

Petrothermale Techniken für die Tiefengeothermie und für die saisonale Wärmespeicherung in mittleren Tiefen: Stand der Projekte in der Schweiz

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Geo-Energie Suisse AG, Zürich

Neunte Niedersächsische Energietage,
1. bis 2. November 2016, Goslar



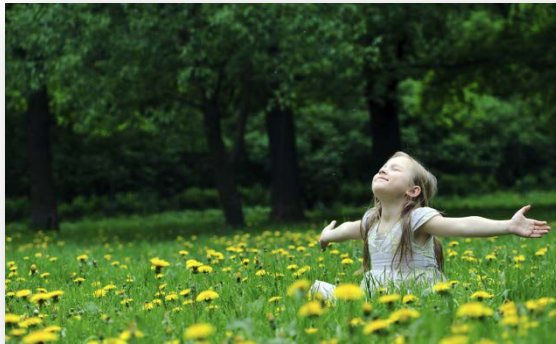
Swiss competence centre for deep geothermal energy

- Geo-Energie Suisse AG was founded in 2010 by 7 Swiss energy providers to evaluate and develop the vast potential of deep geothermal energy.
- Currently planning or developing projects in the cantons of JU, LU, TG and VD



Motivation

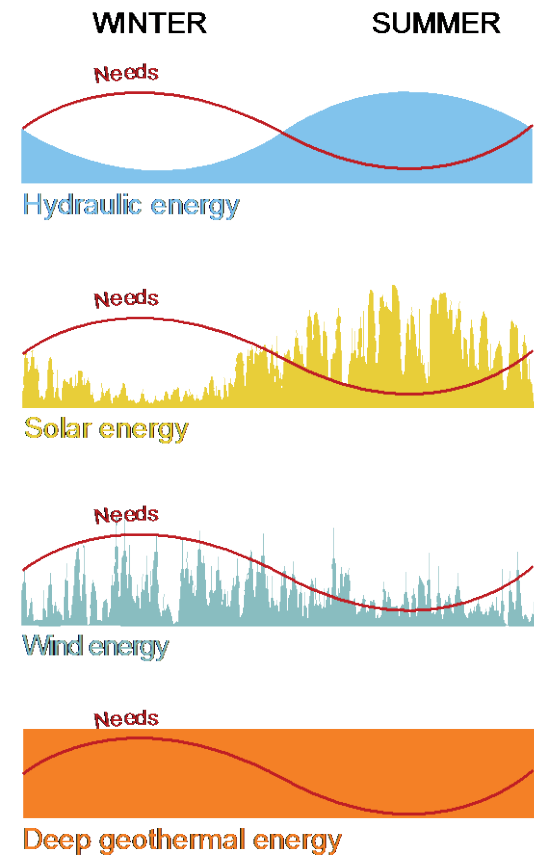
- Local and renewable
- Clean and CO₂-free



- Low impact on the environment and the landscape



- Base-load energy – available 24/24



Motivation



Grünwald

10 power plants produce electricity and heat with an installed electric power of 35 MW

Success story –
Munich, Germany

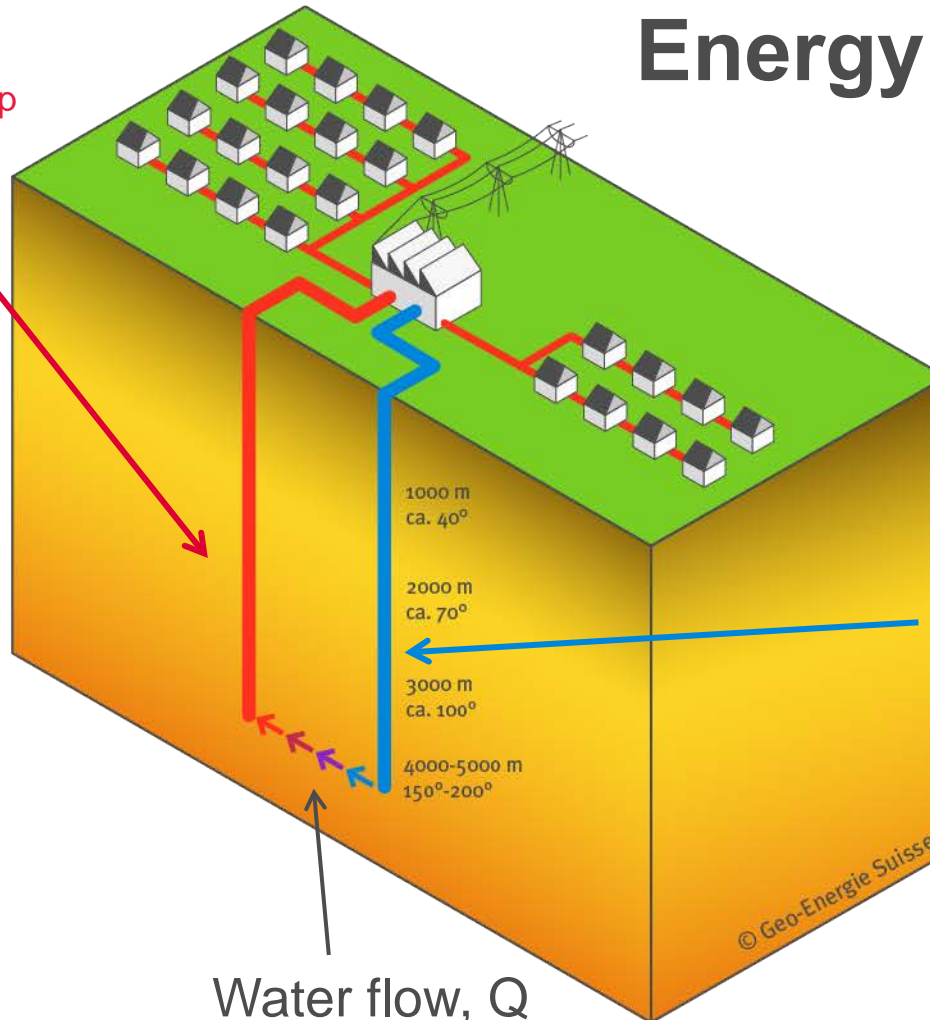


Unterhaching

The Geothermal Energy

Production
Temperature, T_p

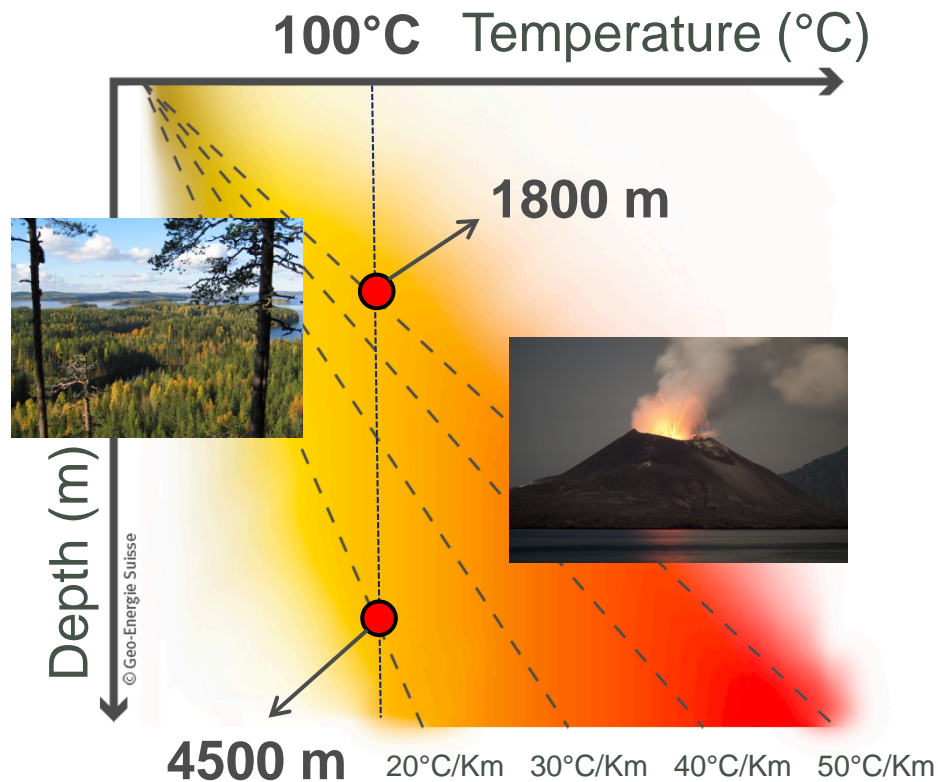
$$\text{Energy} \approx Q^*(T_p - T_i)$$



