

# GESDEC OVERVIEW

Overview of subsurface aspects to consider for authorization process regarding FCC high-risk area site investigations and shaft on swiss territory

CERN – FCC project  
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REPUBLIQUE  
ET CANTON  
DE GENEVE

POST TENEBRAS LUX

Département du territoire  
Service de géologie, sols et déchets



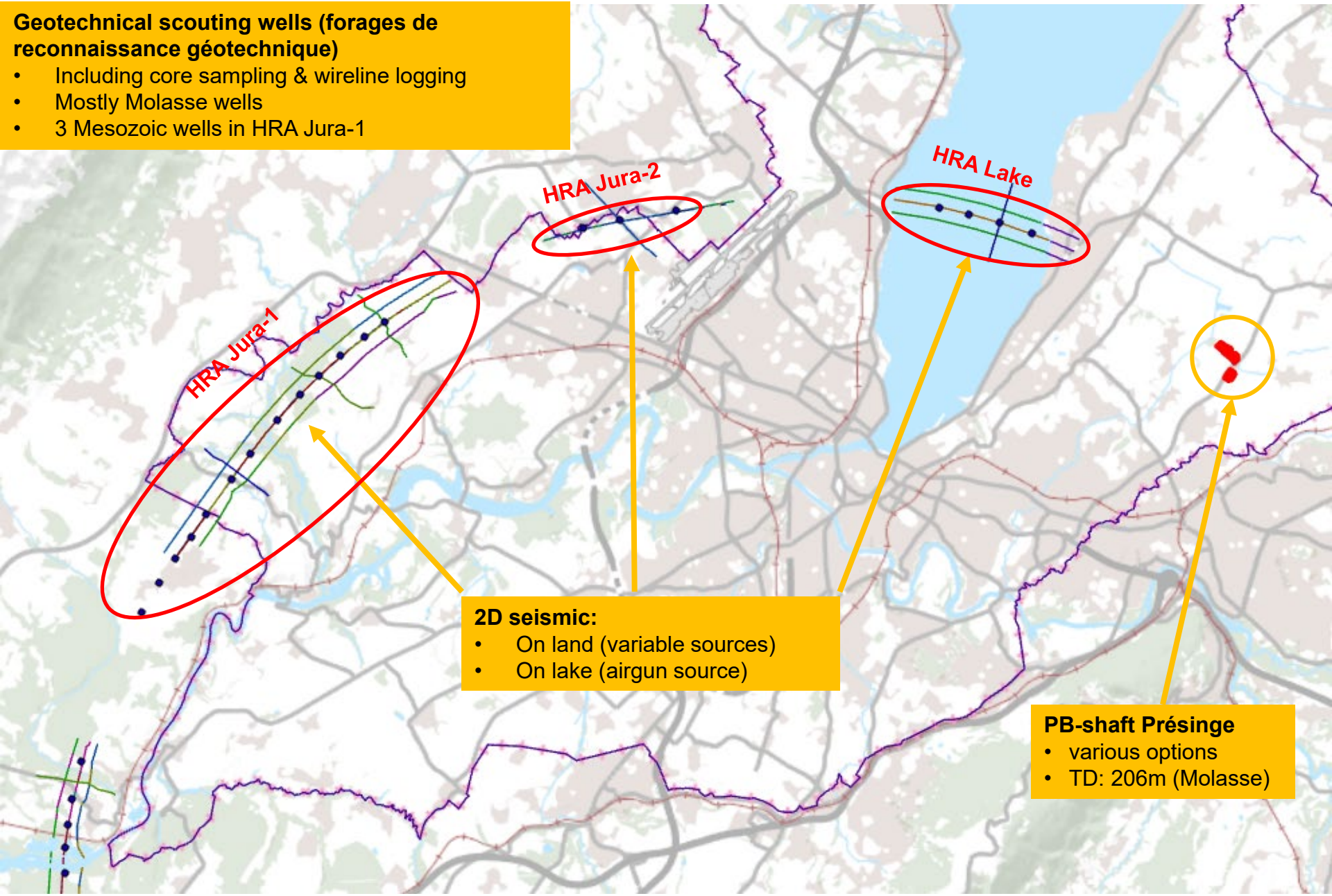
# **SUBSURFACE MISSIONS OF THE GESDEC**

- Ensures protection as well as coordinated the sustainable use of subsurface resources.
- Consulting/directing authority for subsurface works and operations
- Directing authority for geophysical prospection, exploration and exploitation permits of subsurface resources.
- Pilots the developpment of geothermal resource in Geneva (program GEothermies).
- Collects and publishes geological and hydrogeological data and informations.

# High-risk areas and shaft investigations on swiss territory

## Geotechnical scouting wells (forages de reconnaissance géotechnique)

- Including core sampling & wireline logging
- Mostly Molasse wells
- 3 Mesozoic wells in HRA Jura-1



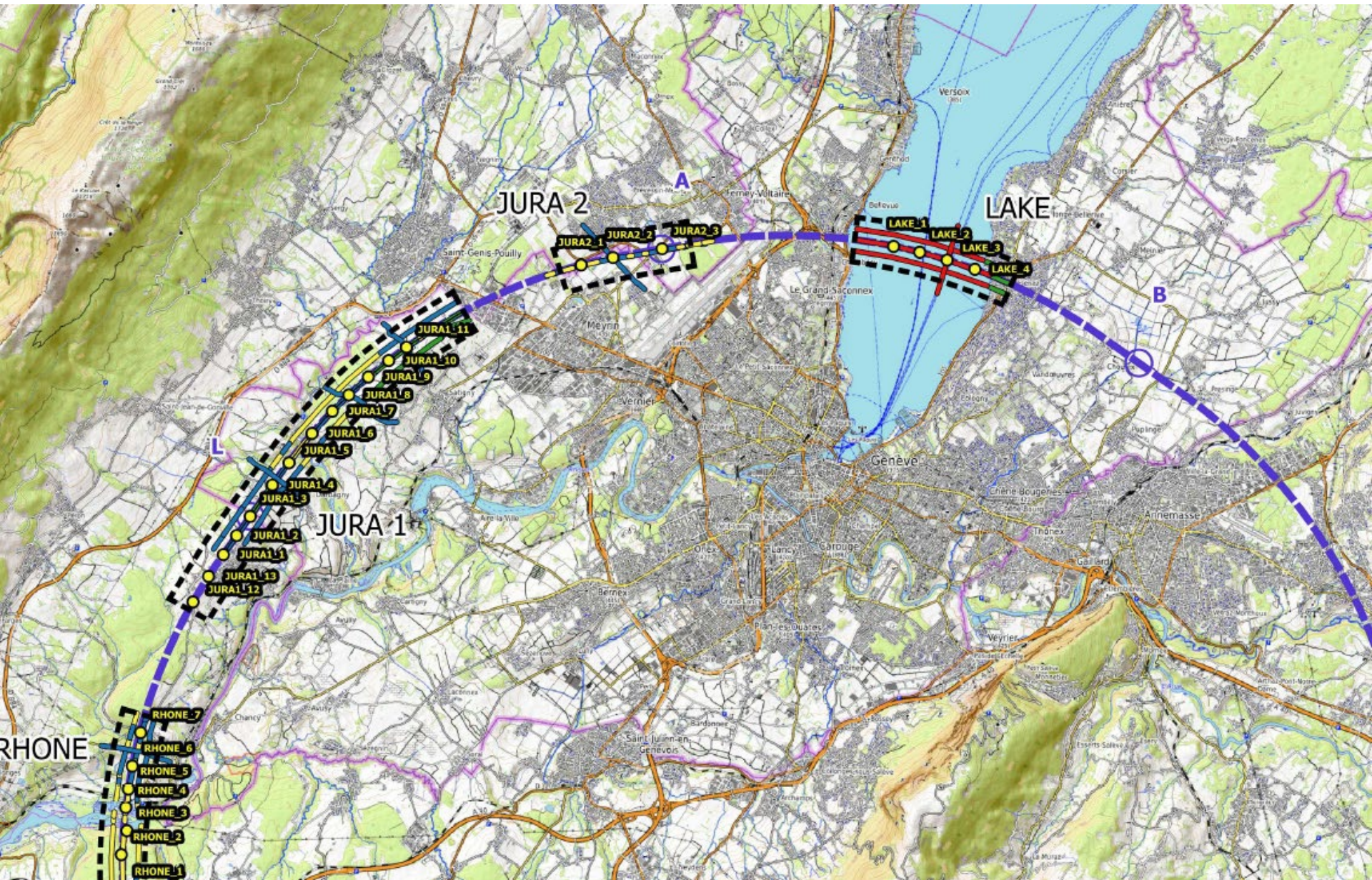
## 2D seismic:

- On land (variable sources)
- On lake (airgun source)

## PB-shaft Présinge

- various options
- TD: 206m (Molasse)







# Underground constructions - general principles

Any construction project follows a construction authorization procedure (OAC) in which the GESDEC is consulted whenever the project penetrates the subsurface by 4m or sits within specific sectors associated with risk on subsurface water resources.

