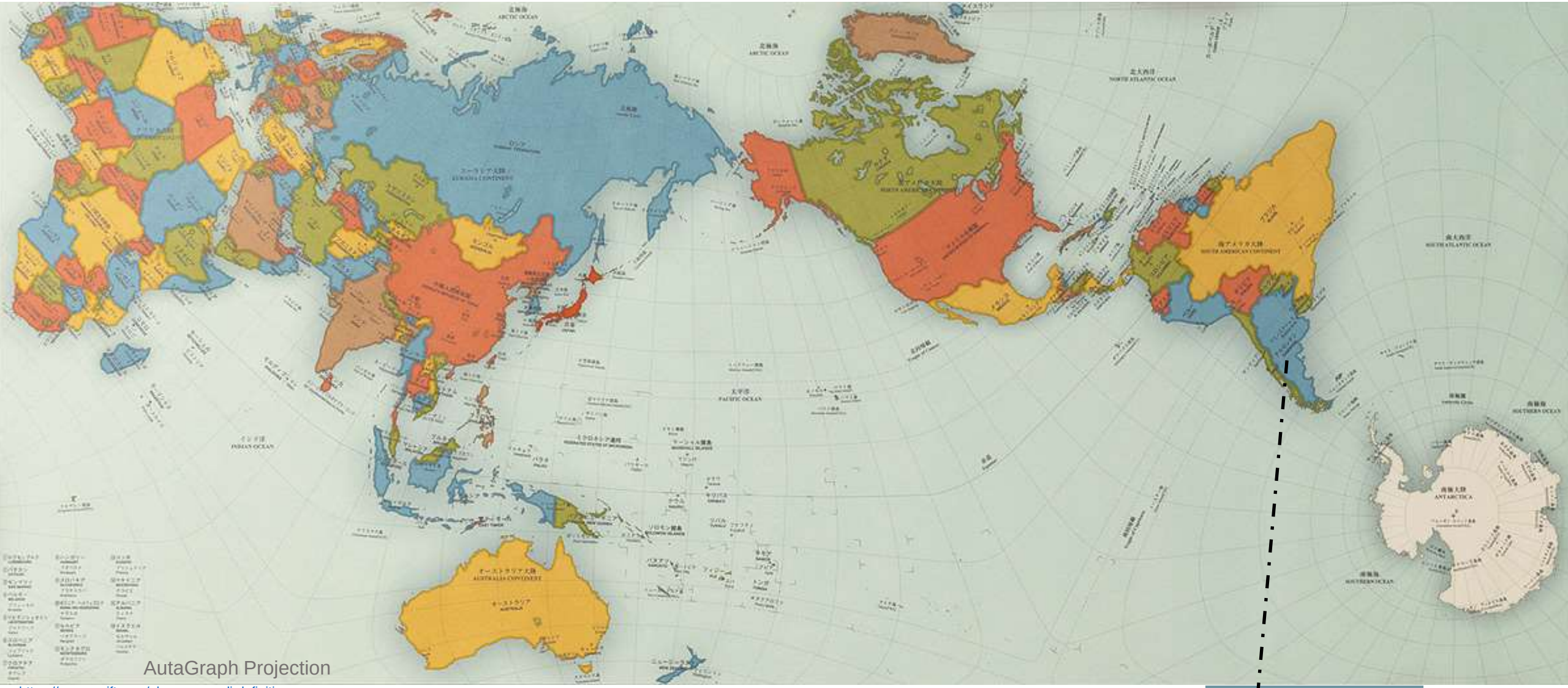
Deep Geological Disposal in Argentina: national context and the ConfinAR Geo Project

María Victoria Altinier.

National Radioactive Waste Management Program (PNGRR)
Nuclear Safety and Environment Area Management (GASNyA)
National Atomic Energy Commission (CNEA)

7th International Conference on Geological repositories
27-31 May, Busan (Korea)



American continental area: 2.780.085 km².
South Atlantic Islands area: 15.908 km².

Source of spatial information: National Geographic Institute (IGN, 2023): https://www.ign.gob.ar/NuestrasActividades/Geografia/DatosArgentina/LimitesSuperficiesyPuntosExtremos

Argentina Republic

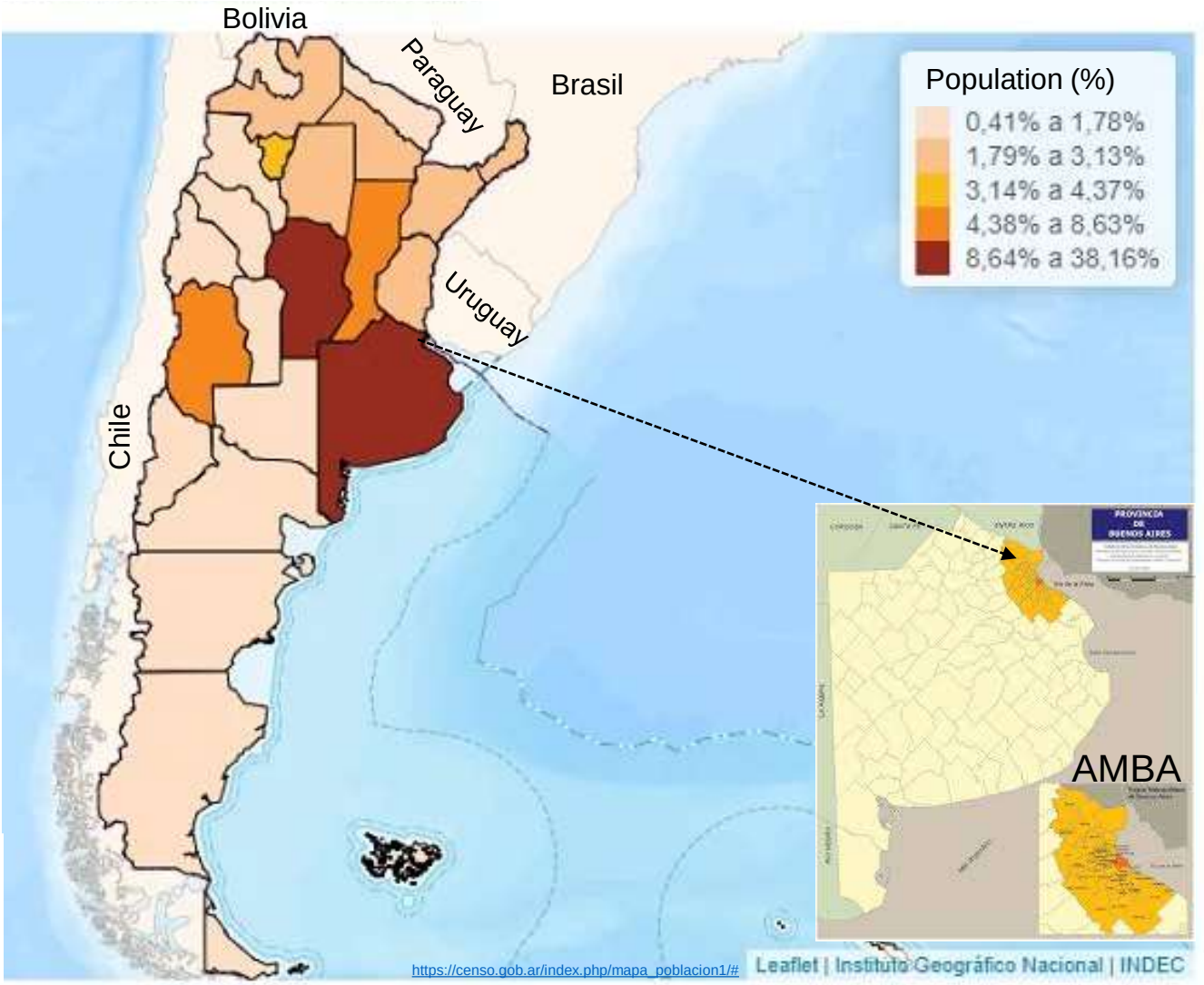
Federal Republic: 23 provinces and a federal district (Autonomous City of Buenos Aires, CABA, 3.120.612 inhab) → political autonomy and their own laws and constitution.

