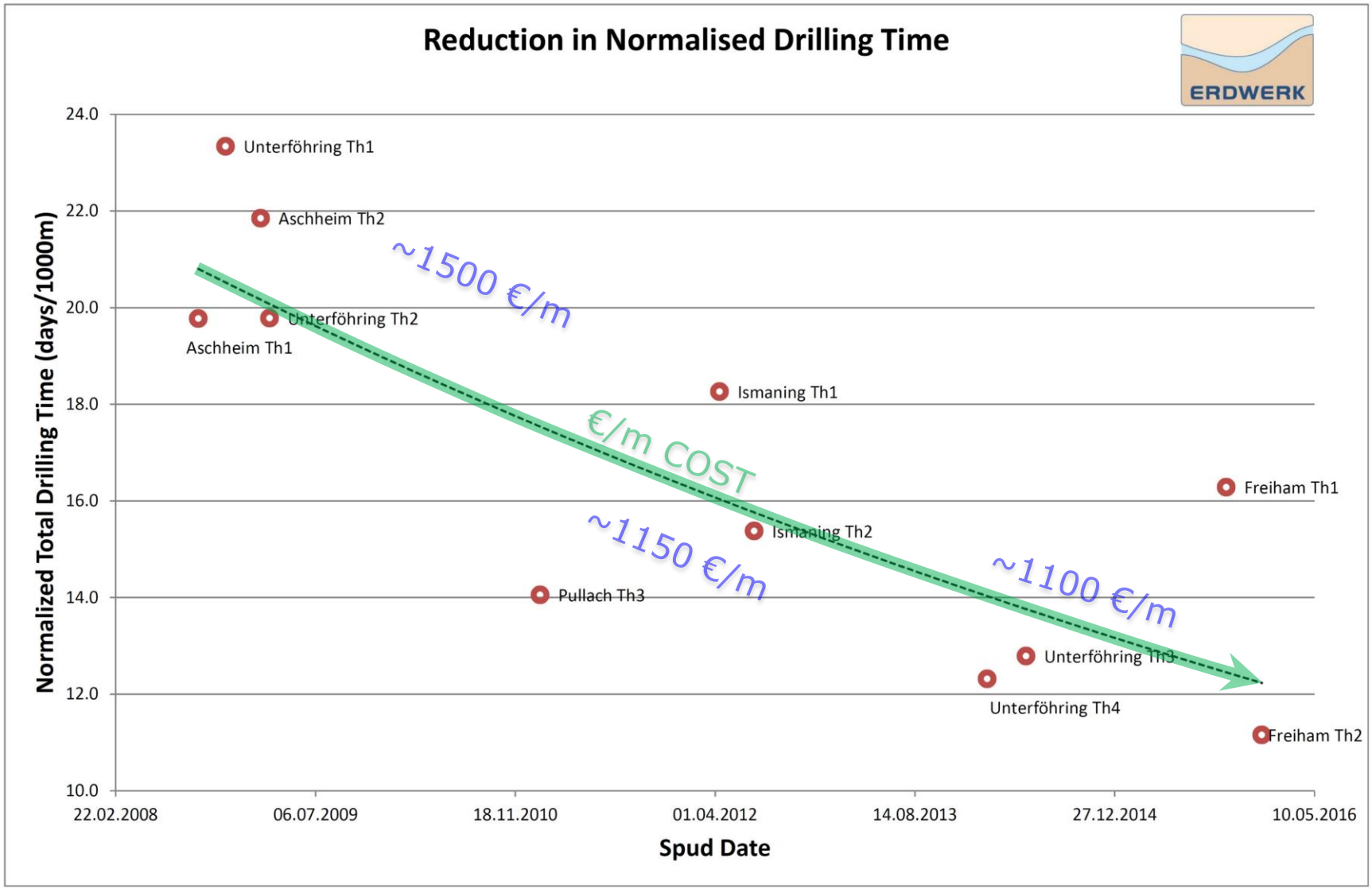
Project Optimization

- Uncertainty = project risk
  - Geological risks to drilling and
  - Hydrological output during production.
- Understanding/mitigating risks = Optimization = Cost savings
- Greater the certainty of envisaged productivity greater the chance a project will succeed at the planning and funding stage.
- Geothermal experience in Munich = reduction in uncertainties through
  - education,
  - Technical innovation
  - collaborative private and university lead research projects.
- Data obtained is utilized, analyzed and fed back