The subsurface impact of the project is evaluated based on the following site-specific principles:

- Construction across groundwater bodies of the public domain are usually avoided or in certain cases allowed to penetrate the saturated aquifer interval by up to 10%.
- In case of derogation, appropriate technical solutions must be undertaken to avoid any obstruction (dam effect) on the subsurface natural flow (i.e. emplacement of a bypass drain system).
- If, in addition, construction cross-cut superimposed groundwater bodies, technical solutions must be undertaken to avoid X-contamination.
- Proportionality must be maintained regarding the construction and its impact on the groundwater body. One cannot "empty" a groundwater aquifer.
- On polluted sites, depollution might be requested depending on underlying hydrogeological conditions.
- For large underground constructions such as FCC shafts, **complete geotechnical and hydrogeological studies** must be carried out. Depending on local knowledge (existing data), such studies might need upstream investigations including the realization of geotechnical wells & piezometric measurements.

# Drilling operations - general principles

Each well project is evaluated for its subsurface aspects on a case by case basis, depending on its location, depth, type and goal in regard to criteria such as:

- Risk on subsurface water resources with special attention regarding:
  - Protection zones of subsurface water resources (extent of aquifers):
    - avoiding wells across public domain groundwater bodies (especially through the Genevois aquifer)
  - Cases of superimposed groundwater tables (risk of X-contamination)
    - appropriate well designs and realisation technics needed.
  - Presence of polluted sites:
    - No well allowed across polluted sites sitting above groundwater bodies or connected aquifer formation)
- Current local hydrogeological knowledge.
- Geological risks and associated uncertainty (gaz; fault-zones; high water flow rates; induced seismicity).
- Drilling technics, well-design, equipment and procedures envisaged to minimize/overcome the risk.
- Well total depth vs top of Mesozoic limestones
  - depth limitation or specific realization conditions.

**Drilling expectations and conditions are defined based on the criticality of the operations.** This is therefore not depth-dependant but mostly driven by the level of geological and hydrogeological risk and/or associated unknown.

→ Decision tools available to orientate the project and authorization request.

# HRA Site and shaft investigation drilling program

By their nature and goal, CERN HRA (and shaft sites) investigation wells are considered as geotechnical "scouting" wells (**forages de reconnaissance**) based on LRSS (*loi sur les ressources du sous-sol*) definition.

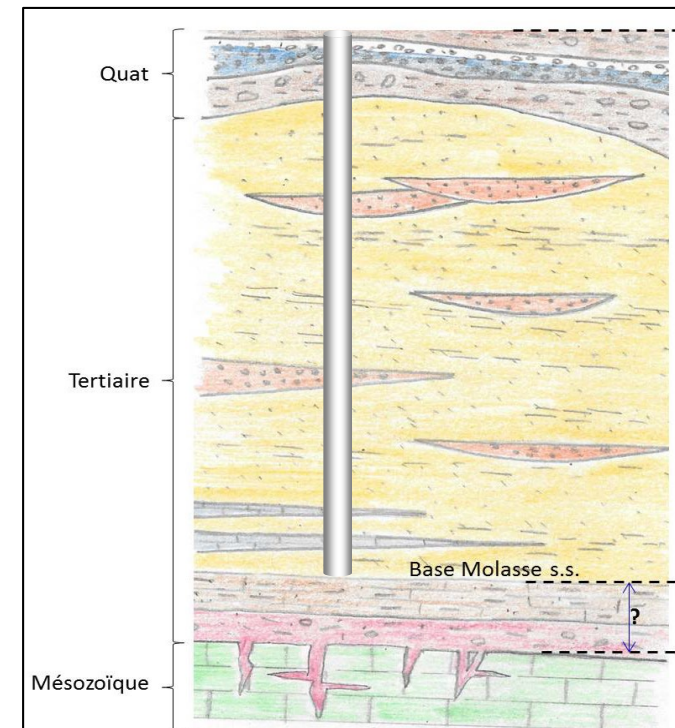
- Each investigation well is subject to a GESDEC authorization regarding their subsurface aspects
- Complementary authorizations might be required regarding other environmental or technical aspects (i.e. OCEau, OCAN, ...)
- In response to hydrogeological and geological risks assessment; site specifications, as well as purpose, diameter and geological target of the project, etc., various degrees of well-complexity and drilling equipment might be required.

From single diameter - "geothermal probe" type of well with:

- Total depth limited to 50m above modelled top Mesozoic surface or to first indication of specific lowermost tertiary lithostratigraphic units (whatever comes first).
- Equiped for gaz management
- On-site constant geological follow-up by expert company with appropriate knowledge on local geology.
- ...

*Note that geological model should be constantly updated with latest information available (including from other projects / data sources), which might affect pre-established drilling constraints*

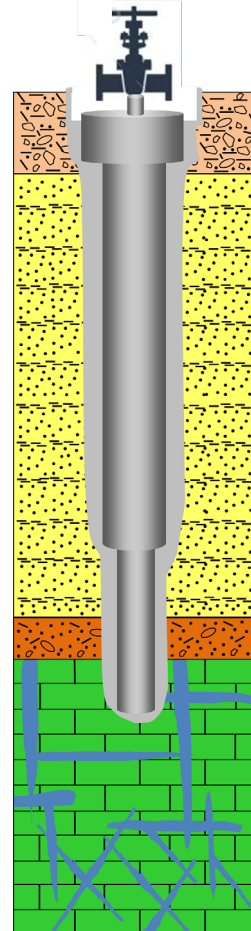
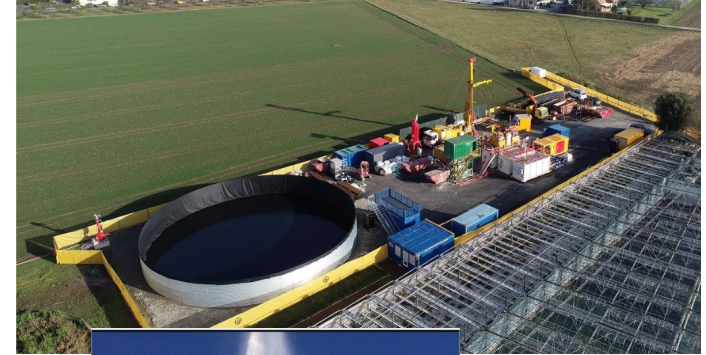
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# HRA Site and shaft investigation drilling program

To more complex drilling operations with:

- More advanced drilling techniques, equipment and well design accounting for pressure kick and potential high flow-rates artesian condition that can be expected in the Mesozoic aquifer limestones:
  - Double pressure barriers: BOP + drilling mud
  - Appropriate number, length and diameters of well-sections to ensure proper cementing
  - Well-integrity and cement integrity logging measurement
  - Drilling mud and water treatment and management facilities on surface (expect 2000m<sup>2</sup> platform size)
- Equipped for gaz management on surface
- HSE protocole (H2S)
- Predefined maintenance and abandon plan
- Monitoring of induced seismicity and associated alarm system (based on outcome of SED-GRID methodology)
- On-site constant geological follow-up by expert company with appropriate knowledges on local geology.
- ...