Population: 46.044.703 inhabitants.
American continental area: 2.780.085 km²

The distribution of the population in the territory is extremely uneven:

- **Metropolitan area of Buenos Aires (AMBA): 13.985.794 inhabitants** distributed over **13.285 km²** (~ 35% population of the country).
- Most populated provinces: Buenos Aires (17.569.053 inhab.), Córdoba (3.978.984 inhab.) and Santa Fe (3.556.522 inhab.).

Data: National Institute of Statistics and Censuses (INDEC) (October 2023): https://www.indec.gob.ar ; https://censo.gob.ar/



Nuclear activities in Argentina

1950-2024

- 1 SMR prototype under construction
- 3 Operative NPPs
- 1 Uranium purification facility
- 1 Heavy water industrial facility
- 1 Nuclear fuel factory
- 1 Uranium Enrichment Facility
- 3 Academic training centres
- 3 Atomic centres
- 6 Research reactors
- 1 Factory mining complex
- 1 Uranium purification facility under construction
- 8 Environmental restoration areas
- 11 Mining activity sites
- 6 Nuclear medicine centres
- 6 Nuclear medicine centres under construction
- 4 CNEA regional centres
- 1 Research reactor (RA-10) under construction
- 5 Particle accelerators for research
- 5 Particle accelerators for radioisotope production
- 1 Technological centre
- 4 Irradiation facilities for industrial uses
- 339 Industrial applications facilities

https://www.argentina.gob.ar/energia/energia-electrica/energia-n

Technical information	Operative NPPs		
	Lima (Buenos Aires) 120 km North from CABA		Embalse de Río Tercero (Córdoba) 700 km from Atuchas
	Atucha I	**Atucha II**	**Embalse**
Type of reactor	KWU PHWR	KWU PHWR	CANDU 6 PHWR
Thermal Power	1.179 MWt	2.175 MWt	2.064 MWt
Gross Electric Power	362 MWe	745 MWe	656 MWe
Moderator and coolant	D_20	D_20	D_20
Fuel	Slightly enriched Uranium (0.85%)	Natural Uranium	Natural Uranium
SF management	Current situation: Wet and dry interim storage onsite. DGR: HLW or SF? ↔ Reprocessing decision has not yet been made.		

https://world-nuclear.org/information-library/country-profiles/countries-a-f/argentina.aspx

1 SMR prototype under construction: CAREM-PWR.
1 NPP planned: Hualong One-HPR1000.

} Location: Lima (Buenos Aires)

Legal framework (RW and SF management)

- **Decree N° 10936/1950:** Creation of the National Atomic Energy Commission.
- **National Constitution, Law N°24.430, Art. 41** (1994).
- **Law N°24.804:** Nuclear Activity National Law (1997).
- **Law N°25.018:** Radioactive Waste Management Regime (1998).
- **Decree Nº1.390/1998:** regulation of the Nuclear Activity National Law (Law N°24804).
- **Law N°25.279:** approval of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (2000).

Regulatory framework (RW and SF management)

Nuclear Regulatory Authority (ARN)

- Autonomous National Entity responsible for regulating and controlling all nuclear activities (Law 24.804).
- Radioprotection, nuclear safety, security and safeguards.
- Responsible for licensing and control for the safety of facilities and persons.
- SF, RW and DS management: specific mandatory regulations and regulatory guidelines.

Policy (RW and SF management)

✓ **National State responsibility:**

- Liable entity **(**Law 25.018): **National Commission of Atomic Energy (CNEA),** through the **National Radioactive Waste Management Program (PNGRR)**.
- **The National State owns fissile materials contained in SF**, considered as a potential energy source (Law 24.804, Art. 2). **The decision of reprocessing has been deferred.**
- **Radioactive Waste Management Strategic Plan (PEGRR):** treatment methodology and technological disposal systems for different waste types. Reviewed and updated every 3 years and subjected to the approval of the Parliament

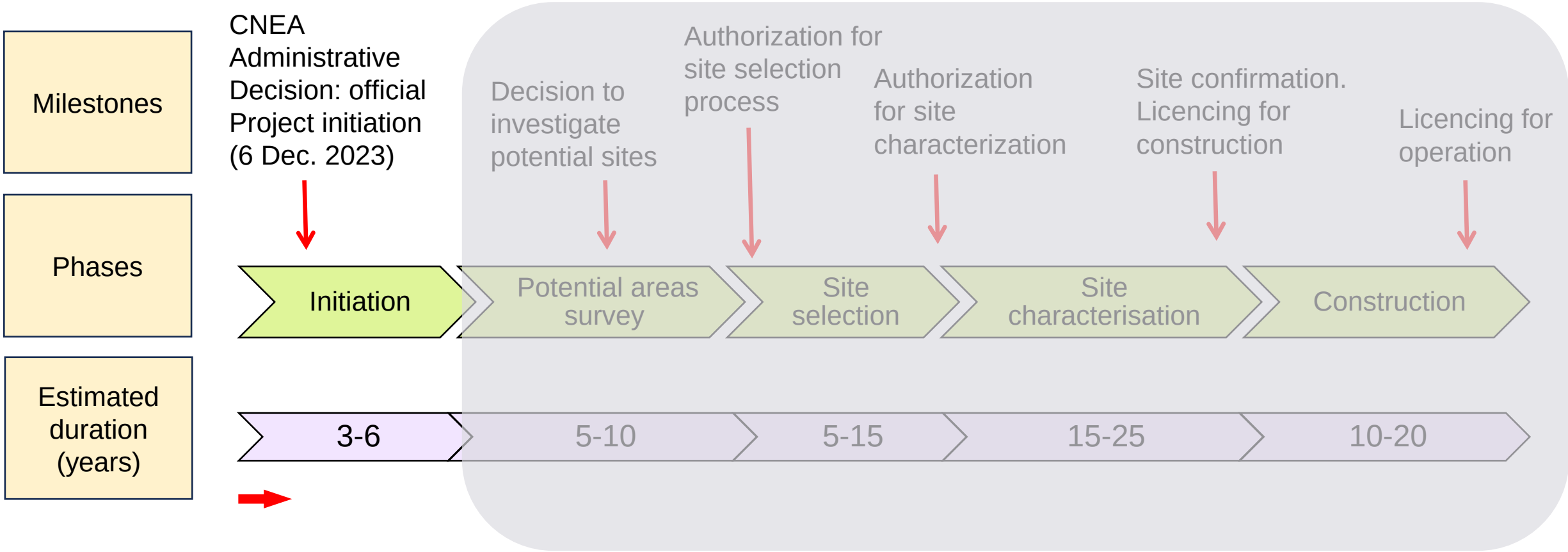
Policy (RW and SF management)

- ✓ **Funding: contributions from the National Treasure** (included and approved in CNEA budget). The Management Fund for Disposal of Radioactive Waste has not been established yet (Law N°25.018).
- ✓ SF from power reactors: NPPs onsite storage, wet in pools and dry in concrete silos. Responsible: NA-SA (NPPs operator) until its transfer to CNEA facilities for disposal.
- ✓ SF from research and radioisotope production reactors: wet storage onsite or in a storage centralized facility (Ezeiza Atomic Center).