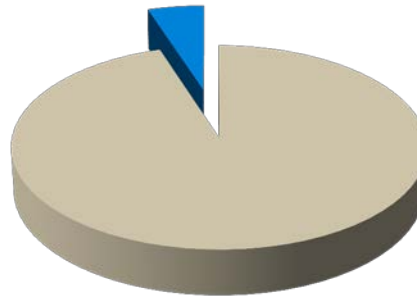
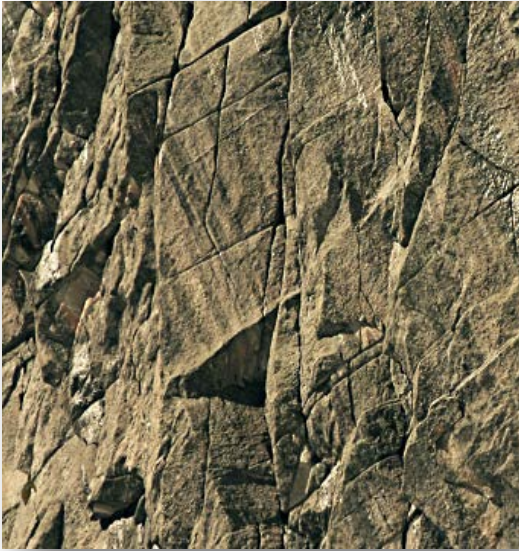
Re-injection
Temperature, T_i

The Heat – Geothermal gradient

The geothermal gradient



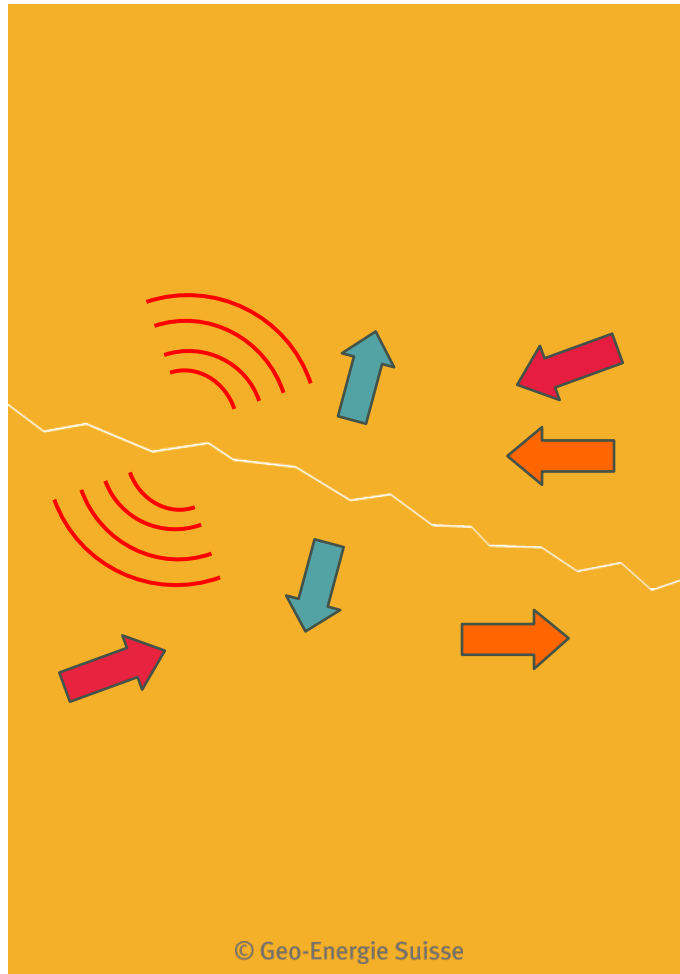
The Water Flow



Message

- Sufficient temperature will always be found. It is only a matter of depth (and costs)
- Large water flows at depth are rare. **Technology is therefore required to extract the heat in most cases**

EGS – Principle of hydraulic stimulation



- Natürliche Klüfte sind Schwachstellen im Fels
- Gebirgsspannungen wirken dauernd. Die Scherfestigkeit verhindert aber ein Gleiten
- Wasserdruck vermindert die effektiven Normalkräfte und deshalb die Scherfestigkeit
- Dies führt zu einer Bewegung der beiden Kluffseiten
- Seismische Energie wird dabei freigesetzt. Dies kann gemessen werden.
- Die Kluffflächen passen nicht mehr genau aufeinander. Die Durchlässigkeit ist nun dauerhaft erhöht.

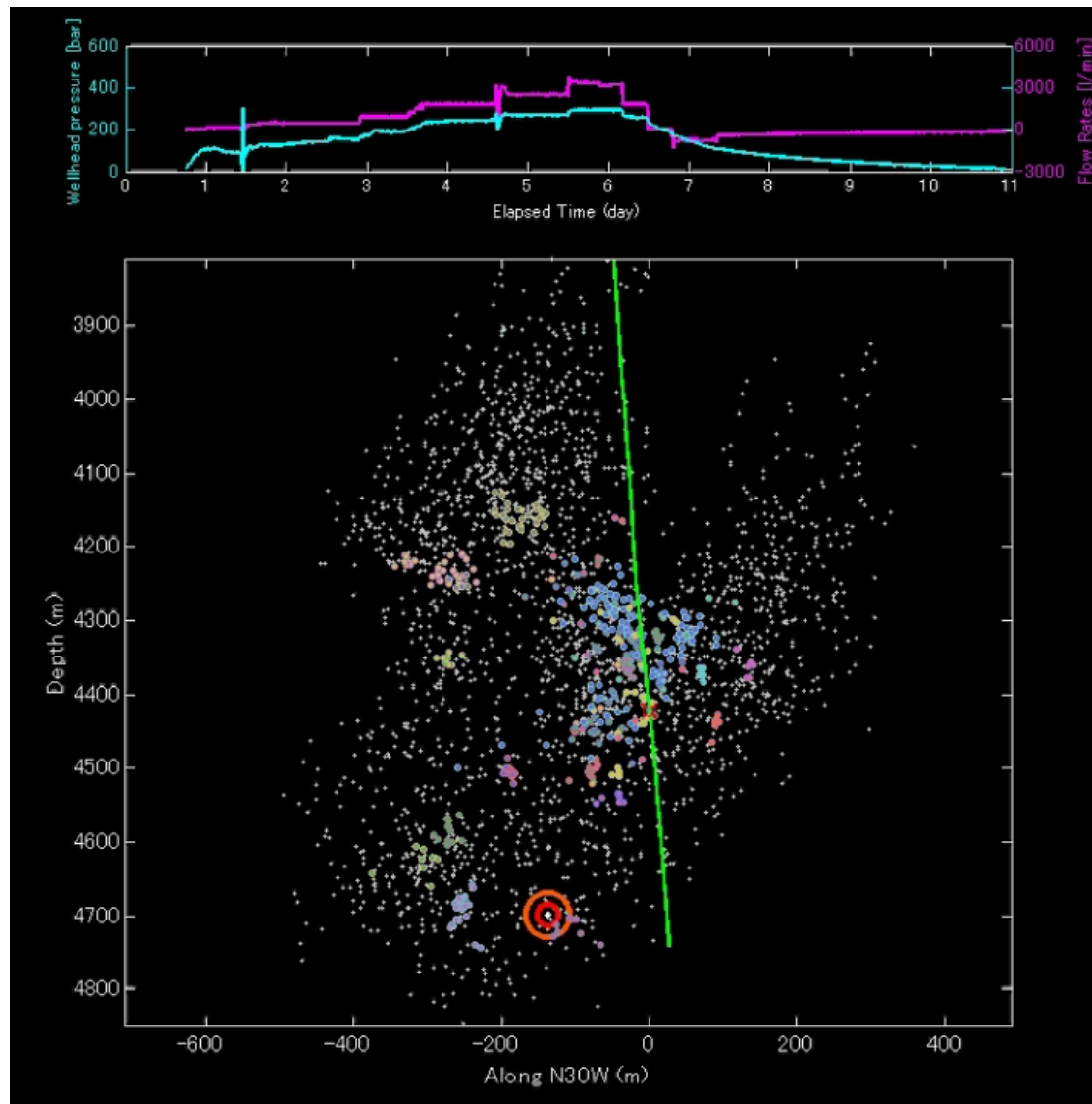
The Basel DHM Project (2006)

- Geplant als erstes kommerzielles EGS-Projekt
- Stimulation eines granitischen Reservoirs in ca. 5 km-Tiefe
- Nach 6 Tagen Wasserinjektion wurde ein Ml 3.4 Beben ausgelöst.
- Drei Jahren später führte die SERIANEX Risikostudie zum definitiven Abbruch des Projektes.

