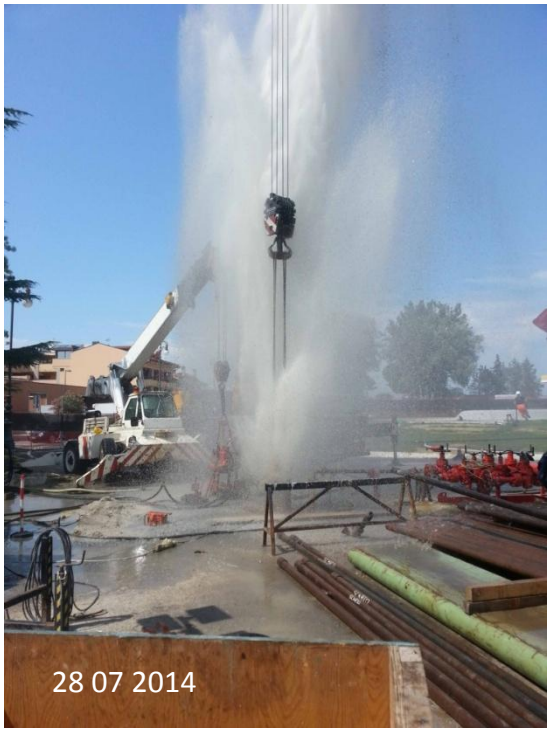
Geothermal Energy: Status and Future in the peri-Adriatic Region Velj Losinj, 25-27 August 2014

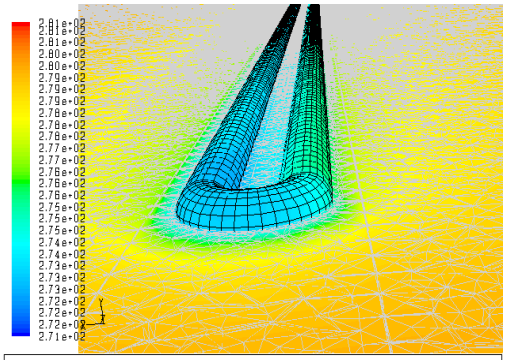
Geothermal heating and cooling in the Regione FVG (NE Italy): Grado District Heating Project and Pontebba ice rink plant

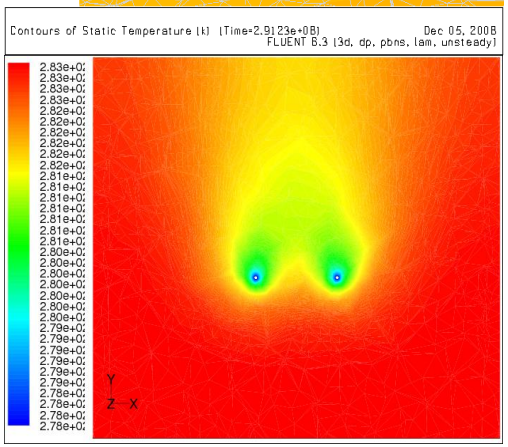
Bruno Della Vedova, DIA UniTs

and Unione Geotermica Italiana

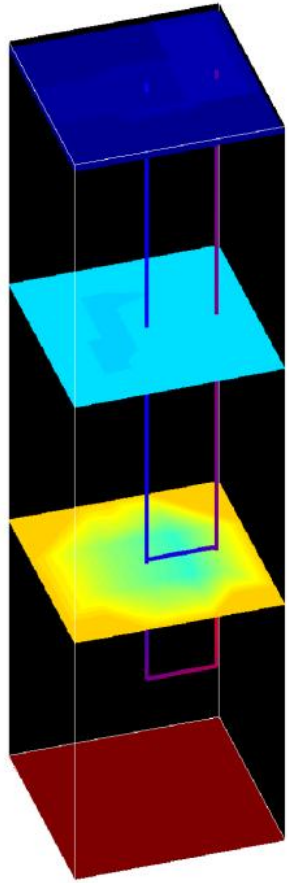


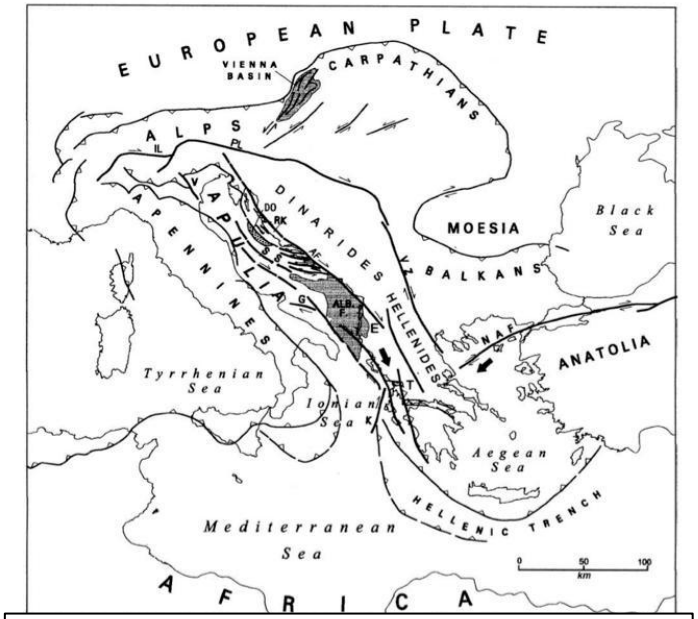
Geothermal Group DIA, UniTS



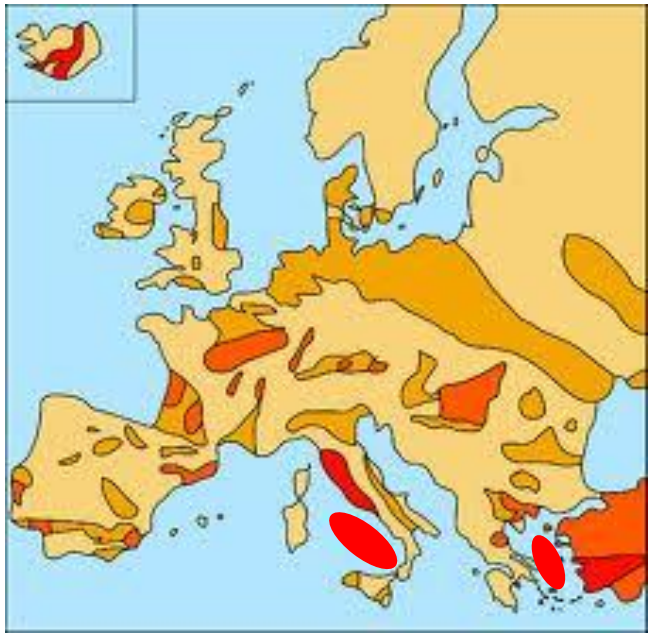


*Eugenio Castelli, Aurelie Cimolino, Bruno Della Vedova, Marzio Piller and Alberto Marcon**



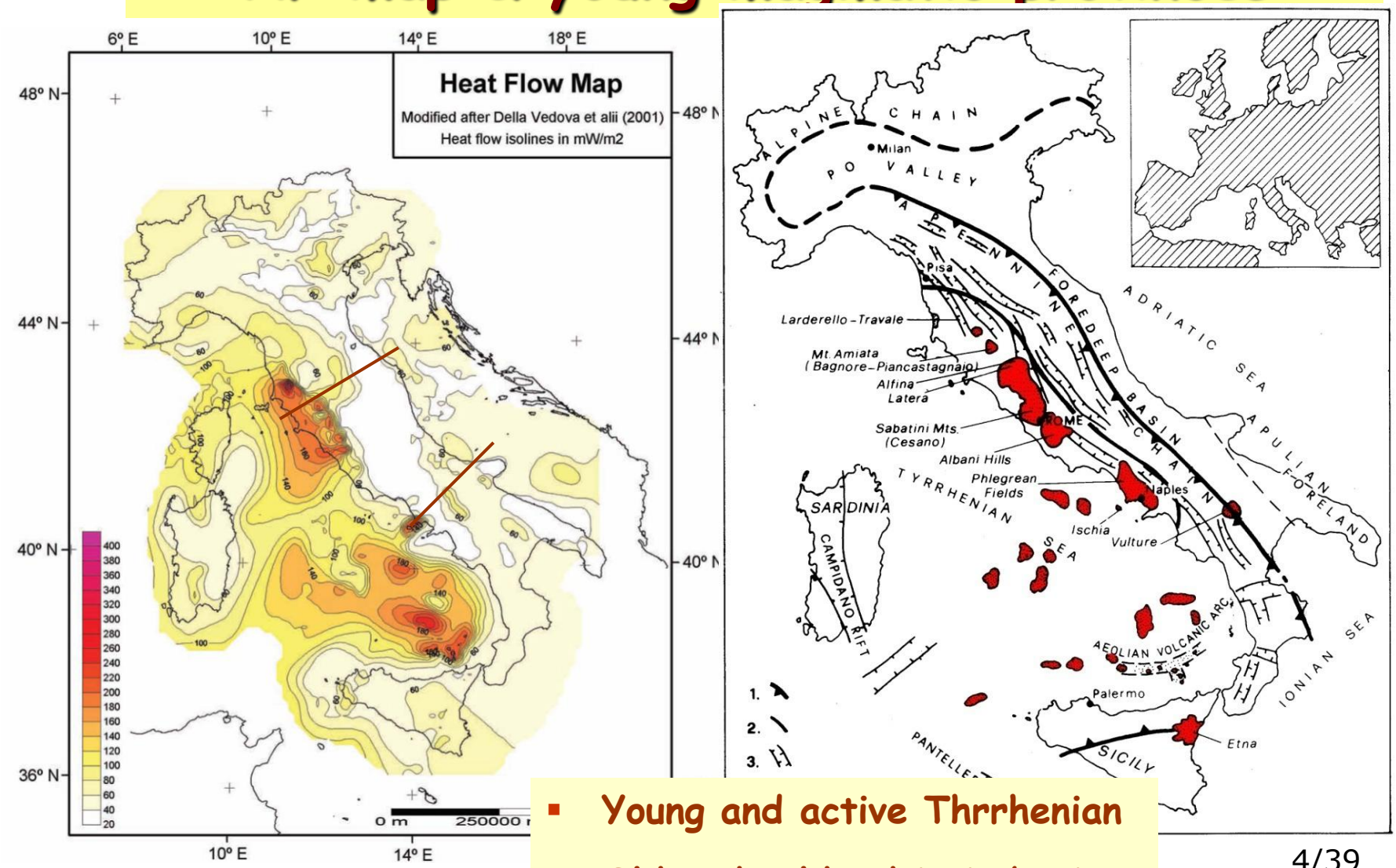


Map of Alpine system (Picha, 2002)



- ***Geothermal Resources in the Adriatic Region***
- **Grado Geothermal District Heating Project**
- **Pontebba Ice Rink Plant**
- **Guidelines and hints for project development**

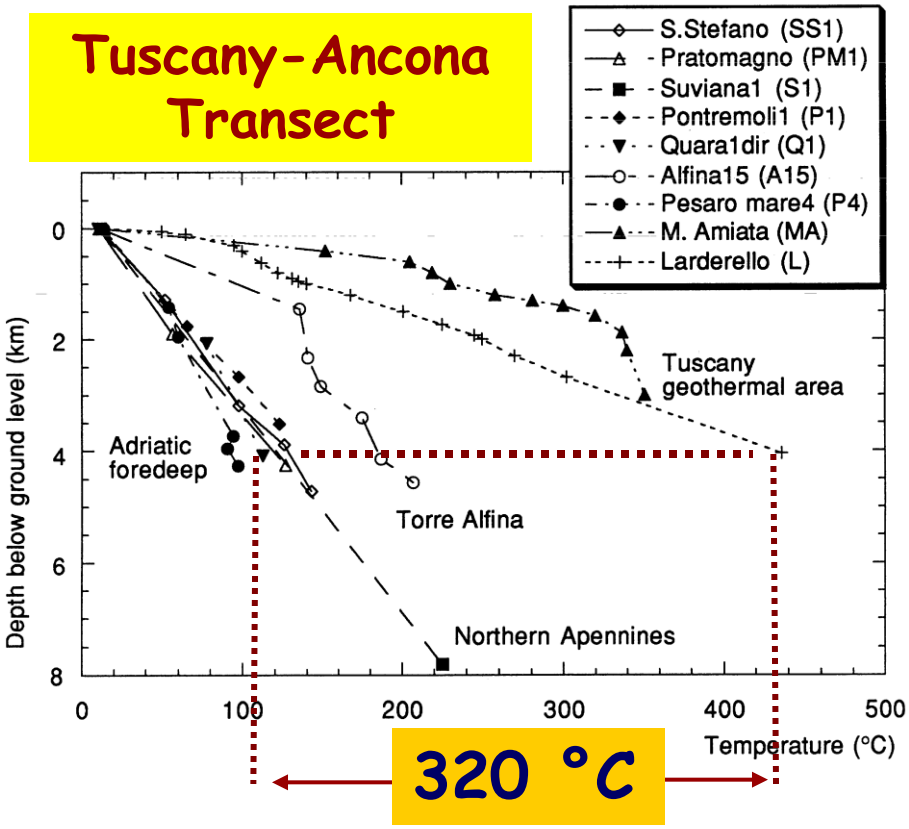
Geothermal resources of Italy: HF map & young magmatic provinces



