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Geoscience for a sustainable Earth
brgm

THE FUTURE GEOLOGICAL SURVEY: A WORK IN PROGRESS

Matt Harrison
Director of Digital Platforms, BRGM

Outline of the Talk

- Downstream engagement
  - Digital Twins
  - SousSol Bien Commun
- Predictive Services
  - MétéoNappe/Predinappe
- Urban Geoscience
  - BIM exists in a heterogeneous environment
- Embracing New Technologies
  - The value of AI technologies in a GSO

JUNON Program

JUNON

« Create a digital research center on the continental environment (agricultural, urban, forest and fluvial), including each level of the critical zone, and dedicated to research and innovation on all links of the value chain from environmental sensor to plain digital twins. »

-4 years long program starting from 2022

-About 15 millions of euros in investments (ARD, CPER and FEDER)

-Some twenty research teams involved (5 research organisms, 4 private companies)

Exceptional Natural resources representative of plain environment!

-Beauce aquifer (biggest European water table)

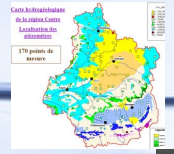
-Beauce grain belt (second biggest one in Europe)

-Orléans forest

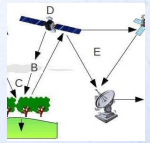
-Loire natural banks and wetlands

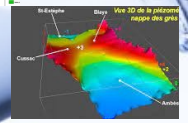
Loire level

Piezometrical network



Archives





Pre-existing models

Satellite Data

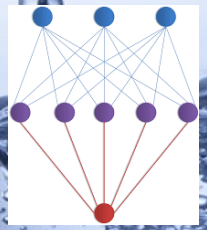
Geological data

PIVOTS Observatories

Météo France

Standardization(FAIR)

Deep Learning



What will be the water table level in 8 months???

Water Digital Twins (example)

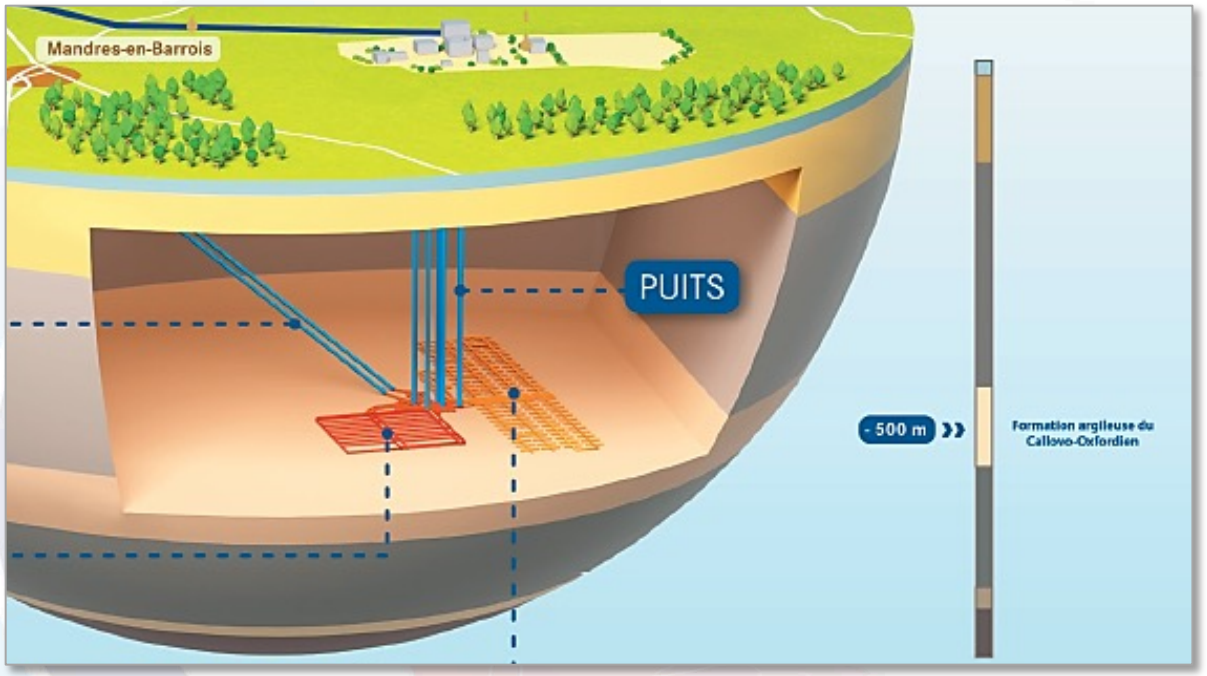
ONE Geology

Providing geoscience data globally

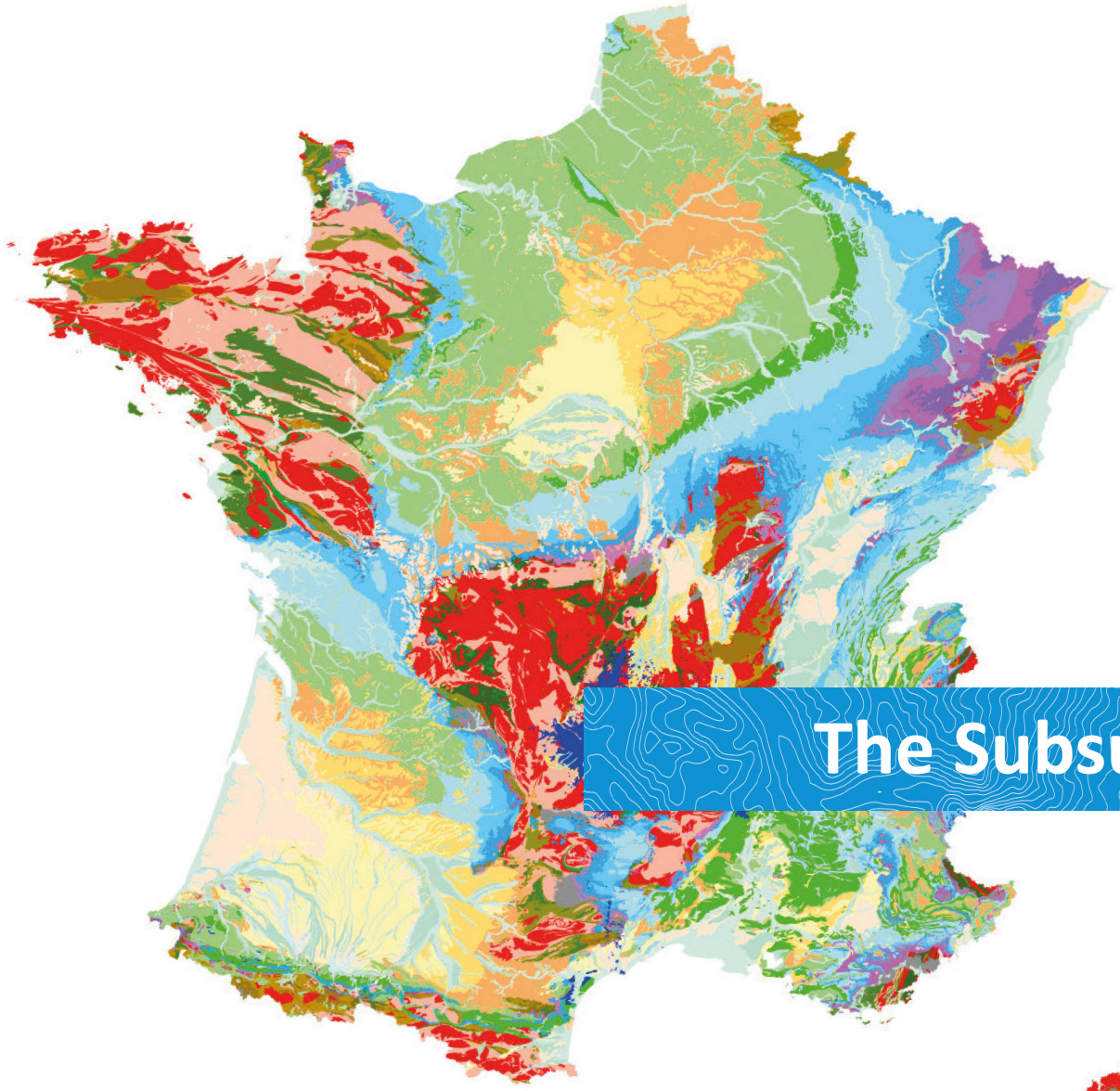
Digital Twins for surface and underground buildings and infrastructures

