



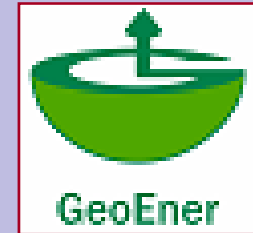
MINISTERIO DE CIENCIA E INNOVACIÓN

Instituto Geológico y Minero de España



I Congreso de Energía Geotérmica en la Edificación y la Industria

Madrid, 15 y 16 de octubre de 2008



Sistemas geotérmicos estimulados: el futuro de la geotermia



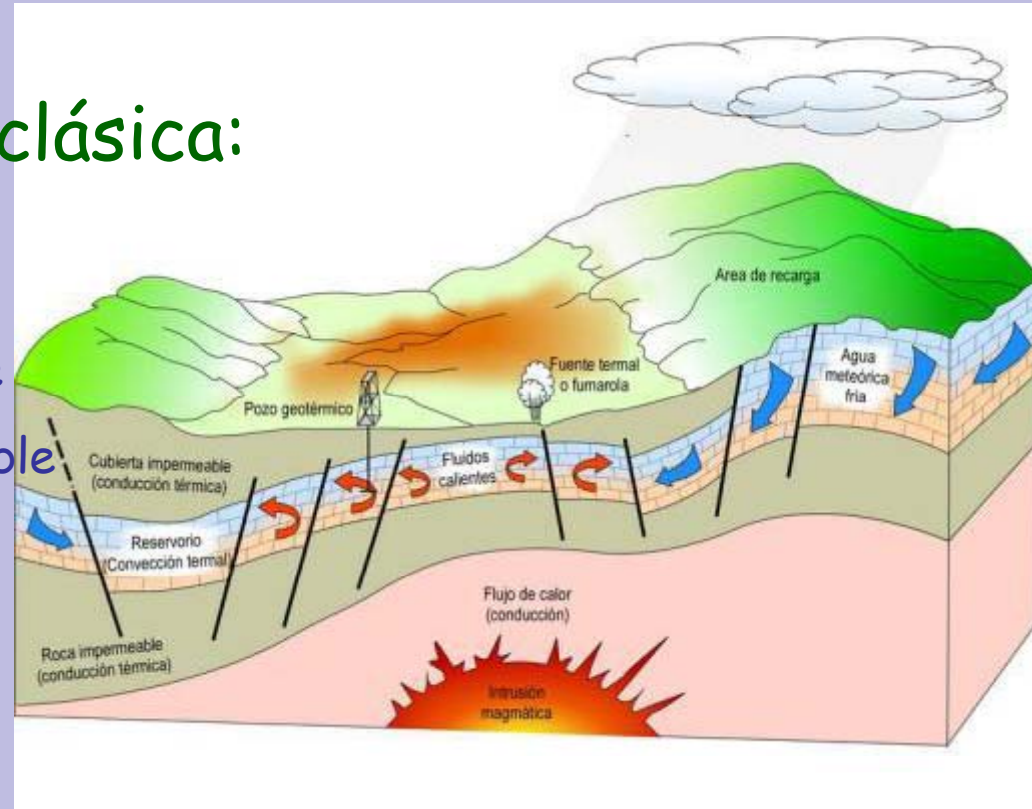
Celestino García de la Noceda Márquez
Departamento de Investigación en
Recursos Geológicos
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c.garcia@igme.es