- Young and active Thrrhenian
- Old and cold Adriatic basin

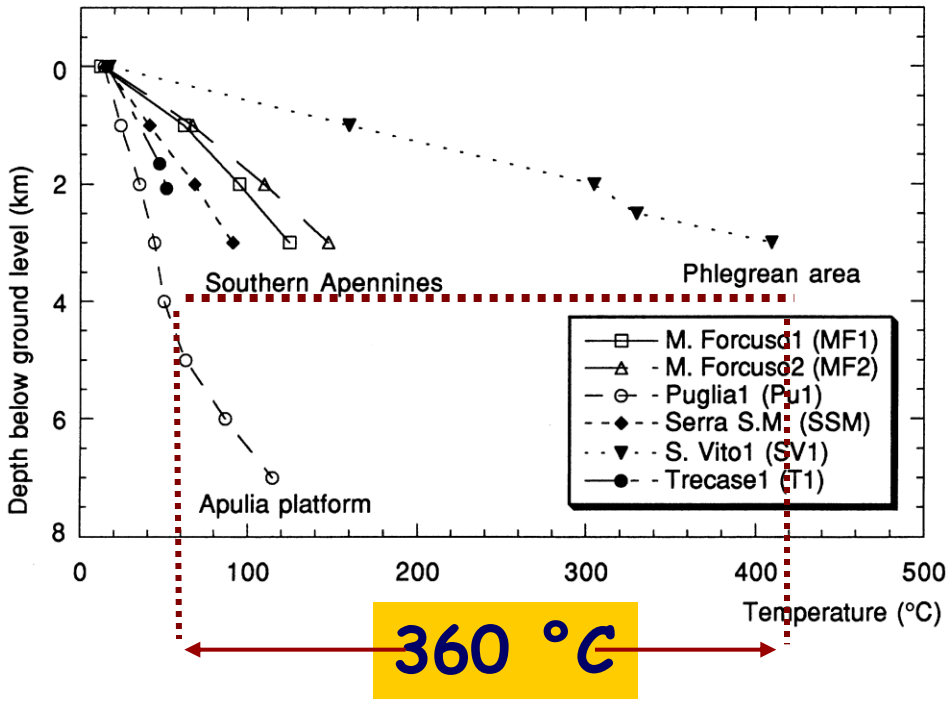
Hot Tyrrhenian vs. cold Adriatic basin

Tuscany-Ancona Transect



320 °C

Naples-Gargano Transect

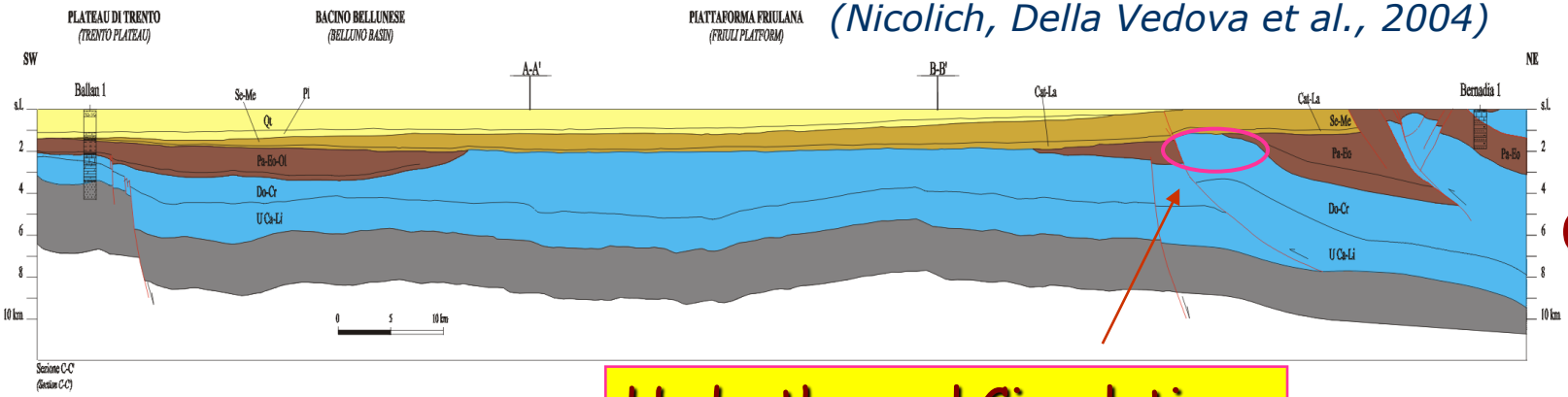


360 °C

Large difference in heat input from upper mantle!

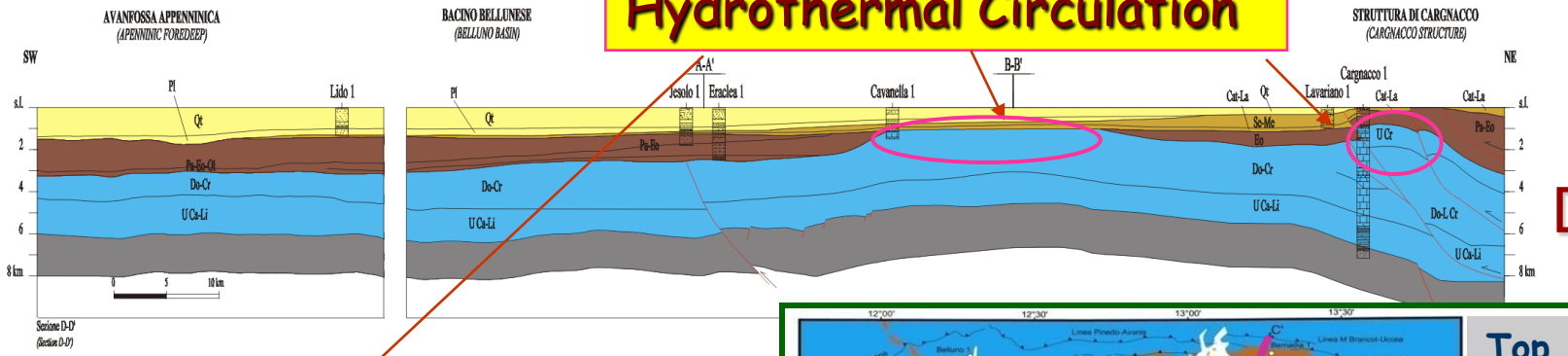
Adriatic Mesozoic Platform

(Nicolich, Della Vedova et al., 2004)

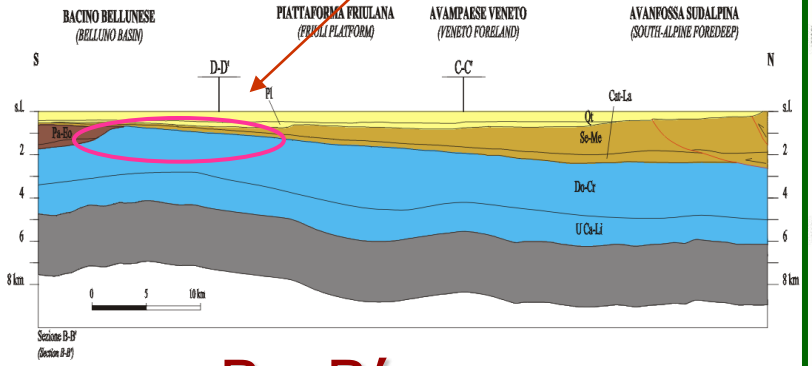


C –C′

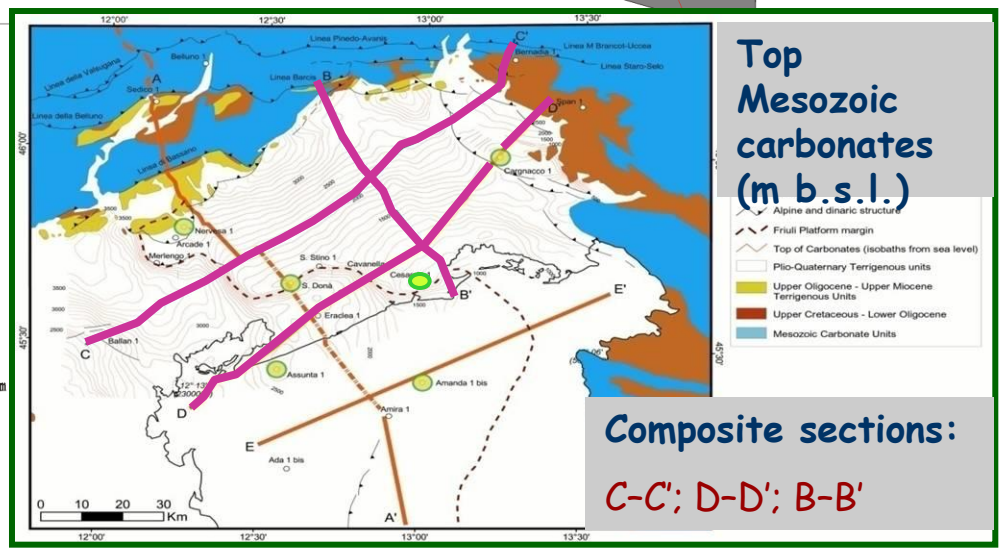
Hydrothermal Circulation



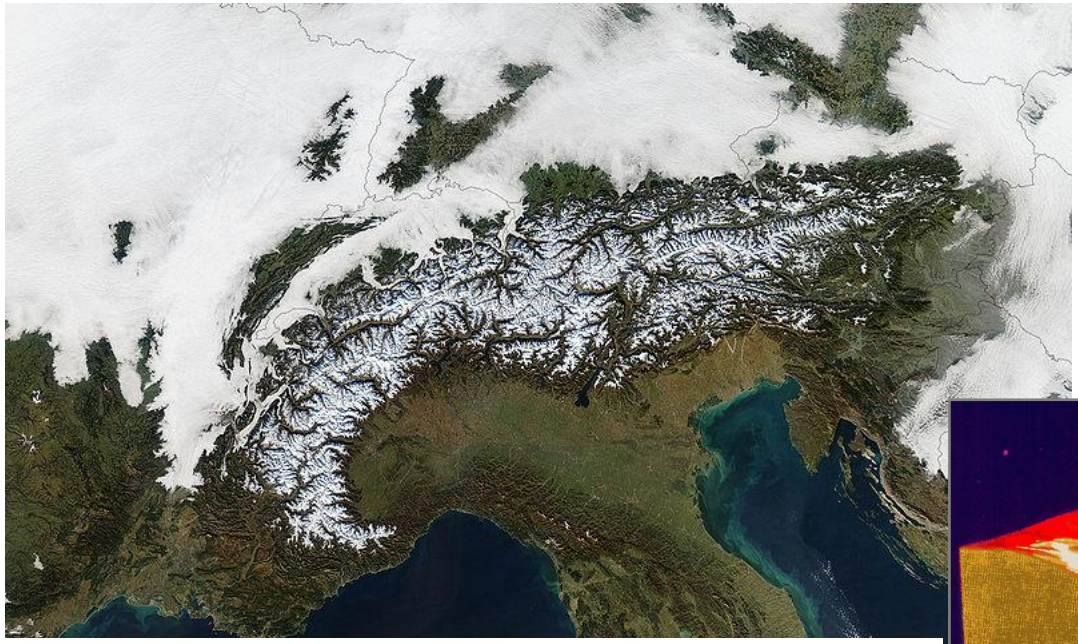
D –D′

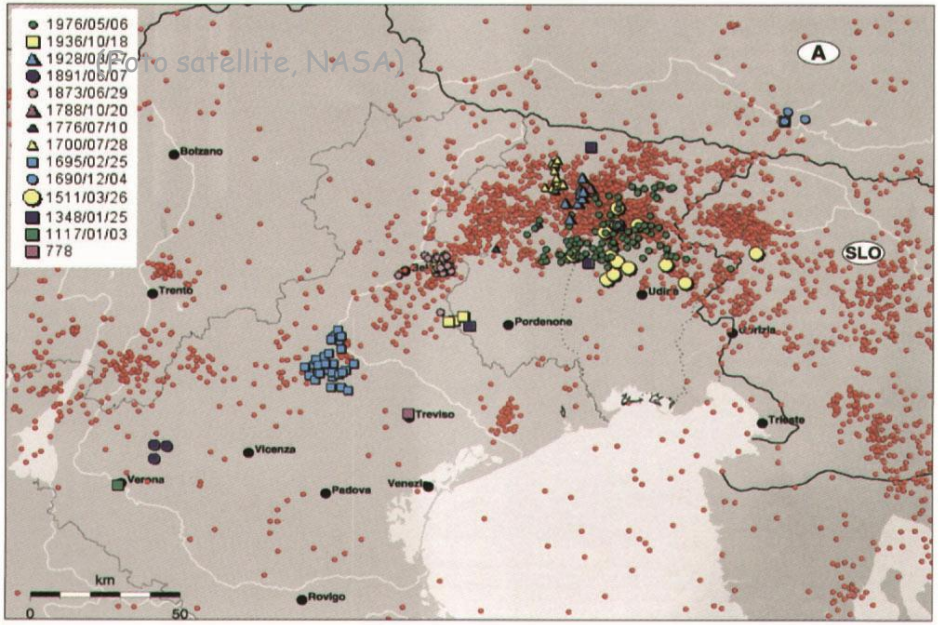


B –B′



Active deformation in the North Adriatic area (Friuli corner)





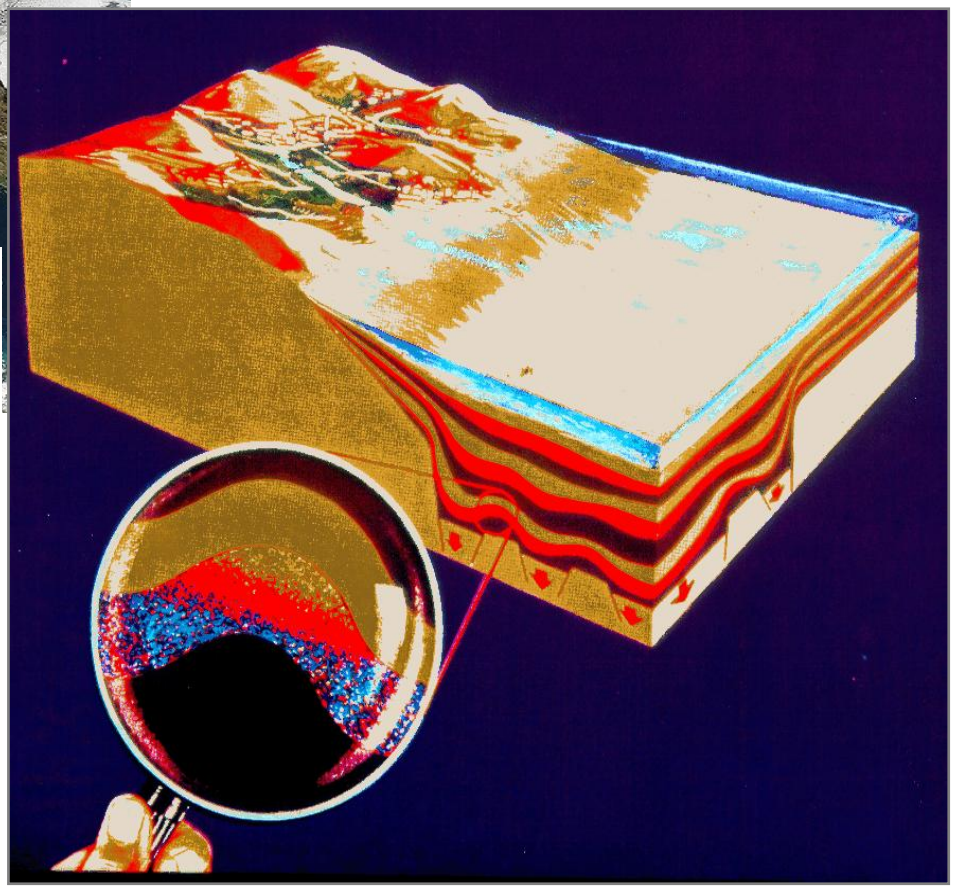
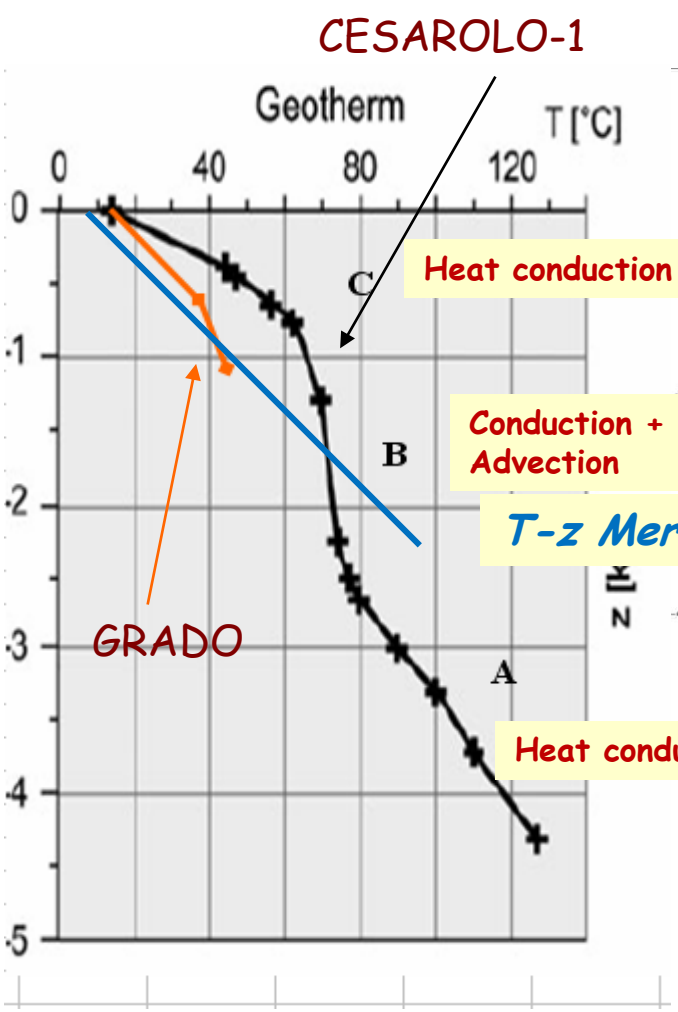