Project Optimization

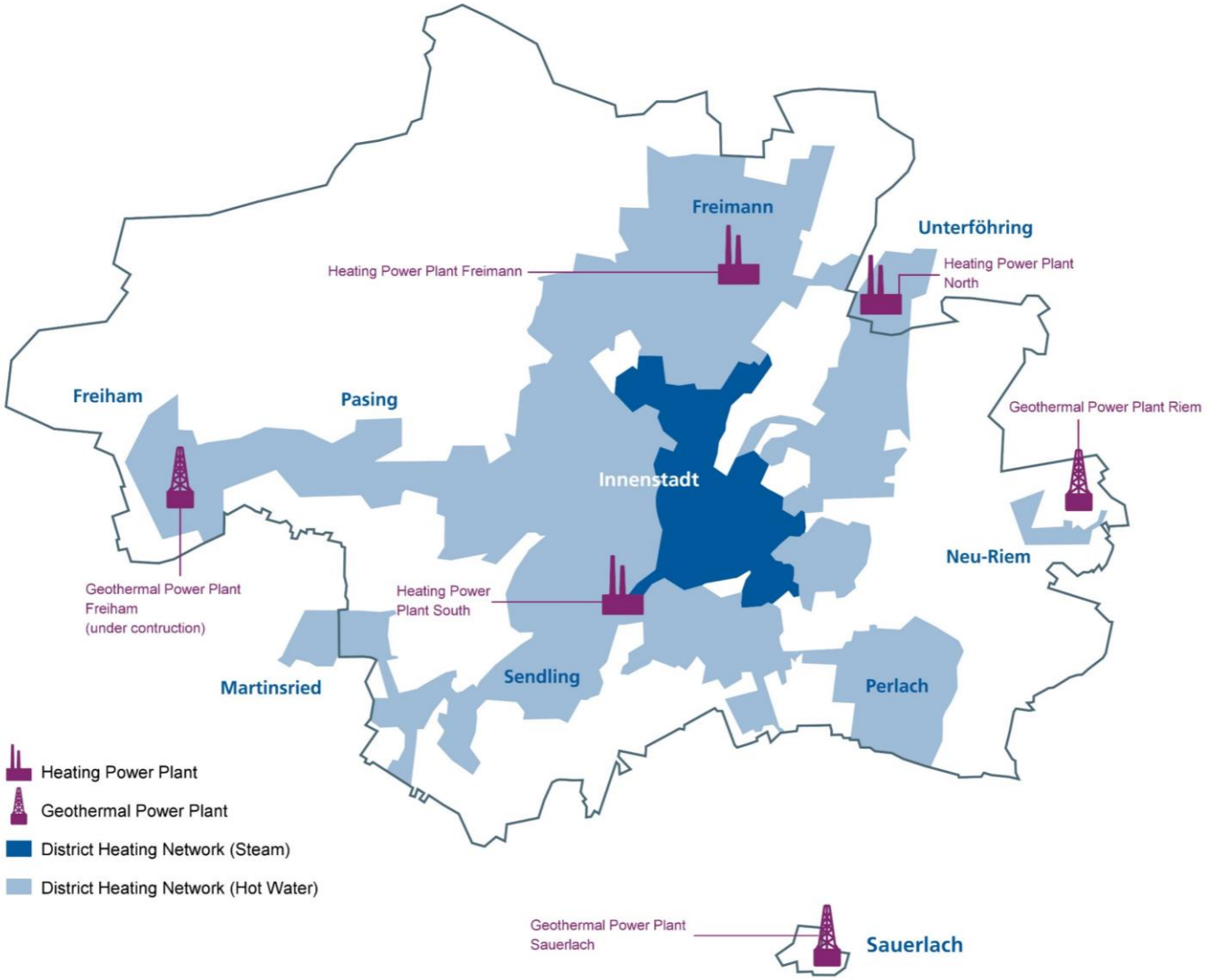


Project Optimization

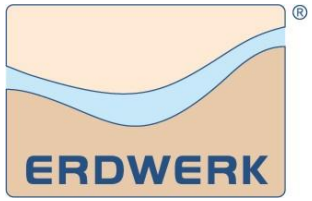


SWM

SWM


Freimann
Heating Power Plant Freimann
Unterföhring
Heating Power Plant North
Freiham
Pasing
Innenstadt
Geothermal Power Plant Riem
Neu-Riem
Geothermal Power Plant Freiham (under contruction)
Heating Power Plant South
Martinsried
Sendling
Perlach
Heating Power Plant
Geothermal Power Plant
District Heating Network (Steam)
District Heating Network (Hot Water)
Geothermal Power Plant Sauerlach
Sauerlach