# Deep regional geological model and fault scheme interpretations (soon available on SITG) + existing Mesozoic-reaching wells

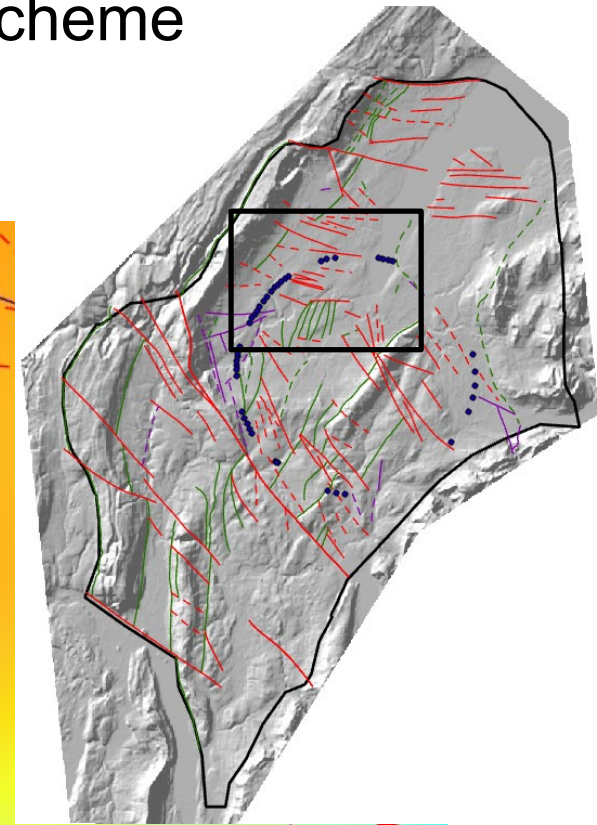
Near top Mesozoic limestones depth interpretation\*



Fault-scheme interpretation\* @ top Mesozoic limestones

\* After deep regional geological model, Clerc 2019, UniGE

Gex1, 1983  
TD @ 91m (in Lower Cret)



GEO-01, 2018  
TD @ 744m (in Upper Jur)  
10bar, 34°C, 45-70l/s @ well-head

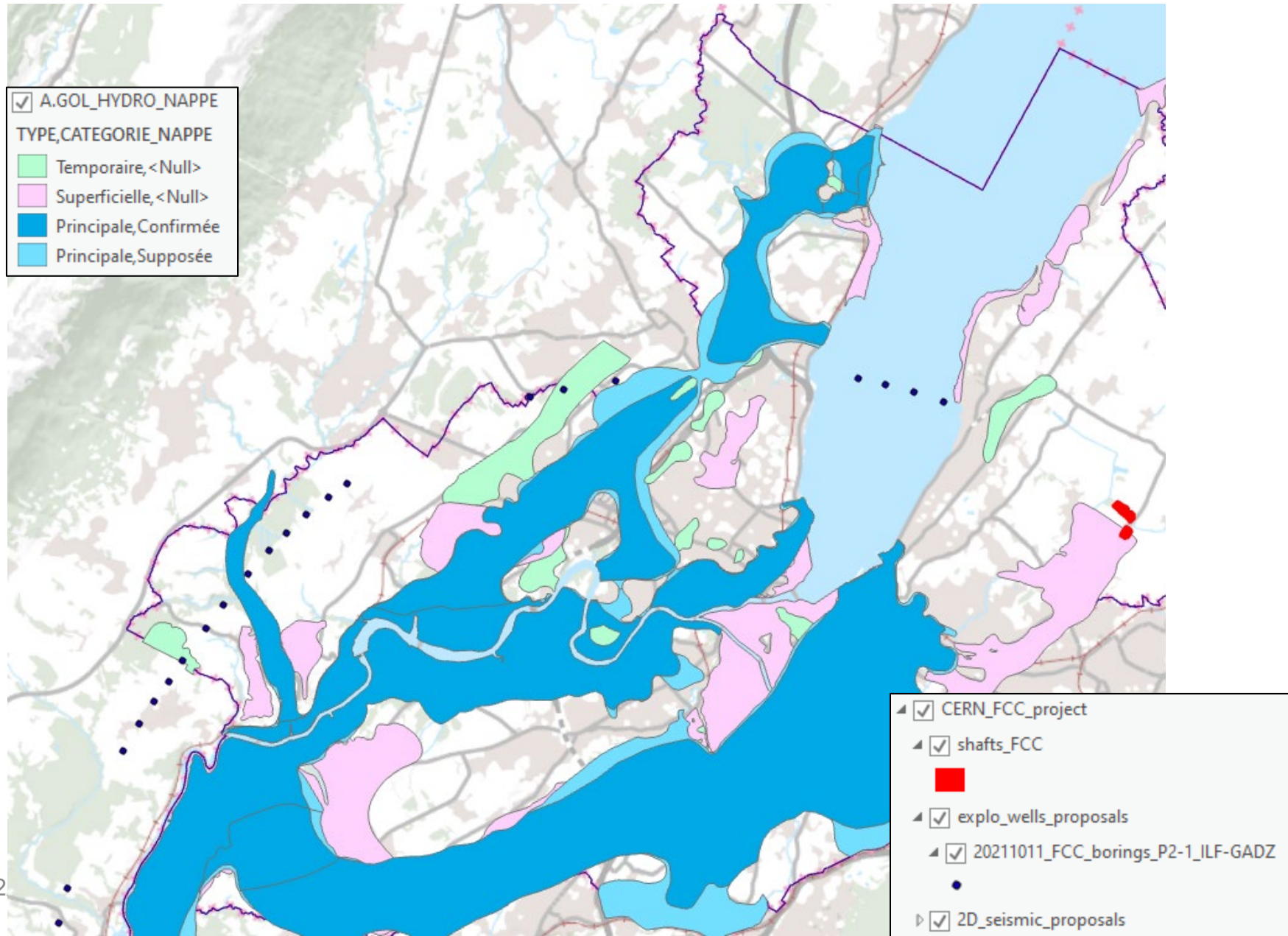
Gex3, 1982  
TD @ 294m  
(in Lower Cret)

Gex4, 1982  
TD @ 292m  
(in Lower Cret)