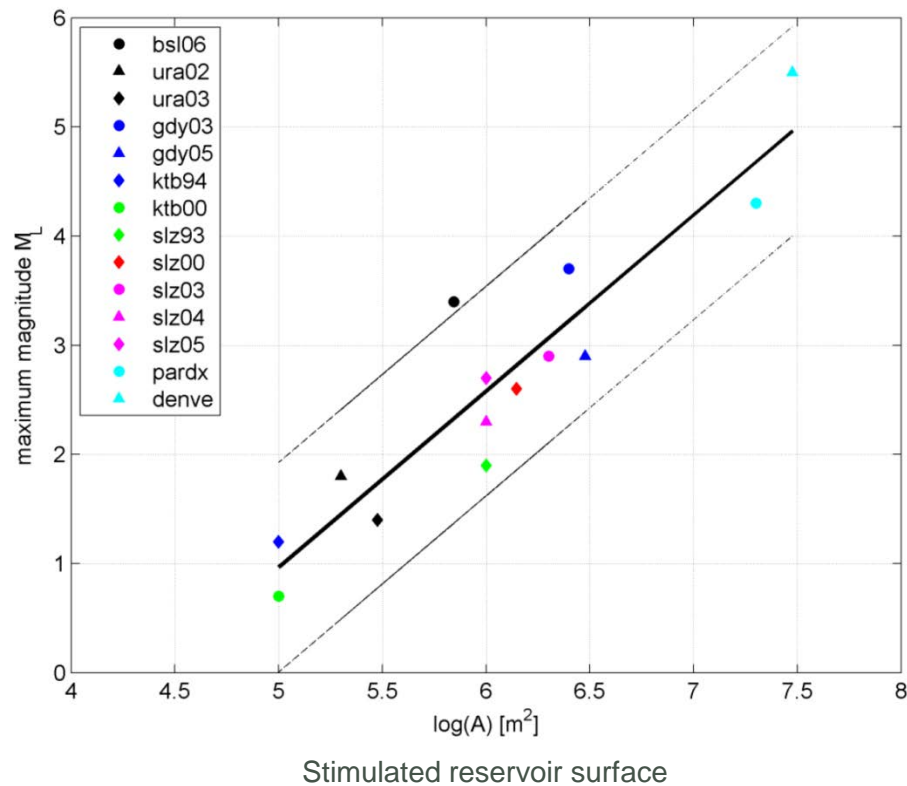
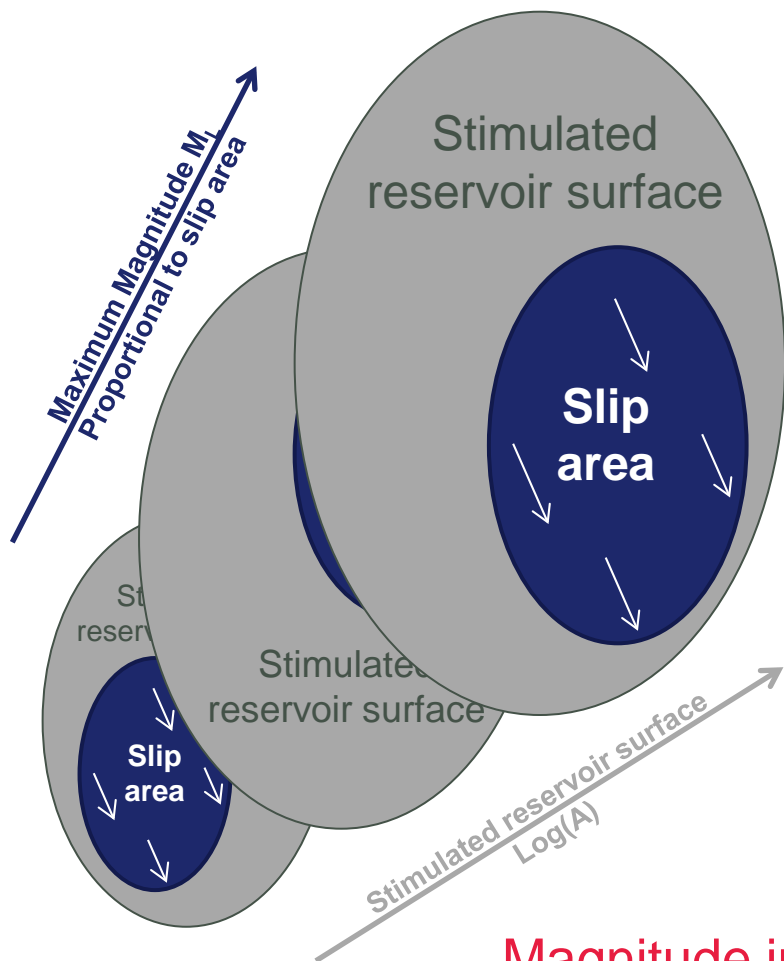


Geothermal Explorers Ltd.

Seismic dataset from the Basel project during the massive stimulation in large open wellbore section

