Regulation framework in France

Main texts at national level

- Mining code
- Law of December 16, 1964 on the regime and distribution of water and fight against pollution
- Law of January 3, 1992 on water
- Law of December 30, 2006 on water and aquatic environments
- Code of environment
- Norm AFNOR NF X10-999 of August 30, 2014 on creation, monitoring and abandonment of underground water exploitation and surveillance wells

- Risk of aquifer interconnection and groundwater disturbance is inherent in all drilling operations and geothermal projects

- Details provided at project level, before drilling, in authorization for research and for exploitation licensing
- Specificities at local scale (e.g. operations in the Paris Basin)
Environment impact assessment study

Ensure protection of soil and surface water
- Assessment of produced water toxicity and evaluation of its consequences in terms of potential pollution of drinking water
- Compliance of well design to prevent contact of fluids with formations intersected by the well up to the surface
  → Principal risk identified is a potential casing piercing resulting in aquifer contamination with geothermal fluids

Ensure groundwater resources protection
- Cementation of the borehole casings
- Mud is either water and bentonite (natural clay), or 100% degradable biopolymers

Measures taken
Risk management and mitigation measures planned (design, during exploitation, periodic regulatory quality control)
Preventive and corrective measures considering potential leakage scenarios
Environment impact assessment study

Ensure no impact on neighboring geothermal operations

- Dynamic model used to assess *hydraulic and thermal interferences* induced by new operations

Compliance with local Water Development and Management Master Plan (SDAGE)

- Balanced and sustainable management of water resources
Environment impact assessment study

Compliance with local Water Development and Management Master Plan

Example of the sensitive aquifers of Albien and Néocomien in Paris Basin: reserved for emergency drinking water supply

- requirements applicable to the volumes of withdrawals from this water table are regulated by regional authority
- requirements applicable when drilling across these formations → double casing in diameters 13"3/8 and 9"5/8 facing the aquifers and a few hundred meters below (cemented), regulatory control logs of casing every 3 years in injection well and 5 years in the production well

State of the art during project phases to avoid introduction of pollutant, ensure insulation of aquifers between them and to protect them from flooding by surface water

Thorough hydrogeological study prior to project

Restitution of all produced volumes to aquifer using doublet technology
Periodic control and monitoring of the exploitation (Dogger limestone operations)

- Monitoring of physical parameters:
  - Daily pressure, flow rate, temperature and geothermal energy → annually transmitted to regional authority (e.g. DRIEE in Paris Basin)
  - Hydrodynamic and electromechanical parameters of the production equipment constituting the geothermal loop (well/formation) → 4 times a year

- Monitoring of bio-physico-chemical parameters of geothermal fluids (corrosion, deposit, bacterial development) → frequency regulated by prefectural decree (e.g. each month for total Fe, pH, conductivity, each 4 months for ionic compound and solid charge, once a year for gaseous composition, O2/H2 etc.)

- Monitoring of corrosion and anticorrosion treatments → every 3 months (weight of submerged metal pieces)

- Monitoring of tubing integrity conditions → every 3 years for injection wells and every 5 years for production wells. Cleaning of the well every 10 years (average)
Data collection

- All information are sent to client and regional authority (DRIEE in Ile-de-France region, DREAL)

- For the Dogger geothermal operations:
  - data are collected and centralized by the BRGM for geothermal operations of Dogger
  - not public but DB with restrictive access for operators and underground consulting companies
  - common effort to operate and preserve the resource in the area
  - available data are used to prepare permits and other regulatory dossiers

  e.g. request for authorization to search for a low enthalpy geothermal reservoir (PERDOTEX) or Application for operating permits (PEX)

SYBASE (BRGM)
Best practices

• Guidelines edited by BRGM and ADEME regarding deep geothermal operations:
  • Built thanks to experience of operators in the Paris basin and the exploitation of the Dogger limestone mainly from 2007 until 2019;
  • Concerns all phases of operations
    • from conception, to drilling, development, exploitation and maintenance of the wells through multiples topics
  • Available in English: https://www.geothermies.fr/english-content

• Abandonment procedure (NF X 10-999 norm & Mining code art.41 decree n° 2016-1303 of October 4, 2016)
  • ensure long term insulation of wells, protection of shallow aquifers, work plan.
Conclusion and perspectives

• Only one accidental intrusion of geothermal fluid into superficial freshwater aquifers identified in France in Coulommiers in 1996 (Gombert et al., 2018)

• Good practices edited based on experience in Dogger geothermal operations

• Good basis for other aquifers in France

• Improvements of guidelines expected thanks to new operations in other basin and other formation in France (e.g. experience in Bordeaux, Triassic exploration, etc.)

• Towards a generalized deep geothermal resource management?
Thank you for your attention

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