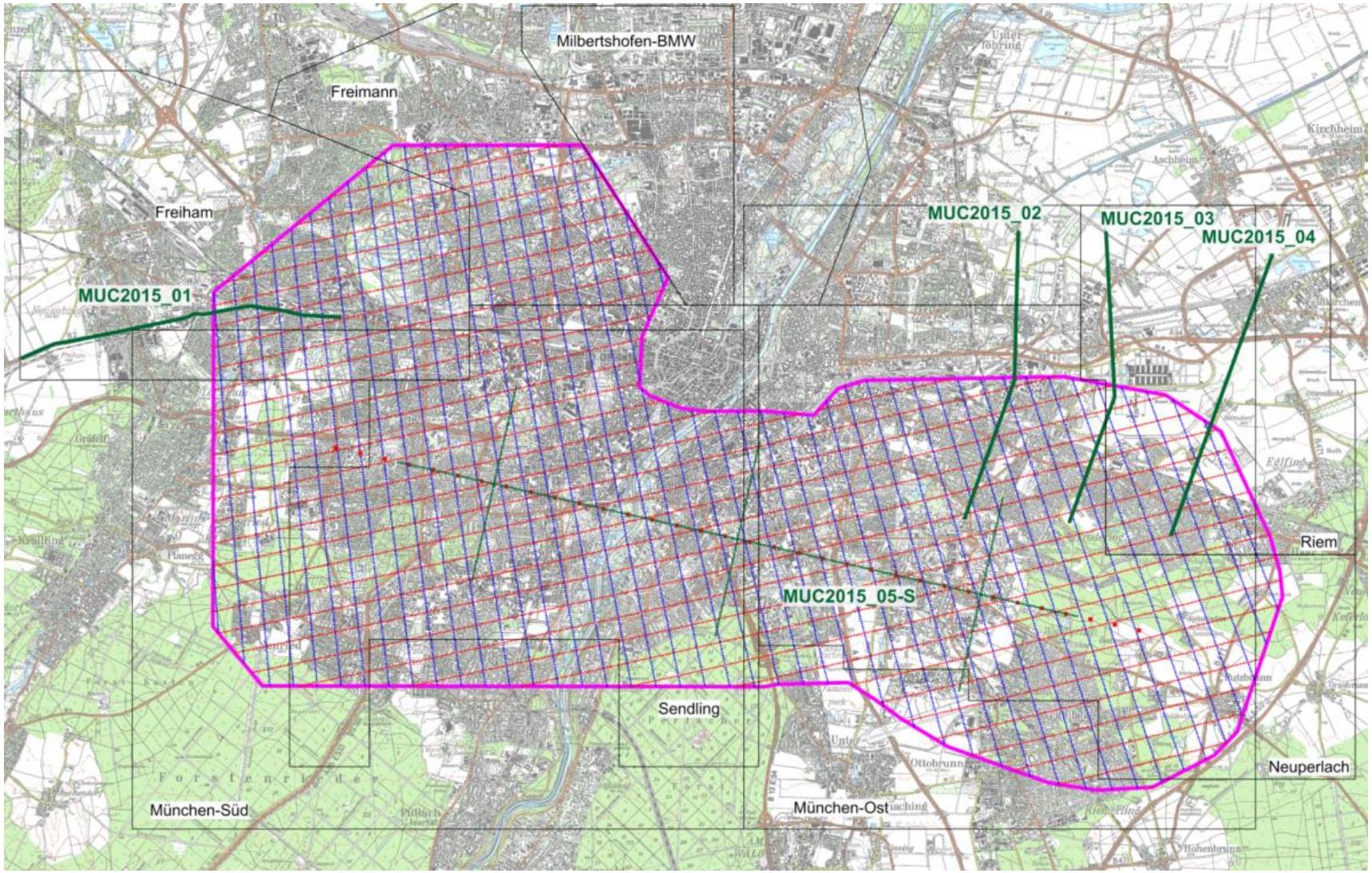
SWM - GRAME



SWM - GRAME


Feldmoching
Allach
Freimann
Unterföhring
Moosach
Aschheim
Schwabing
Aubing
Pasing
Neuhausen
Bogenhausen
Maxvorstadt
Alt-
stadt
Laim
Ludwigs-
vorstadt
Au
Berg
am Laim
Gräfelfing
Großhadern
Haar
Trudering
Giesing
Planegg
Perlach
Sendling
Grasbrunn
Neuried
Putzbrunn
Neubiberg
Unterhaching
Ottobrunn
Pullach
Grünwald
Hohenbrunn
2D - Seismic Survey
3D - Seismic Survey
City of Munich
Inner City
Outside of City Limits