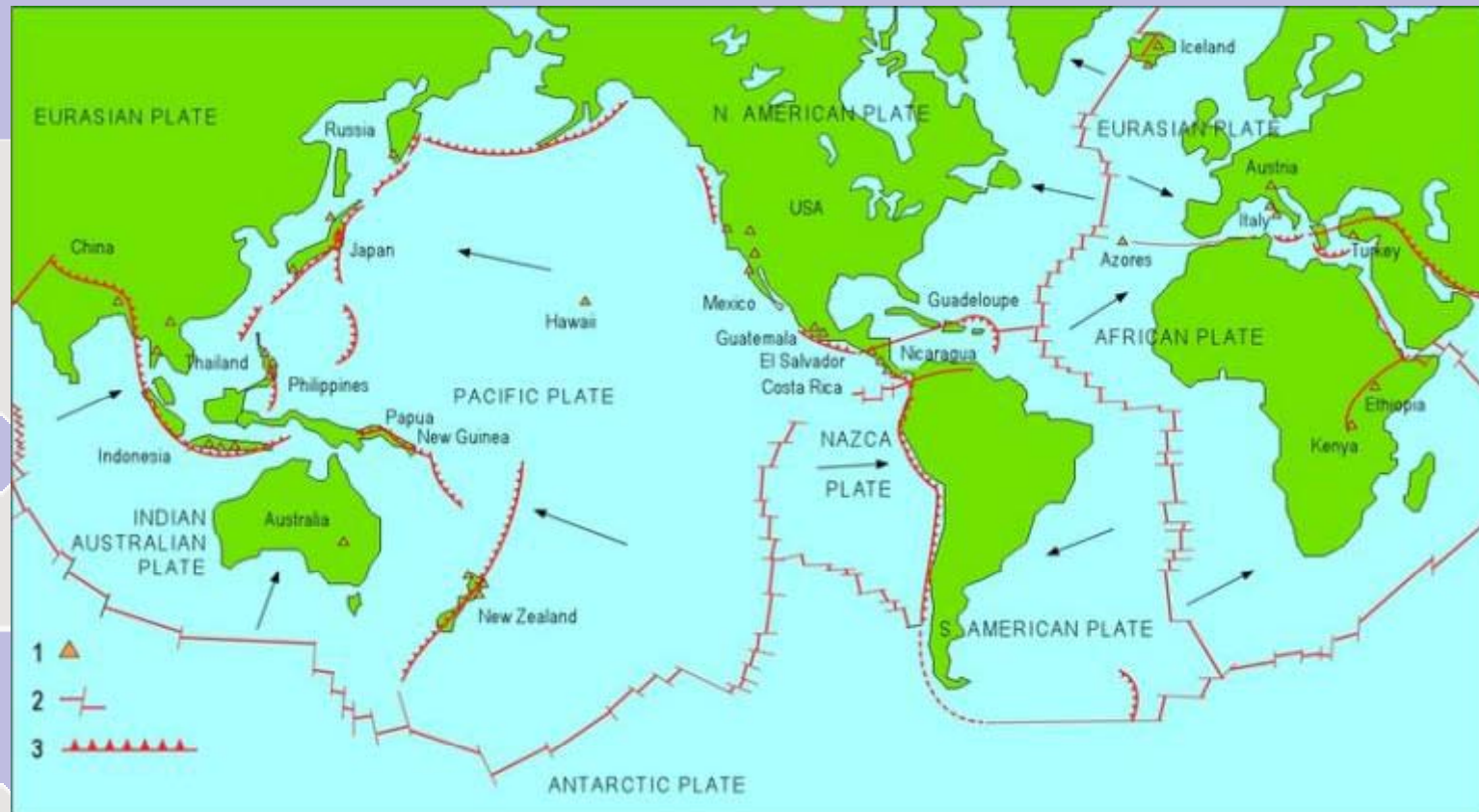




La geotermia clásica:

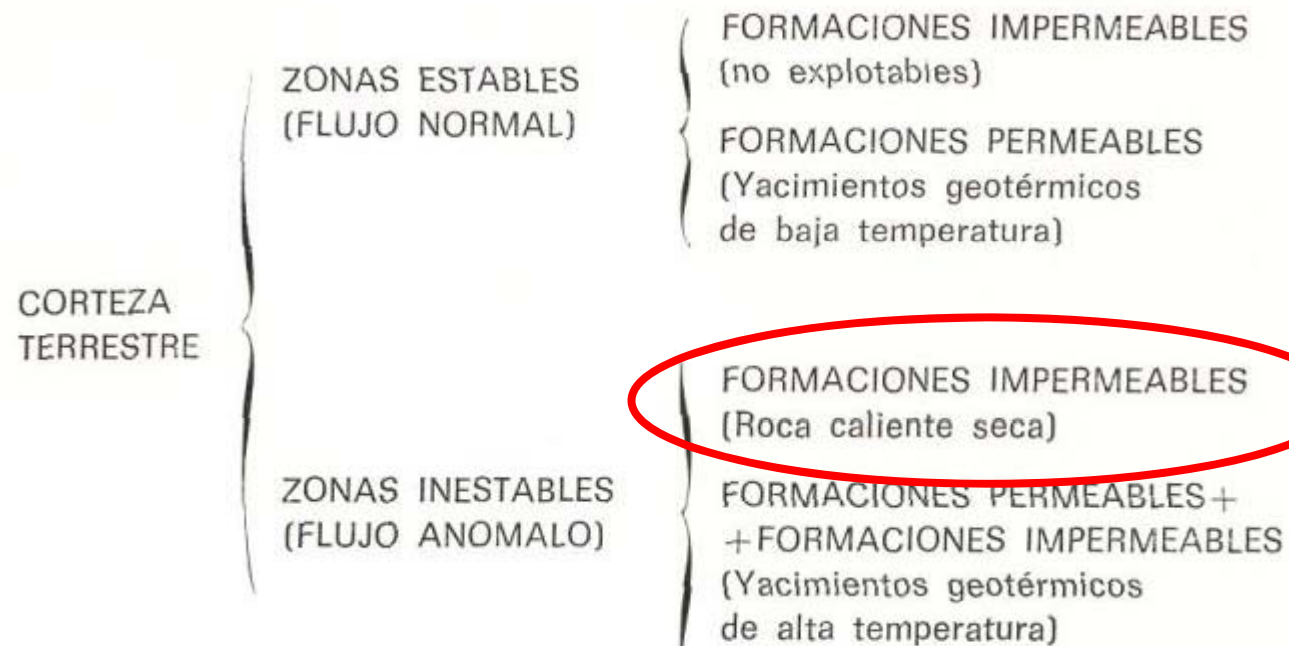
- Cobertura
- Almacén permeable
o Base impermeable
- o Fluido
- Foco de calor