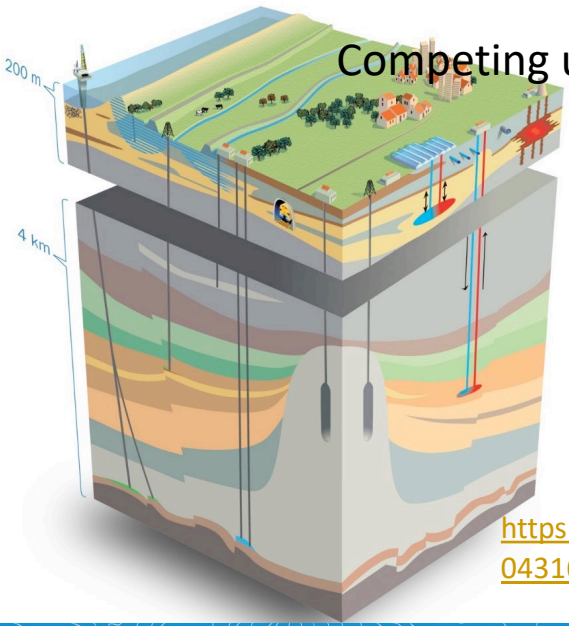
Digital City Synergy project, Helsinki

High Speed 2 Project, London



Geological repository of nuclear waste
CIGEO Project, France





Competing uses of the subsurface

https://doi.org/10.1016/j.landusepol.2019.104316

The Subsurface as a Common Good

Sous-sol, bien commun

Auditorium Marie Curie du CNRS // 3 rue Michel-Ange – 75016 Paris

Géosciences pour une Terre durable
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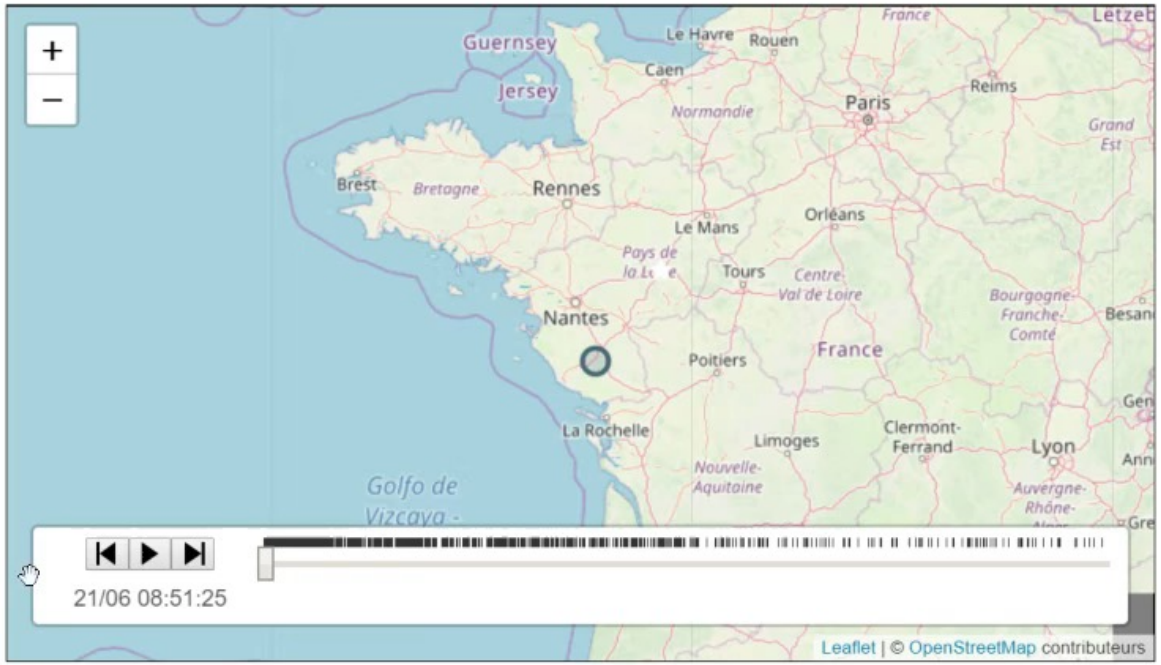
SURICATE NAT