DGR Projects in Argentina

1980–1997	“Repository of high activity radioactive waste. Feasibility study and preliminary engineering project”, **Gastre Project**. **Discontinued in 1992 and canceled in 1997**.
1991–2004	“Study of geological environments suitable for the location of repositories for the final disposal of low, medium and high activity radioactive waste.” **Subproject: “Repository for HLW Disposal” (1996-2004)**.
2020–2023	**IAEA TC Project ARG9016** “Building Capacities for Selecting and Characterizing Potentially Suitable Sites for Geological Disposal of Radioactive Waste and Spent Nuclear Fuel“.
2020-ongoing	**ConfinAR Geo Project.**

ConfinAR Geo Project



2023 Milestone

December 2023

- **Approval of the ConfinAR Geo Draft Project** by CNEA Presidency Administrative Decision (RESOL-2023-797-APN-CNEA#MEC, published in the Public Administration Bulletin on December 12, 2023 (BAP N°41/2023).
- **Authority was granted to the PNGRR** for designing, planning, and managing the ConfinAR Geo Project.

Scenarios for DGR

Not reprocessing SF

- **SF from power reactors *** (natural U and slightly enriched U ~ 0,85%)
- **SF from research and radioisotope production reactors** (19,75% of 235U).
- HLW from reactor operations.
- ILW from fuel fabrication and enrichment, and nuclear applications.

Reprocessing SF

- **HLW and ILW** from SF **reprocessing** (NPPs * and research reactors)**.**
- HLW from reactor operations.
- ILW from fuel fabrication and enrichment, ad nuclear applications.

* 4 NPPs + lifetime extensions: 3 NPPs in operation and one more projected.

Host rock: granitic or clay

Main activities (2022-2024)

- Establishing cooperative agreements with universities and S&T organizations.
- Promoting dialogue with stakeholders.
- Developing strategies to promote dialogue, and social and political involvement.
- Training, Technical Meetings, Congress.

AMBER 6.7
Quintessa

Main activities (2024-2026)

- Drafting: Roadmap, Masterplan, Communication Plan.
- Outlining a preliminary R&D Plan.
- Estimating the inventory.
- Available geological data: compilation, study, update.
- Defining site selection criteria.
- Generic safety study for different DGR options and scenarios.
- Performing a preliminary cost analysis.

Challenges 2024-2027

- Extremely limited budget and HHRR.
- Economic and political instability.
- Most staff (around 12 people) work part-time on the Project; only one person works full-time.
- Developing strategies to ensure the continuity and progress of the Project.
- Building social confidence and getting people involved within a context of political and economic instability.

Pablo Bernasconi.
https://www.instagram.com/pablobernasconi73/

Somethings to highlight

- The IAEA TC Project has been fundamental in initiating the ConfinAR Geo and obtaining the engagement and support from CNEA senior managers. Furthermore, through workshops held at the CNEA headquarters, we established the foundation for collaboration with different sectors of CNEA, ARN (regulator body), NA-SA (NPPs operator) and universities. This provided us with the opportunity initiate the socialization process of the ConfinAR Geo Project within a favorable context.
- The first dialogues with different stakeholders* were successfully established. They showed a high level of interest and engagement with issues related to radioactive waste and spent fuel disposal.

*Stakeholders: several members from the public (scientific journalist, researchers, students, professors, representatives of universities, unions and government; professionals and senior managers from ARN and NA-SA; representatives from different CNEA areas and decision makers.

- The collaborative working approach, implemented from the beginning, is fundamental to successfully carrying out the project's activities and progressing.
- The dialogue, free-flowing interaction, and effective communication among team members are fundamental for facilitating agreement in decision-making, developing best practices to manage the project, and reaching its progress.

ONDRAF/NIRAS

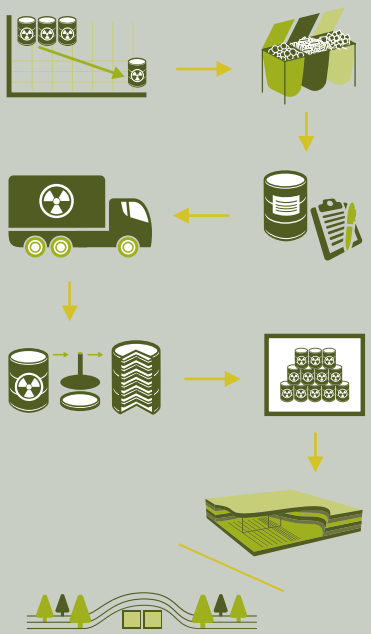
Current Status of Belgian DGR

Philippe Lalieux

Long-Term Waste Management Director

What does ONDRAF/NIRAS do?

Radioactive waste management



Dismantling and remediation

Inventory

Enriched fissile materials

Scientific research

Preparation of policy

Socio-economic investments

Participation and involvement

Long-term financing

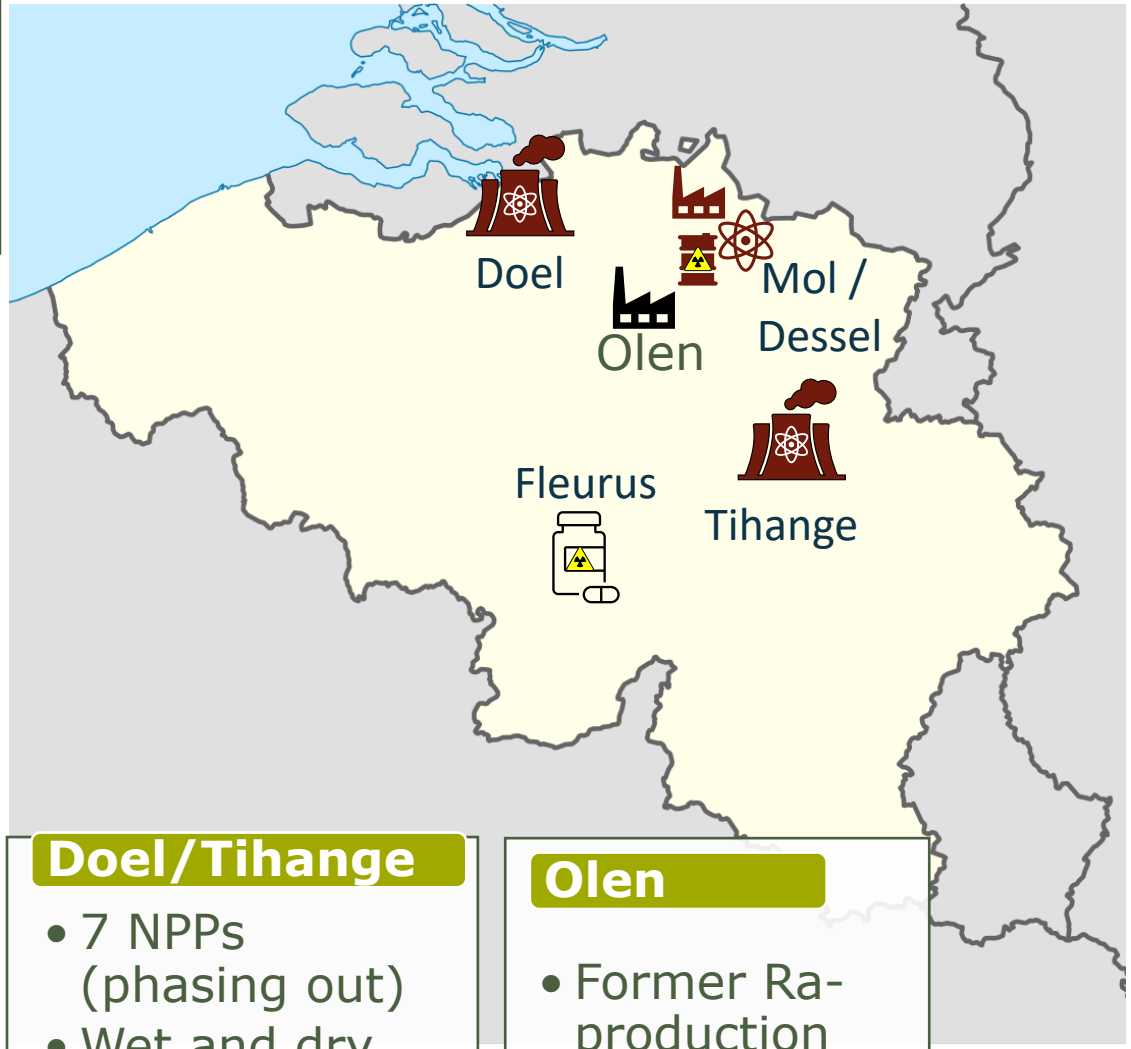
Long and Diverse Belgian Nuclear History