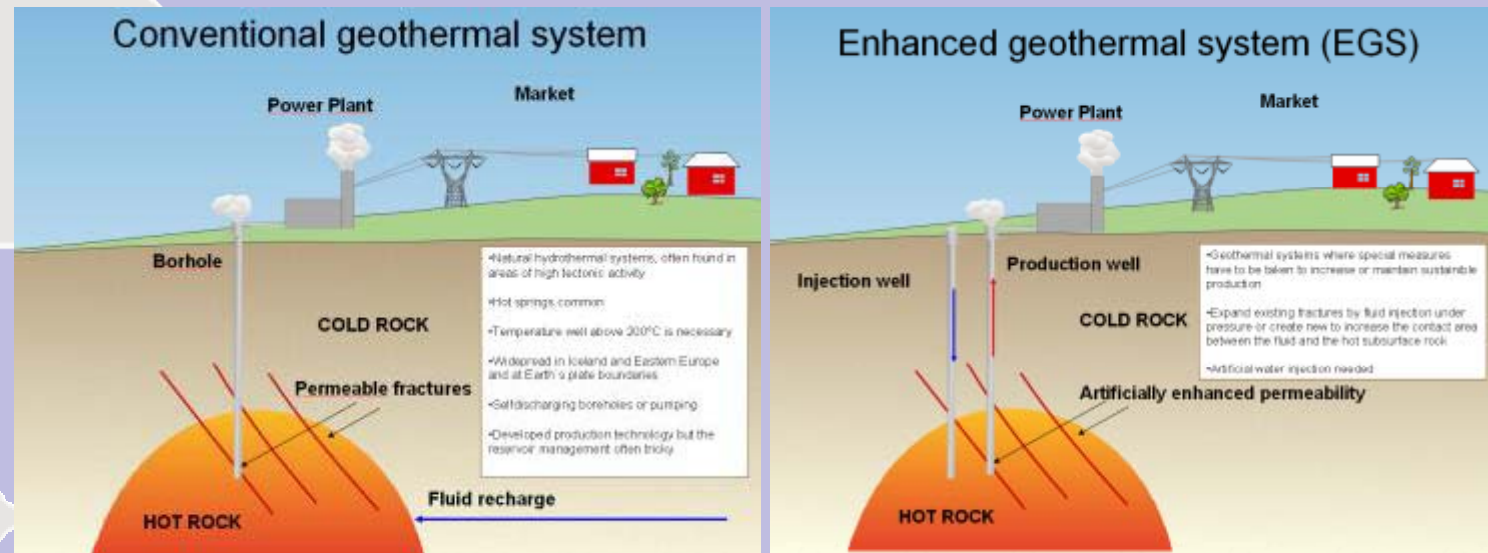
Los yacimientos geotérmicos de roca caliente seca:

Relación entre energía y yacimiento geotérmico y estabilidad geológica

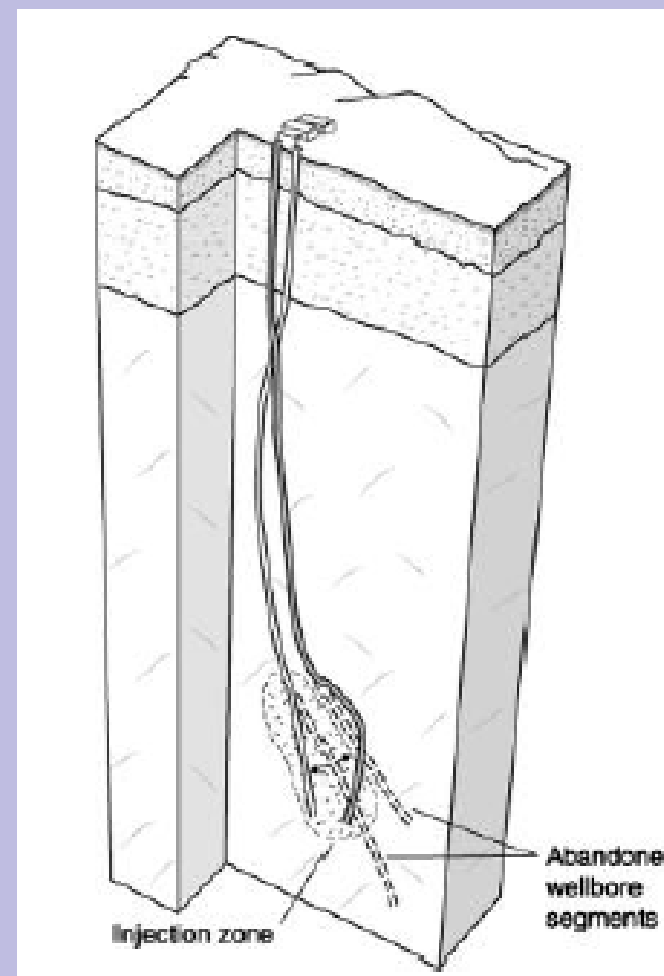


La idea básica de los sistemas HDR-EGS.