11/2

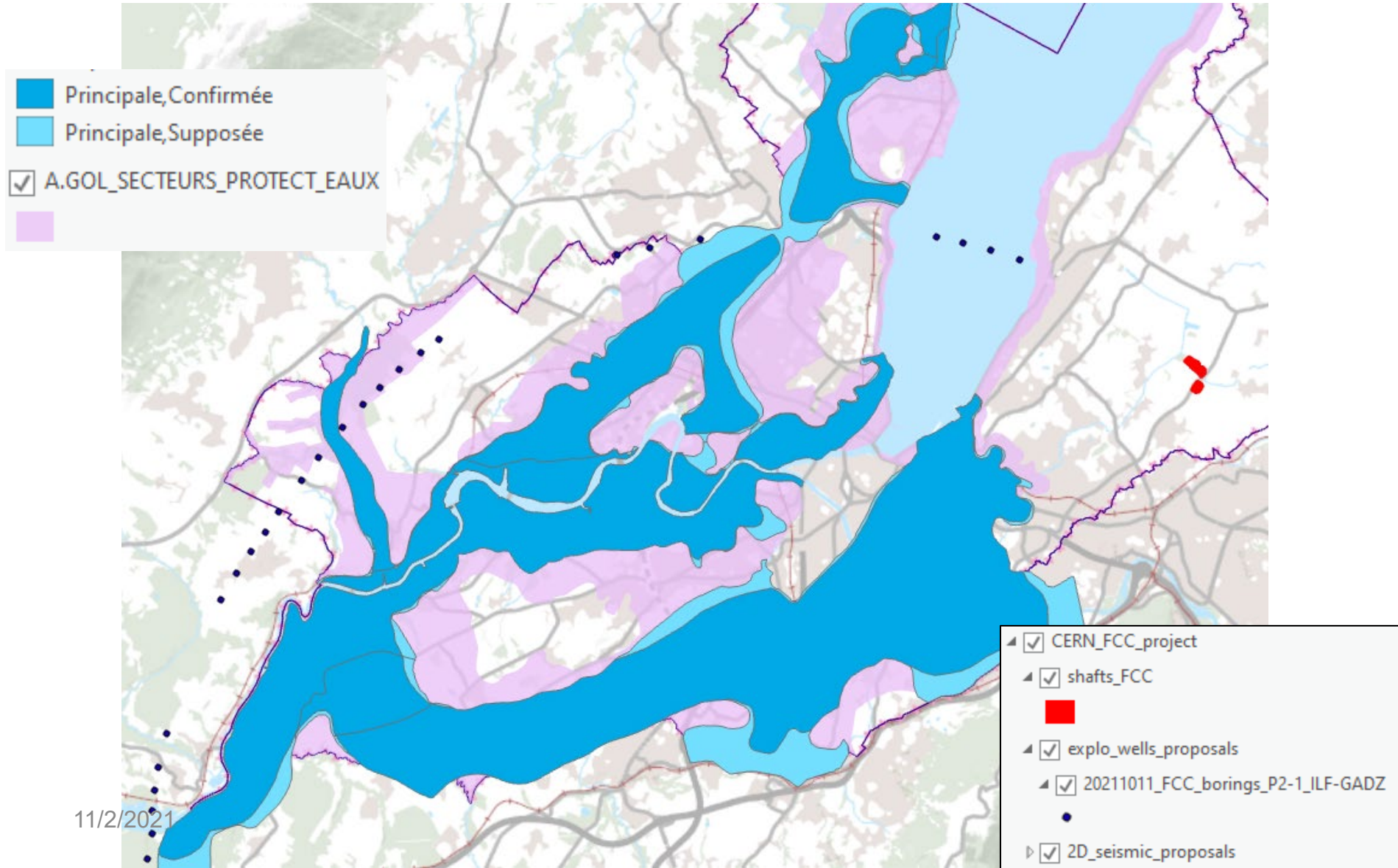
- CERN\_FCC\_project
- shafts\_FCC
- explo\_wells\_proposals
- 20211011\_FCC\_borings\_P2-1\_ILF-GADZ
- 2D\_seismic\_proposals

# Extension of known Quaternary underground water (available on SITG)



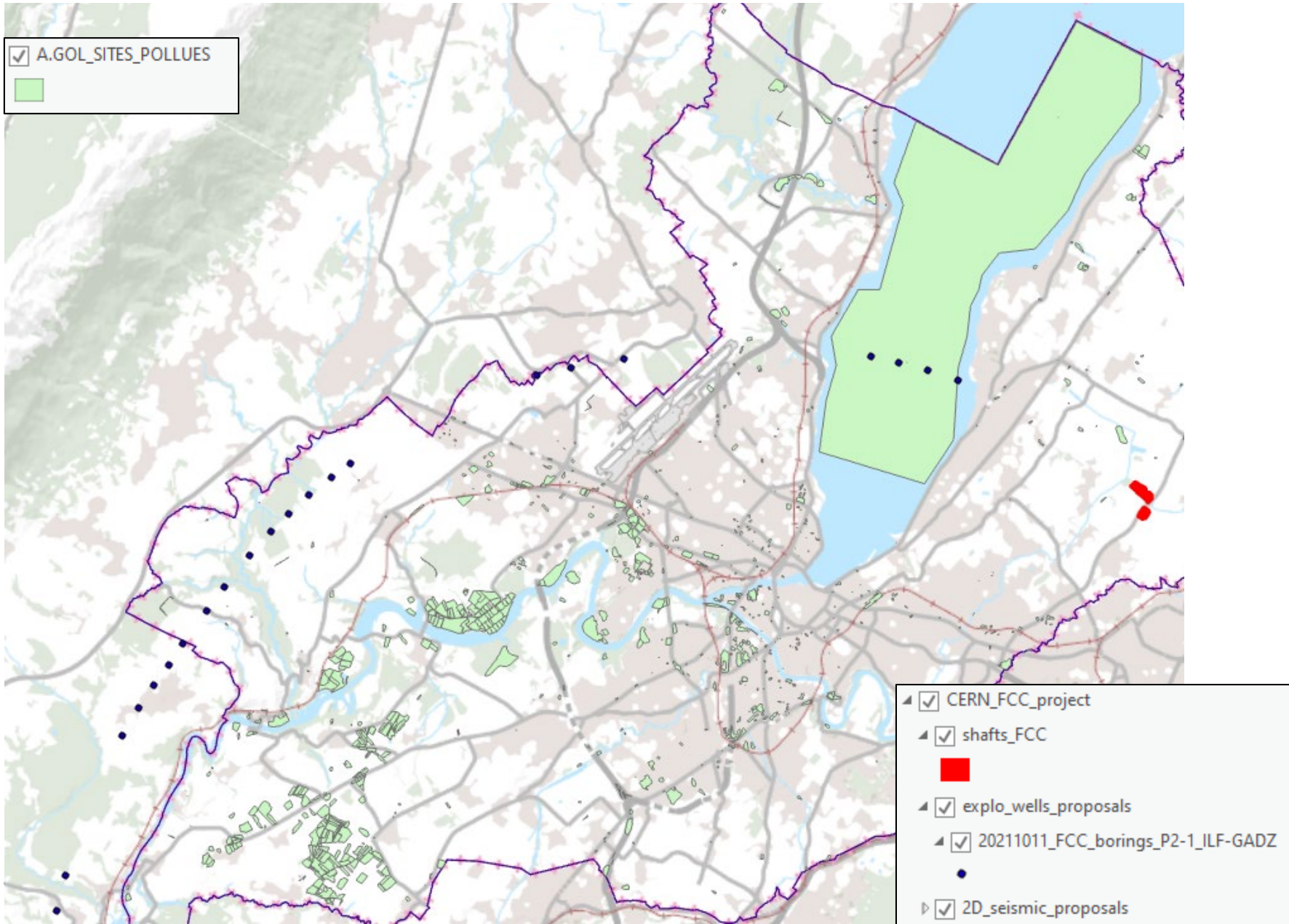


# Protection zones of Quaternary underground water + underground water bodies of the public domain (nappes principales) (available on SITG)