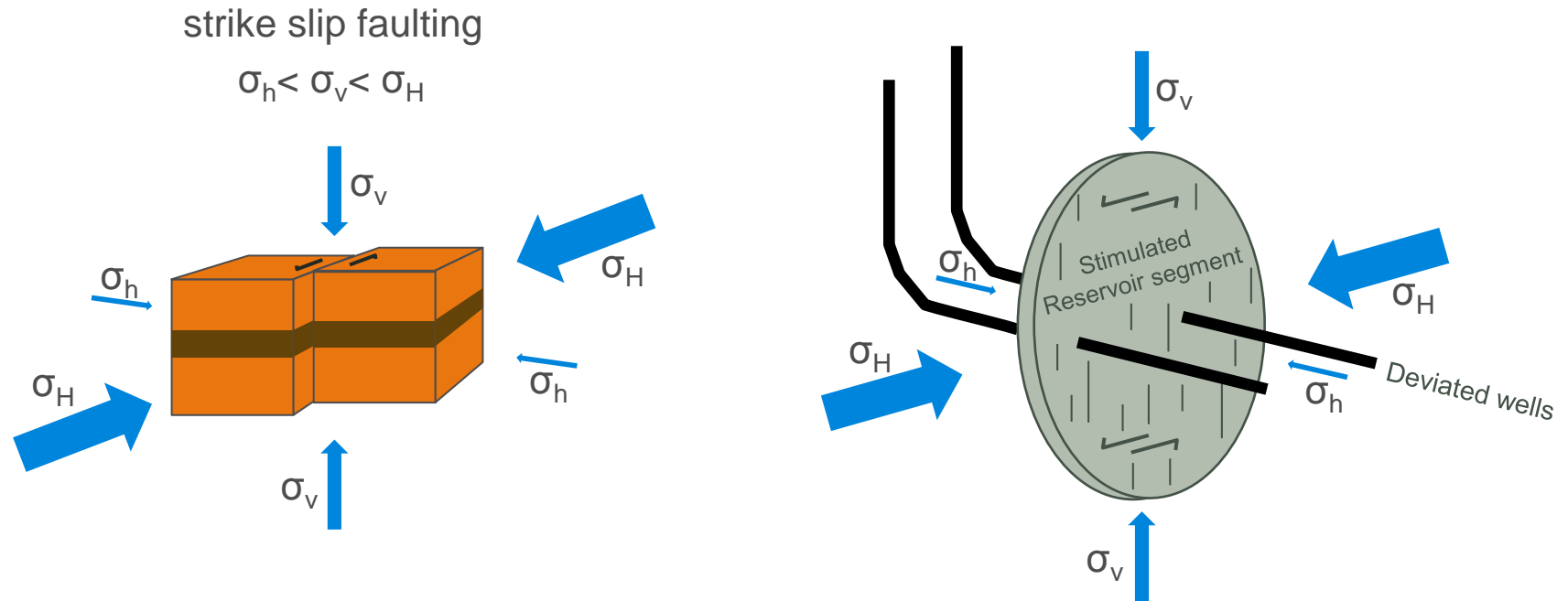


Basel: Key findings on induced seismicity



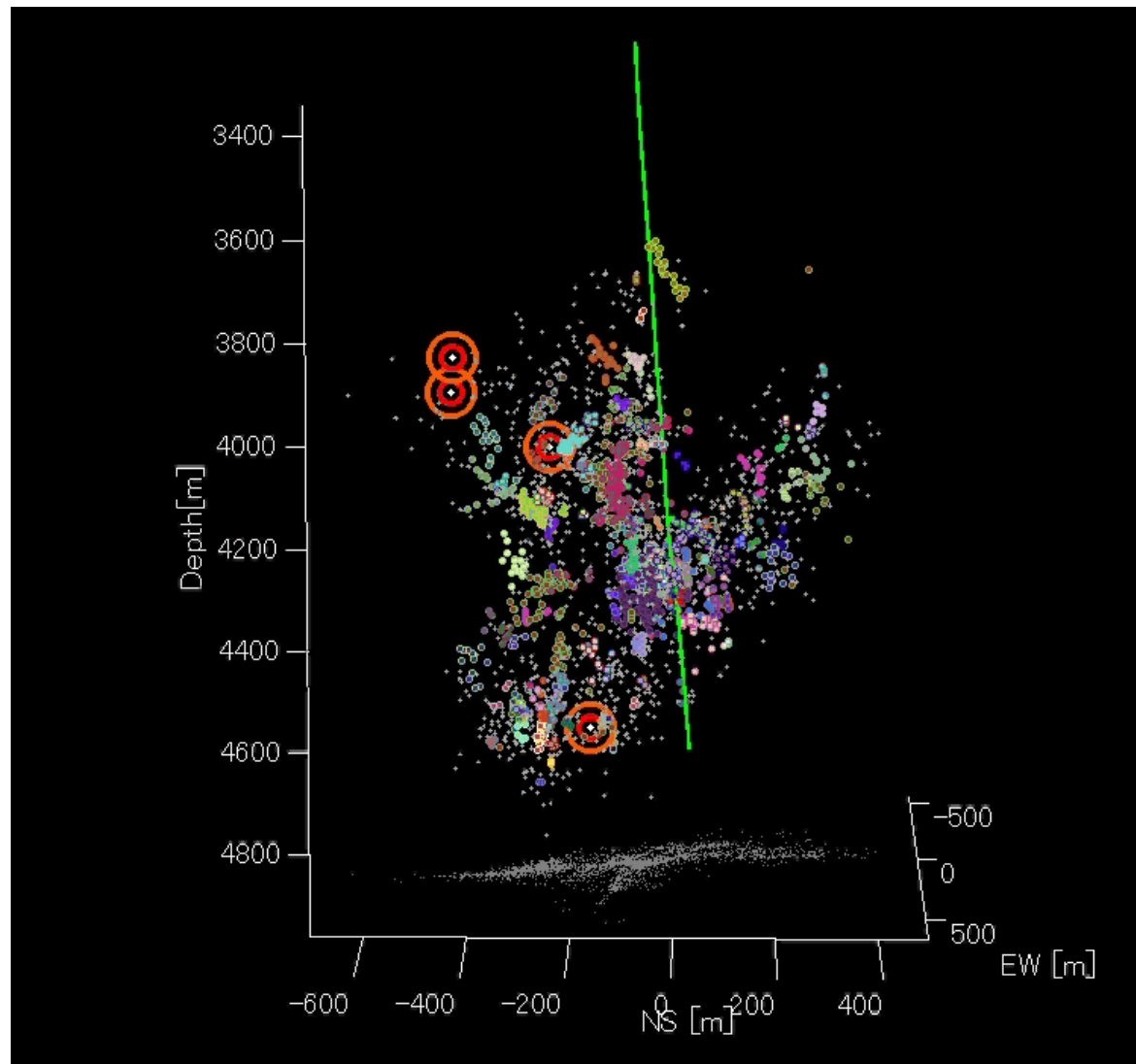
Magnitude increases with stimulated reservoir area (Serianex, 2009)

EGS – Orientation of the stimulated reservoir

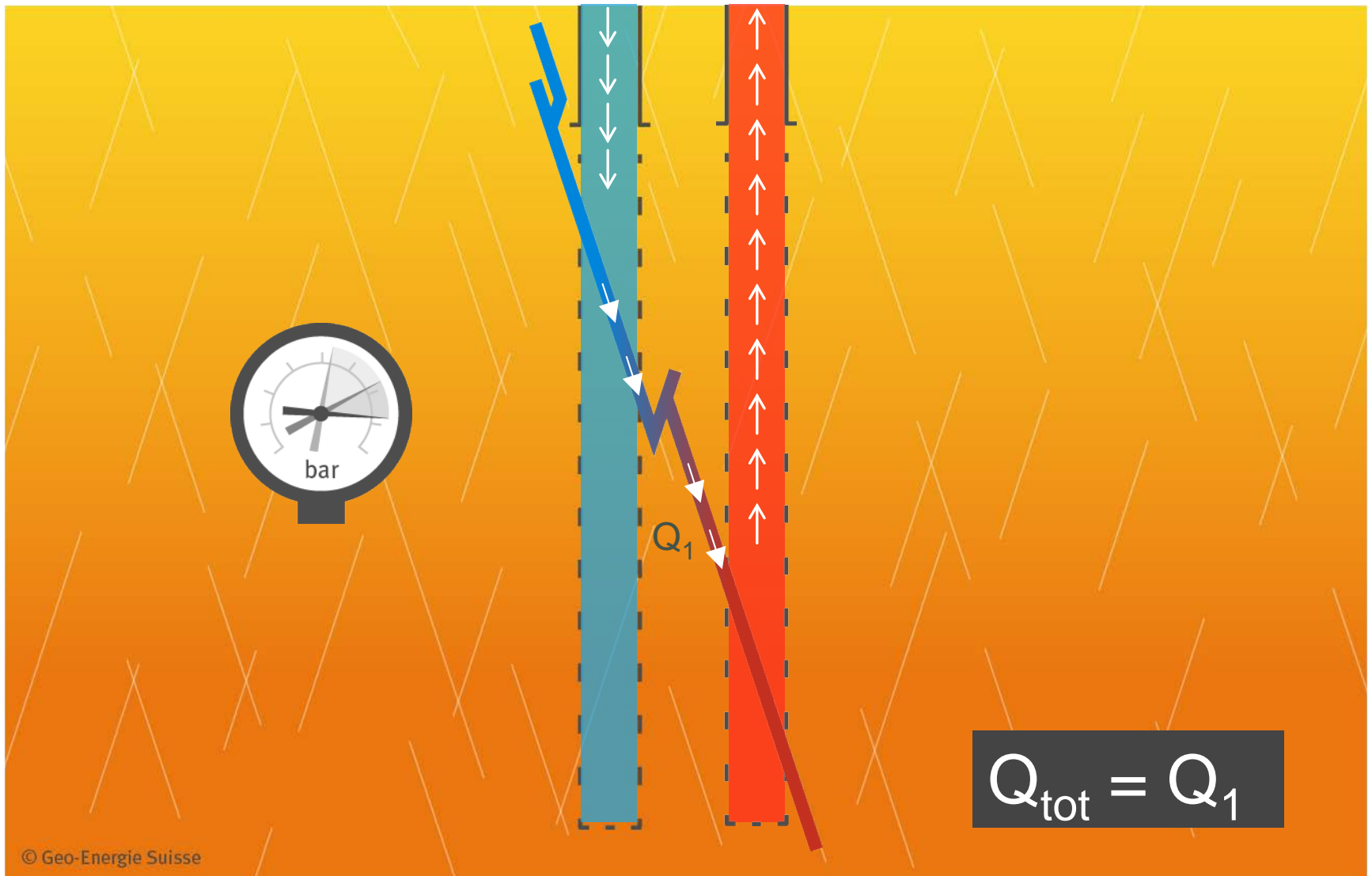


- In a strike-slip stress regime, a vertical disked-shaped reservoir develops during stimulation
- → In such stress regimes, the drilling of deviated wells is required