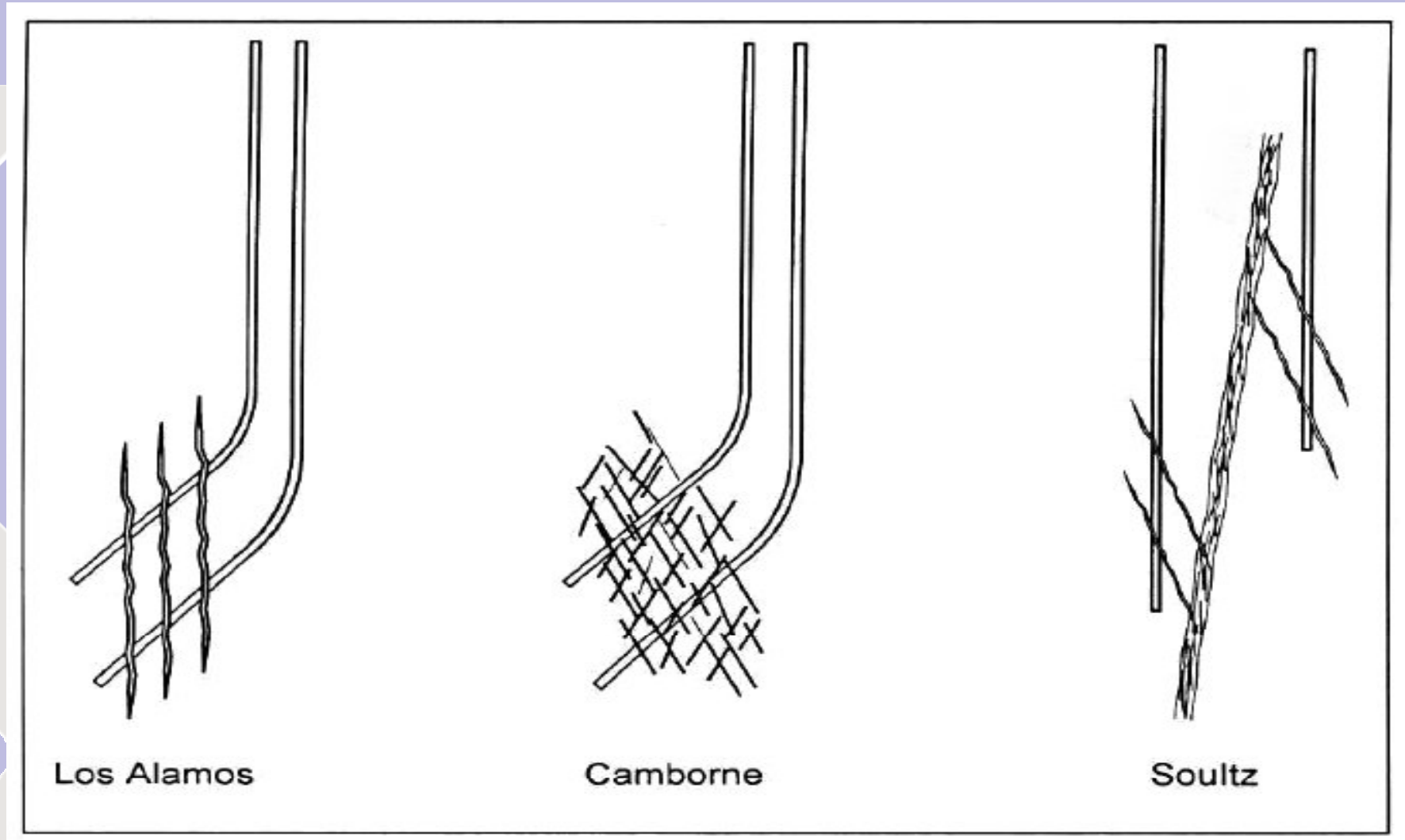
Comparación con los sistemas geotérmicos convencionales



La idea básica de los sistemas HDR:



Evolución del mecanismo de HDR a partir de las diferentes experiencias:



El desarrollo de una tecnología:

EGS

Enhanced Geothermal Systems

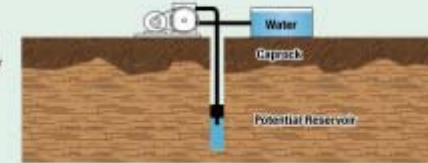
Engineered Geothermal Systems

How

an Enhanced Geothermal System works

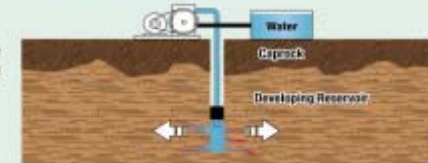
1 Drill an Injection Well

A production-injection well is drilled in hot rock that has limited permeability and fluid content.



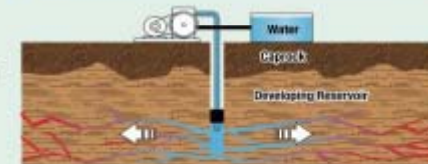
2 Inject Water

Water is injected at sufficient pressure to induce fracturing, or open existing fractures within the rock mass.



3 Hydro-fracture

Pumping of water is continued to extend fractures some distance from the injection wellbore.



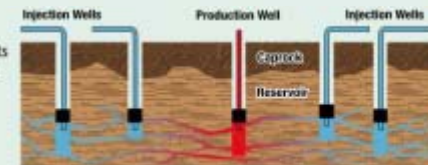
4 Doublet

A second production well is drilled with the intent to intersect the stimulated fracture system, and circulate water to extract the heat from the rock.