Fleurus

- Isotope Production
  - BMB (being dismantled)
  - IRE

Mol/Dessel

- Reprocessing Pilot Plant – Eurochemic (being dismantled)
- Belgoproces
  - Treatment & conditioning facilities
  - Storage facilities
- Surface disposal facility for LLW (in construction)



Doel/Tihange

- 7 NPPs (phasing out)
- Wet and dry SF storage facilities

Olen

- Former Ra-production plant (to be remediated)

Mol/Dessel

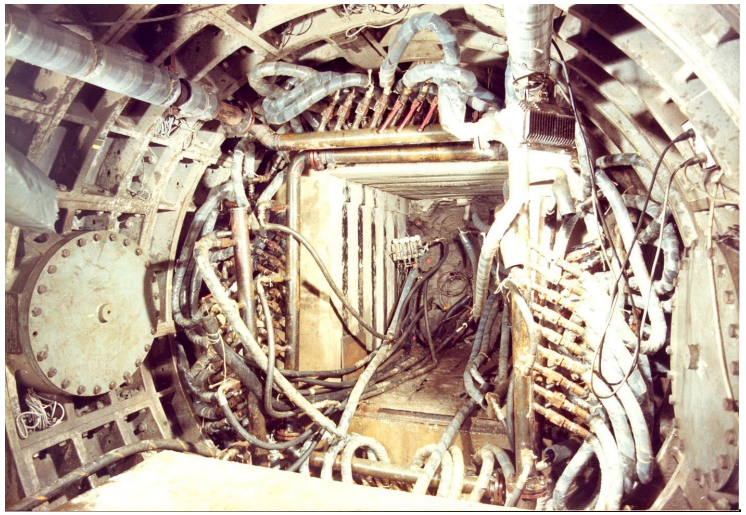
- Fuel fabrication
  - UOX – FBFC (dismantled)
  - MOX – Belgonucléaire (dismantled)
- Nuclear Research – EC JRC
- Nuclear Research – SCK
  - 3 research reactors (1 being dismantled)
  - Hot labs
- Underground Research Laboratory

Very Diverse Waste Types, with Lot of Legacy Waste, in Relatively Limited Quantities

- **LLW**
  - Conditioned in concrete boxes for surface disposal
  - Waste volume to be disposed of (in boxes): **~ 152 500 m³**
- **ILW–long-lived**
  - Total volume to be disposed of (as stored): **9 500 m³**
- **HLW & SF**
  - Vitrified waste from reprocessing: **70 m³** (as stored)
  - **~ 10 000 spent fuel assemblies**
- **Ra-bearing LLW–long-lived**
  - **~ 30 000 m³ unconditioned waste** (tailings)

Belgian DGR Programme

- **SCK started studies on geological disposal back in 1974**
  - When 1st NPP was connected to the grid
  - Focus on poorly indurated clays present under the nuclear zone of Mol/Dessel
- **Generic URL nearly from the inception of the program (early 1980's)**
  - First dedicated URL in poorly indurated clays
- **But no formal DGR policy until 2022**
  - 2014: transposition into Belgian law of the EC Directive 2011/70/Euratom
  - 2021: policy proposal for geological disposal submitted by ONDRAF/NIRAS based on
    - ❑ 40 years RD&D
    - ❑ SEA and public consultation
    - ❑ several internationally reviewed safety cases