Seismic dataset showing the 3D geometry of the Basel reservoir after 3 months

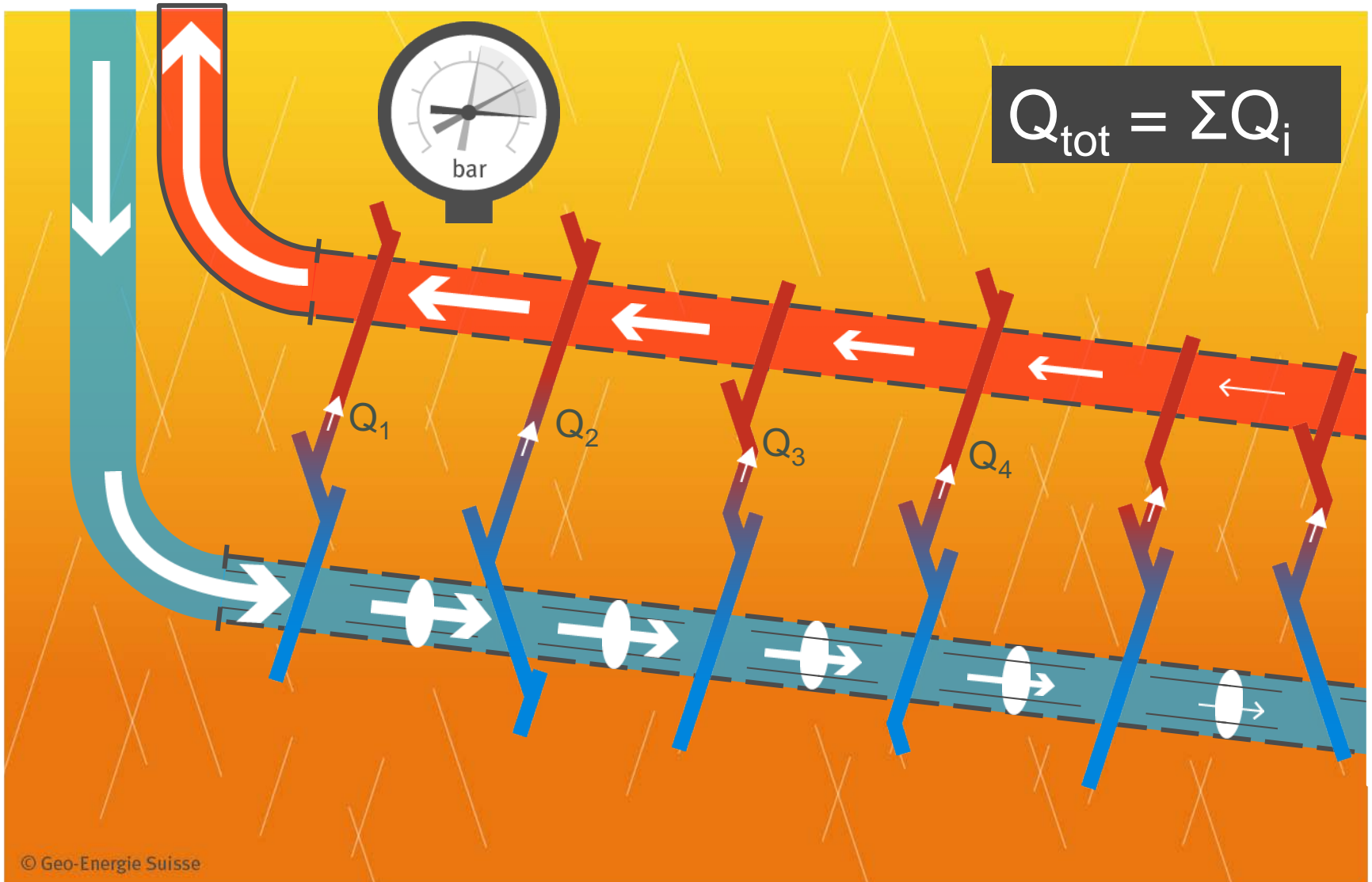


Stimulation of an open-hole vertical well



© Geo-Energie Suisse

Multi-stage stimulation of isolated segments



© Geo-Energie Suisse

Project DESTRESS / EU-Horizon 2020

Multi-stage and cyclic stimulation



Objectives

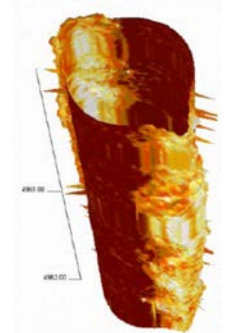
Demonstration of soft stimulation treatments of geothermal reservoirs.

Project description

16 Partners from research and industry from 6 European countries and South Korea will demonstrate soft stimulation in existing or planned boreholes at up to 7 sites in sedimentary and crystalline rocks.

Significance

Geo-Energie Suisse focuses on the development and testing of zonal isolation techniques and multi-stage shear stimulation treatments at the Haute-Sorne site.



Budget

Total budget Euro 25 Mio., Geo-Energie Suisse CHF 5.6 Mio.

Project duration

March 2016 – February 2020




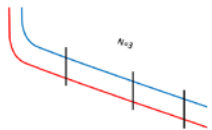
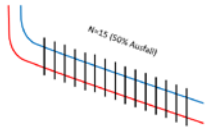
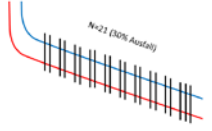
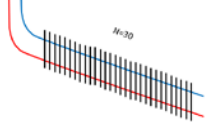
Swellable packers

Project DESTRESS / EU-Horizon 2020

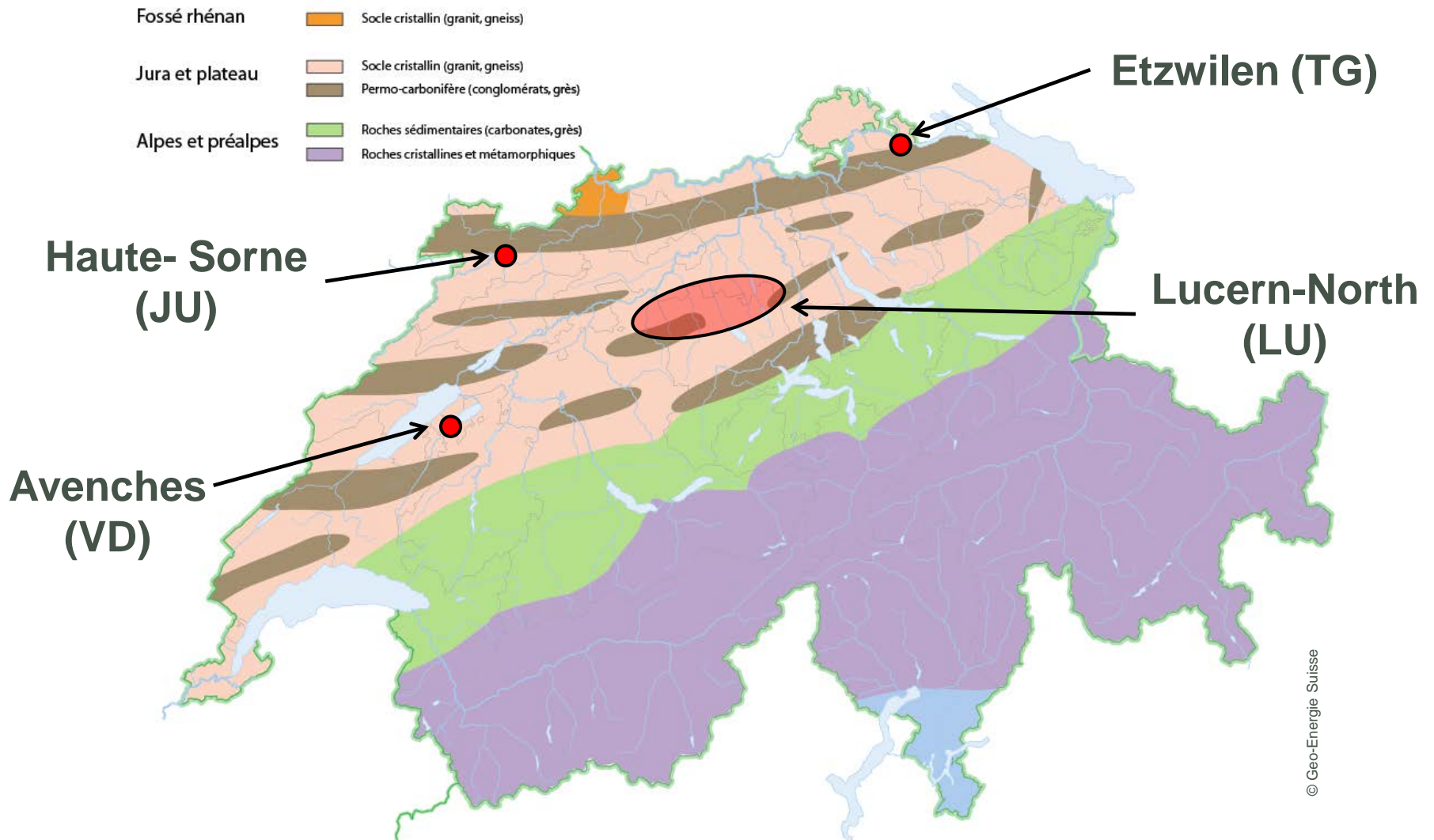
Multi-stage and cyclic stimulation



What are the economics?