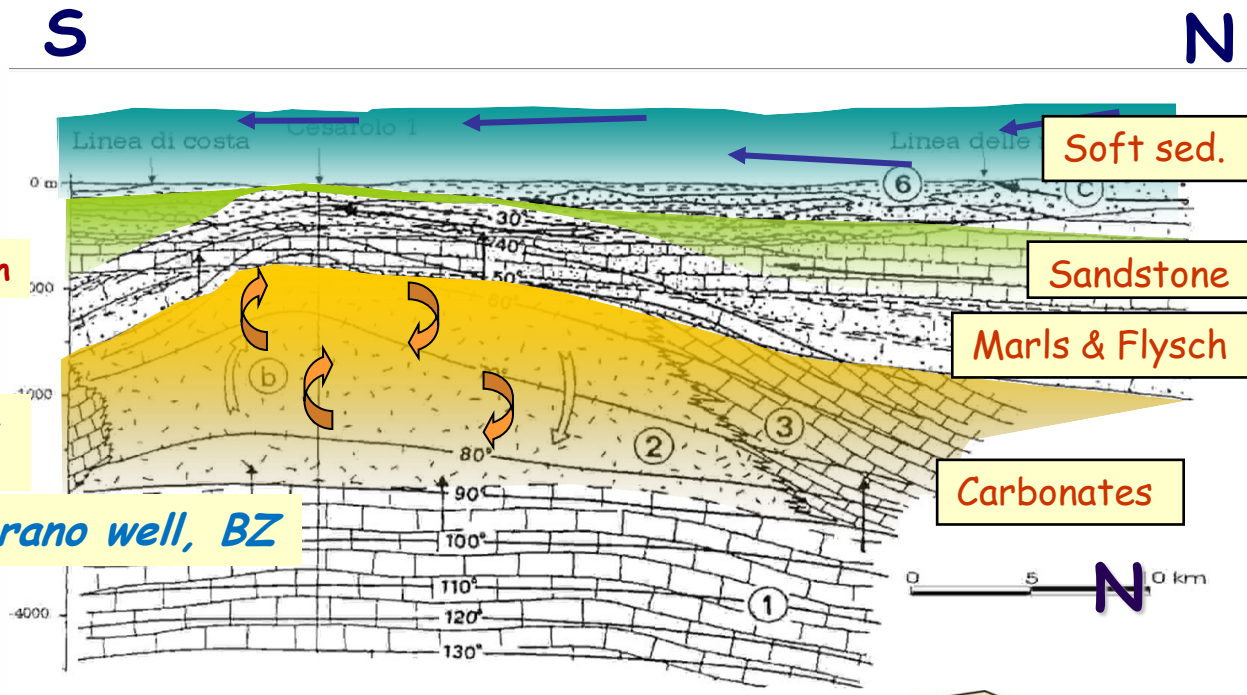
Fig. 6 – Distribuzione degli epicentri di terremoti di magnitudo superiore a 2,5 registrati dalla Rete Sismometrica del FVG dal 1977 al 2004. Sono anche riportate le località più gravemente danneggiate dai maggiori eventi che hanno colpito la regione dal 778 d.C. al 1976 (Intensità ≥ X MCS).

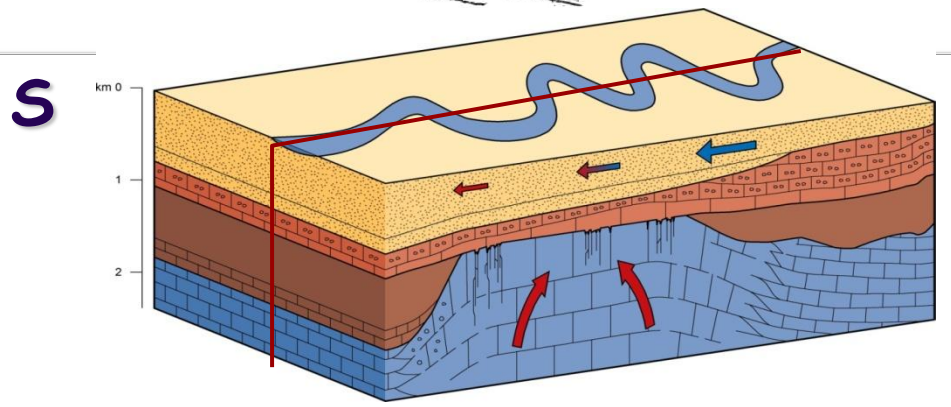
(*Zanferrari , 2006*)

2-D Geothermal model

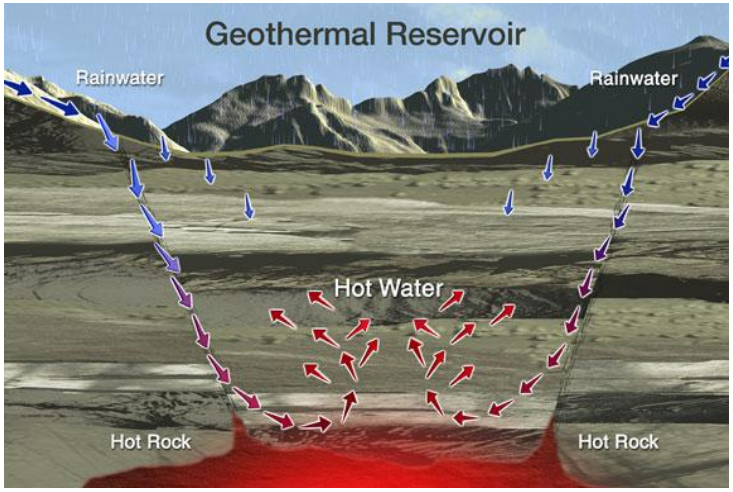


T-z Merano well, BZ

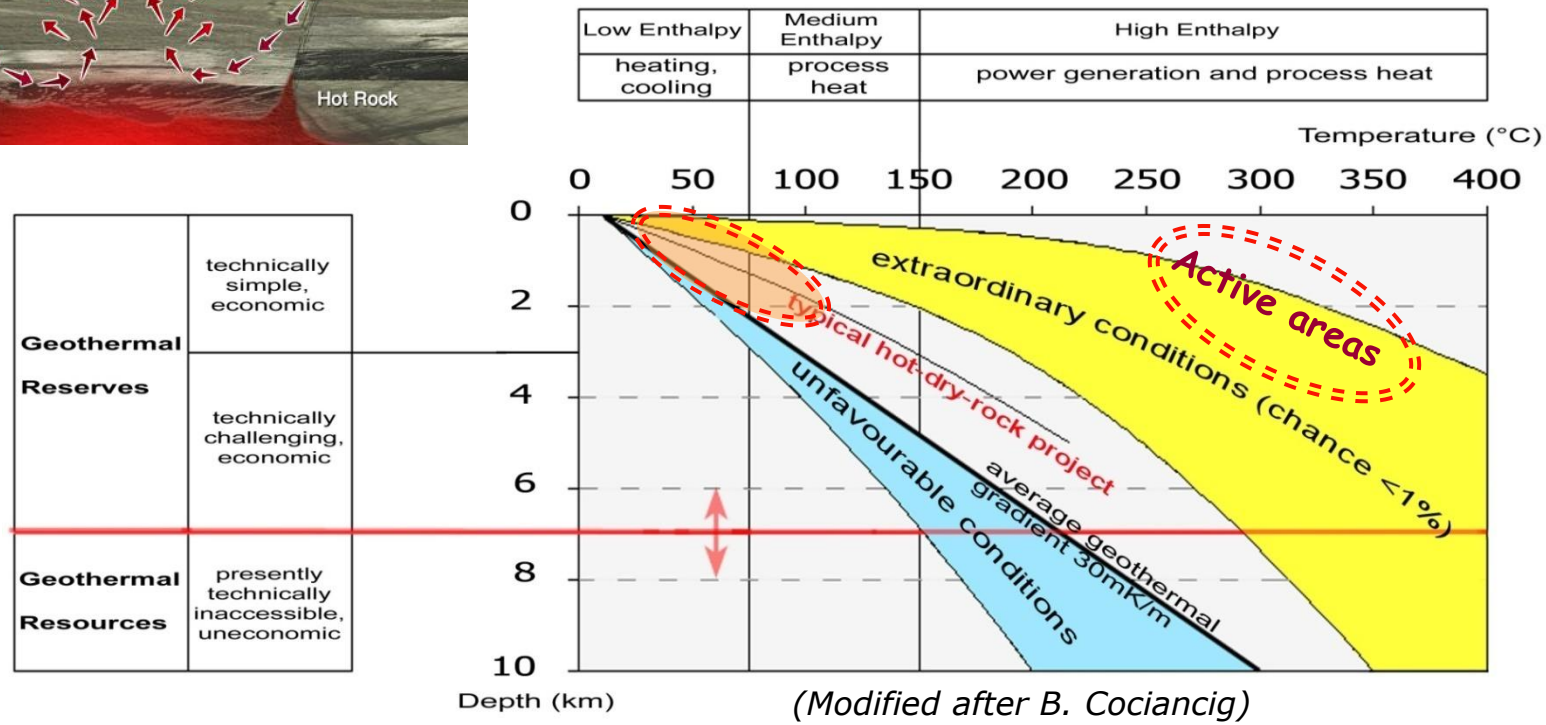




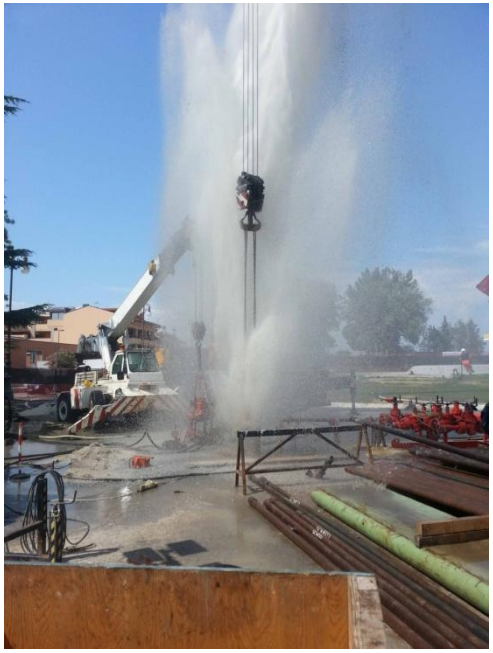
Geothermal Resources & Reserves



- Heat potential is enormous
- Available at shallow depth in active areas
- Constant source and largely renewable



(Modified after B. Cociancig)



- Geothermal Resources in the Adriatic Region
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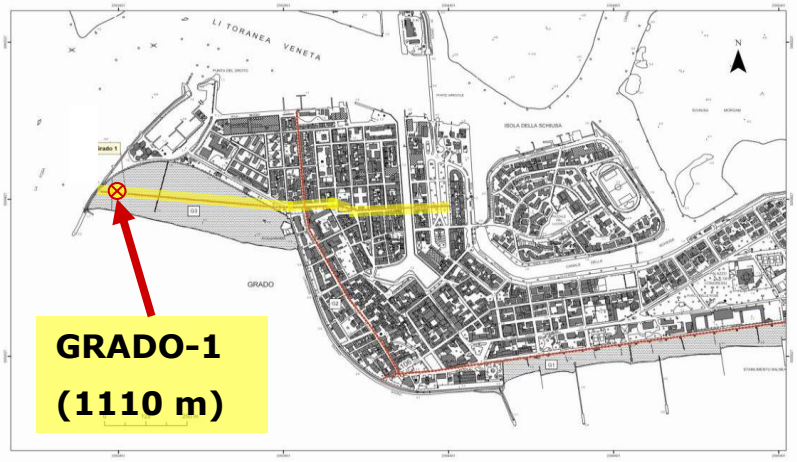
RFVG calls for geothermal applications within POR FESR 2007-2013