5 Multiple Injection Wells

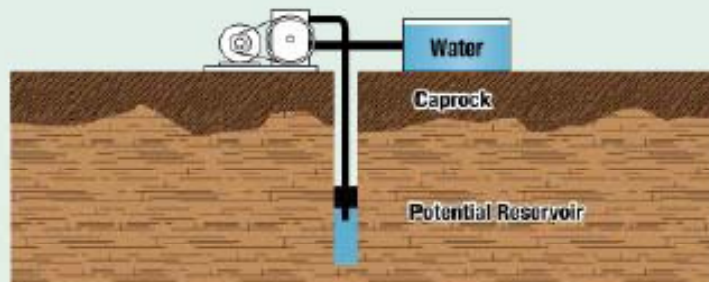
Additional production-injection couplets are drilled to extract heat from large volumes of rock to meet power generation requirements.



Creación del yacimiento:

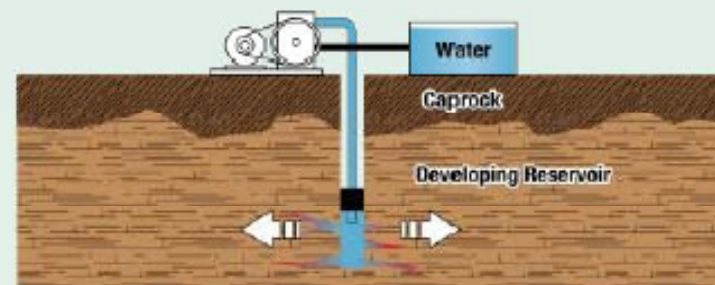
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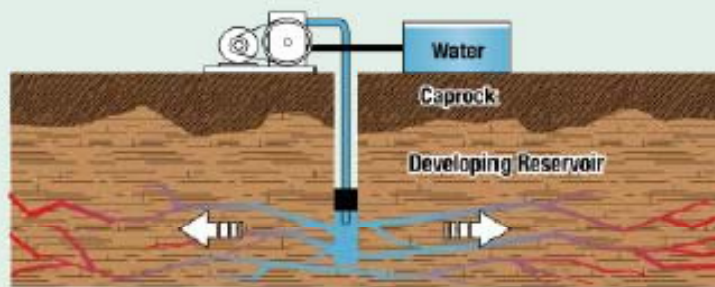
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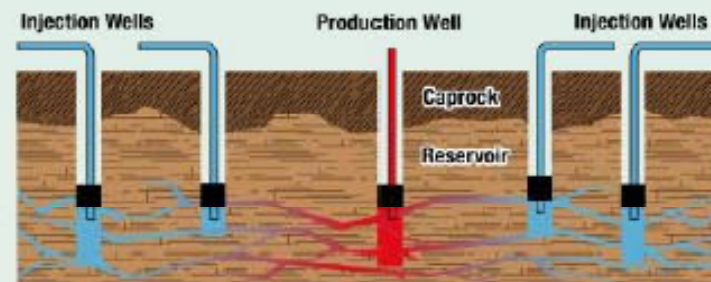
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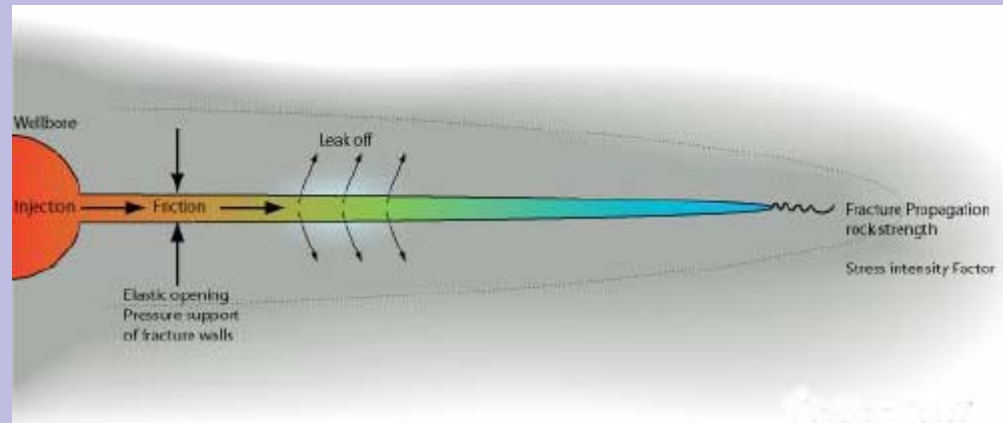
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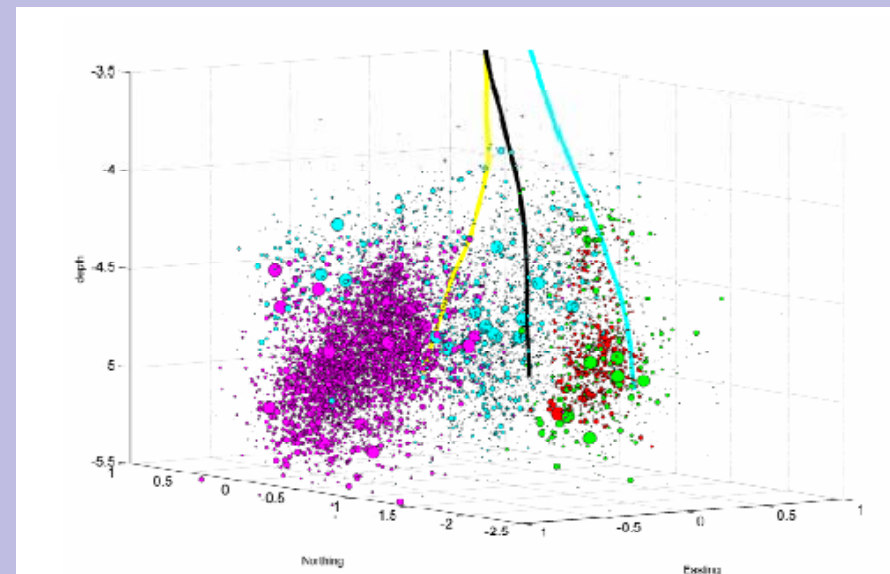
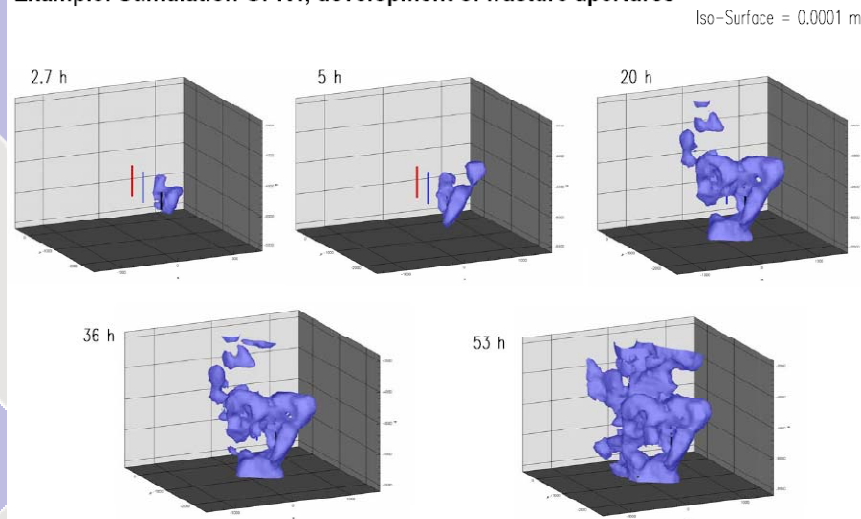