URL HADES

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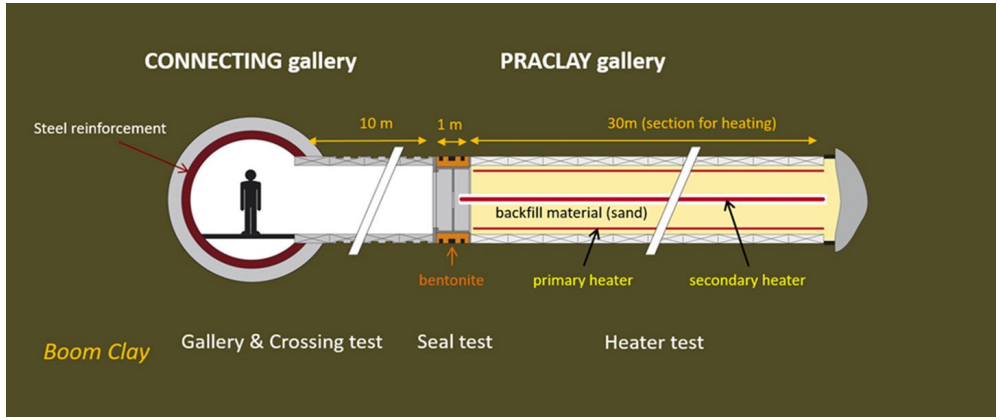
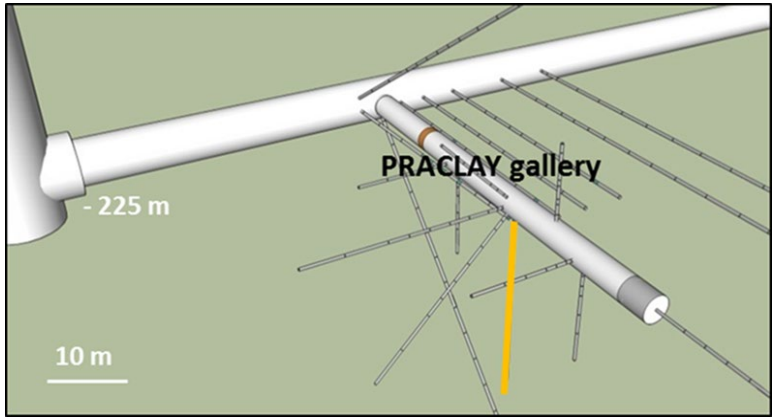
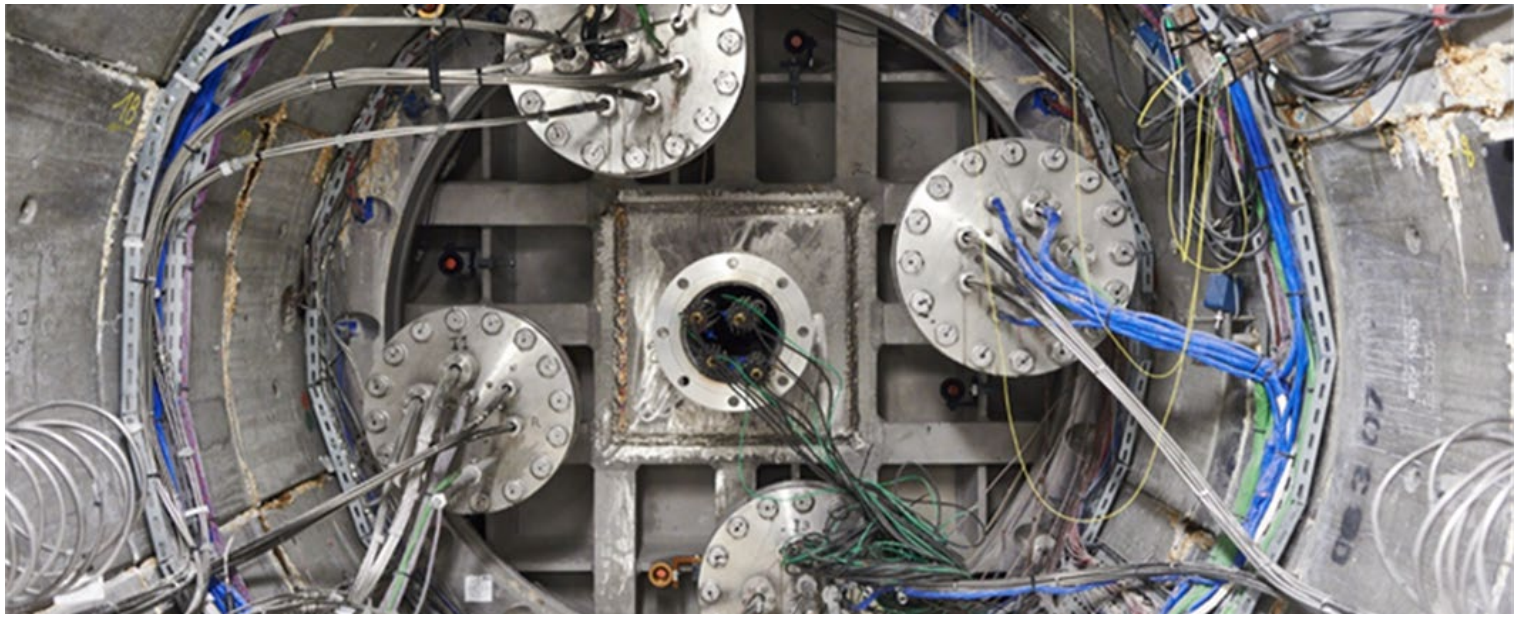

CONNECTING gallery
PRACLAY gallery
Steel reinforcement
10 m
1 m
30m (section for heating)
backfill material (sand)
bentonite
primary heater
secondary heater
Boom Clay
Gallery & Crossing test
Seal test
Heater test


PRACLAY gallery
- 225 m
10 m



Belgian DGR Policy 2022

- Royal Decree of 28 October 2022 provides for the 1st part of the National Policy for the long-term management of HLW/ILW, including spent fuel
  - Geological disposal
  - On the Belgian territory
  - On one or several sites
  - Decisional reversibility (accompanied by a regular evaluation of alternatives)
  - To be accompanied by a yet-to-be-defined participative decision-making process

- But no indication of host rock or site
- 1st part that must be completed up to site selection
- 1st part that must be confirmed

➔ Societal Debate 2023-2024

Societal debate 2023-2024
-confirm or modify decision in principle on deep geological disposal
-get input for decision-making process (Royal Decree 2)

Part One: Royal Decree on 28/10/2022

- Deep disposal
- Belgian territory
- Reversibility of the decision

2022

Part Two

- Participatory decision-making process

?

Part n

- Reversibility and retrievability modalities
- Spent fuel situation…

?

Part n+1

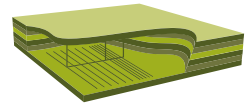
- …

?

Last part

- Selection of the site(s) where the solution will be implemented

?



Societal Debate 2023-2024

- Aimed at
  - Confirming geological disposal
  - Providing recommendations for the siting decision-making process
- Multiple participative and dedic
  ated approaches involving citizen's, youth, experts, institutions…
- Carried out by an independent actor
  - *King Baudouin Foundation*

NU VOOR MORGEN

PRÉSENTS POUR LE FUTUR

April '23

Dec '23

Feb '24

March '24

Website with accessible knowledge base and interactive debate platform

Tour of Belgium

In conversation with experts/stakeholders around the 5 central themes

Public forum

WE 1

WE 2

WE 3

School track

Youth top

Interim report 1 input via website

Interim report 2 Tour of Belgium

Interim report 3 Synthesis of interviews with experts/stakeholders

Interim report 4 Public forum

Interim report 5 School track

Draft final report

Broad stakeholder forum

Final report with conclusions and recommendations + proposal roadmap

Fondation Roi Baudouin

Agir ensemble pour une société meilleure

Key Results: Confirmation of Geological Disposal

3 preliminary conditions

Act within an ethical framework	*Create conditions for broad and sustainable participation*	*Adequate actors, distincs roles, transparant responsibilities*

e.g. independent "guardian" for siting

1 overarching principle

Do not allow the decision-making process to stall

3 missions

Invest in multiple scenarios and evaluate periodically	*Initiate site identification*	*Secure financing for future generations*