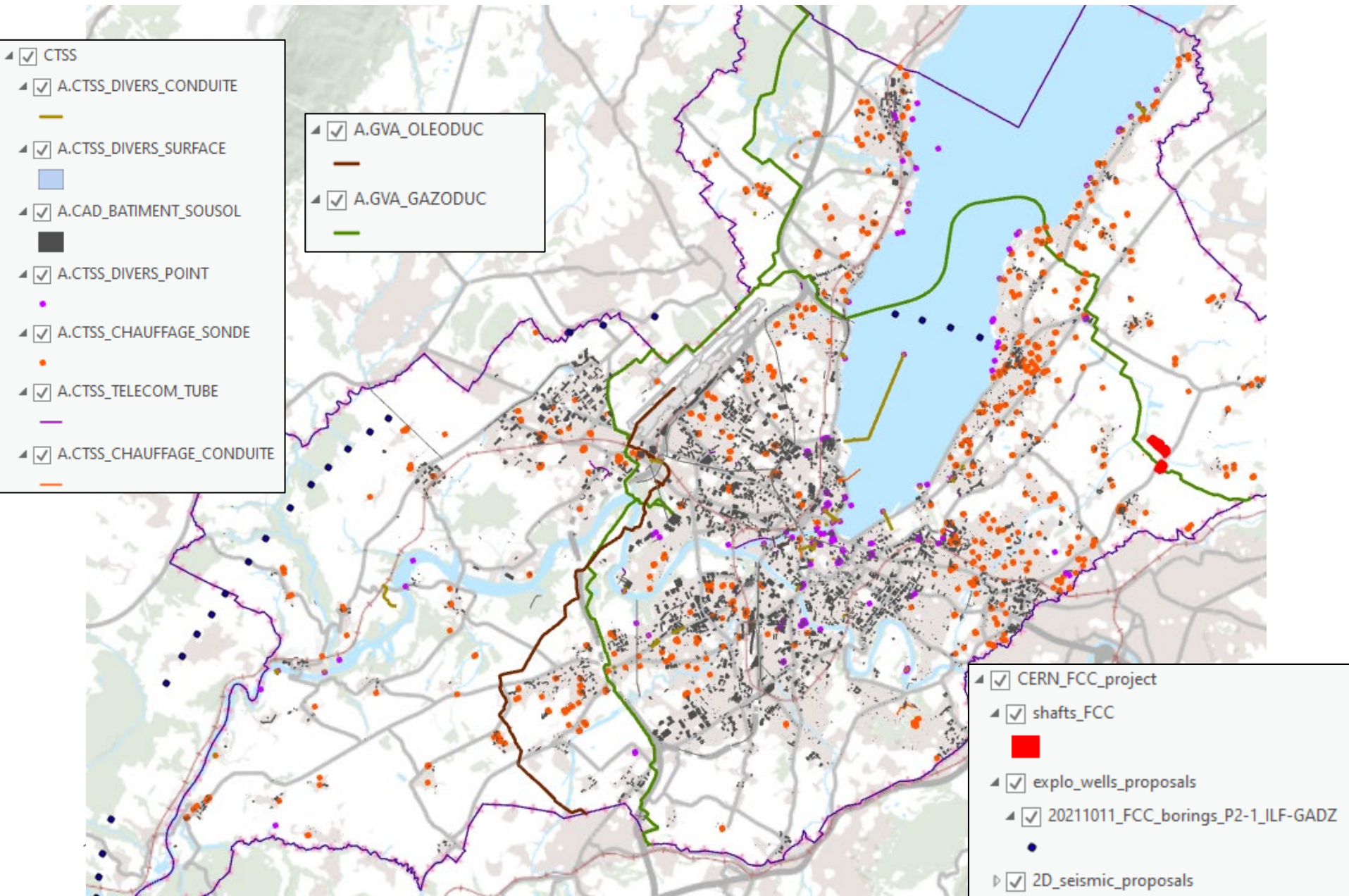




# Polluted sites (available on SITG)



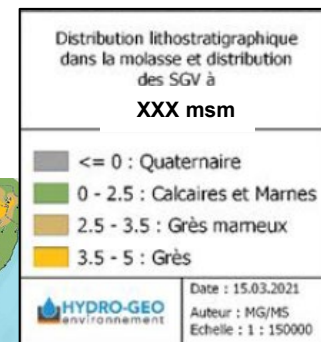
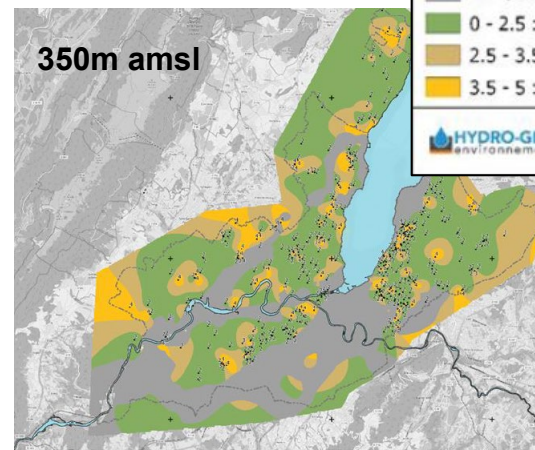
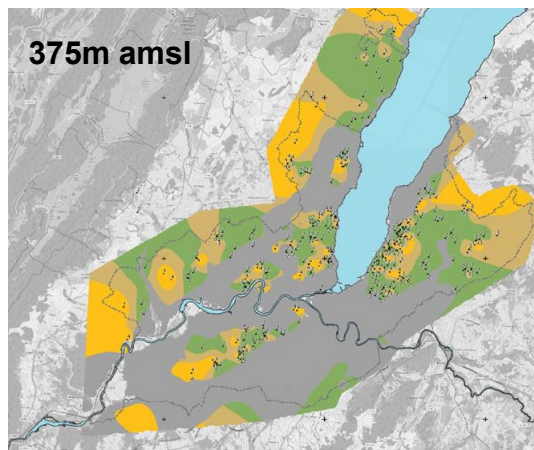
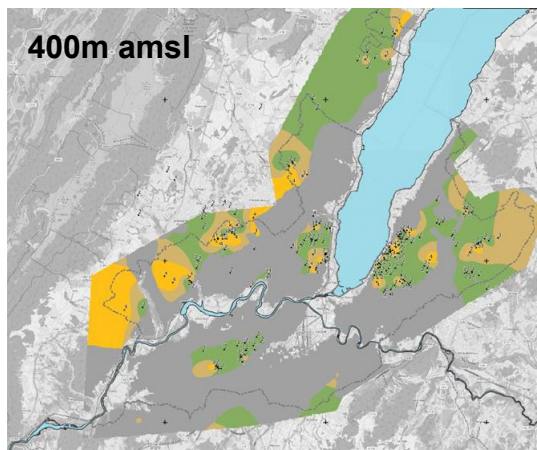
# Man-made underground infrastructure - CTSS (available on SITG)



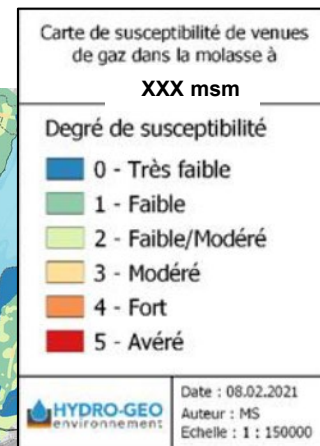
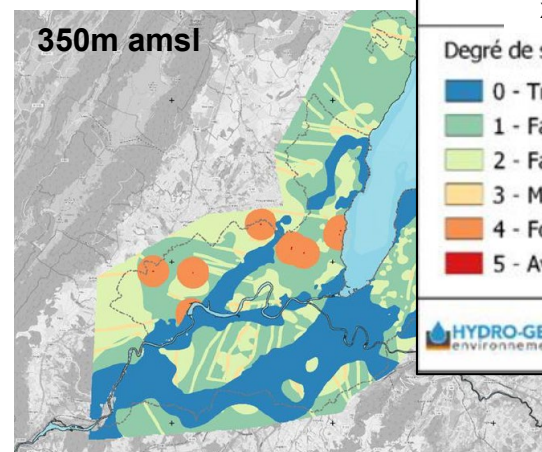
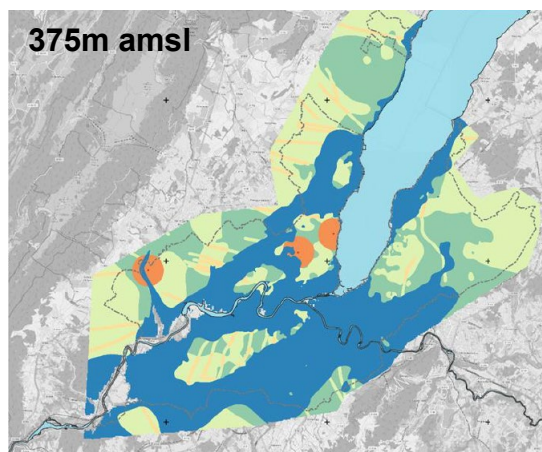
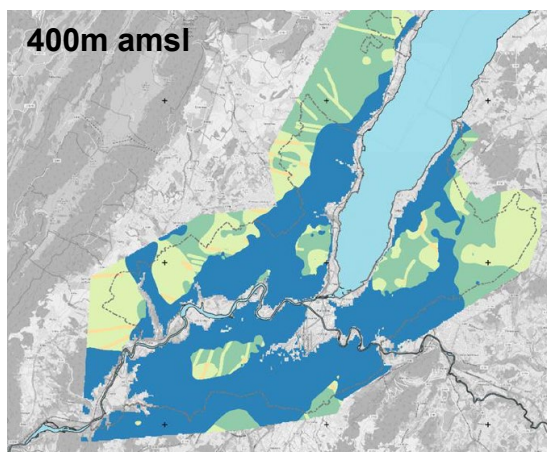