Estimulación:

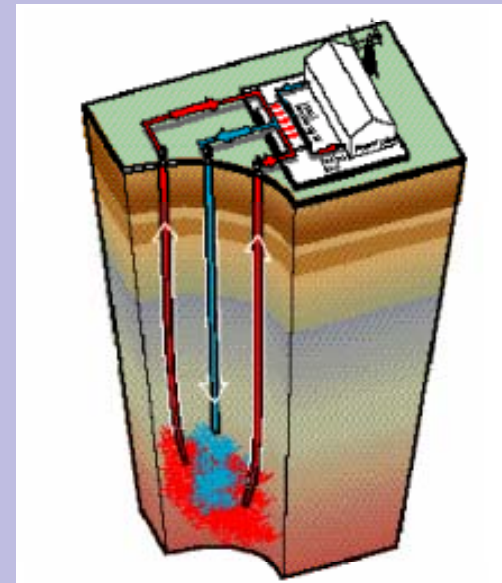
Incremento de la productividad



Example: Stimulation GPK4, development of fracture apertures



EGS: de la idea a
la demostración

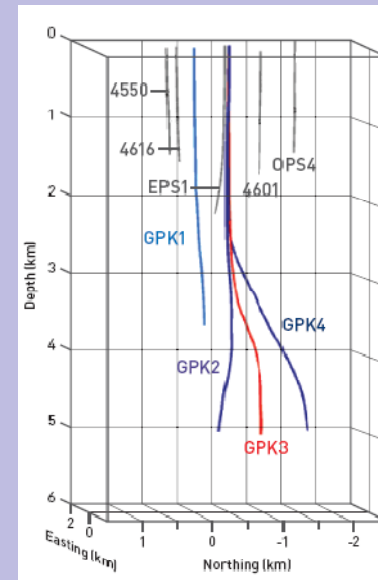
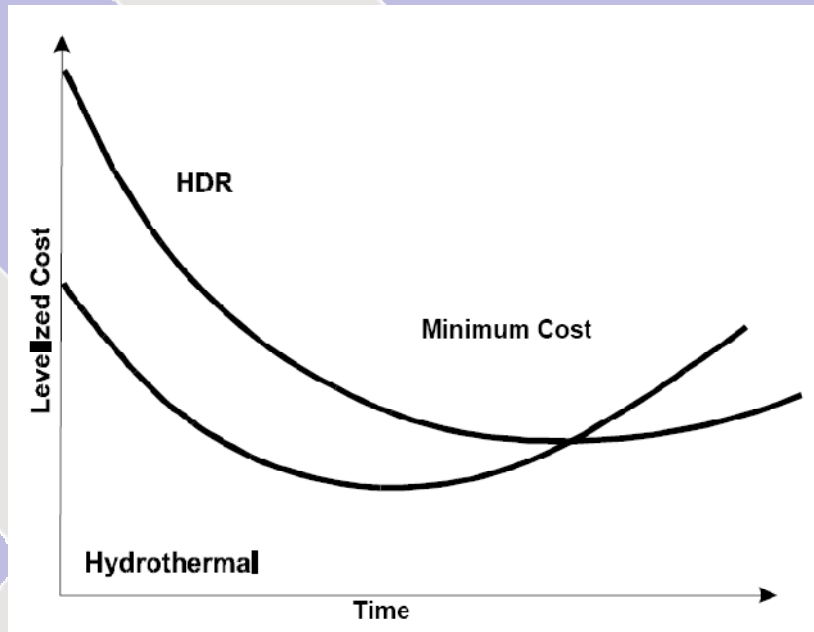