VIGIE CITOYENNE DES RISQUES NATURELS

Projet soutenu par fondation MAIF pour la recherche

- RECHERCHER UN ÉVÉNEMENT
- ACTIVITÉ TEMPS-RÉEL TWITTER
- FICHES THÉMATIQUES
- TOP CONTRIBUTEURS : PODIUM
- ADMIN

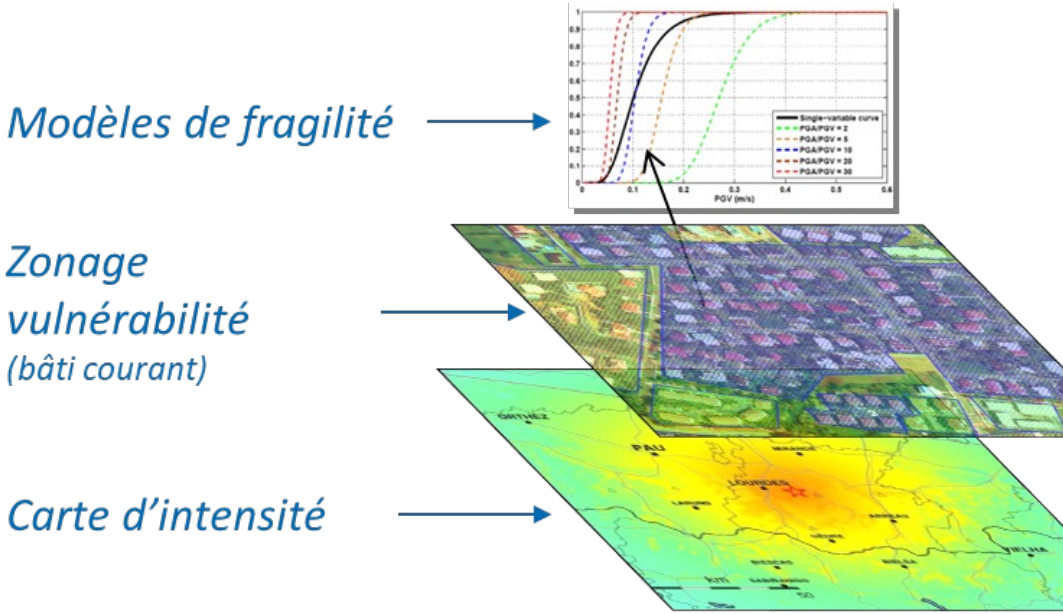
Série temporelle



1. SENSOR-BASED DATA-DRIVEN RAPID RESPONSE

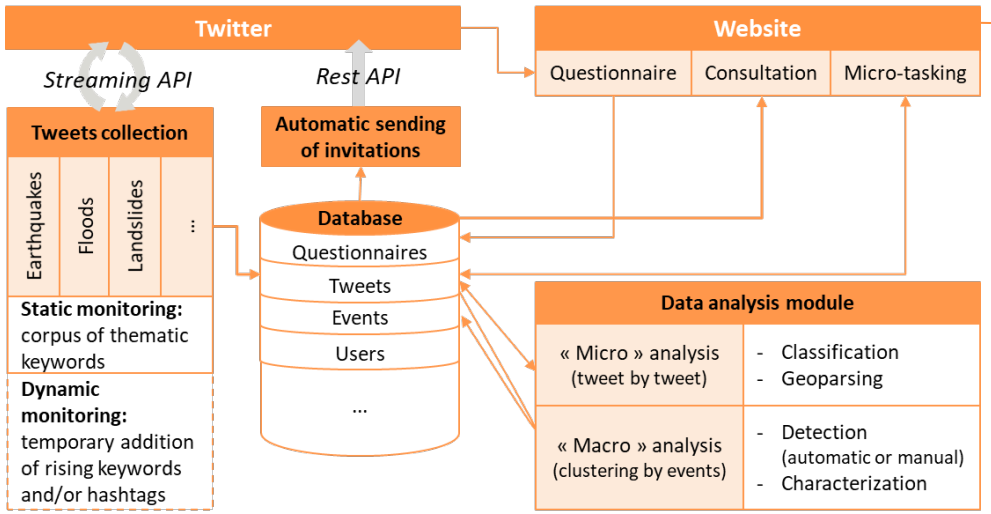
- **Principle of the SEISAid tool**

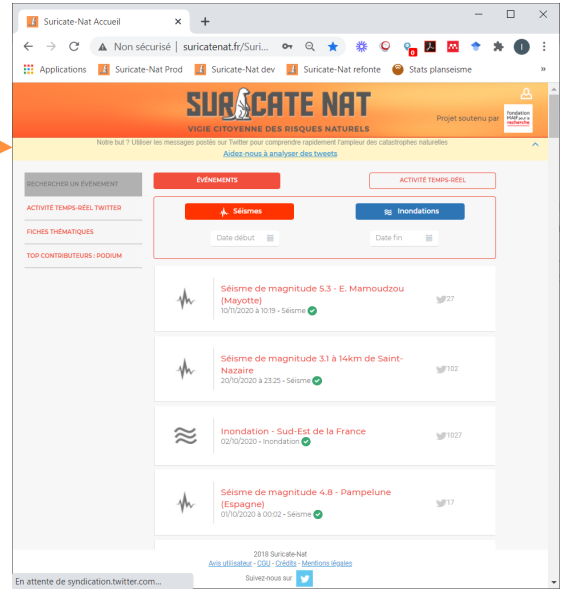
1. **Assessment of the intensity of ground motions**
   - Models PLUS observations (seismometers)
2. **Estimated number of buildings affected by intensity level and vulnerability classes**
   - Statistical model based on the characteristics of buildings (age, constructive mode)
3. **Estimation of damages and human losses**



2. CITIZEN-BASED DATA-DRIVEN RAPID RESPONSE

- **Principle of the SURICATE-Nat platform**
  - **Automatic analysis of tweets immediately during/after occurrence of natural disasters**
    - Enrich the flow of raw data from Twitter into a human based instrumental stream that can then be analyzed as those coming from technological sensors
    - New version of SURICATE-Nat: event driven architecture