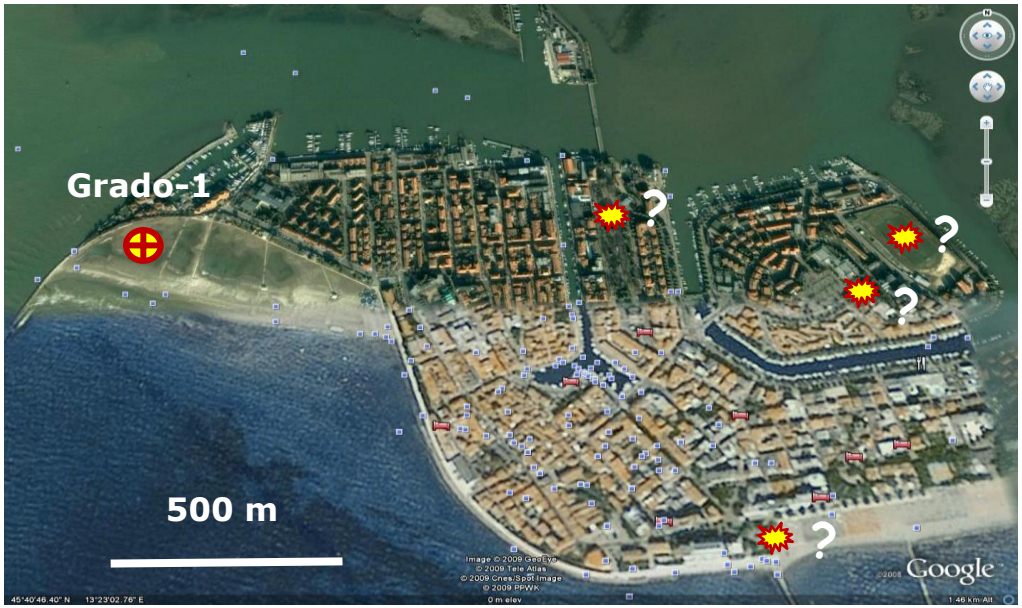
(EU Funding: 77% of admissible costs to beneficiary public administrations)

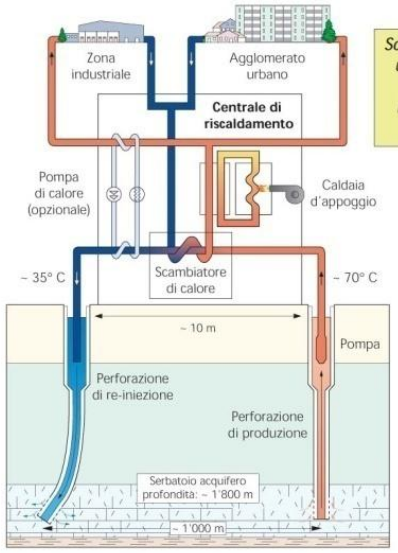
RFVG Calls	Submitted Proposals (N)	Funded Projects (N)	Initial budgets		Started Projects (N)
			Admissible costs (€)	Contribution (€)	
Borehole Heat Exchangers + HPs (1)	23	14 (Pontebba)	3.957.237,35	2.656.157,59	10
Geoth. Resources beyond 700 m	2	1 (Grado 2)	2.495.999,20	1.921.920,00	1
Geoth. Resources up to 700 m (1)	3	2	481.932,40	371.087,95	1
Borehole Heat Exchangers + HPs (2)	9	6	1.511.786,12	1.164.075,31	5
Geoth. Resources up to 700 m (2)	2	1	636.548,49	490.142,34	1
Total	39	24	**9.083.504,56**	**6.603.383,19**	18

Grado Geothermal Project-Phase 1 (DOCUP-2 funding)

- Geological and Geophysical survey
- Regional geothermal prospect
- Design and drilling of Grado-1 exploration well
- Logging, pumping tests, modelling, geothermal potential assessment
- Deployment of a distribution network segment

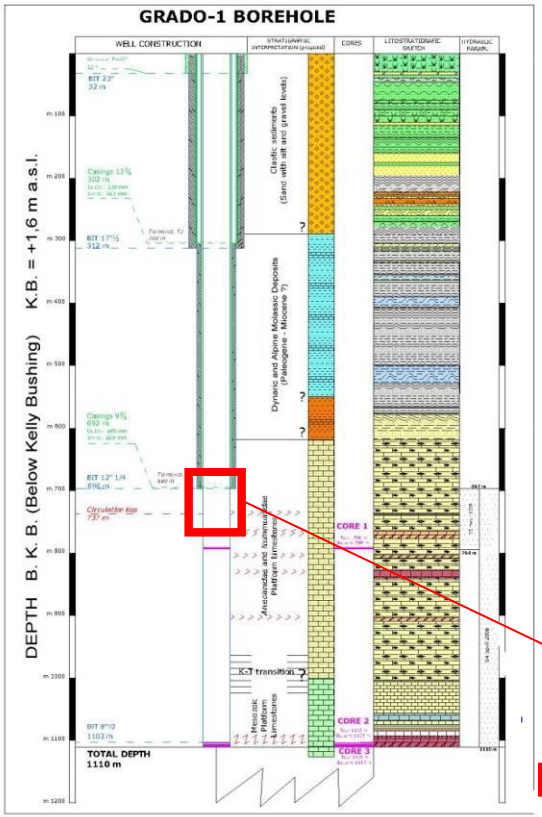




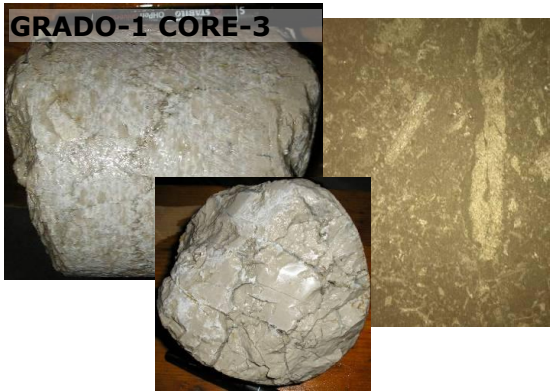


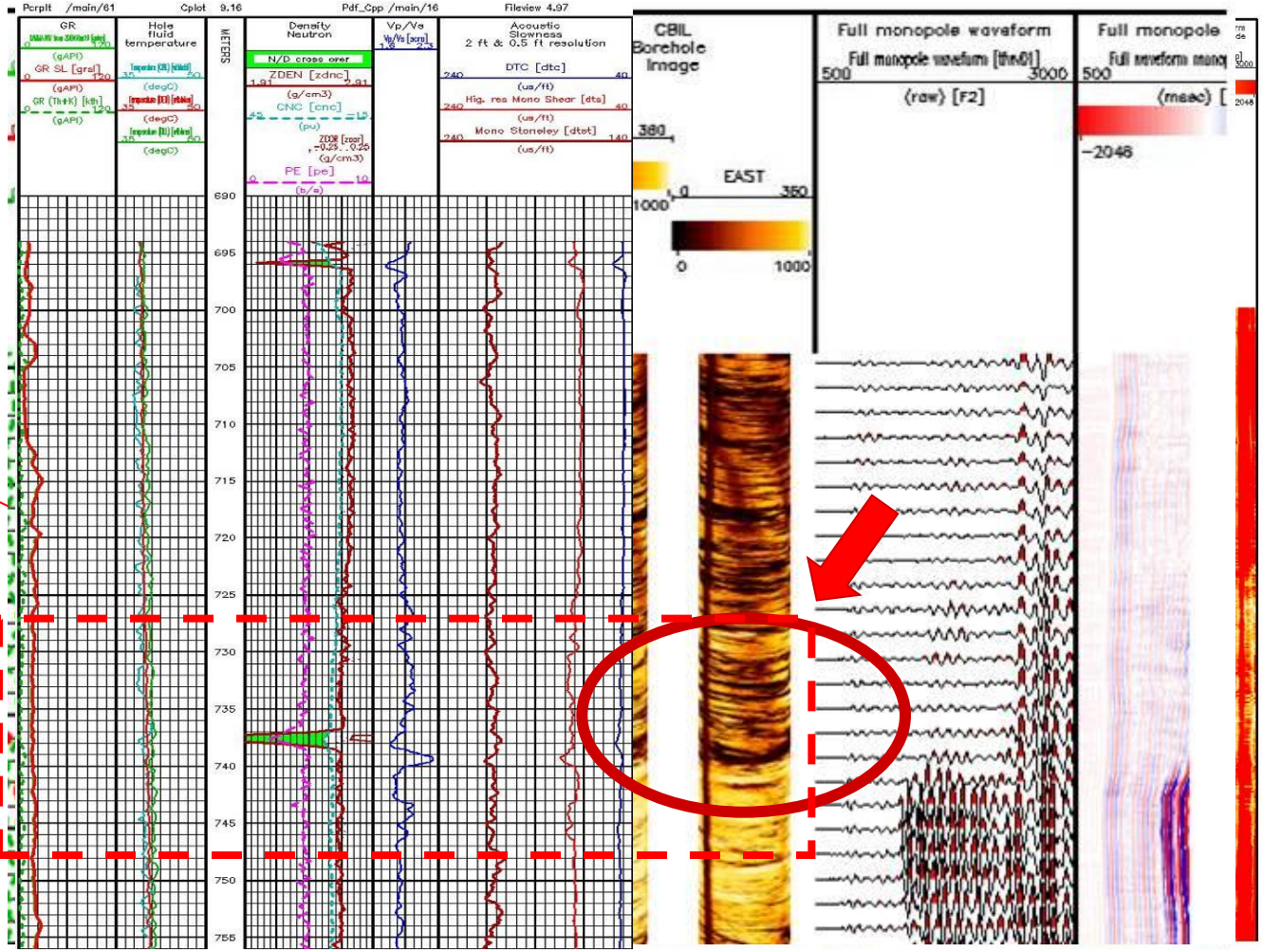
Schema tipo di un «doublet» geotermico nella regione parigina