EGS: desde los primeros esquemas y las primeras experiencias a los planteamientos de futuro

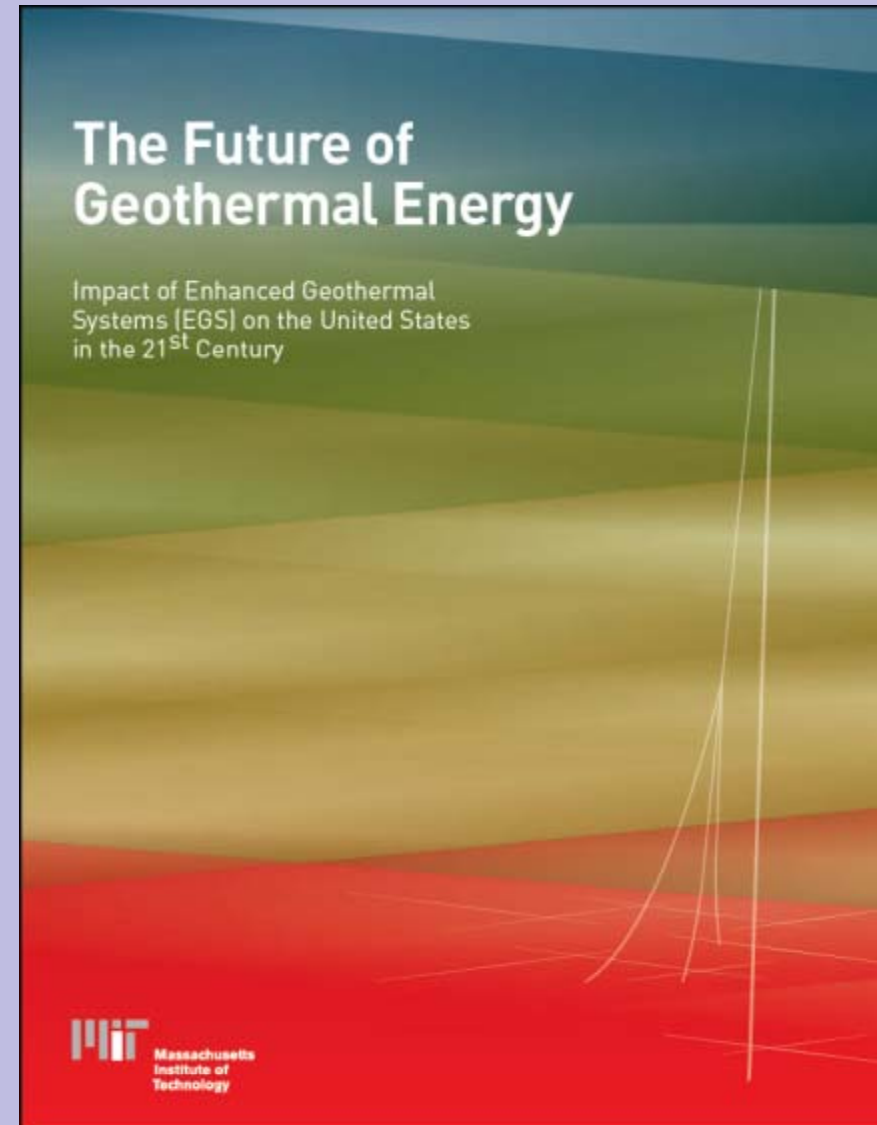
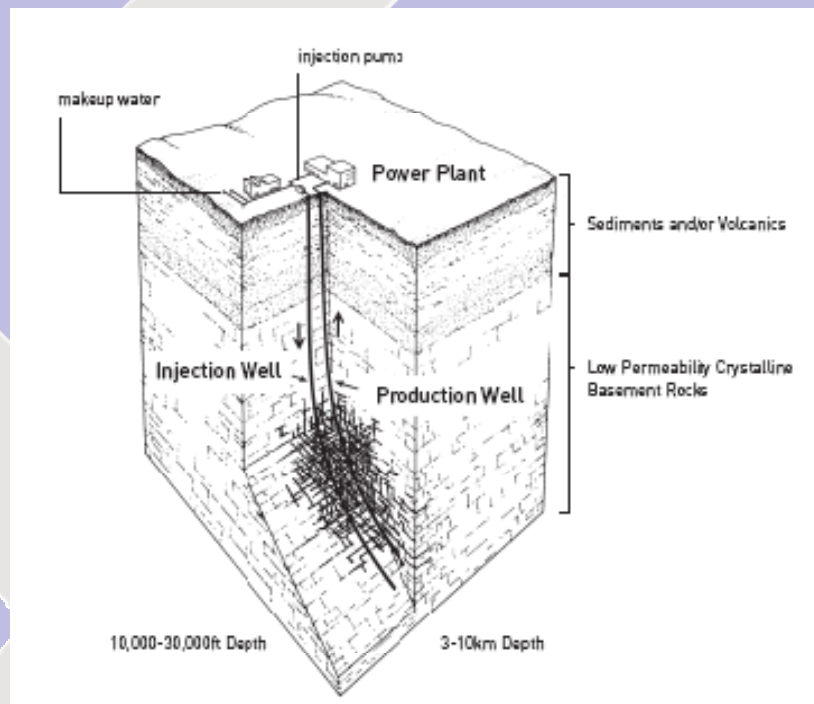
Commercial **Potentially commercial**



*Hydrofracture, targeted injection, acid leaching, directional drilling, etc.