Utilisation System	Increase Factor of:	
	El. Power	Costs
 <p>Vertical Single-Open-Hole-System, 1 fracture</p>	1	1
 <p>Single-Open-Hole-System, 3 fractures</p>	1.8	1.2
 <p>Multi-Stage-System; 50% failure rate of stages</p>	2.9	1.6
 <p>Multi-Stage-System; 30% failure rate of stages</p>	4.2	1.6
 <p>Multi-Stage-System; 0% failure rate of stages</p>	6.2	1.6

Site Selection – Target lithology



The Haute-Sorne EGS Pilot Project

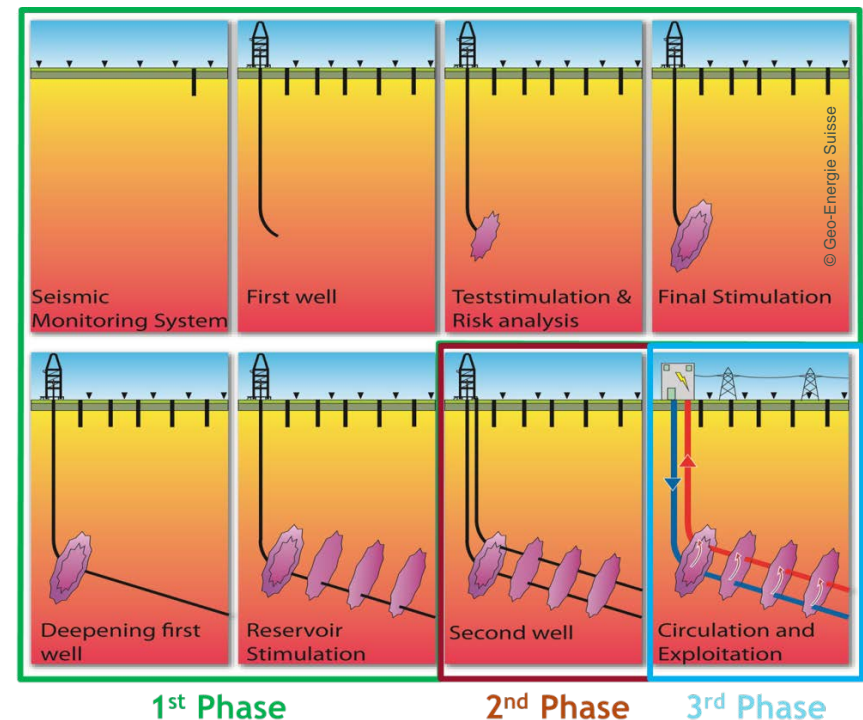


Etappen und Zeitplan

- 1st Phase: 2016-2019
- 2nd Phase: 2019-2020
- 3rd Phase: 2020-2021

Projektüberblick

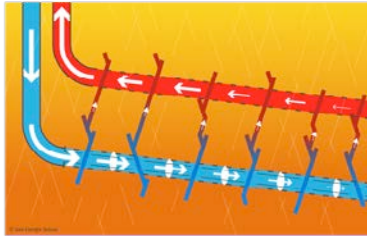
- Geothermisches Kraftwerk mit max. 5 MW_{el} Leistung
- Stromversorgung für ca. 6000 Aushalte
- Potential für ein Fernwärmenetz
- Budget von etwa CHF 100 Millionen



Haute-Sorne Project site



Seismic risk - Summary

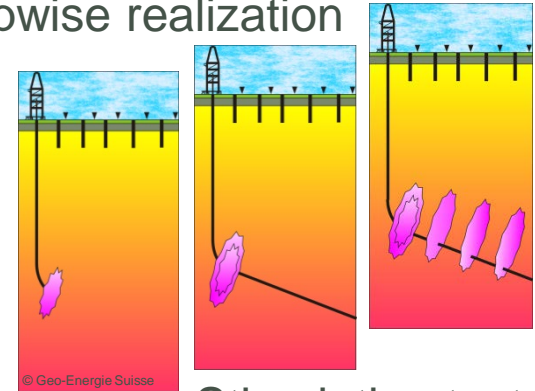


Safer concept

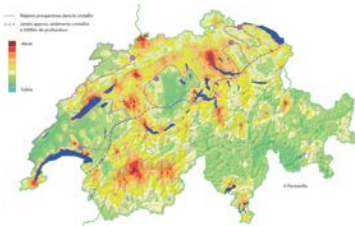


Risk studies

Stepwise realization



Stimulation test



Site selection



Continuous risk evaluation



Conservative traffic light system



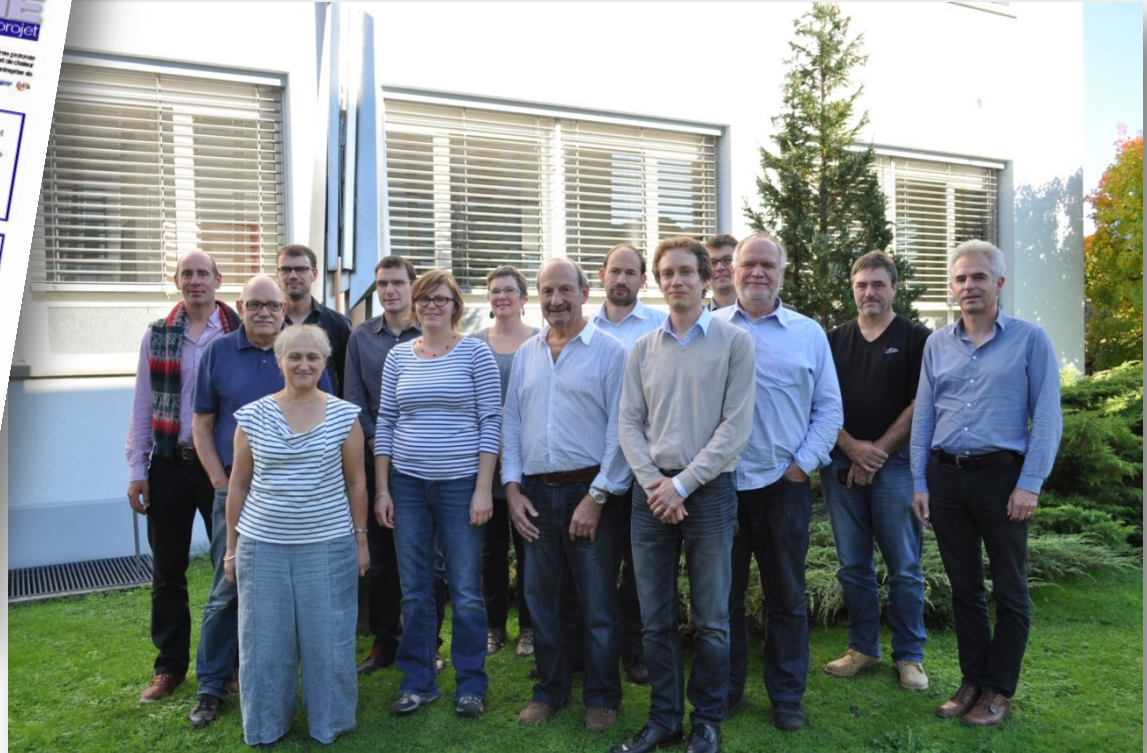
Real-time monitoring

Communication: Information Meetings



- Several information meetings organised for the population
- Specific information meetings for the political authorities
- Publication of 4 information bulletins