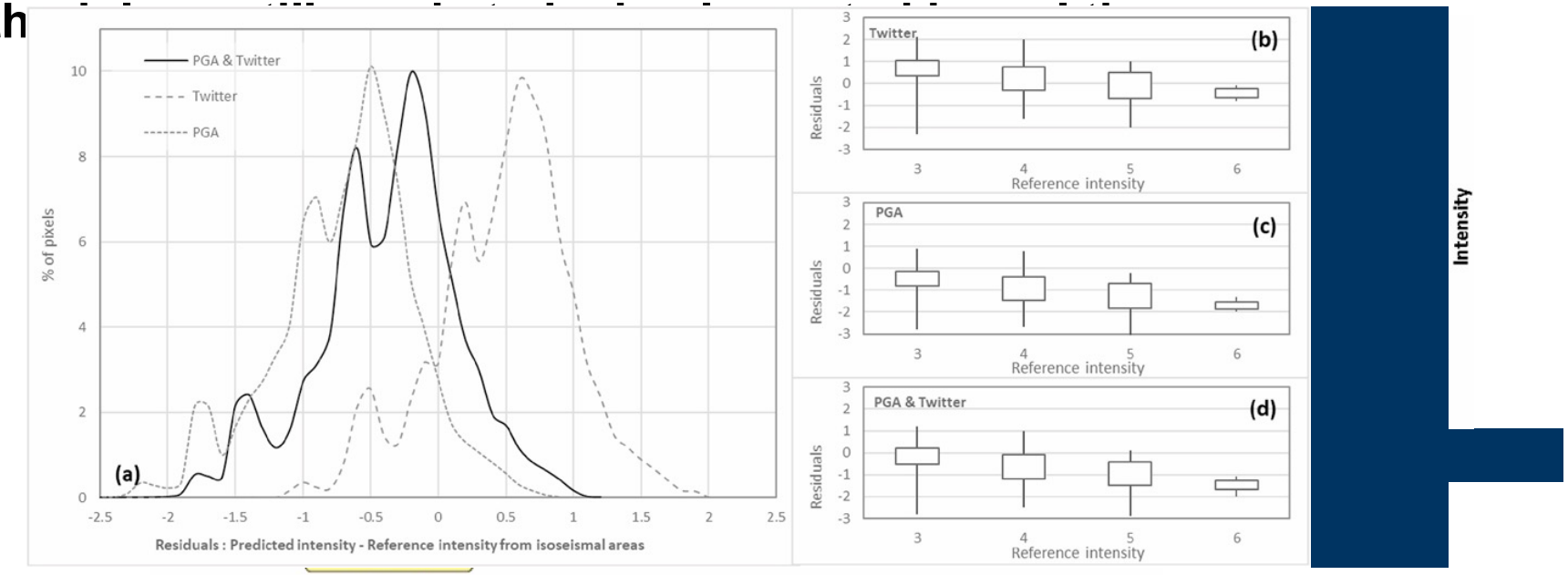




Auclair, S. et al. (2019). SURICATE-Nat: Innovative citizen centered platform for Twitter based natural disaster monitoring. ICT-DM, IEEE. doi: 10.1109/ICT-DM47966.2019.9032950

3. multi-sensors DATA-DRIVEN RAPID RESPONSE

- **Towards a fusion of sensor-based and citizen-based data**
  - **Development of a method for coupling data analysis**
    - Agnostic spatio-temporal clustering of tweets
    - Combination of data from seismic stations and Twitter with Bayesian Networks
  - **This meth**



Fayjaloun, R., Gehl, P., Auclair, S., Boulahya, F., Guérin-Marthe, S., & Roullé, A. (2021). Integrating strong-motion recordings and Twitter data for a rapid shakemap of macroseismic intensity. International Journal of Disaster Risk Reduction, 52, 101927.

Géosciences pour une Terre durable
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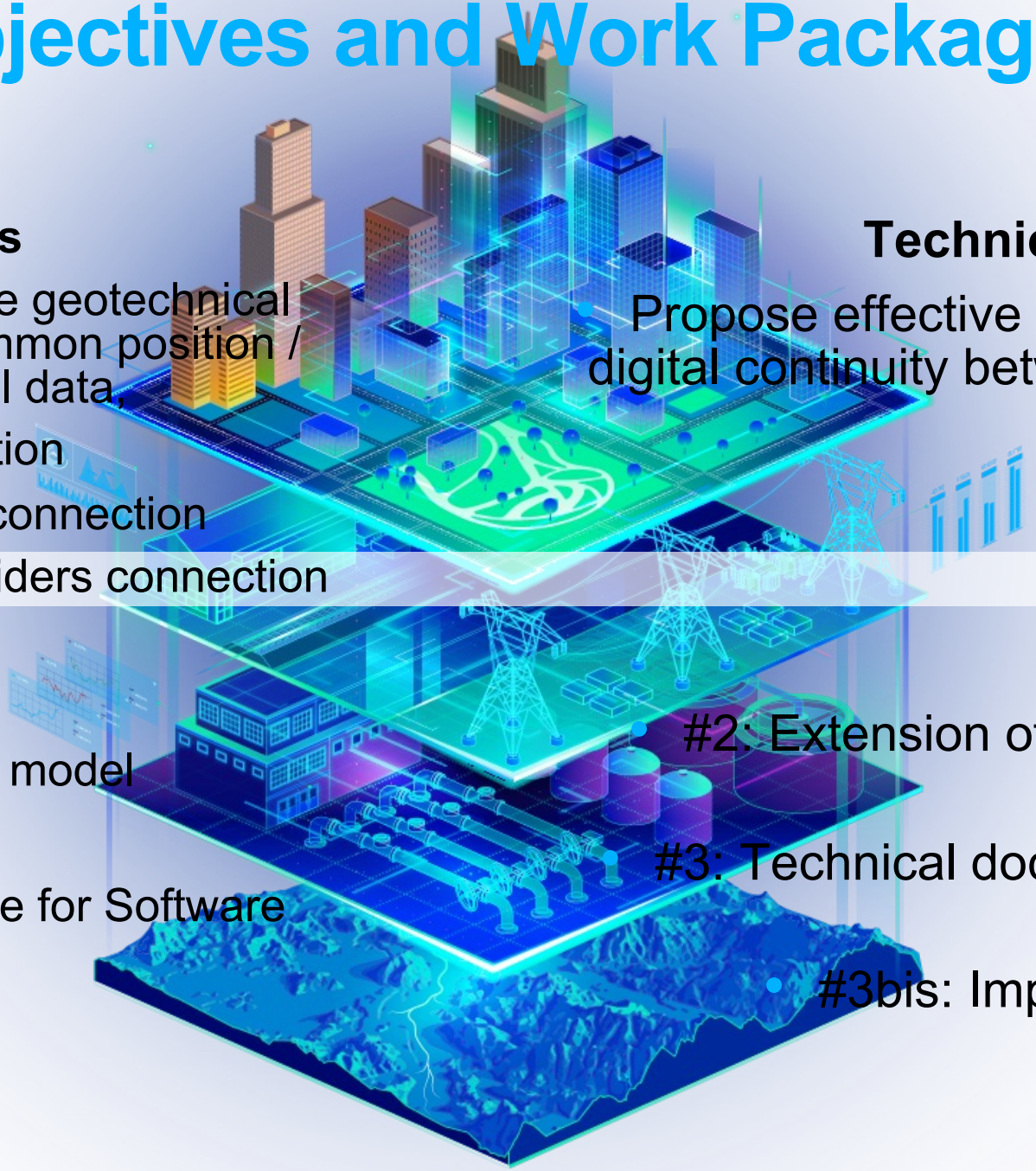
Geotech IE objectives and Work Packages (reminder)

Community oriented goals

- Contribute to federate the geotechnical community around a common position / proposal for geotechnical data,
  - Scientific – IT connection
  - BIM – GIS and more connection
  - Users – Solution providers connection