# Lithostratigraphy and Gas occurrence probability in Molasse interval (*under finalization*)

Probability maps of Molasse lithostratigraphy at various elevation levels



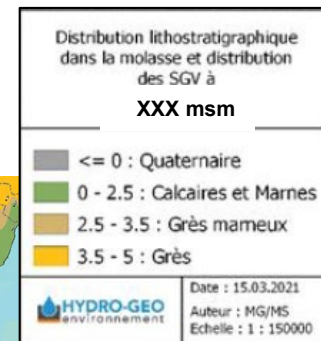
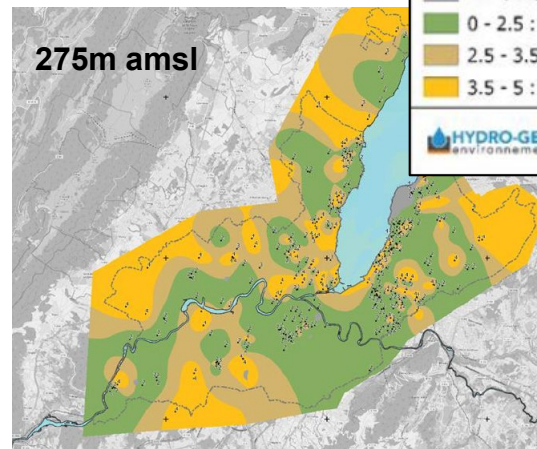
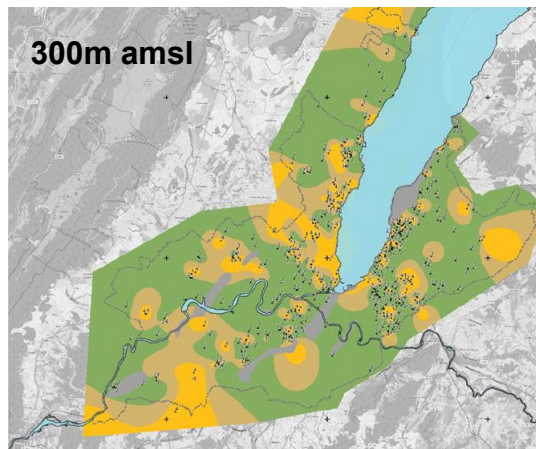
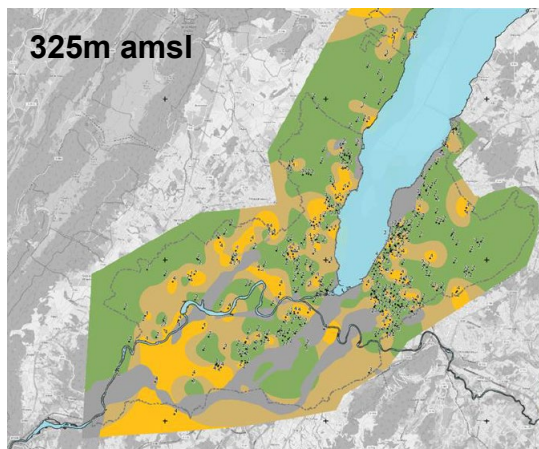
Probability maps of gas occurrence risk at various elevation levels



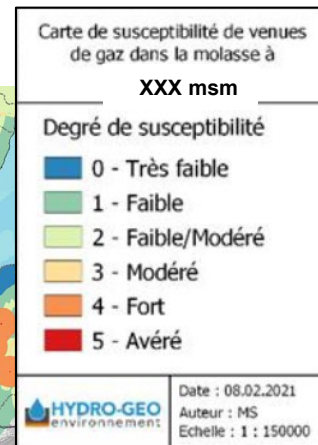
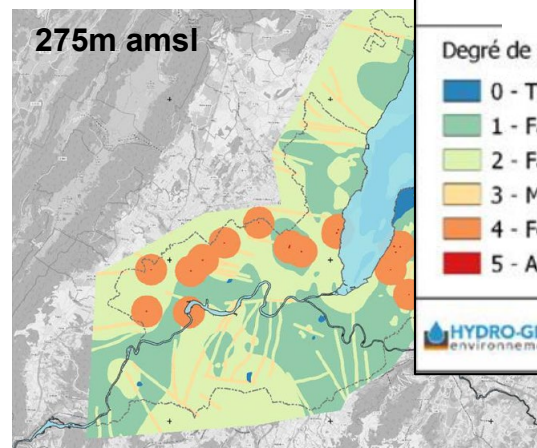
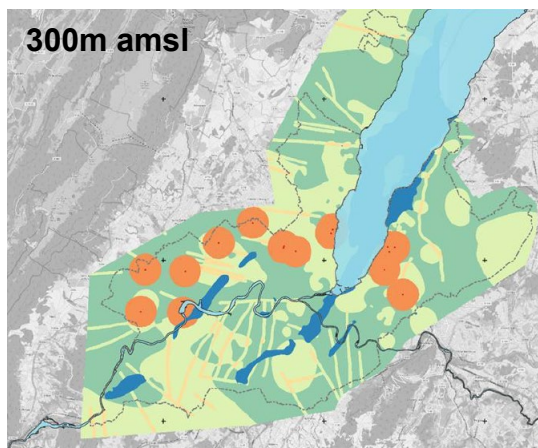
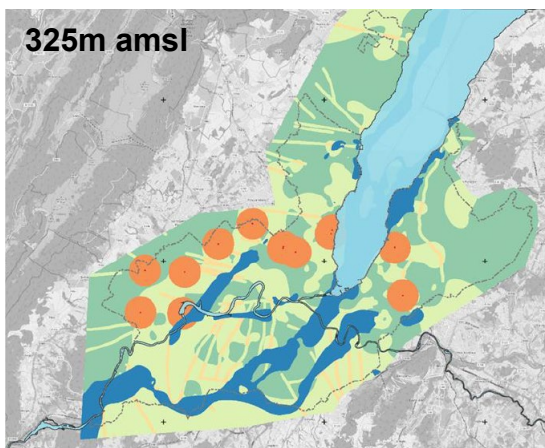


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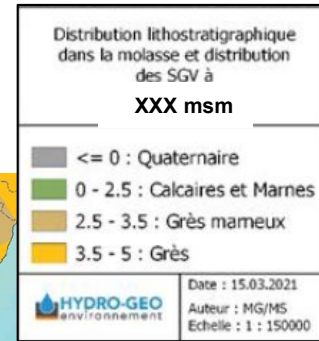
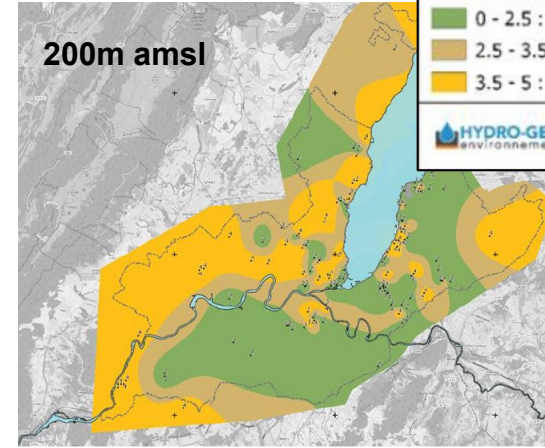
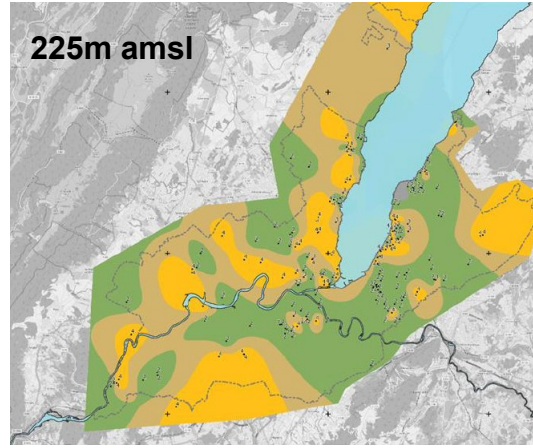
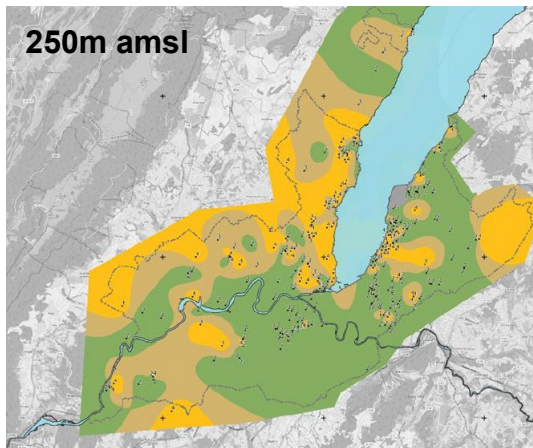
Probability maps of gas occurrence risk at various elevation levels