Well Grado-1: Geophysical Logs

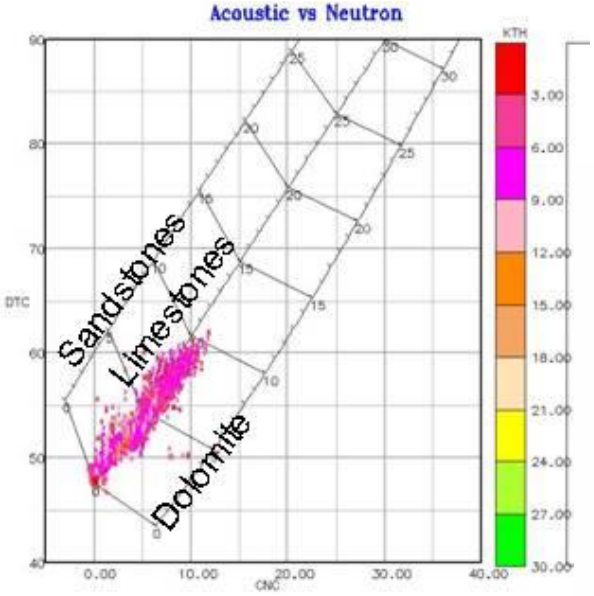


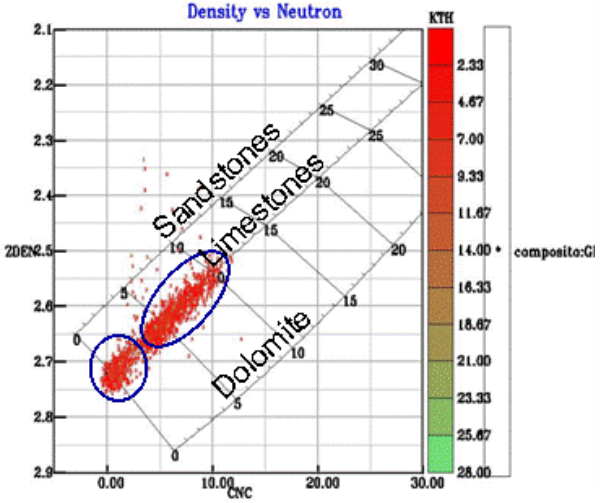
Fractures +Fluids circulation

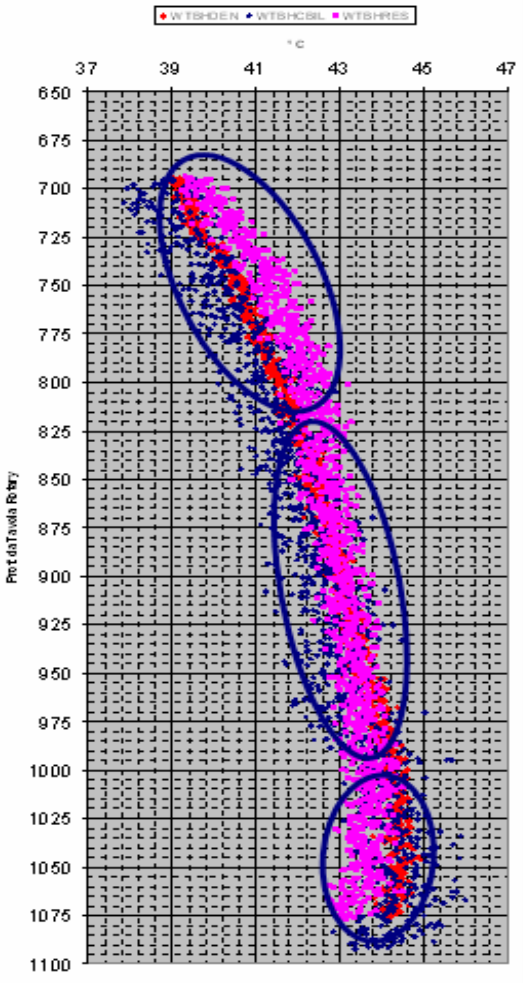


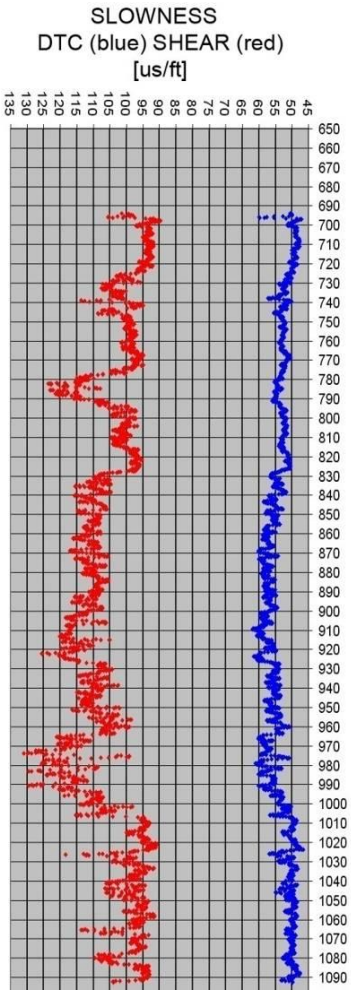


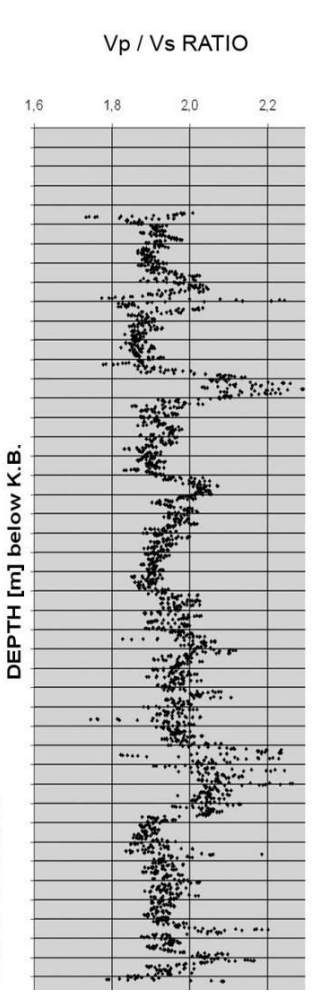
Well Logging results



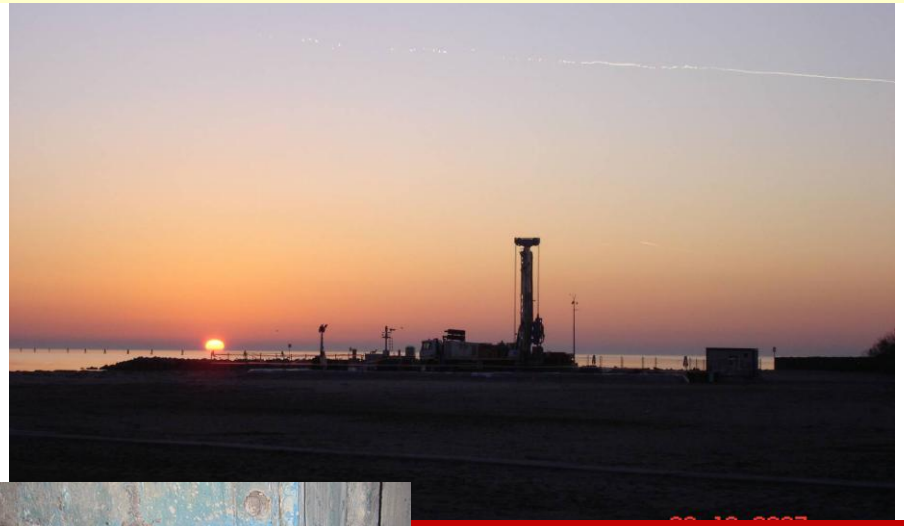








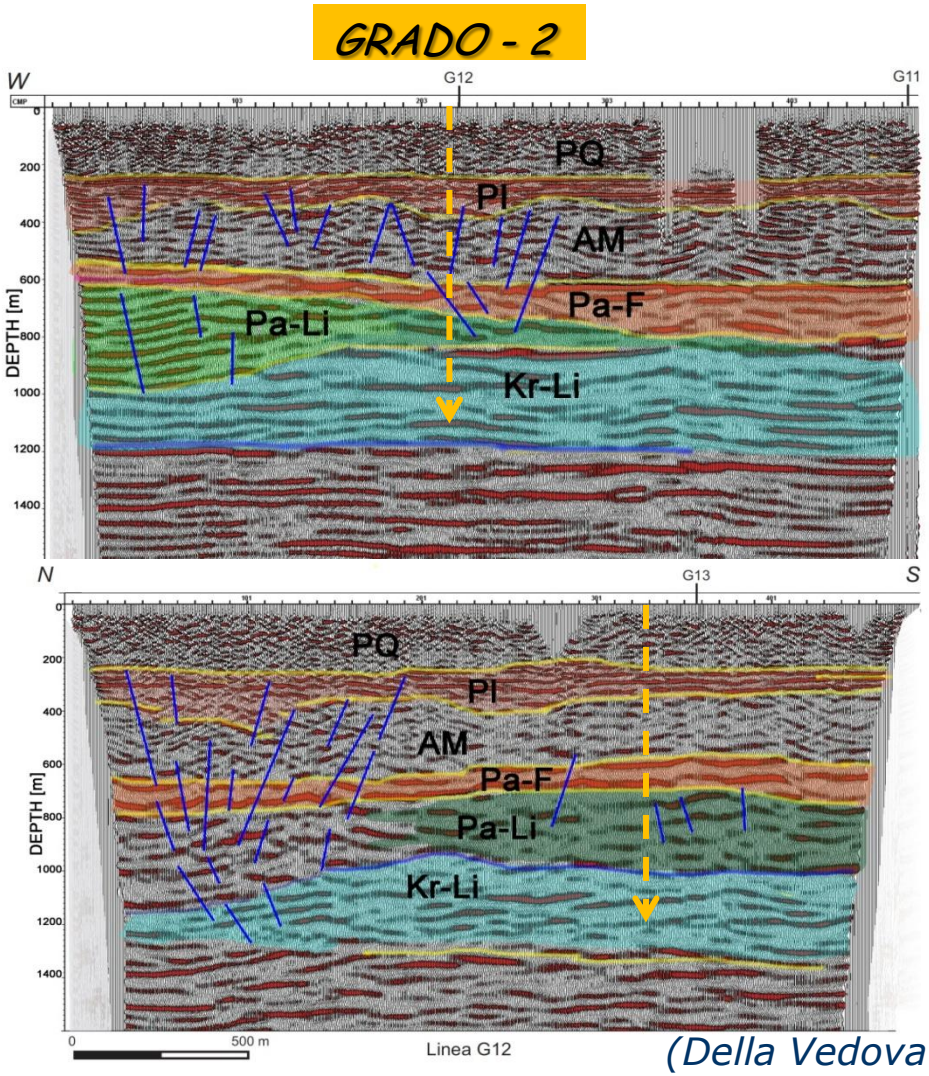
GRADO-1: T monitoring and pumping tests

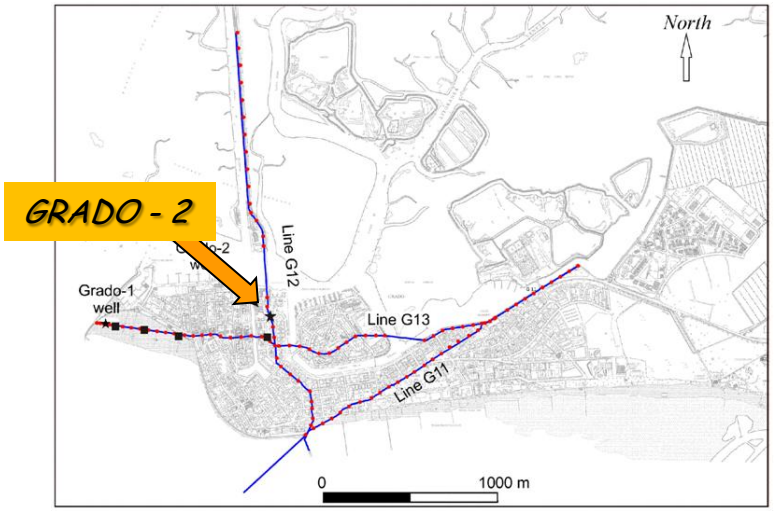


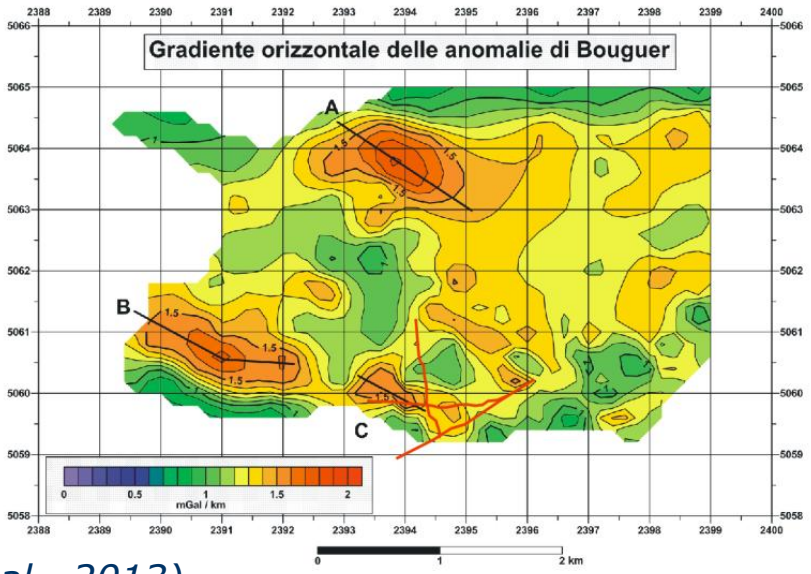
- **Production:** 100 ton/h (28 l/s)
  144 ton/h (40 l/s)
- **Pressure:** 250 kPa
- **T :** 42-44 °C
- **Salinity:** 16 ‰ NaCl
- Permanent T sensors at 300 and 700 m depth

Grado Geothermal Project-phase 2 (POR-FESR funding)

Geophysical Survey, OGS 2012

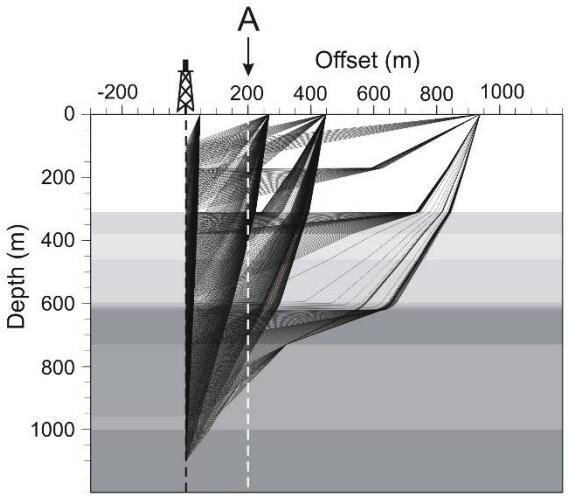


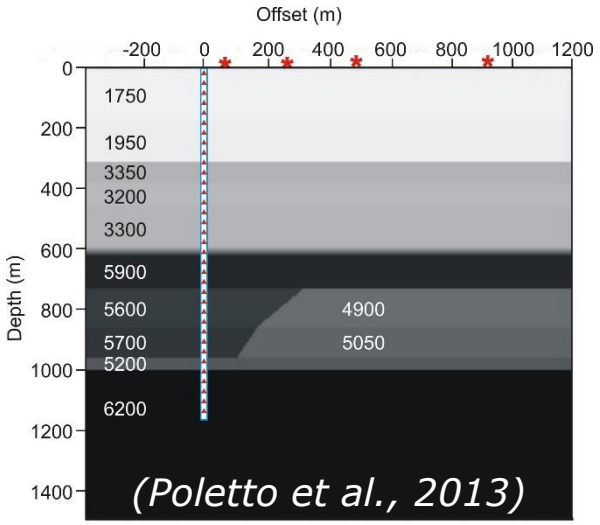




(Della Vedova et al., 2013)