Work packages:

- #1: Common conceptual model
- #4: Technical paper
- #5: Implementation Guide for Software Vendors



Technical oriented goals

- Propose effective solutions to enable digital continuity between GIS and BIM

Work packages:

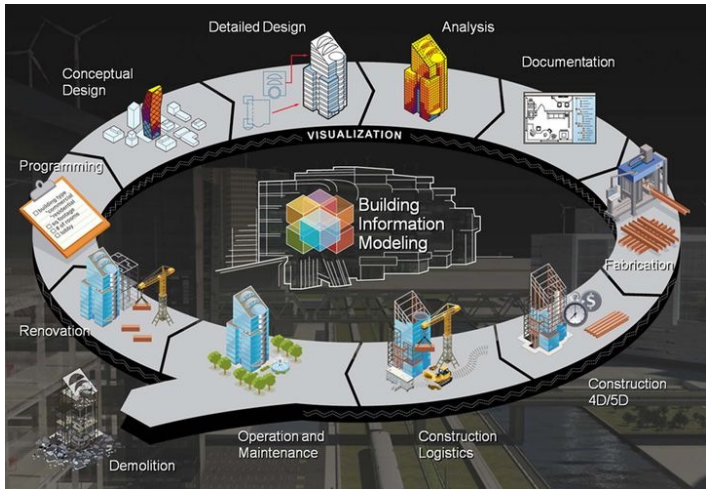
- #2: Extension of OGC Geoscience standards,
- #3: Technical documentation on the use of OGC APIs
- #3bis: Implementation forum

Image courtesy © ESRI

BIM and its status in France

Building Information Modeling (BIM)

- Targetting a « Digital Twin » of the construction
- Becoming more and more present for infrastructures (road, rail, bridge, tunnel, earthworks and geotechnics)

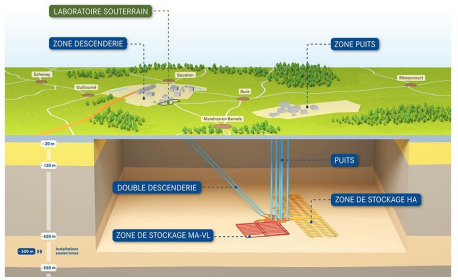


France is among the leaders in BIM

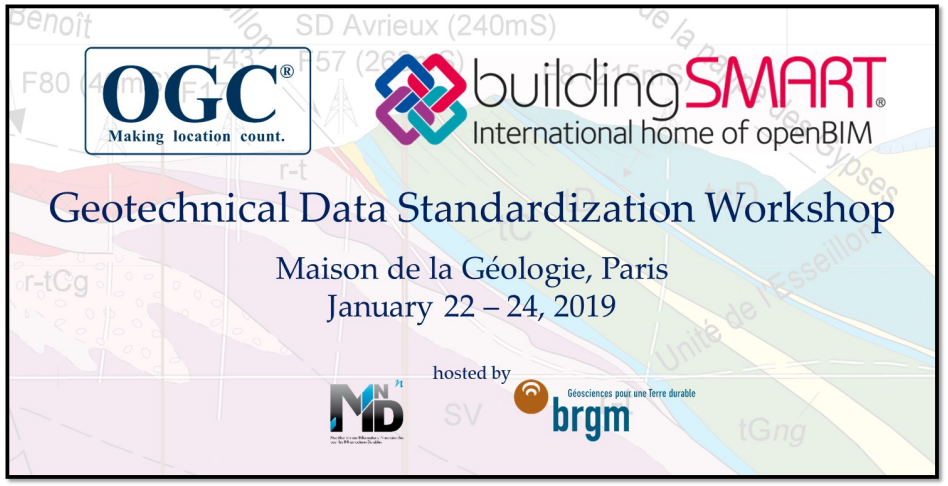
- BIM is not mandatory in France, yet lot of projects rely on it
- Supported by the French Ministry: Building Digital Transition Plan, Plan BIM 2022
- France is very active in the definition of open standards for BIM (OpenBIM) especially for infrastructure
  - The MINnD project federates constructors, engineering, research organizations and owners on that topic
- Several big infrastructure projects in France, especially in the domain of underground infrastructures