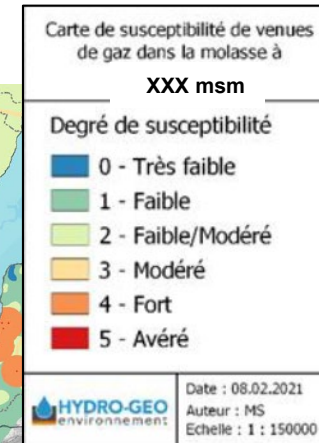
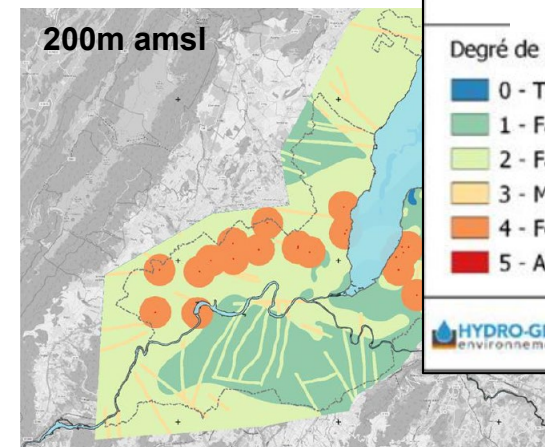
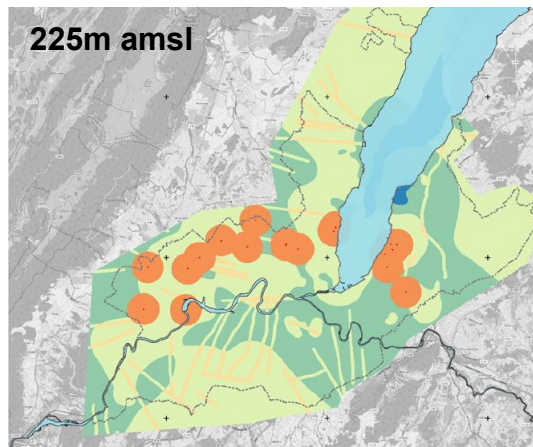
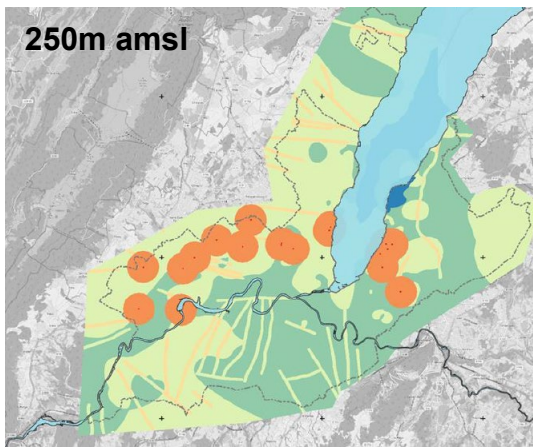


# Lithostratigraphy and Gas occurrence probability in Molasse interval (*under finalization*)

Probability maps of Molasse lithostratigraphy at various elevation levels



Probability maps of gas occurrence risk at various elevation levels



# Decision-making tools: GESDEC Subsurface Geoanalysis tool *(available soon online)*

**GESDEC | GEOANALYSE SOUS-SOL** Aide

Thèmes ▾ Outils ▾ Rechercher un lieu ou des données 🔍

Projet Affichage

Options du projet

Catégorie du projet  
Construction ▾

Emprise en profondeur maximale du projet  
0 m.

Positionnement des ouvrages

Type d'ouvrages  
 Sondages  
 Périmètres

Sélection

**GÉOLOGIE**

- Projet/ouvrage traversant les unités géologiques suivantes :
  - Toit de l'Alluvion ancienne
  - Toit du Riss
  - Toit de la Molasse
  - Toit du Mésozoïque

**SITES POLLUÉS**

- Projet/ouvrage situé dans le périmètre d'un site pollué

**DANGERS NATURELS**

- Projet/ouvrage situé dans une zone instable
- Projet/ouvrage situé dans une zone de mouvement permanent

**HYDROGÉOLOGIE**

- Projet/ouvrage situé dans un secteur de protection des eaux souterraines
- Projet/ouvrage situé dans une zone de protection des puits de captage
- Projet/ouvrage situé dans un secteur où l'eau souterraine est exploitée pour l'eau potable

**GÉOTHERMIE**

- Projet/ouvrage situé dans une zone d'interdiction de sonde géothermique verticale
- Projet/ouvrage situé dans une zone d'interdiction de système géothermique sur nappe
- Projet/ouvrage situé dans un périmètre d'exploitation de géothermie
- Projet/ouvrage situé à proximité d'une installation de géothermie

**CADASTRE TECHNIQUE DU SOUS-SOL (CTSS)**

- Projet/ouvrage situé à proximité d'une conduite de chauffage
- Projet/ouvrage situé à proximité d'une sonde géothermique
- Projet/ouvrage situé à proximité d'une zone de sondes



# Decision-making tools: ERES – Etude de risque sur les eaux souterraines (available)

- Method for identifying, quantifying and classifying risks on groundwater.
- Applicable to all kind of wells (geotechnical, hydro, geothermal)
- Used to highlight the critical issues and challenges specific to a project and its context in order to define the mitigation and management measures to be taken into account.
- Composed of groundwater risk assessment grids, classified according to the different stages of the life of a borehole: realization; exploitation and dismantling.

		ECHELLE D'EXPOSITION				
		0 NON APPLICABLE	1 MINEURE	2 MODÉRÉE	3 IMPORTANTE	4 MAJEURE
ECHELLE DE PROBABILITÉ	0 NON APPLICABLE	0	0	0	0	0
	1 IMPROBABLE	0	1	2	3	4
	2 PEU PROBABLE	0	2	4	6	8
	3 PROBABLE	0	3	6	9	12
	4 TRÈS PROBABLE	0	4	8	12	16



ECHELLE DU NIVEAU DE RISQUE	
Non applicable	0
Risque acceptable	1-3
Risque modéré	4-6
Risque important	8-9
Risque majeur	12-16