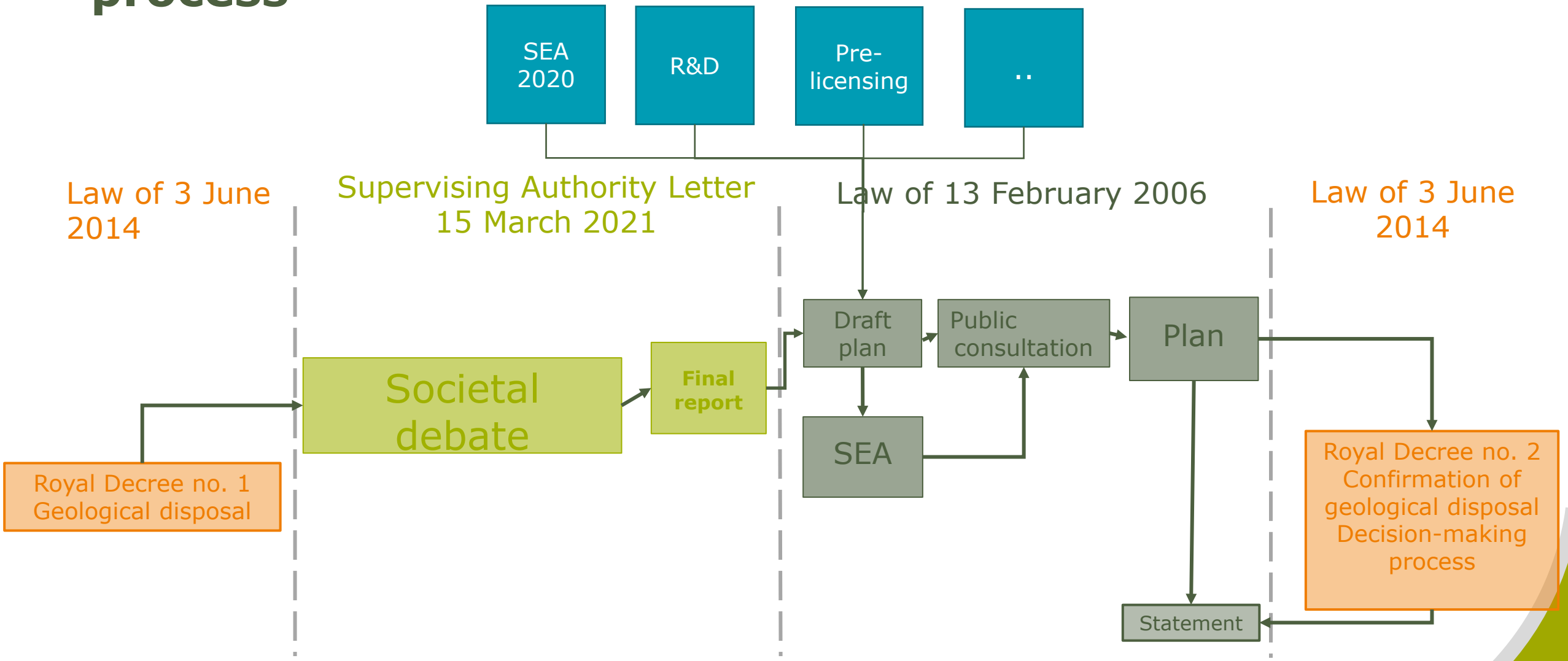
Way Forward

Preparation of the 2nd Royal Decree establishing the decision-making process towards siting

- Input from Societal Debate
  - Confirmation of deep geological disposal
  - Confirmation of principles laid down in first Royal Decree: step-by-step decision-making process, transparency, reversibility and retrievability,…
  - Multiple scenario's (all including DGR), with emphasis on international or shared DGR
- Input from national and international REX
- Input from R&D
- Input from Belgian ARTEMIS-mission December 2023

➔ Proposal to be submitted by ONDRAF/NIRAS to the next Belgian government (2025)

Relationship between the societal debate and the SEA process



7th International Conference on Geological Repositories
[Session 2 : Setting the foundations for initiating DGR programmes]

National Plan of Deep Geological Repository in Republic of Korea

2024. 5.28

Jaihak Lee

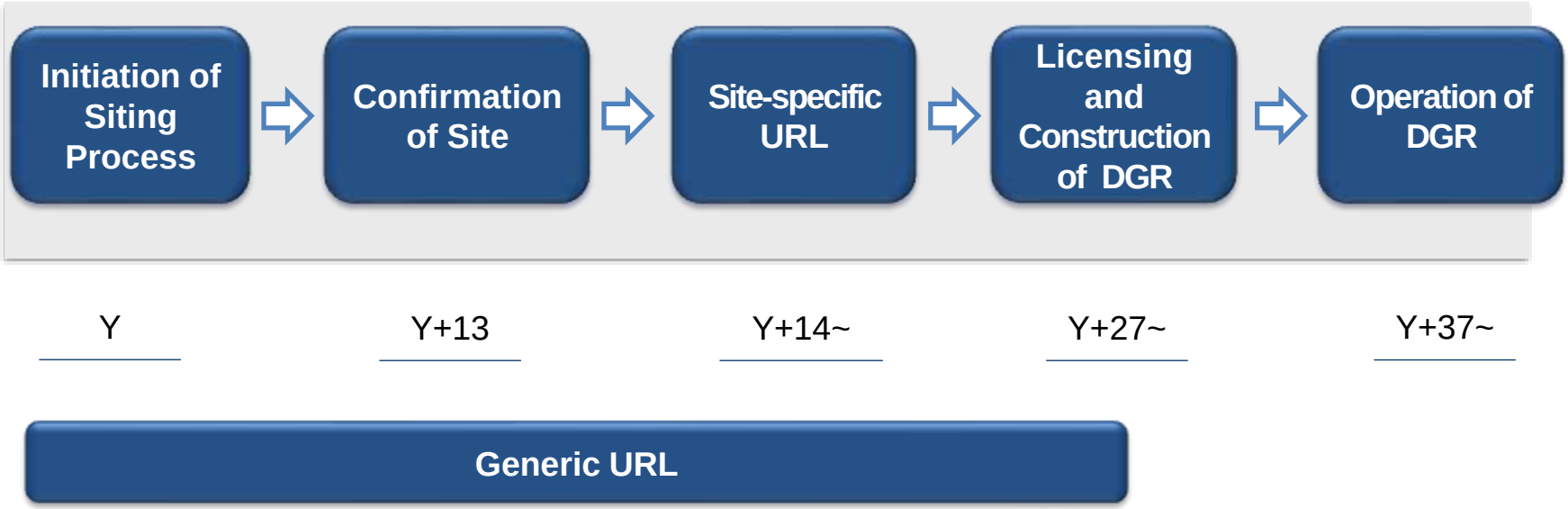
Contents

KORAD

1. Project Roadmap of DGR

Roadmap for DGR (The 2nd Master Plan for HLW Management)

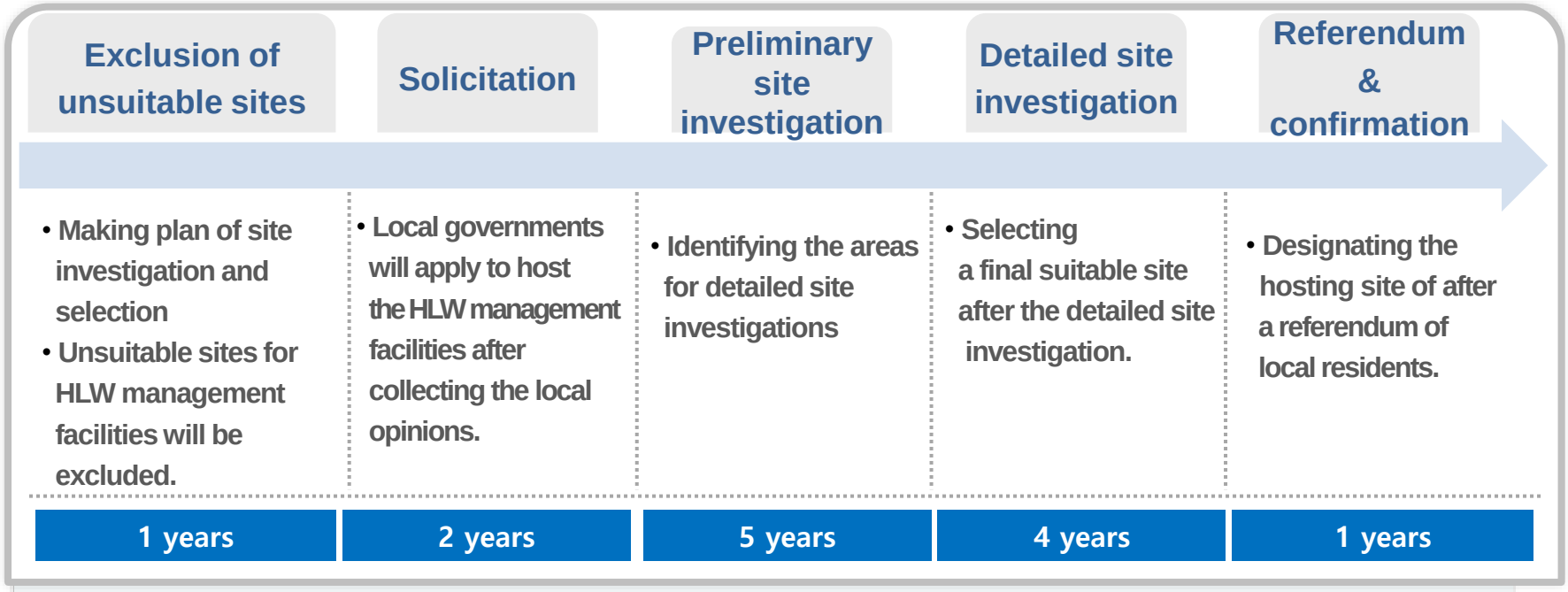
1. Operating DGR within 37 years after initiation of the site selection
2. Creating the hosting communities as a "safe and livable city"