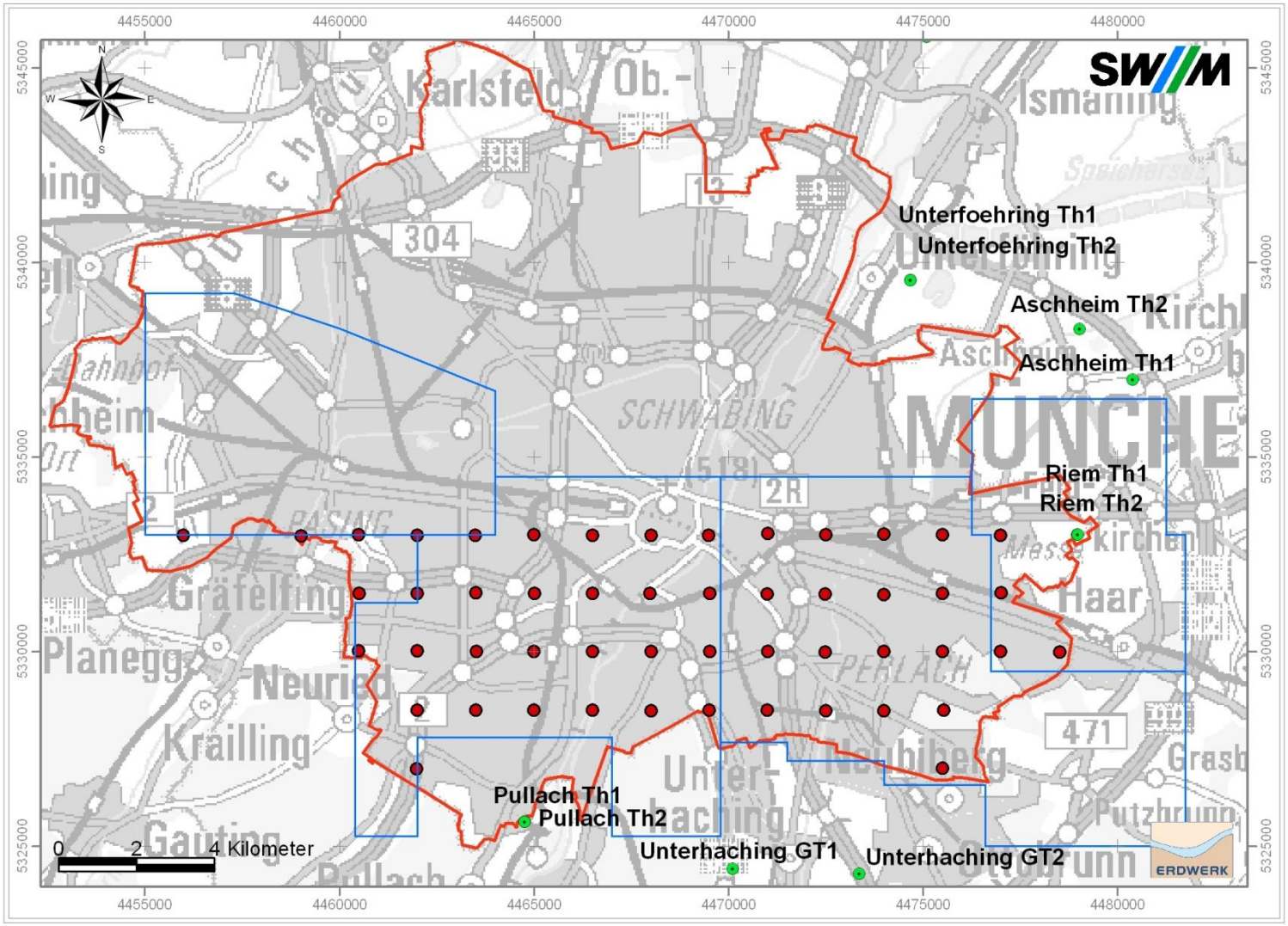
SWM - GRAME


Milbertshofen-BMW
Freimann
Freiham
MUC2015_01
MUC2015_02
MUC2015_03
MUC2015_04
MUC2015_05-S
Riem
Sendling
Neuperlach
München-Süd
München-Ost