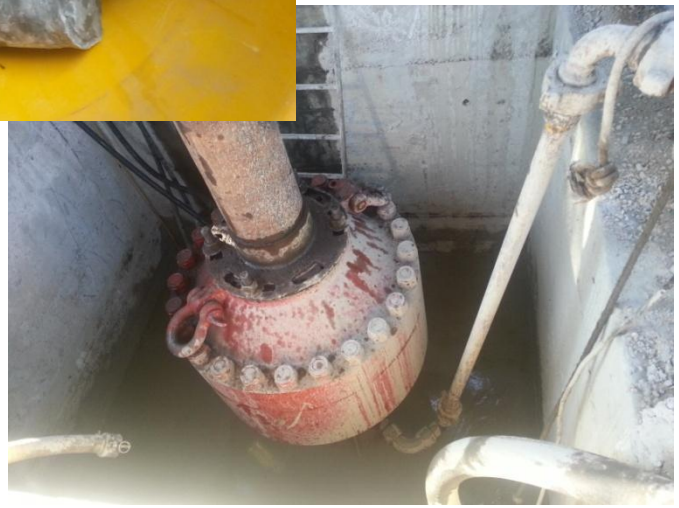
VSP data



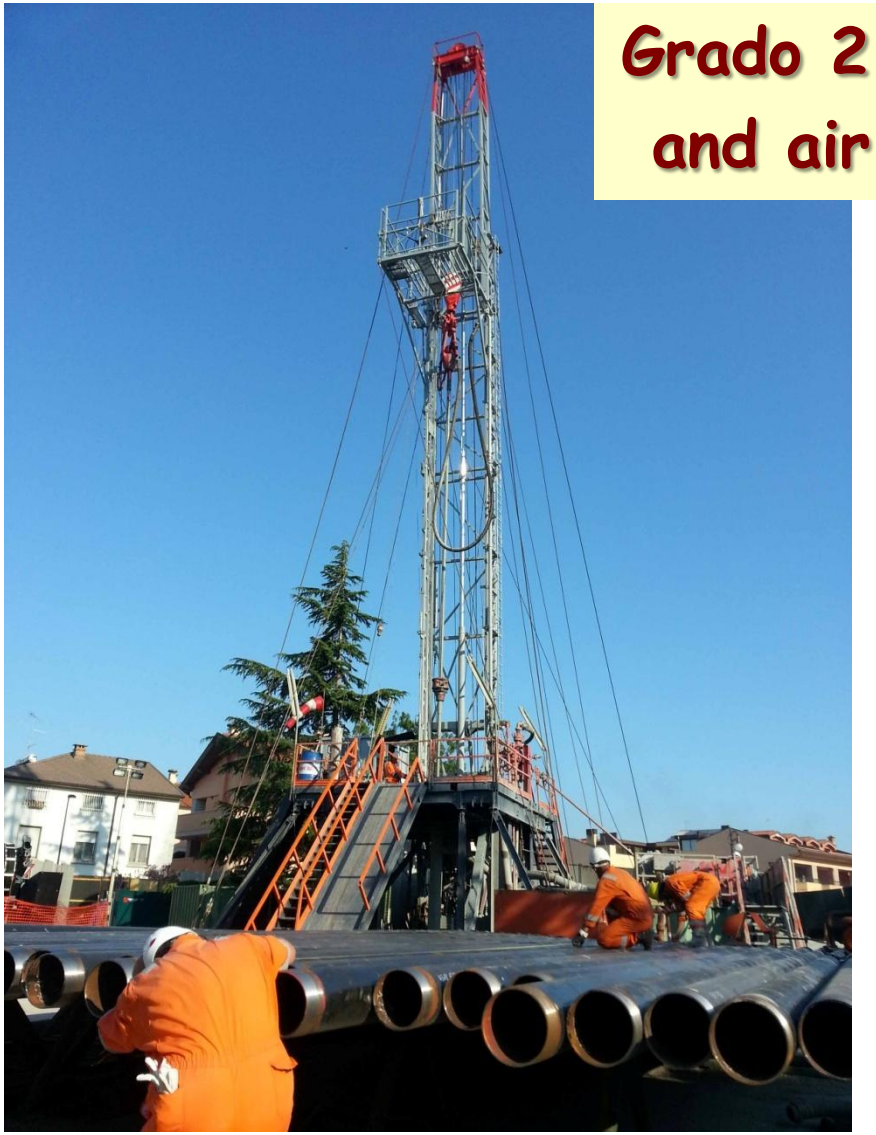


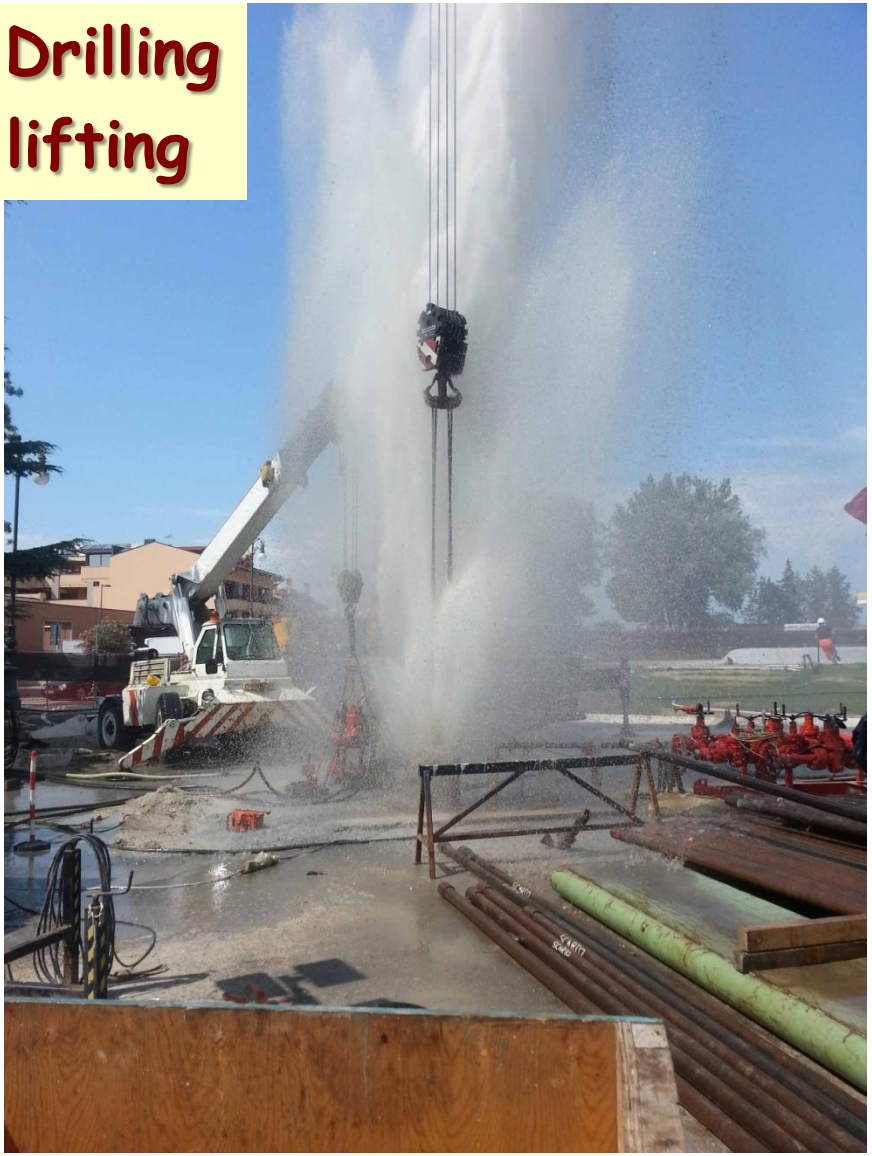
(Poletto et al., 2013)