Communication: Accompanying group



Permit delivered June 15, 2015

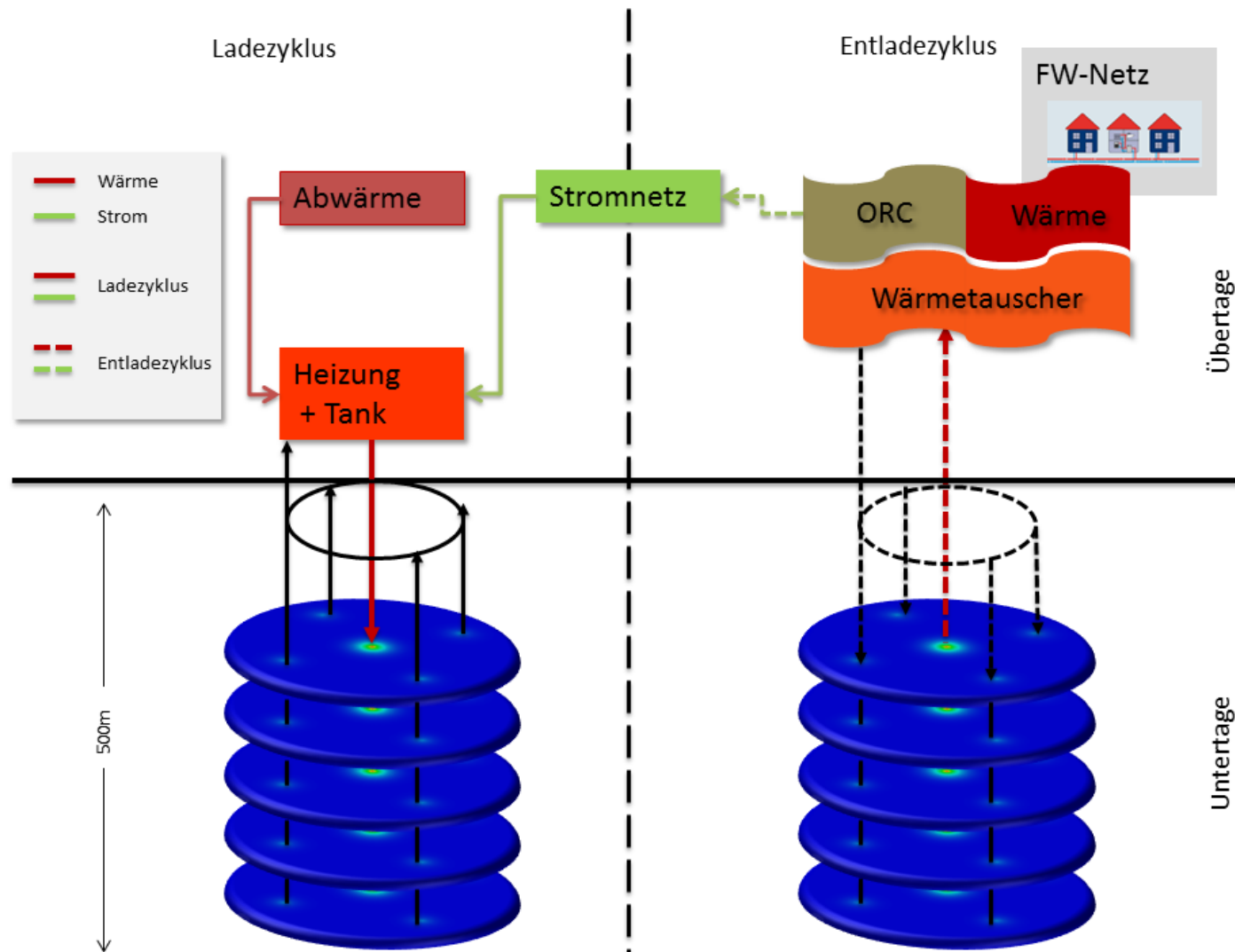


Peter Meier,
CEO
Geo-Energie Suisse

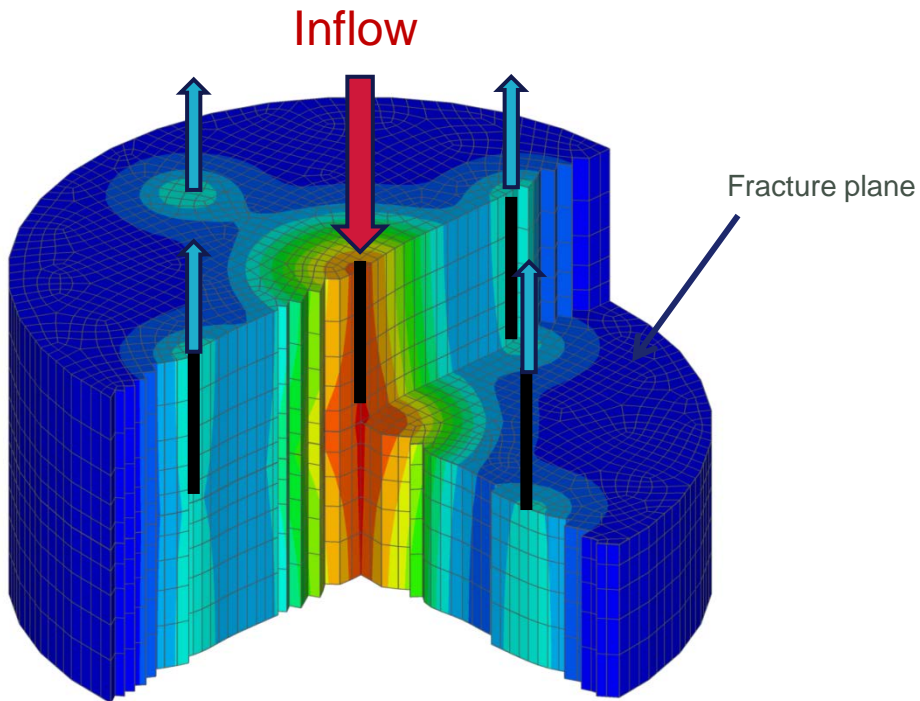
Philippe Receveur,
Minister
Canton of Jura

Jean-Bernard Vallat,
President
Commune of Haute-Sorne

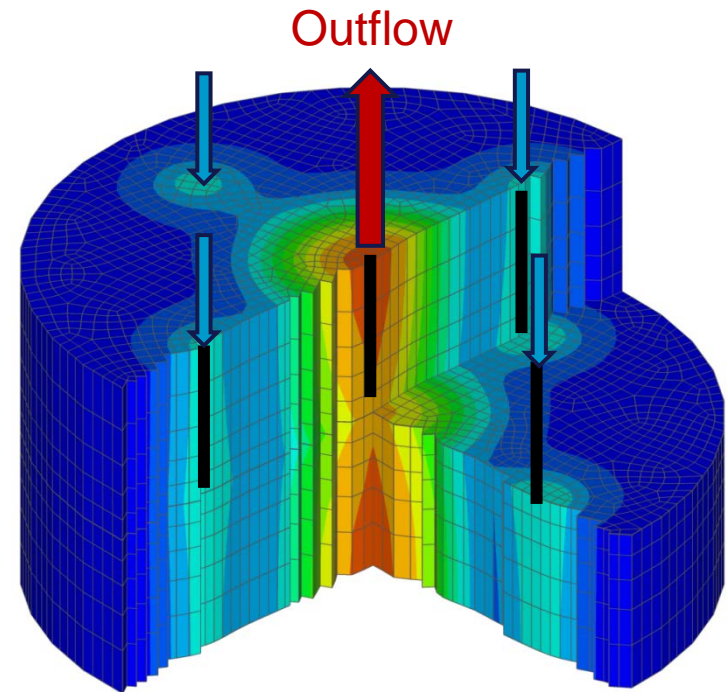
Weitere Entwicklungsmöglichkeiten: Untergrundspeicher für Wärme