TUNNEL EURALPIN LYON TURIN

Grand Paris express

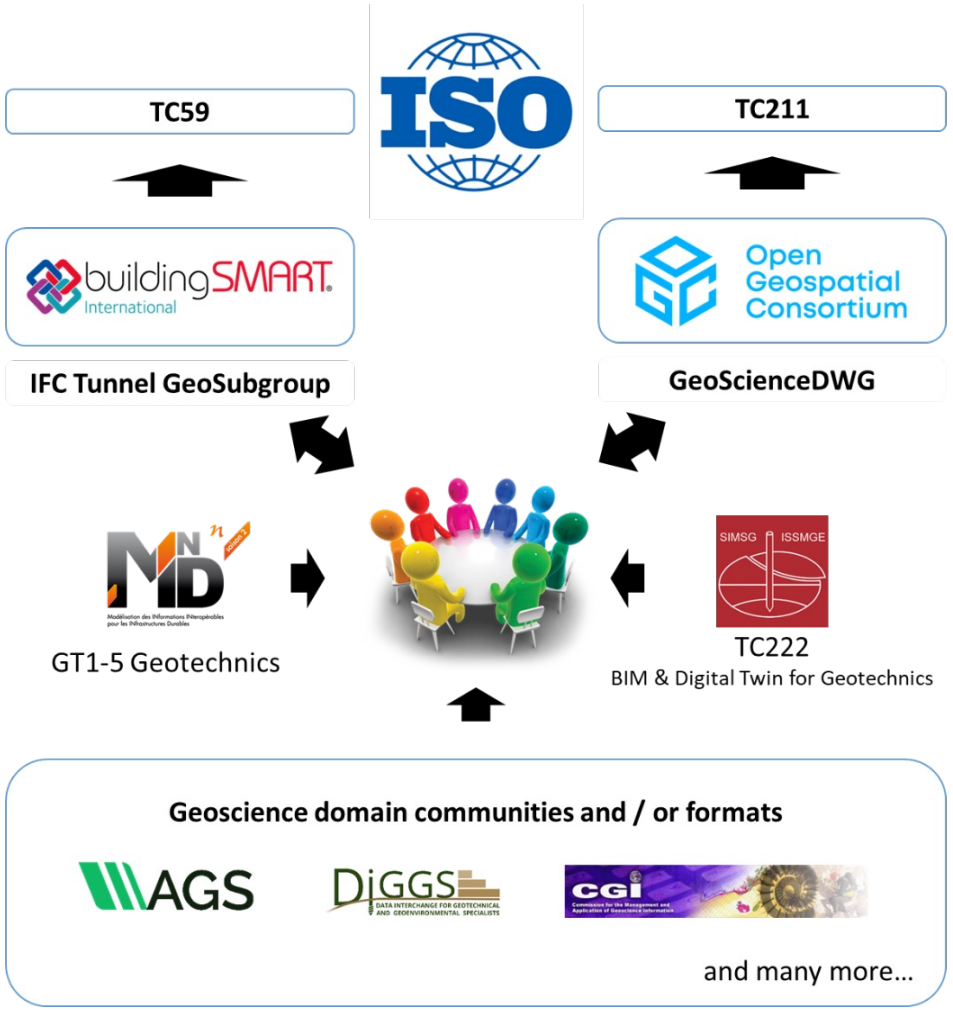


DISSEMINATION AND INTERNATIONALIZATION



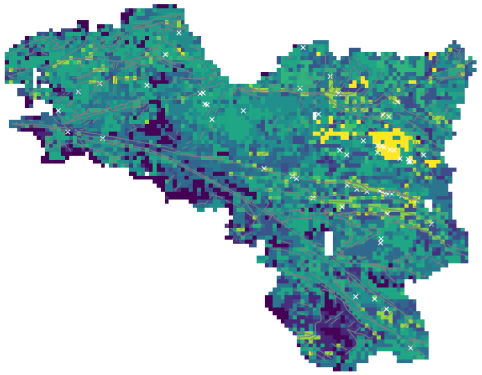
Standardization

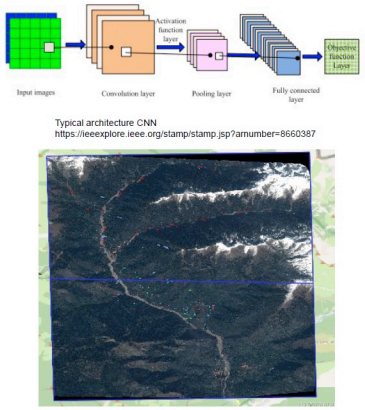
Forum

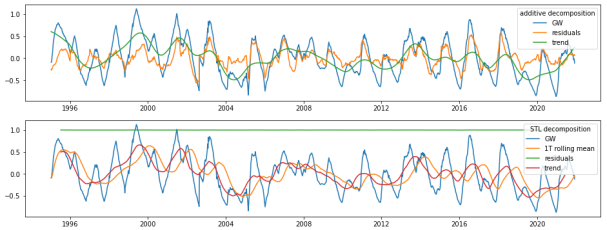


4 AI topics of interest for BRGM have been identified:

- Predictive mapping
- Image analysis
- Time series forecasting
- Natural language processing







➢ **Detail use cases of these 4 topics**

IA projects at BRGM

Predictive mapping

Développement de la Recherche vers l'Opérationnel en Prédictivité (DROP)

Vincent Labbé, Bruno Tourlière, Axel Rousseau, Guillaume Bertrand (DNG/DGR)

Objective : Ease and increase visibility of predictive mapping inside BRGM

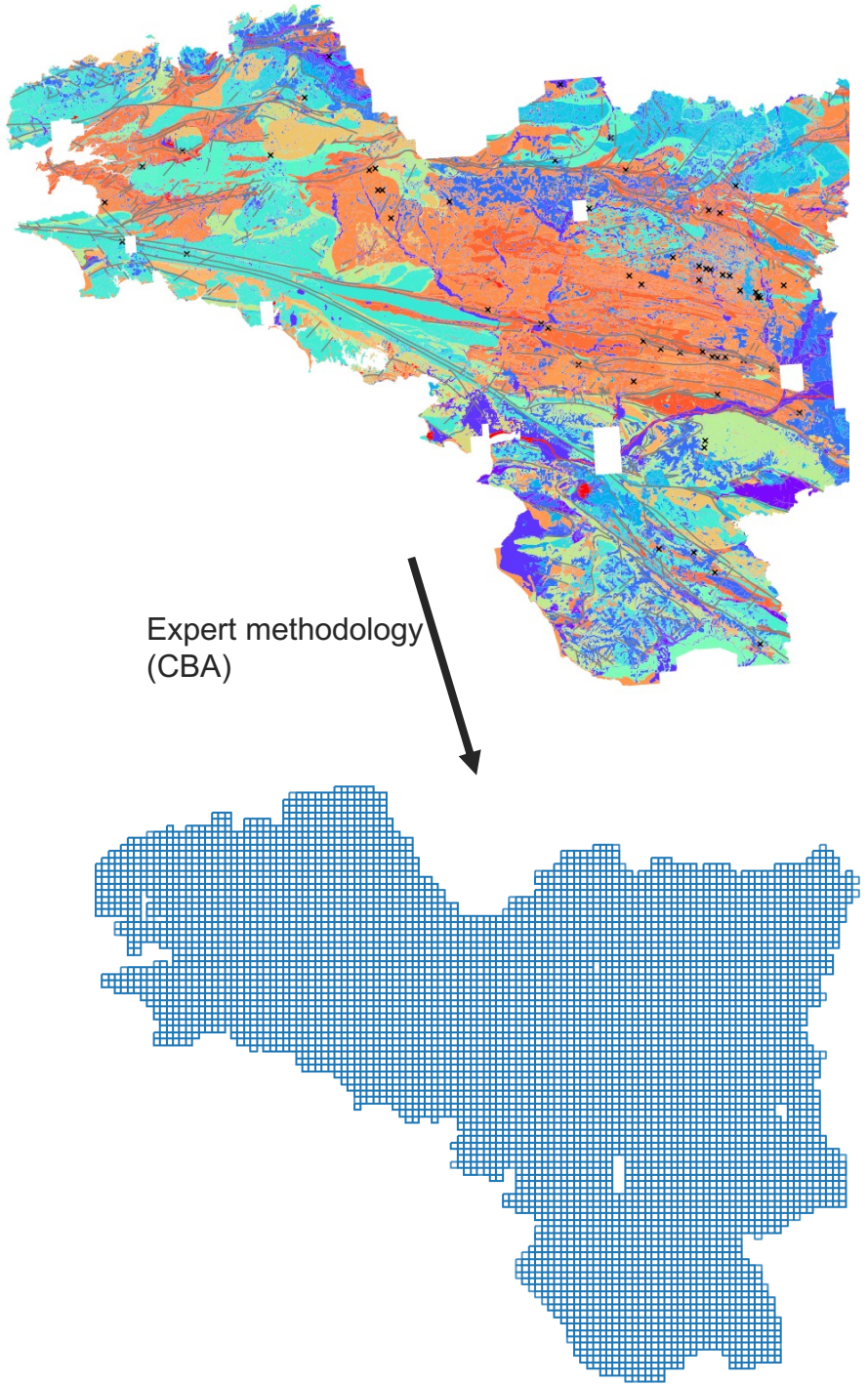
Realisation :

- Python library: CBA (*Tourlière et al.*, 2015) grid creation, data preprocessing, generation and evaluation of the model (random forest), generation of the predictive map
- Creation of a functional prototype of a QGIS plugin

Perspectives :

- From POC to production
- Technical advances and new features
- Dissemination (open source ?) and provision (web API?)