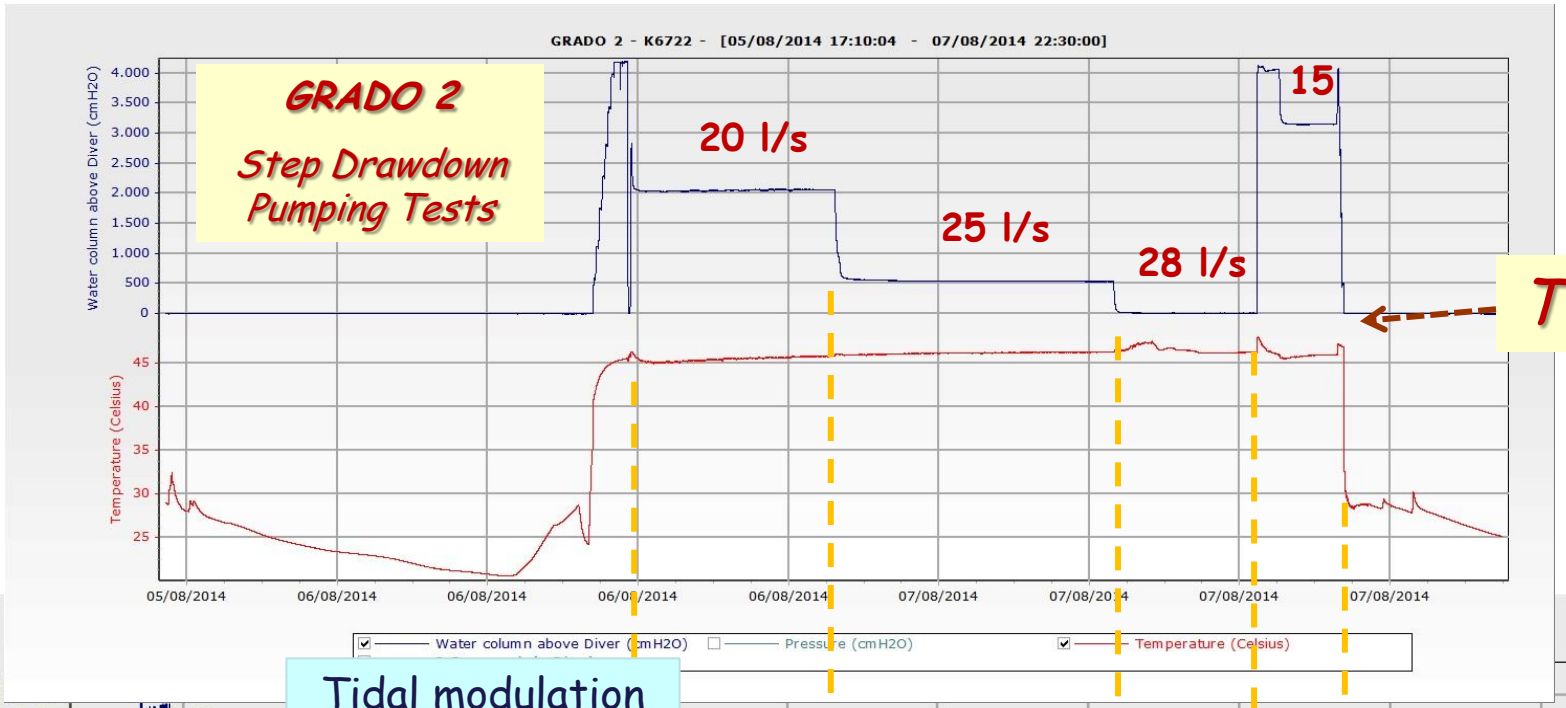
Grado 2 drilling



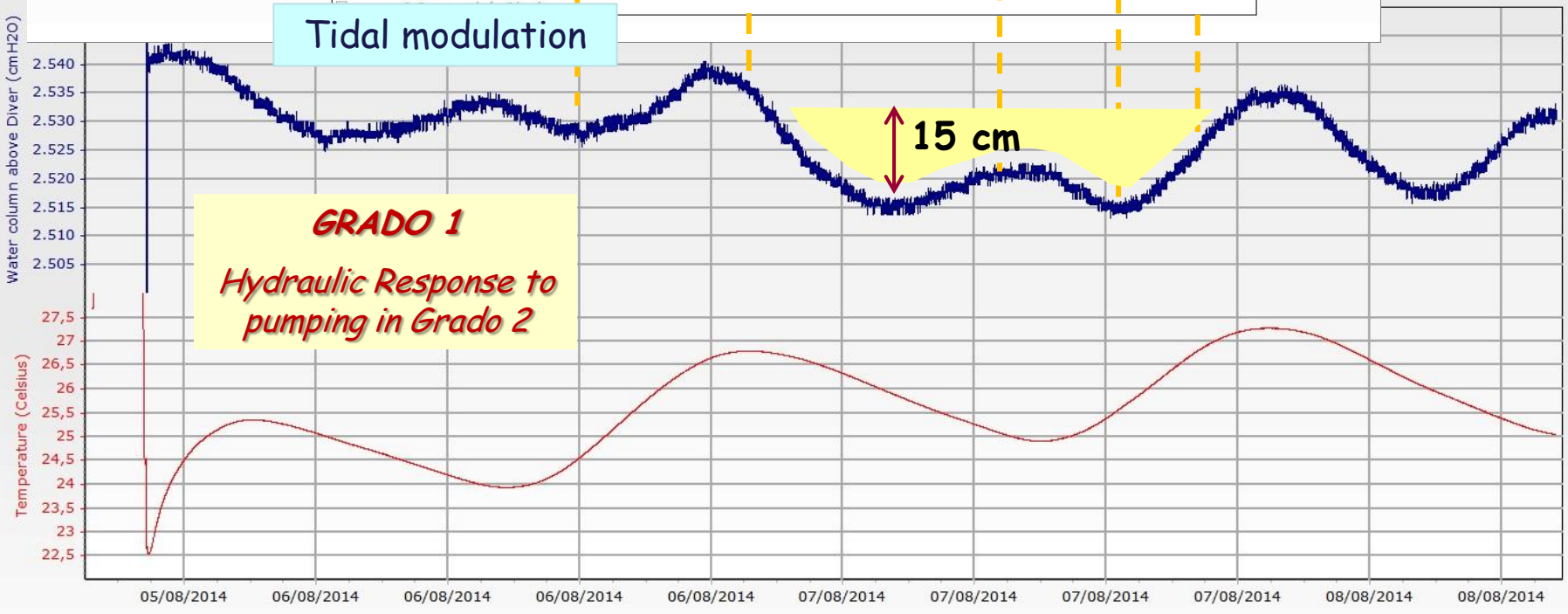
Grado 2 Drilling and air lifting



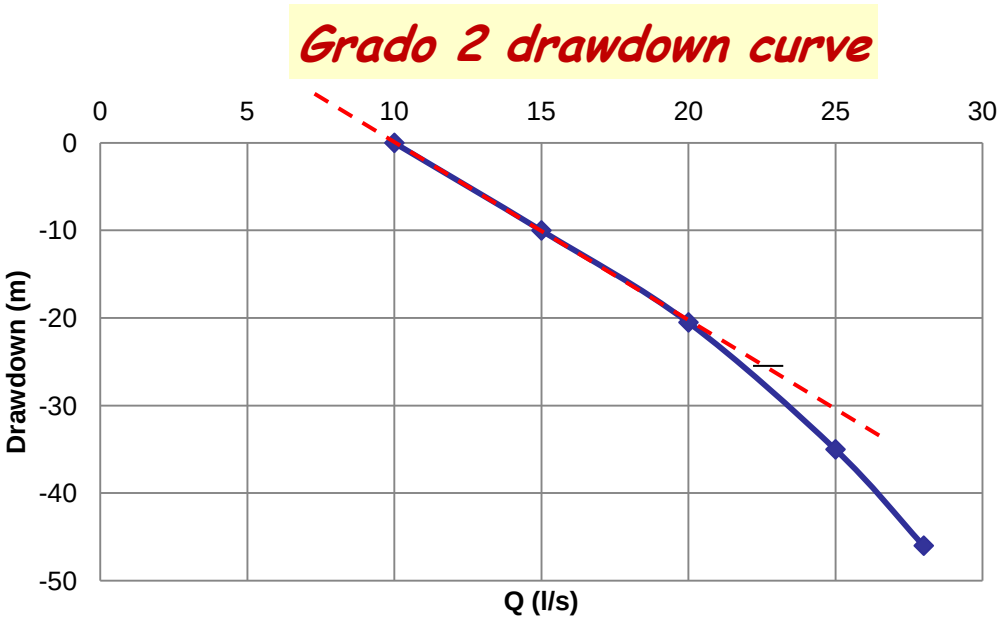


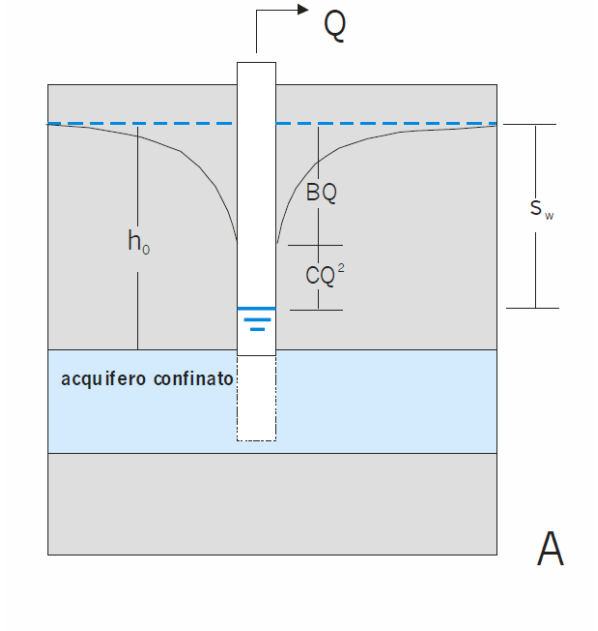


Tidal modulation



1st Pumping Test Drawdown Curve



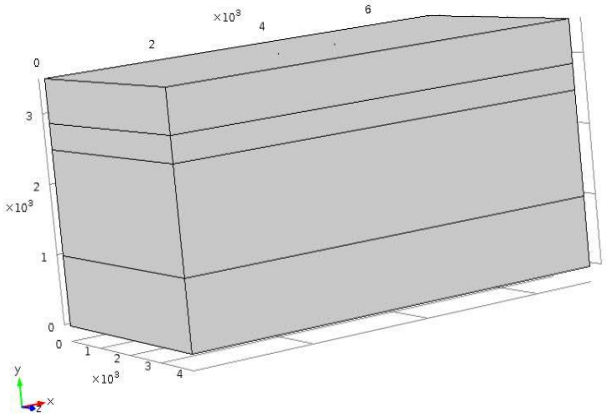


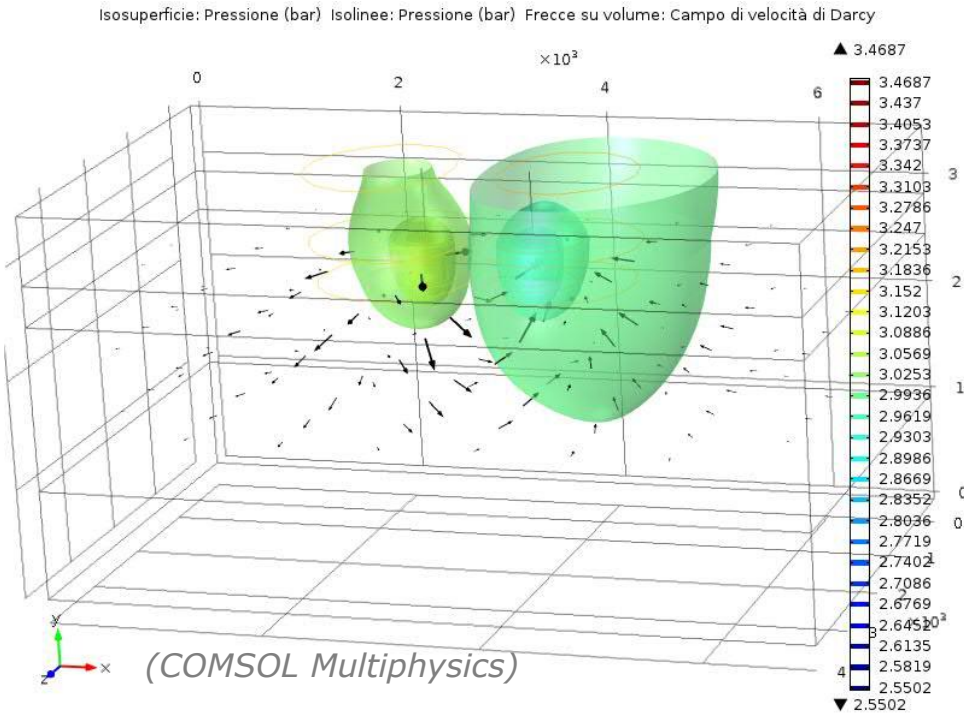
$$s_w = BQ + CQ^2$$

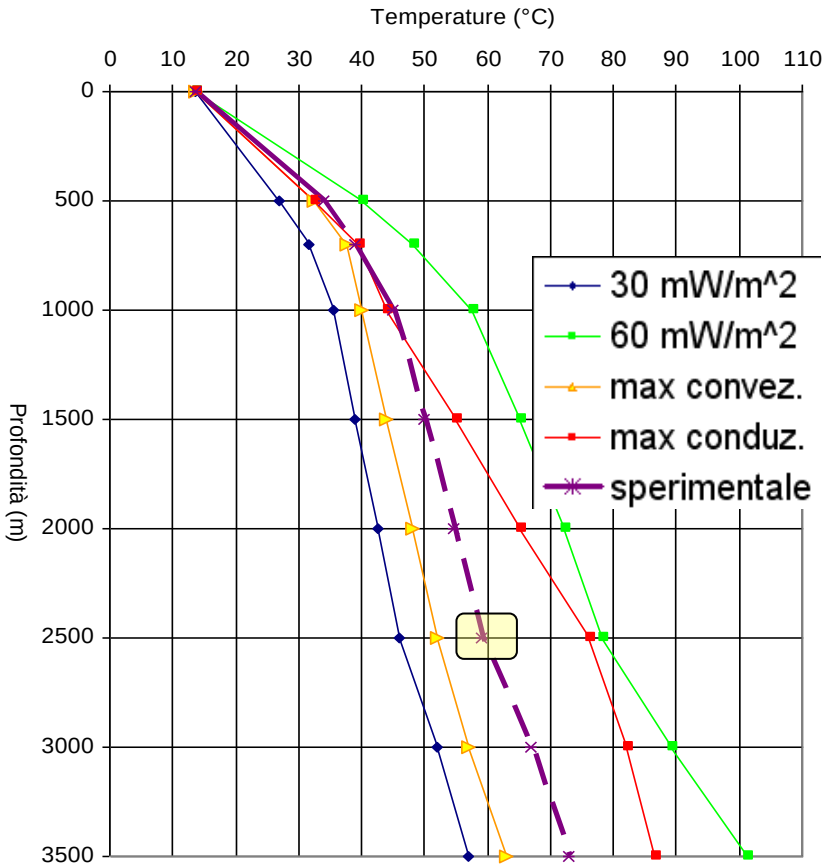
laminar flow up to 20 l/s

Cleanout and acidizing of deeper 250 m of carbonates still to be carried out to increase production rate as in Grado-1

3-D Heat +Fluid Flow modelling



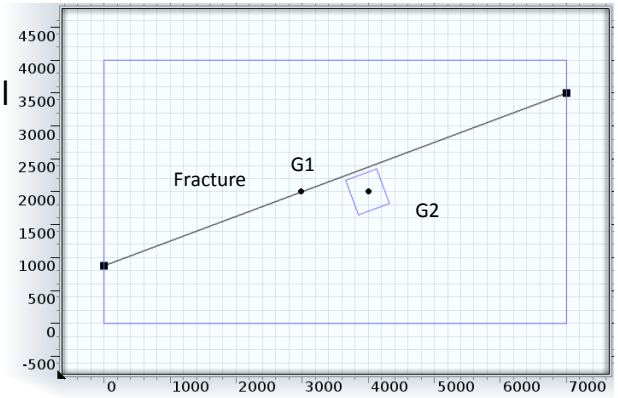


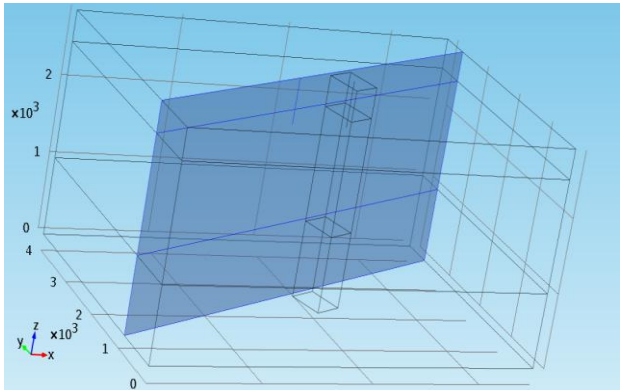


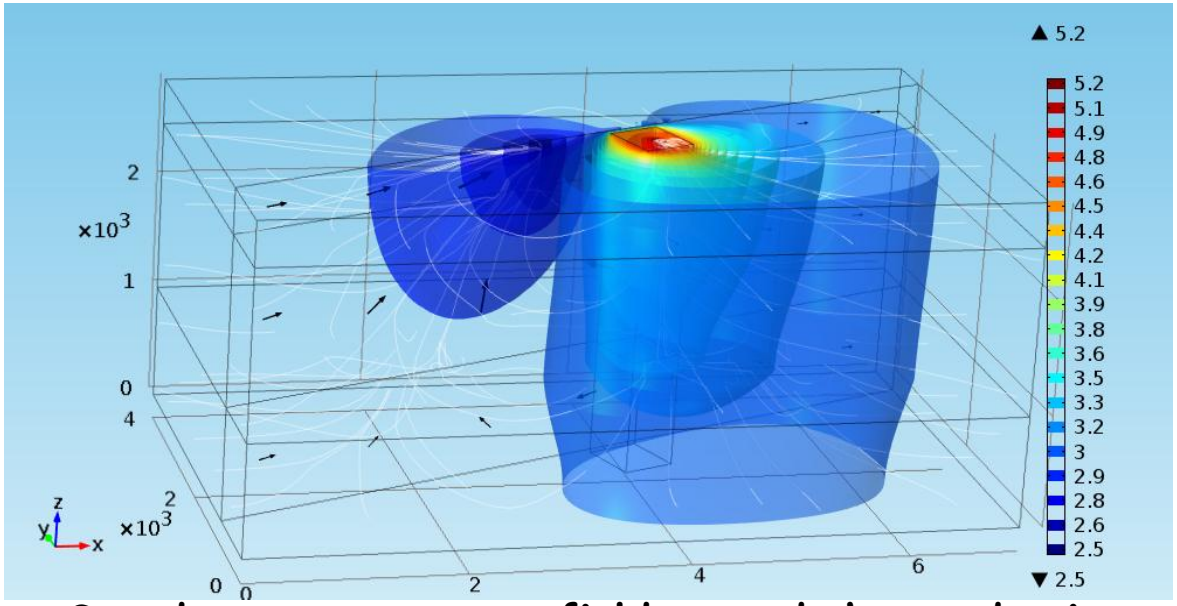
THERMO FLUID-DYNAMIC MODELLING

G1 Re-injection well

G2 Production well







Steady-state pressure field around the production and re-injection wells

Horizontal Directional Drilling under the port canal

Network will link 6 public buildings

- Geothermal Resources in the Adriatic Region
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- Pontebba Ice Rink Plant
- Guidelines and hints for project development

Open Loop System

High efficiency and limited investment

Water resources in peri-Adriatic Areas

a) Surface water bodies (canals, rivers, basins, sea, …): estimated T range 10-22 °C

b) Drainage waters from tunnels in mountain areas: 8-40 °C

c) Artesian wells: 13-18 °C

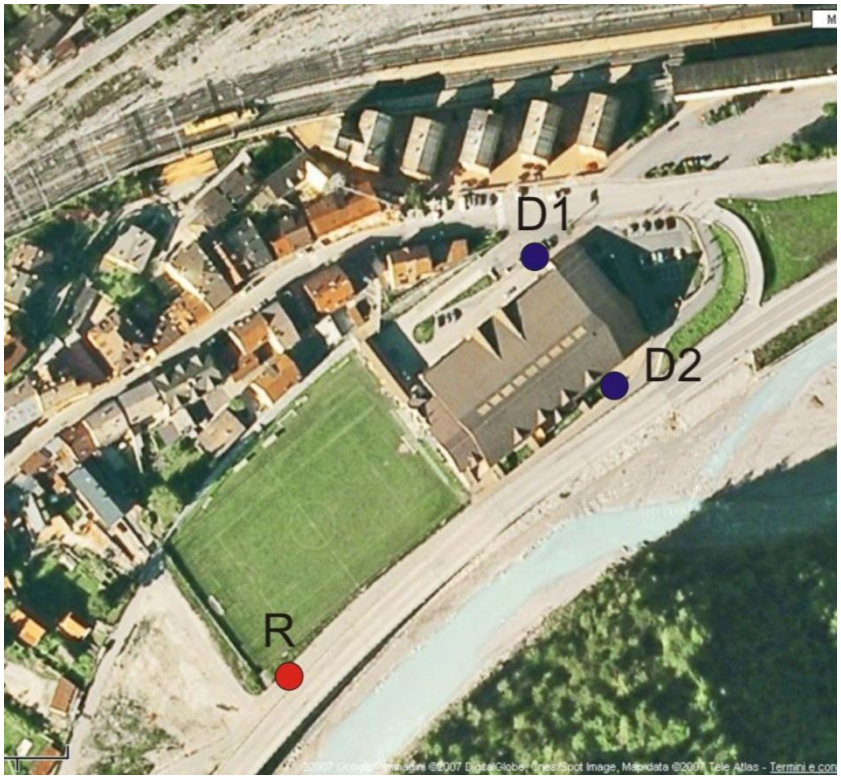
d) Shallow unconfined aquifers (50-100 m): 8-14 °C

e) Hydrothermal waters from new or existing wells : 12-30 °C

f) Low T deep aquifers : 30-90 °C

g) ….

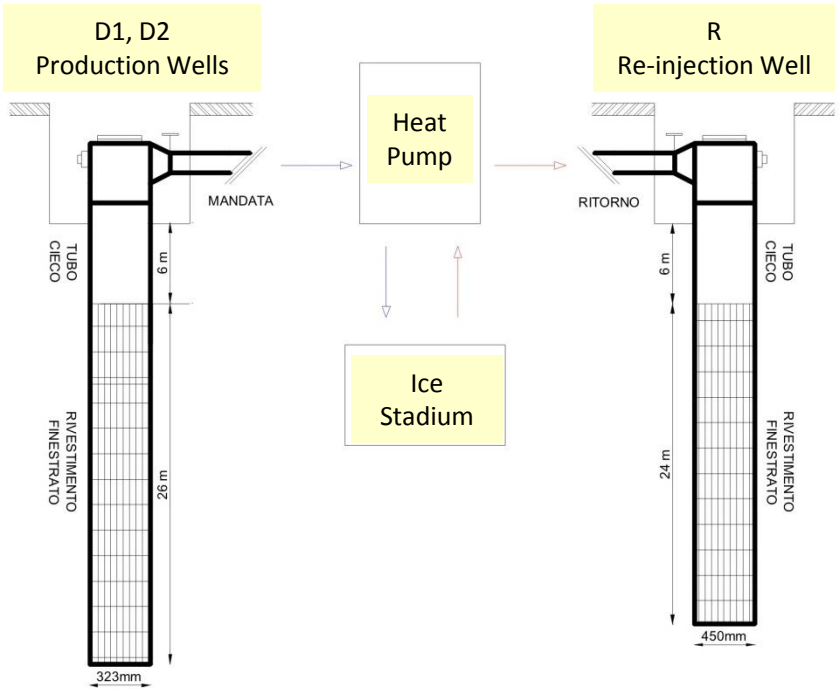
OPEN LOOP PONTEBBA ICE RINK PLANT



Groundwater source → 2 production wells D1 + D2

Water discharge → 1 re-injection well R

Production and re-injection wells



- Grounwater temperature 8,5 – 9,0 °C
- Cooling/heating power: 600-700 kW
- Production rate 50 l/s (20 + 30 from D1 & D2)
- Max. temperature difference = 3 °C