EGS: desde los primeros esquemas y las primeras experiencias a los planteamientos de futuro



EGS en España:

- Aumentar el potencial de recursos de media entalpía explotables

- ▶ Ya conocidos
- ▶ No a gran profundidad
- ▶ Baja productividad



EGS en España:

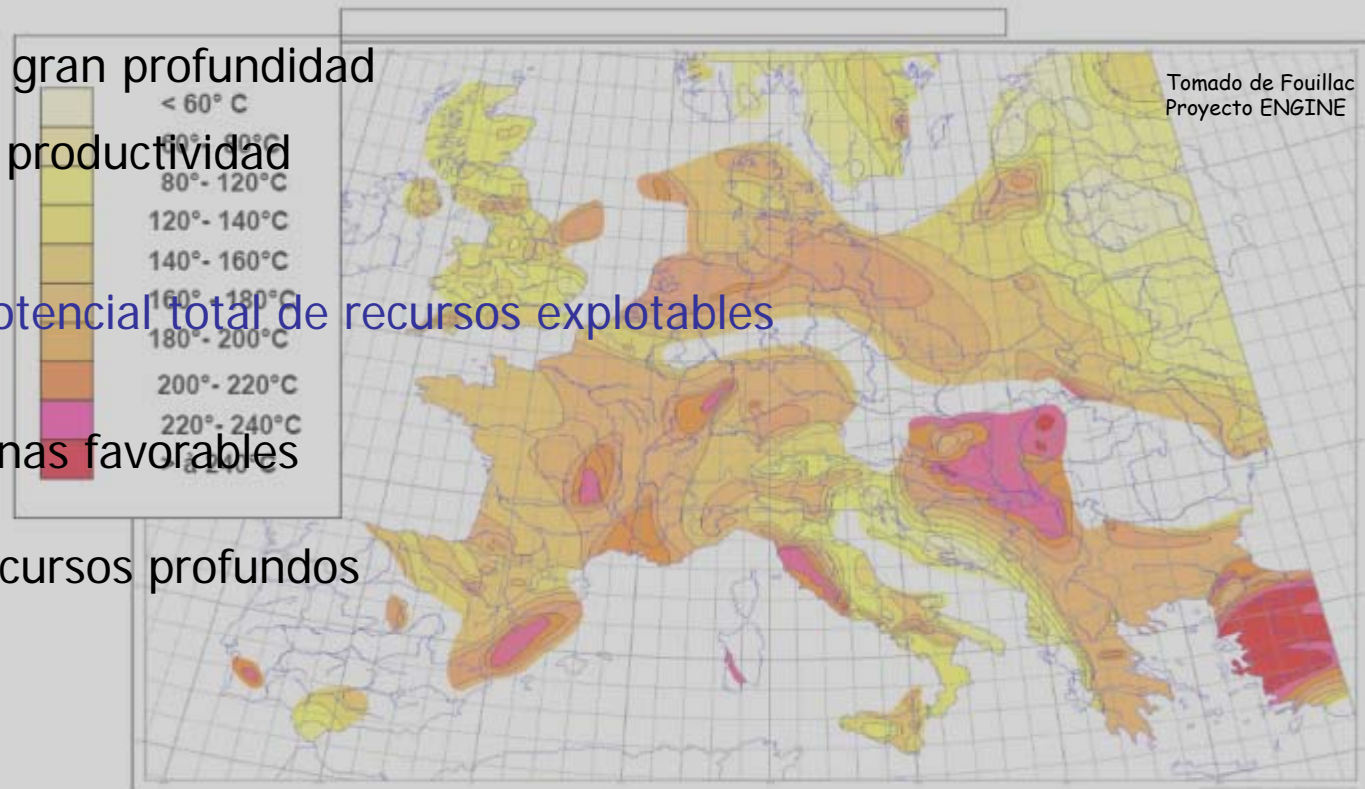
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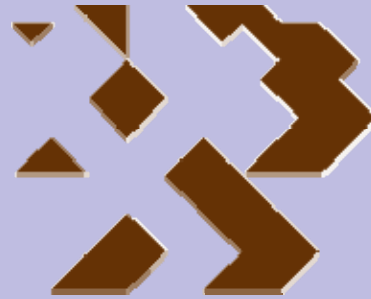
- ▶ Ya conocidos
- ▶ No a gran profundidad
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- Aumentar el potencial total de recursos explotables

- Zonas favorables
- Recursos profundos

Extrapolated temperatures at 5km depth in Europe





Instituto Geológico
y Minero de España

Muchas gracias por su atención

c.garcia@igme.es

Madrid, 15 de octubre de 2008