➢ Combination of expert methodologies and AI techniques



Time series forecasting

Demonstrate synergy to the state-of-the-art approaches for groundwater applications

1. Modeling and forecasting

Adding **new approaches, methods and tools** (data driven) to all reading existing one (physically based) for GroundWaterLevel prediction **to face new challenges** :
* in real time prediction
* massiv target predictions (20k wells)
* with new predictors (climatic models/satellites,…)
* and so many more !

2. Data Analysis

Entering the era of BigData for **new insight** on existing dataset (regulatory, monitoring, scientific reports,…) to :
* drive mitigation actions
* optimize monitoring network
* ...

made with <3 by V. Godard

Time series forecasting

1. Modeling and forecasting

Needs identified all over France (if not Europe/World)

Objectives :

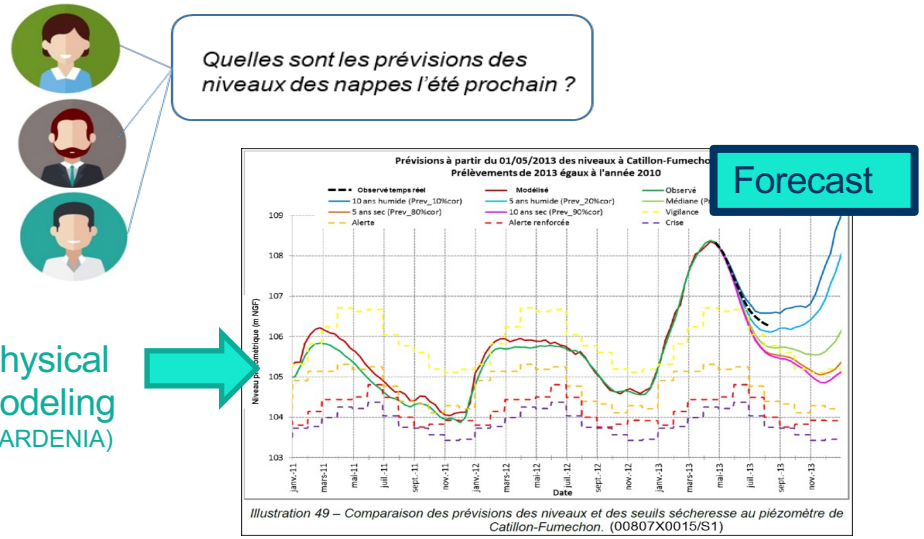
- Deliver a Proof of Concept
- Set up tools and technics for next step
- Gain in expertise

Achievements :

- Jupyter Notebooks (Python)
- Variety of RNN tested
- End to end project : from data collection to predictions
- Code versioning and documentation on Gitlab

Perspectives :

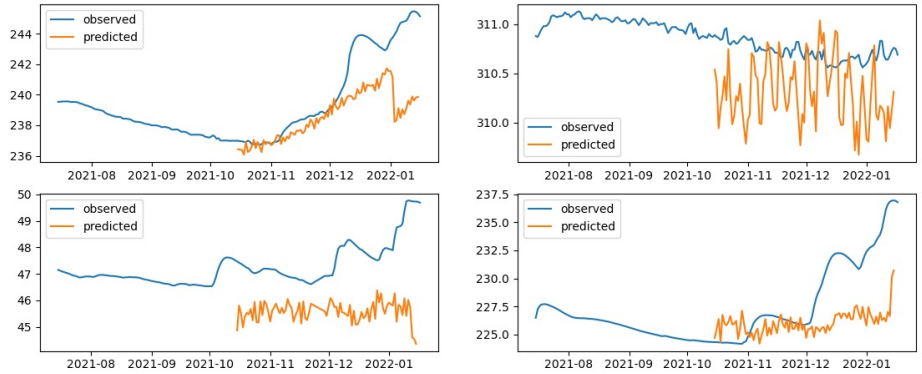
- A first web service in end of 2022 for fully automated predictions



Prévisions de niveaux établies à partir d'une modélisation (Gardenia) Bault et al. 2013

Illustration : E. Rouxel

AI modeling (LSTM)

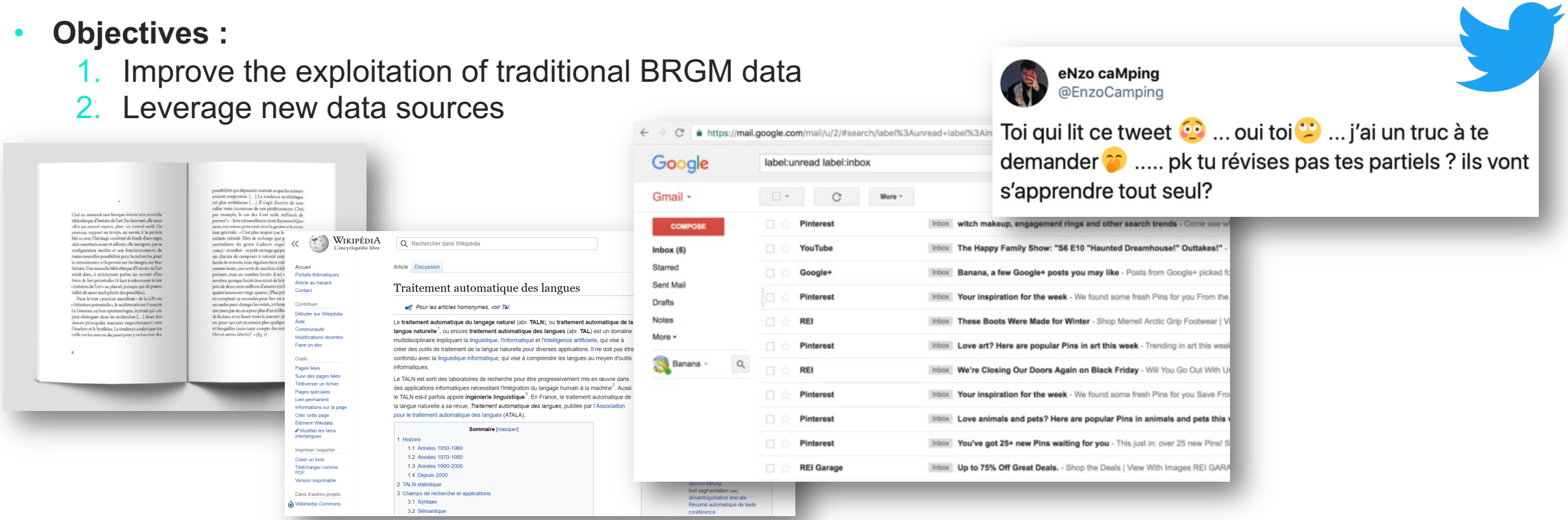


Natural language processing

Tools developed to automatically exploit the growing volume of textual documents

- Textual data are complex : ambiguity, implicit and heterogenous
- Explosion of the amount of data available with the internet