Site Selection Procedures for DGR

Basic Directions

- Selecting a hosting site as early as possible for safe management of HLW
  - Interim storage facilities and DGR are to be co-hosted in one site
- Having objective and transparent site selection procedures and methods in place
- Improving public trust by disclosing the results of site investigations and evaluations at each stage in a transparent manner



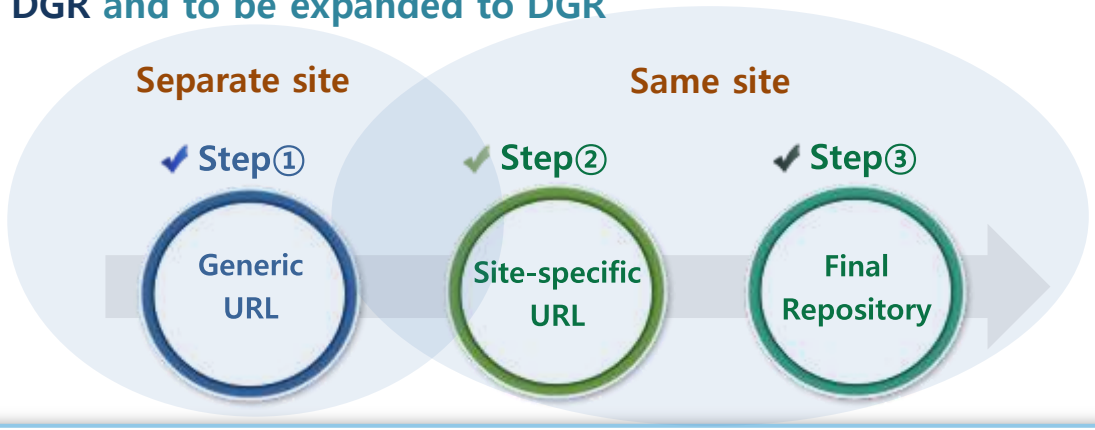
Siting Criteria (example)

Safety Functions	Criteria (16)
1. Retention and Retardation of Radionuclide	1.1 Hydraulic barrier effects
	1.2 Hydrogeochemical conditions
	1.3 Release pathways and properties
	1.4 Radionuclide transport properties
2. Stability of Host Rock	2.1 Site stability and rock properties
	2.2 Uplift/subsidence and erosion
3. Effectiveness of Isolation	3.1 Spatial extent
	3.2 Conflicts of land-use
	3.3 Prediction of long-term changes
4. Compatibility of Disposal System	4.1 Repository-induced effects
	4.2 Ease of rock characterization
	4.3 Explorability of spatial conditions
	4.4 Surface hydrological conditions
	4.5 Rock mechanical properties and conditions
	4.6 Underground access and drainage
	4.7 Thermal properties

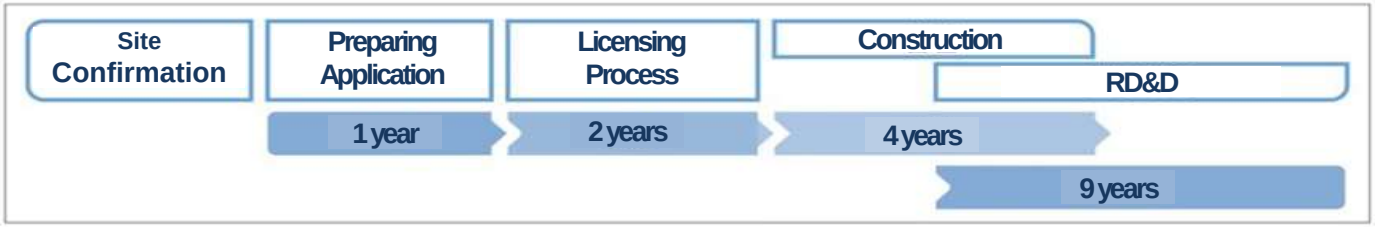
Project Plan of URL

Basic Directions

- Generic URL to be constructed and operated for R&D on disposal system at another site before Site-specific URL
- Site-specific URL to be constructed operated for RD&D and license of DGR and to be expanded to DGR



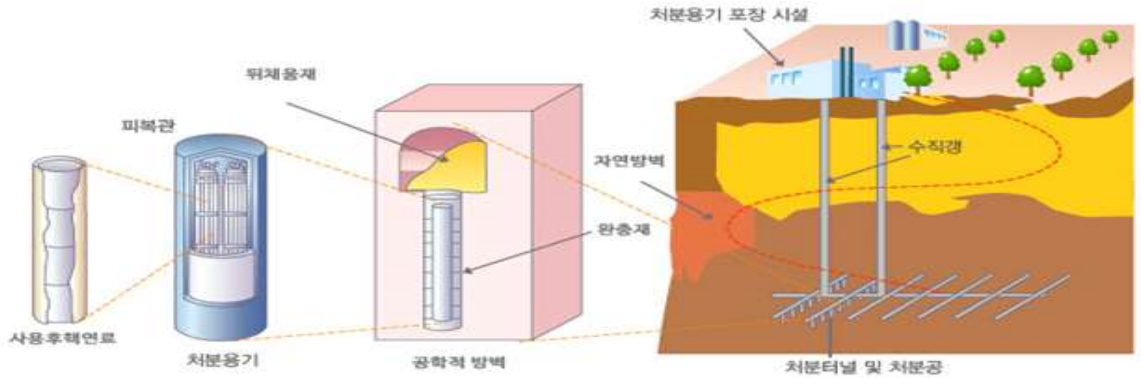
Milestone



Concept and Plan of DGR

Concept

- DGR & multi-engineered barrier to be primarily considered
- Retrievability during operation to be also considered
- DGR to be constructed expanding the site specific URL and be operated