SWM - GRAME


Die reine Kraft der Alpen
20 Moosach (Pelkovenstr.)
E DM 1095
DMT
2214

SWM - GRAME

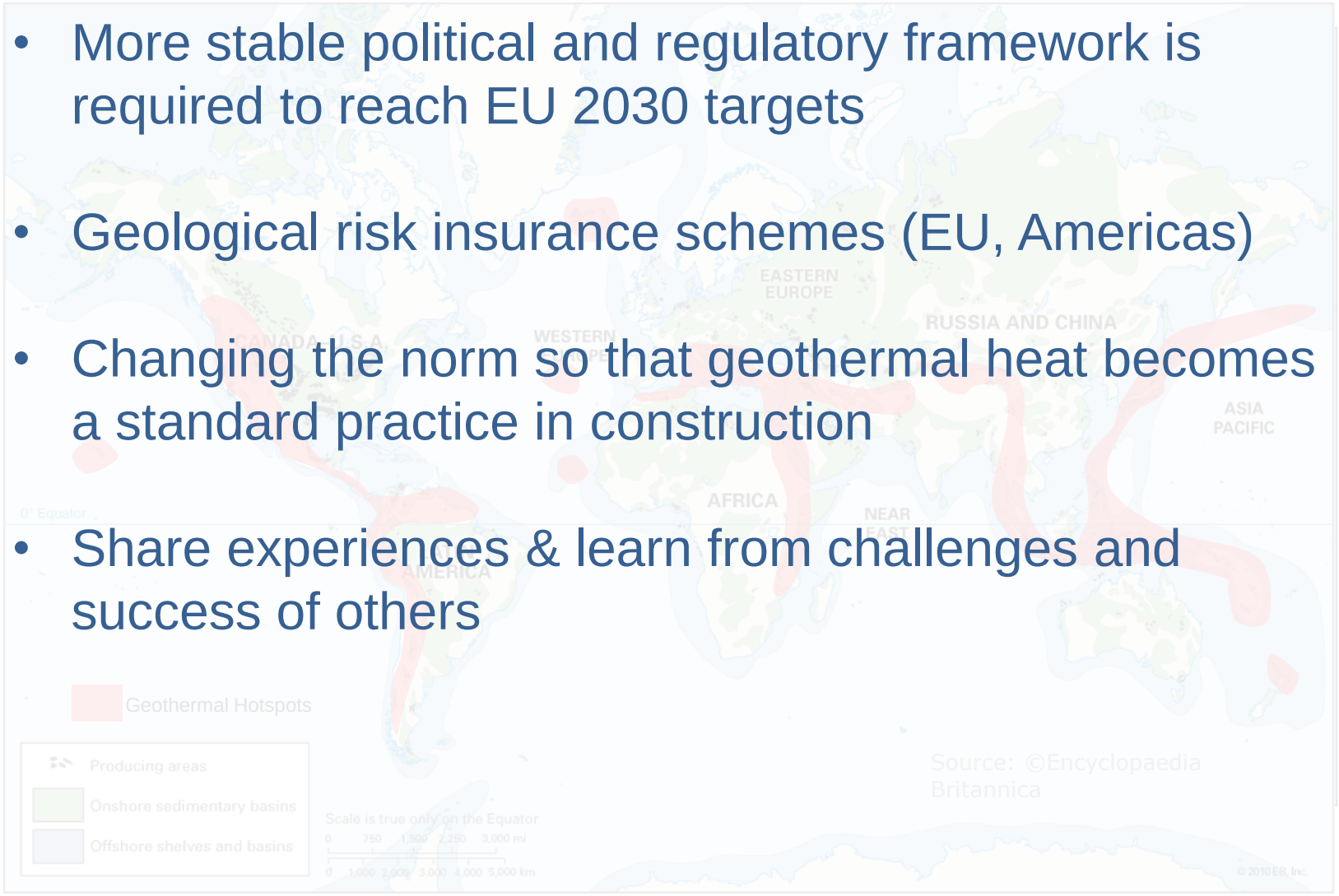

4455000
4460000
4465000
4470000
4475000
4480000
5345000
5340000
5335000
5330000
5325000
Unterfoehring Th1
Unterfoehring Th2
Aschheim Th2
Aschheim Th1
Riem Th1
Riem Th2
Pullach Th1
Pullach Th2
Unterhaching GT1
Unterhaching GT2
0 2 4 Kilometer
SWM
ERDWERK

Beyond Munich

- Holzkirchen 150° C at approximately 5000m TVD
- Direct use DHN
- Combinded heat & power
- DHN already constructed
- Possibilities for smaller communities

Worldwide Geothermal Potential

- More stable political and regulatory framework is required to reach EU 2030 targets
- Geological risk insurance schemes (EU, Americas)
- Changing the norm so that geothermal heat becomes a standard practice in construction
- Share experiences & learn from challenges and success of others



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