- **Objectives :**
  1. Improve the exploitation of traditional BRGM data
  2. Leverage new data sources



Natural language processing

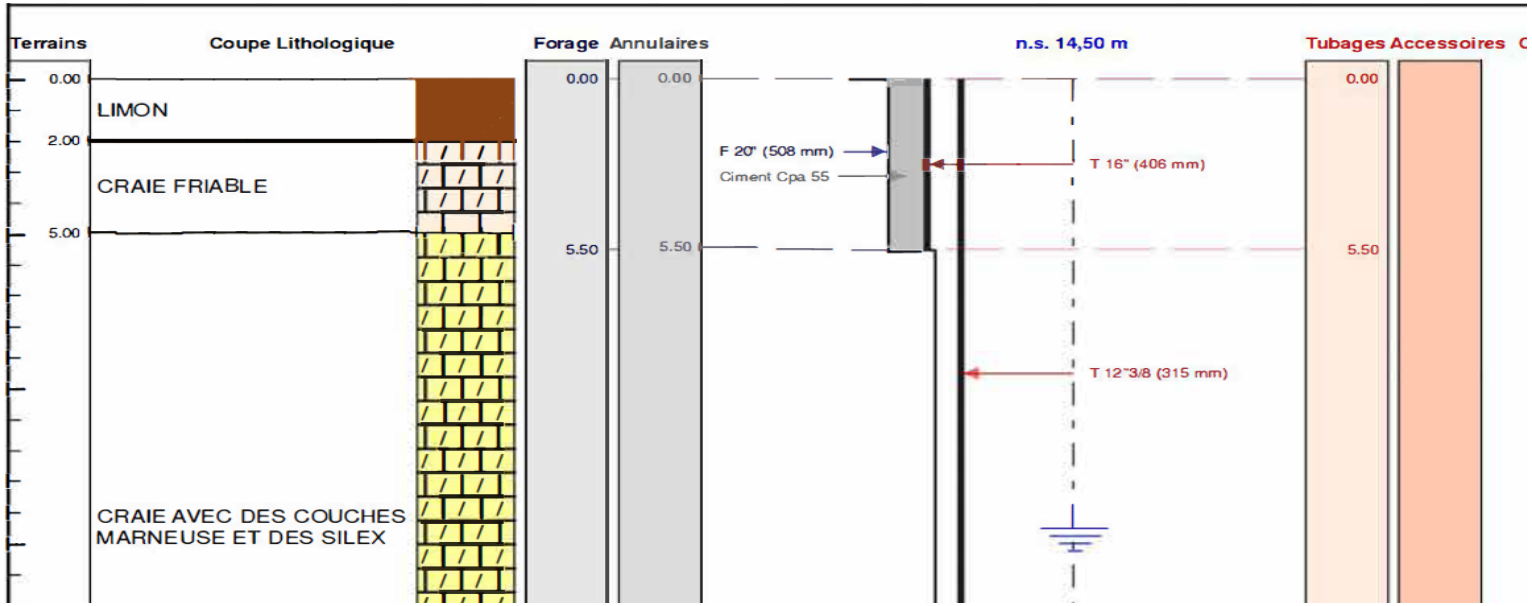
1. Improve the quality and accessibility of geological data

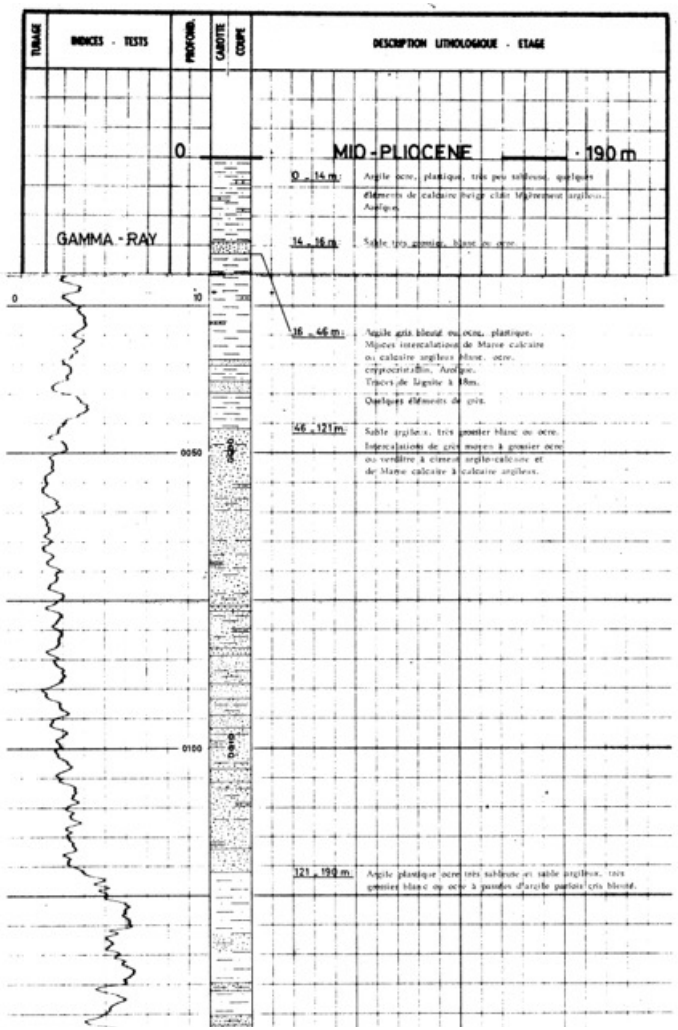
Banque du Sous-Sol database : >1 000 000 of boreholes descriptions

→ Most of them are searchable and editable texts

→ But there is also >500 000 scanned documents

➔OCRization has to come first !!





Merci de votre attention
Thanks for your attention

Contact Details:
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m.harrison@brgm.fr

Weathering erosion in an open pit potash mine, DRC – N. Charles