Nappe	TRAVAUX			
	P	E	R	
Risques liés à l'environnement traversé	Arrachement / cisaillement des installations	0	1	0
	Artésianisme	3	1	3
	Colmatage de l'aquifère	0	1	0
	Corrosion	1	1	1
	Dégradation de la cimentation	0	1	0
	Difficulté de cimentation / défaut d'étanchéité	4	1	4
	Dissolution de formations géologiques	0	1	0
	Effondrement / tassement superficiel	0	1	0
	Fuite de produits polluants sur la place de forage	2	1	2
	Hydratation de formations géologiques gonflantes	0	1	0
	Imprévu géologique	3	1	3
	Introduction artificielle / pertes de fluides dans l'aquifère	3	1	3
	Malfaçon du forage	1	1	1
	Mise en communication de nappes	0	1	0
	Mobilisation de radioéléments	2	1	2
	Modification des conditions physico-chimiques du milieu	3	1	3
	Non tenue du trou de forage	3	1	3
Perçement du tubage	0	1	0	
Remontées d'hydrocarbures liquides	2	1	2	
Venues de gaz	3	1	3	
Risques liés à l'aquifère cible	Arrachement / cisaillement des installations	0	3	0
	Artésianisme	3	3	9
	Colmatage de l'aquifère	3	3	9
	Corrosion	3	3	9
	Dégradation de la cimentation	0	3	0
	Difficulté de cimentation / défaut d'étanchéité	0	3	0
	Dissolution de formations géologiques	0	3	0
	Effondrement / tassement superficiel	0	3	0
	Hydratation de formations géologiques gonflantes	0	3	0
	Imprévu géologique	4	3	12
	Introduction artificielle / pertes de fluides dans l'aquifère	4	3	12
	Malfaçon du forage	1	3	3
	Mise en communication de nappes	4	3	12
	Mobilisation de radioéléments	3	3	9
	Modification des conditions physico-chimiques du milieu	3	3	9
	Non tenue du trou de forage	3	3	9
	Perçement du tubage	2	3	6
Remontées d'hydrocarbures liquides	3	3	9	
Venues de gaz	3	3	9	
DEVELOPPEMENT DU/DES PUIITS				
	Arrachement / cisaillement des installations	0	3	0
	Augmentation de la turbidité	0	3	0
	Corrosion	3	3	9
	Détérioration de l'équipement du puits	1	3	3
	Effondrement / tassement	2	3	6
	Hydratation de formations géologiques gonflantes	0	3	0
	Injection d'eau polluant le milieu	0	3	0
	Mise en communication de nappes	4	3	12
	Mobilisation de radioéléments	3	3	9
	Modification des conditions physico-chimiques du milieu	3	3	9
Remontées d'hydrocarbures liquides	3	3	9	
Venues de gaz	3	3	9	
DEMANTELEMENT				
	Artésianisme	0	1	0
	Defaut de scellement	1	1	1
	Dégradation de la cimentation	3	1	3
	Mise en communication de nappes	3	1	3
	Mise en place de matériaux de remplissage inappropriés	1	1	1
Risques liés à l'aquifère cible	Artésianisme	1	3	3
	Dégradation de la cimentation	3	3	9
	Mise en communication de nappes	3	3	9
	Mise en place de matériaux de remplissage inappropriés	1	3	3

# FCC Geophysical prospection (2D seismic on swiss territory)

## – quick overview –

3 main components:

### Permitting

Authorization from private and public parcel owners to deploy acquisition material (geophones and/or source points) on their parcels.

### Communication

Depending on their size, duration, timing of acquisition and material deployed, such surveys can represent highly visible and disturbing activities, which need to be presented and explained to the concerned population

### Cantonal prospection authorization (delivered by the GESDEC)

As "directing authority", the GESDEC coordinates the authorization procedure by circulating the demand across the concerned services and offices to collect their conditions, synthesize them and deliver the cantonal prospection authorization.

The request for autorisation must be addressed to the GESDEC and contain:

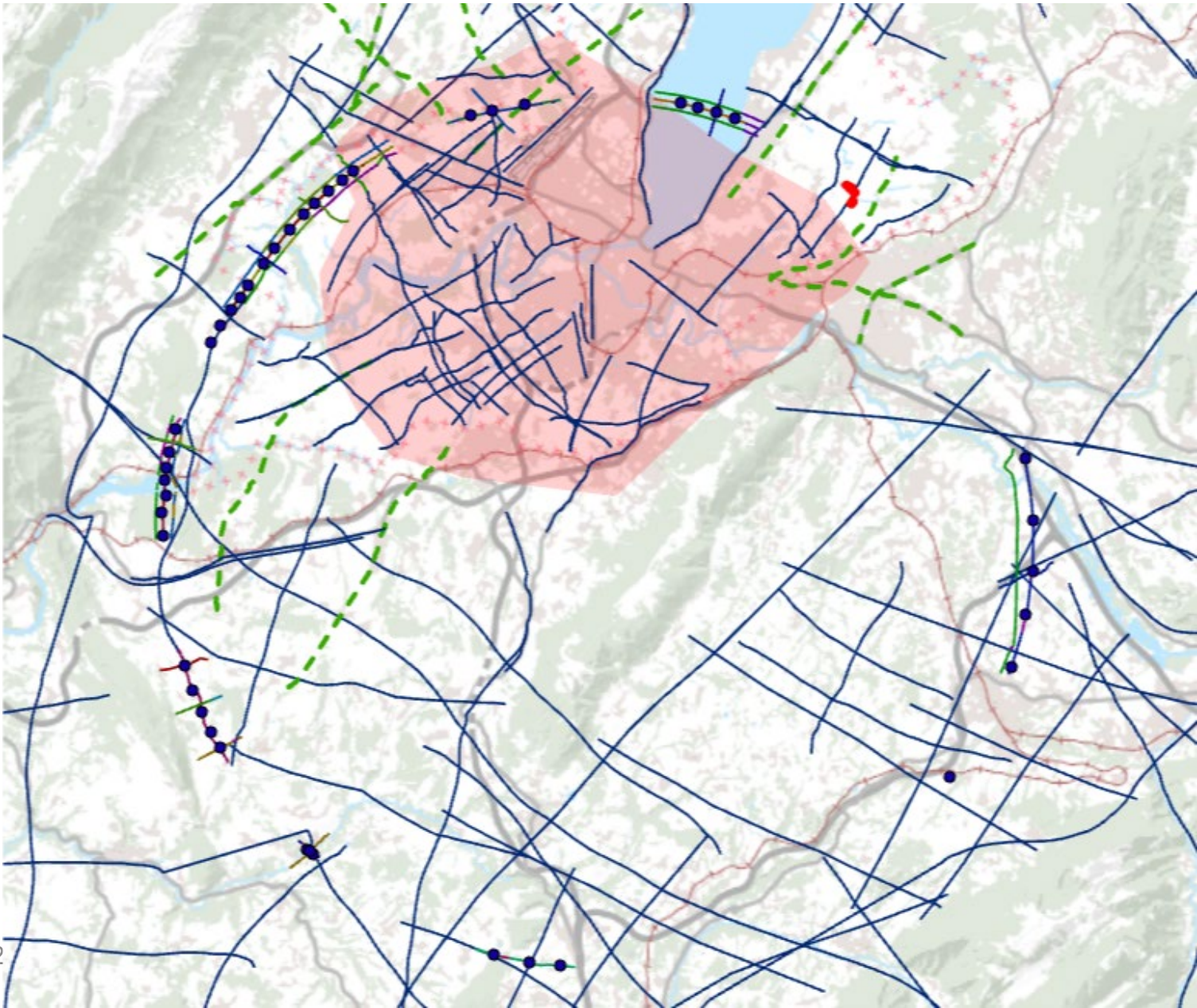
- Description of the method and goal of the survey
- Details on the operating mode (type of sources, deployment)
- Details on the acquisition plan (precise location of source points, geophones, etc.)
- Specific measures or mitigation measures envisaged to assess preidentified questions or constraints
- ...

→ *More details can be provided from recent 3D seismic survey*

11/2/2011 → *French procedures are different and need to be carried out in parallel*



# Existing and planned 2D/3D seismic data around the FCC project



# Conclusions / recommandation

- It is highly recommended that the preparation of a drilling demand is accompanied by an expert company with a good knowledge on local geology and cantonal procedures.
- Elements presented here are not exhaustive and do only concern subsurface aspects of a project evaluated by the GESDEC. Depending on the situation, other authorizations might be needed regarding surface environmental and/or technical aspects.
- In addition to the assessments presented above, description of well measurements, tests and sampling program must also be provided.
- All geological geophysical data (s.l) must be delivered to the GESDEC, who can use them internally to update published models, information plans, etc. The data remain property of its owner and can remain confidential for a certain time on owner's request.
- Deployment of a natural seismicity monitoring system should be coordinated with the Canton (GESDEC) for best complementarity