Lade- und Entladezyklus am Beispiel einer einzelnen Kluft

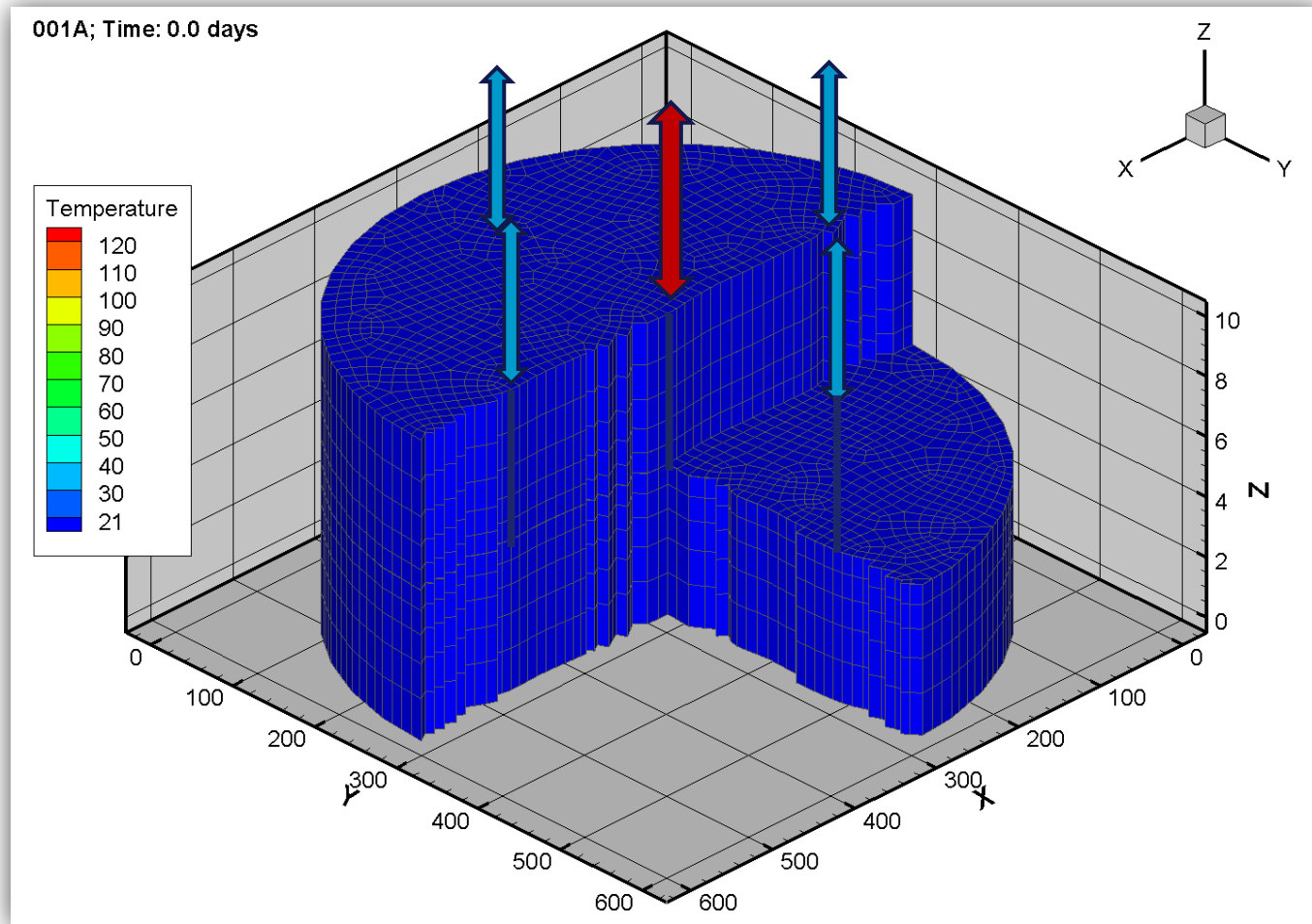


Load Cycle



Unload Cycle

Zeitliche Entwicklung der Reservoirtemperatur



Energetisches Potenzial und grobe Kostenschätzung

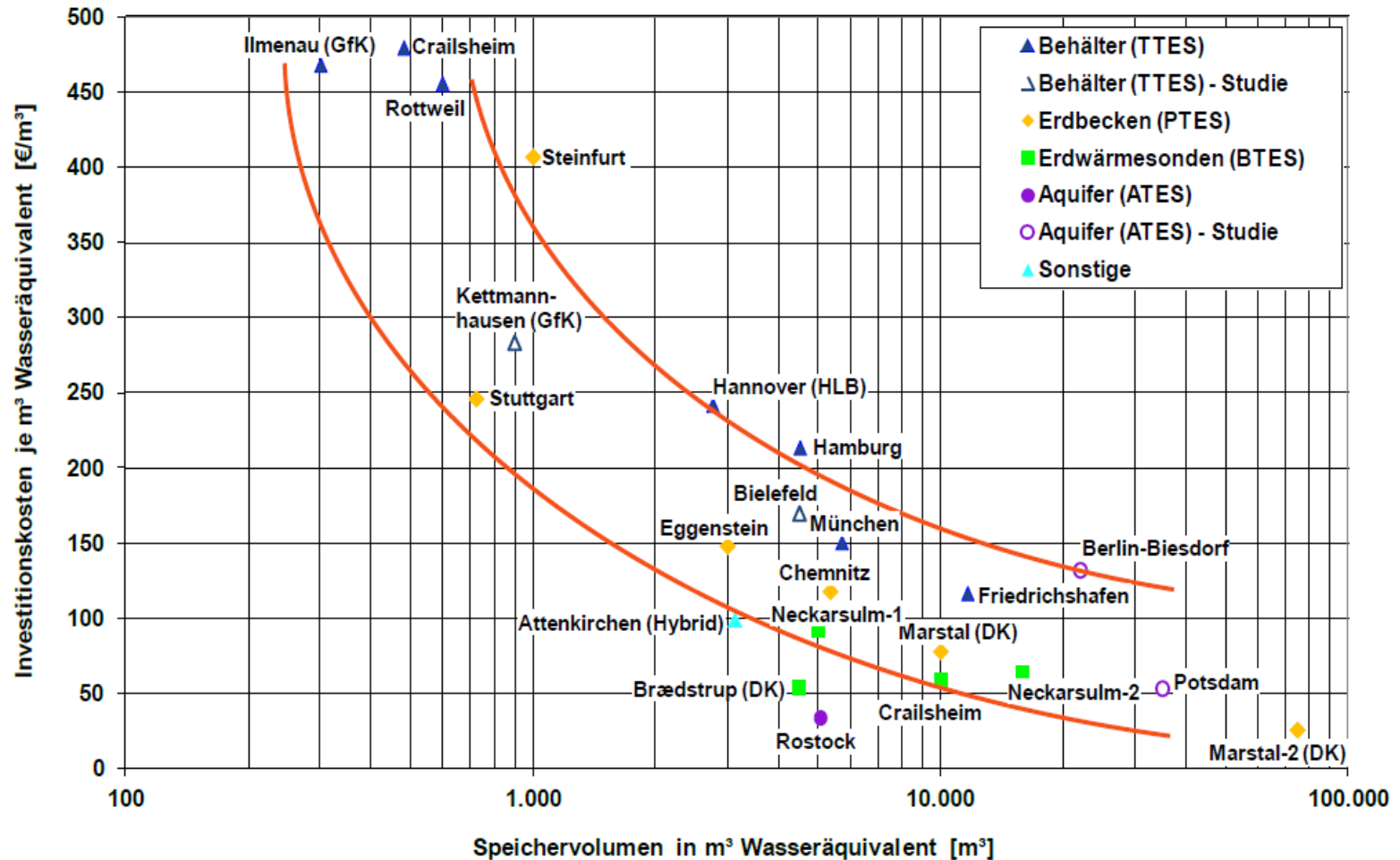
Kennwerte Geospeicher:

- 10 Reservoirscheiben
- Gesamtfliessrate: 25 l/s
- Injektionstemperatur beim Laden/Entladen: 120°C / 50°C

Abschätzung des energetischen Potenzials und der Kosten:

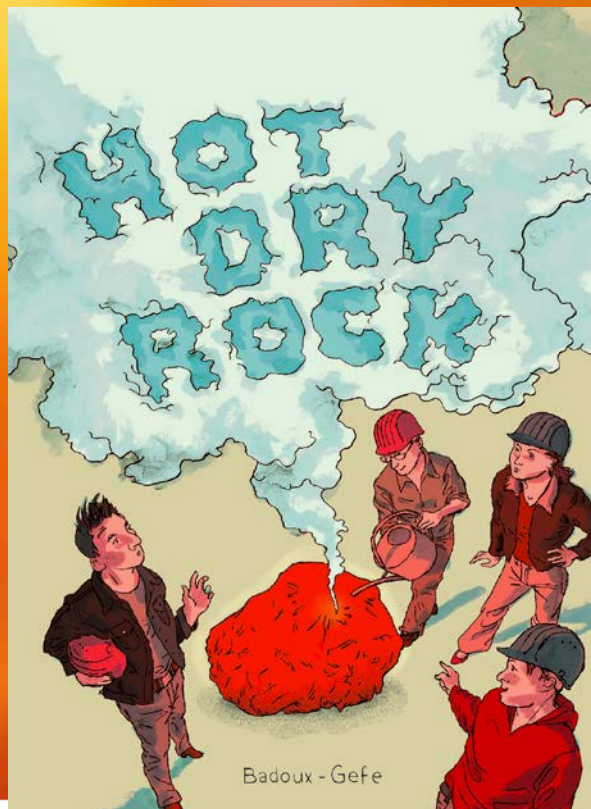
- Thermische Entladeleistung: $\approx 7 \text{ MW}_{\text{th}}$
- Gespeicherte Wärme: $\approx 110 \text{ TJ}$
- Speichervolumen: 380'000 m³ Wasseräquivalent
- Investitionskosten: 1 – 4 Mio. CHF
- Spezifische Investitionskosten: $\approx 10 \text{ CHF} / \text{m}^3 \text{ Wasseräquivalent}$

Speichervolumen und Investitionskosten im Vergleich



Neues Energiegesetz (EnG)

- **Stromprojekte**
 - Ausdehnung Risikogarantie von heute 50% auf 60%
 - Erkundungsbeiträge bis 60% der Bohr- & Testkosten
 - Fonds: bis ca. CHF 58 Mio./Jahr !
- **Wärmeprojekte**
 - CO₂-Gelder für wärmegeführte Projekte
 - Fonds: bis ca. CHF 30 Mio./Jahr!
- **Positiven Parlamentsentscheid zum EnG am 30. September 2016**
 - Referendum ergriffen: Unterschriftsammlung bis Januar 2017
 - Voraussichtliche Volksabstimmung: Mai 2017
- **Frühtmöglichste Inkraftsetzung EnG: Januar 2018**



Danke für Ihre Aufmerksamkeit !