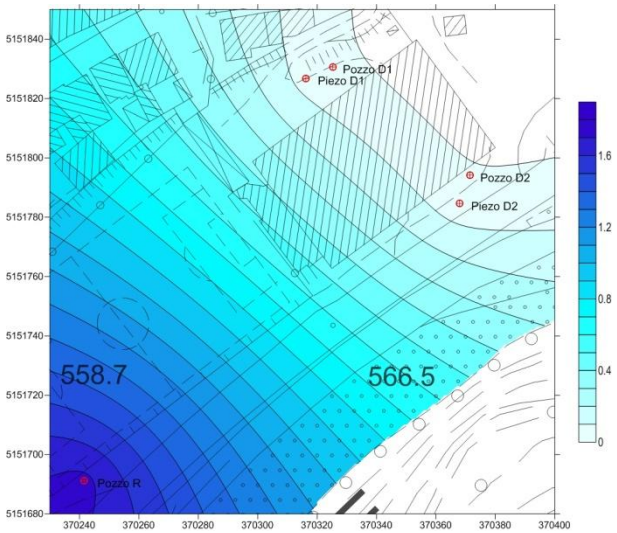
D1 e D2 production

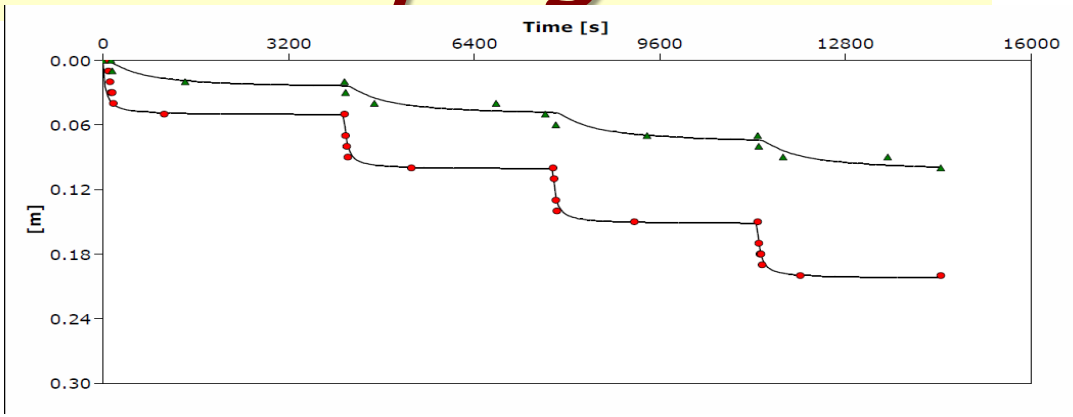
- 32 m deep, 13" 3/8 casing, 8 mm
- Screen from 6 to 32 m

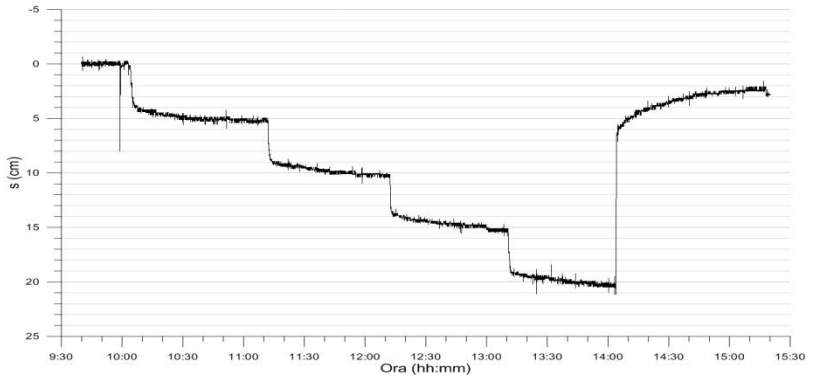
R re-injection

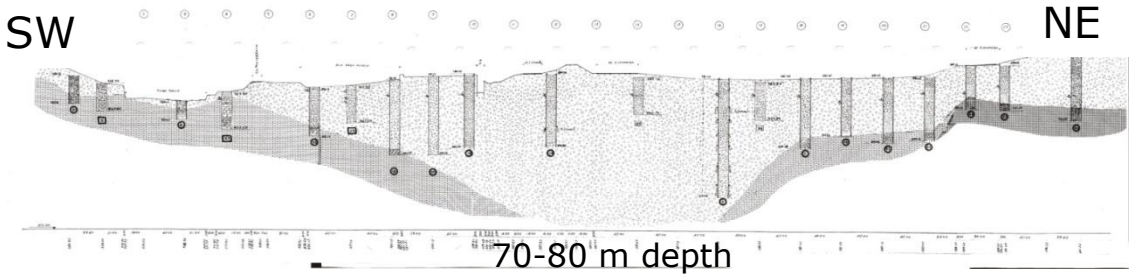
- 30 m deep, 18" casing, 9 mm
- Screen from 6 to 30 m

Step Drawdown Pumping Tests



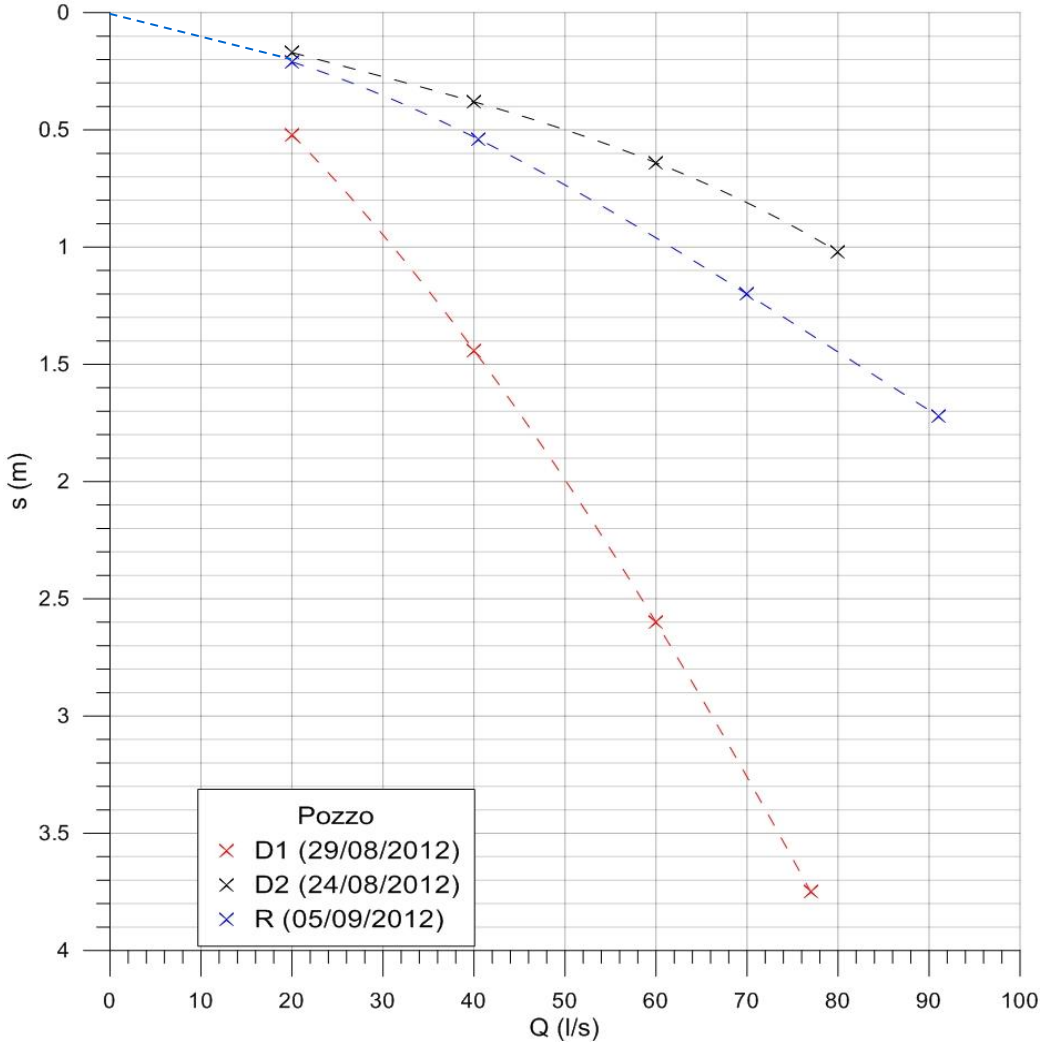


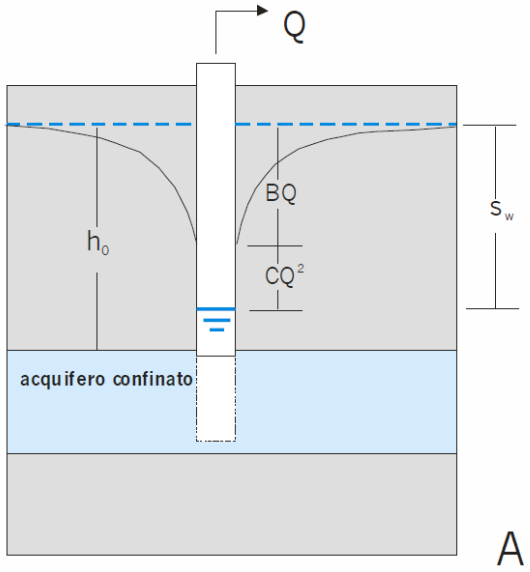




70-80 m depth

Pumping Tests Drawdown Curve





$$s_w = BQ + CQ^2$$

Production rates:

D2= 40 l/s

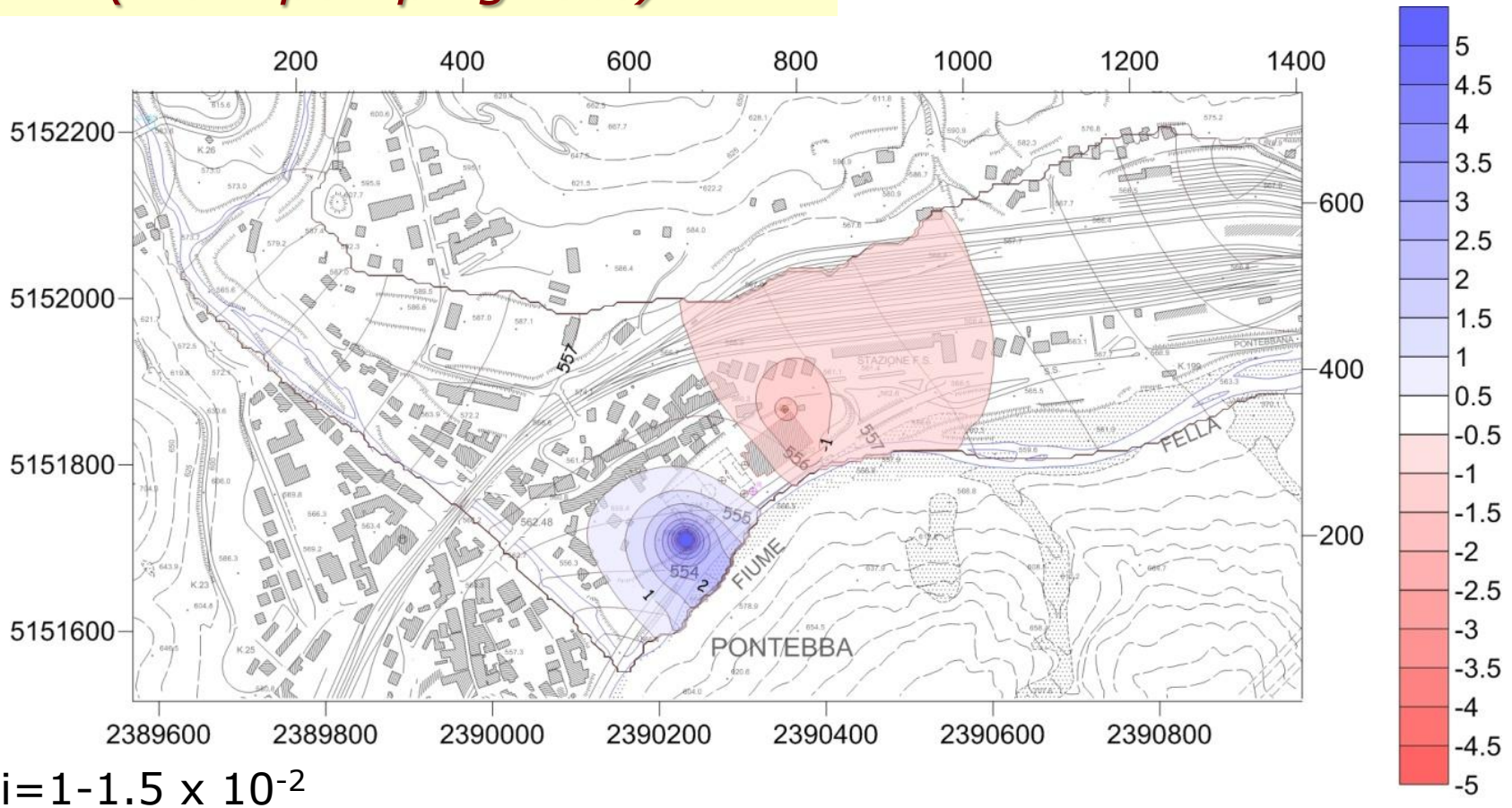
D1 = 25 l/s

Critical conditions for pumping Wells: Simulation in dry season (max. pumping rate)

D1+D2=72 l/s

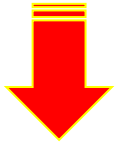
R=72 l/s

K=1x10^{-3} m/s, K_{Fella}=1x10^{-5} m/s



i=1-1.5 x 10^{-2}

- Geothermal Resources in the Adriatic Region
- Grado Geothermal District Heating Project
- Pontebba Ice Rink Plant
- Guidelines and hints for project development



It's not sustainable to exchange heat with the geothermal reservoir at a rate higher than that naturally occurring

Geothermal Systems Guidelines 1

Geothermal Resources Oriented

- Find out areas with good geothermal/hydrothermal potential (T, k)
- Carry out geological and geophysical surveys to identify structures, stress regime, fractures orientation, … (locate wells)
- Characterize resource and assess its geothermal potential (drilling)
- Temp., depth and drilling costs are critical design parameters
- Recharge is critical for sustainable open-loop systems
- Carefully design geothermal systems: reduce geological risk to limit financial risk
- Integrate locally available RES and conventional …..
- Monitor and optimize the performance

Geothermal Systems Guidelines 2

Environment oriented

- Check campatibility with Urban Development Plan, avoid protected/excluded areas (unstable areas, polluted stes, archeologic and military areas, …)
- Carefully evaluate geologic impacts (subsidence, flooding, landslides, …) at various time scales
- Assess environmental hazards: depletion of water resource, aquifers recharge, flooding, potential contamination, subsidence, ….)
- → **total re-injection**

Geothermal systems guidelines 3

Regulatory framework

- Obtain authorization, permits (drilling, pumping and reinjection of water)
- Maintain distance from permit/property boundaries
- Stimulate competition among enterprises
- Check for incentives and supporting measures
- …..

Geologic and Environmental Risks associated to geothermal systems

Open-loop systems

- Hydraulic interconnection of aquifers
- Aquifer contamination
- Geotechnical problems: subsidence, landslides, flooding, …
- Recharge, hydraulic sustainibility
- Thermal plume
- Fooling at the heat exchanger plates
- …

Closed-loop systems

- Drilling contamination
- BHE and/or piping failure
- Long-term foot-print
- Thermal contamination
- …..

Advantages

- Constant production
- High efficiency potential
- Good integration capacity
- Limited footprint
- Low CO_2 emission

... and Challenges

- *Reduce geologic risk*
- *Reduce drilling costs*
- *Enhance performance and reliability of RHC*
- *Reduce payback time*

Thanks for your attention!

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