Milestone

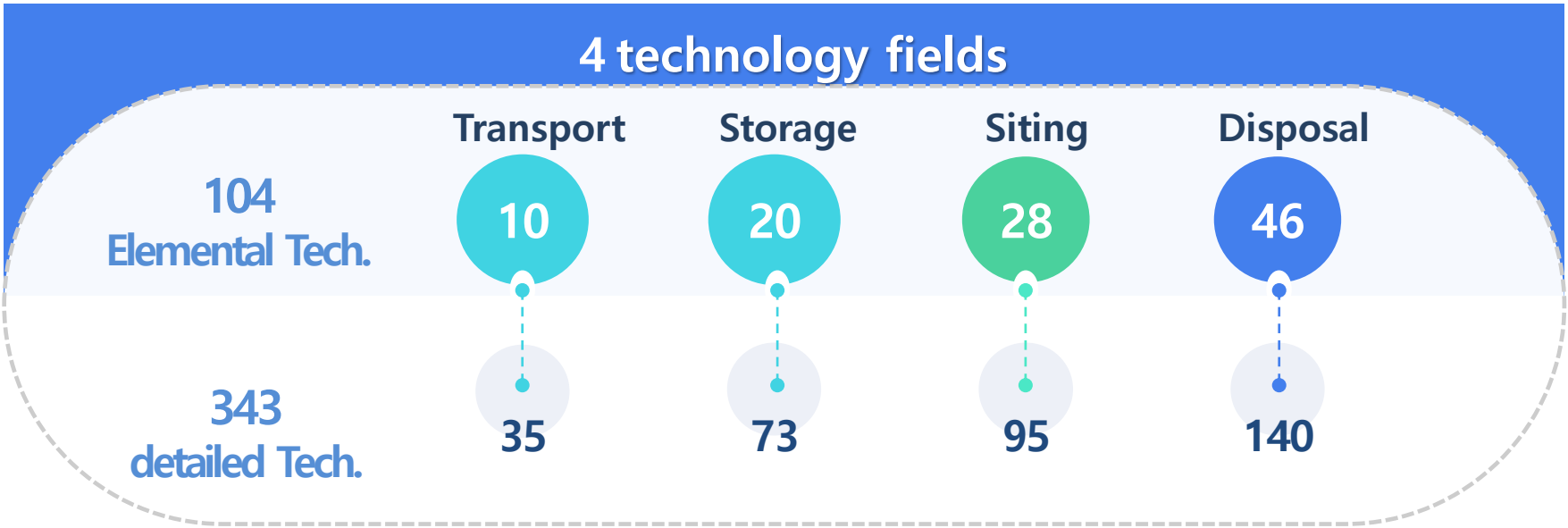
Site Confirmation	Construction / RD&D of Site –Specific URL	Licensing & Construction	Operation of DGR
	14 years	10 years	

Strategies for R&D roadmap

1. Identifying all necessary elemental technologies for the entire management process to support the 2nd master plan for HLW management
2. Developing the technology required for HLW management from a mid- to long-term perspective that can ensure consistency and continuity
3. Promoting the timely acquisition of necessary technologies for each stage of management
4. Enhancing reliability of policies and public acceptance and suggesting the ways to secure the technology for safe management of HLW

Technologies Identification

- Identify elemental and detailed technologies through expert discussions based on overseas R&D programs, licensing documents of disposal facilities in leading countries international organization reports
- Set detailed definitions, goals, and contents for each elemental technologies.



R&D Strategies for Siting Technologies

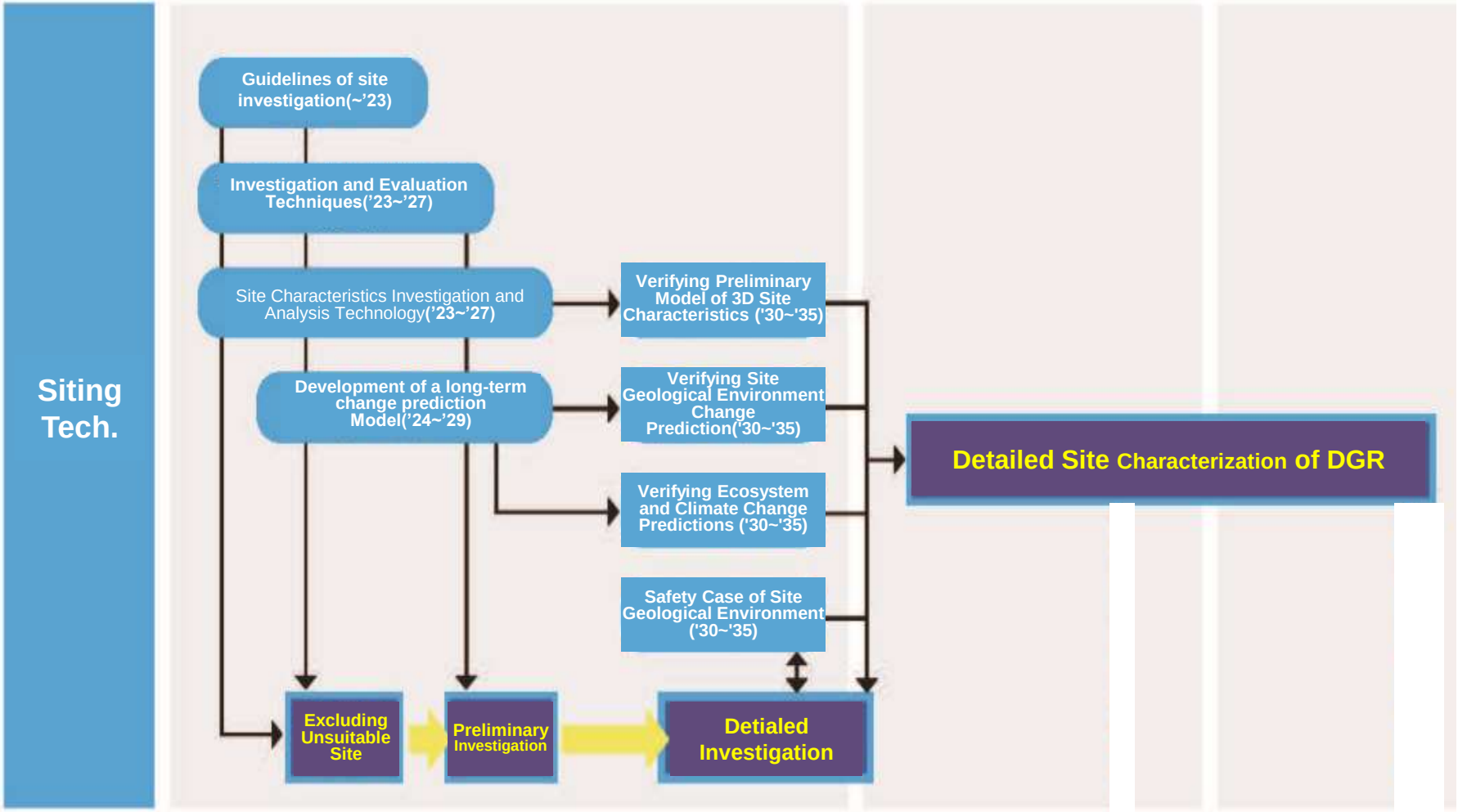
Goal

Securing site investigation and evaluation technologies in consideration of the implementation procedures and required period for each site selection stage by 2029

Strategies

1. The criteria, methodologies and procedures to be developed for excluding unsuitable sites by 2023
2. The long-term stability evaluation technology of bedrock behavior, the preliminary modelling of site characteristics and the modelling for geological environmental changes to be developed by 2029
3. The site investigation and evaluation system to be developed, adapting advanced IT technology to improve objectivity and accuracy for site selection by 2029

R&D Roadmap for Siting Technologies



R&D Strategies for Disposal Technologies

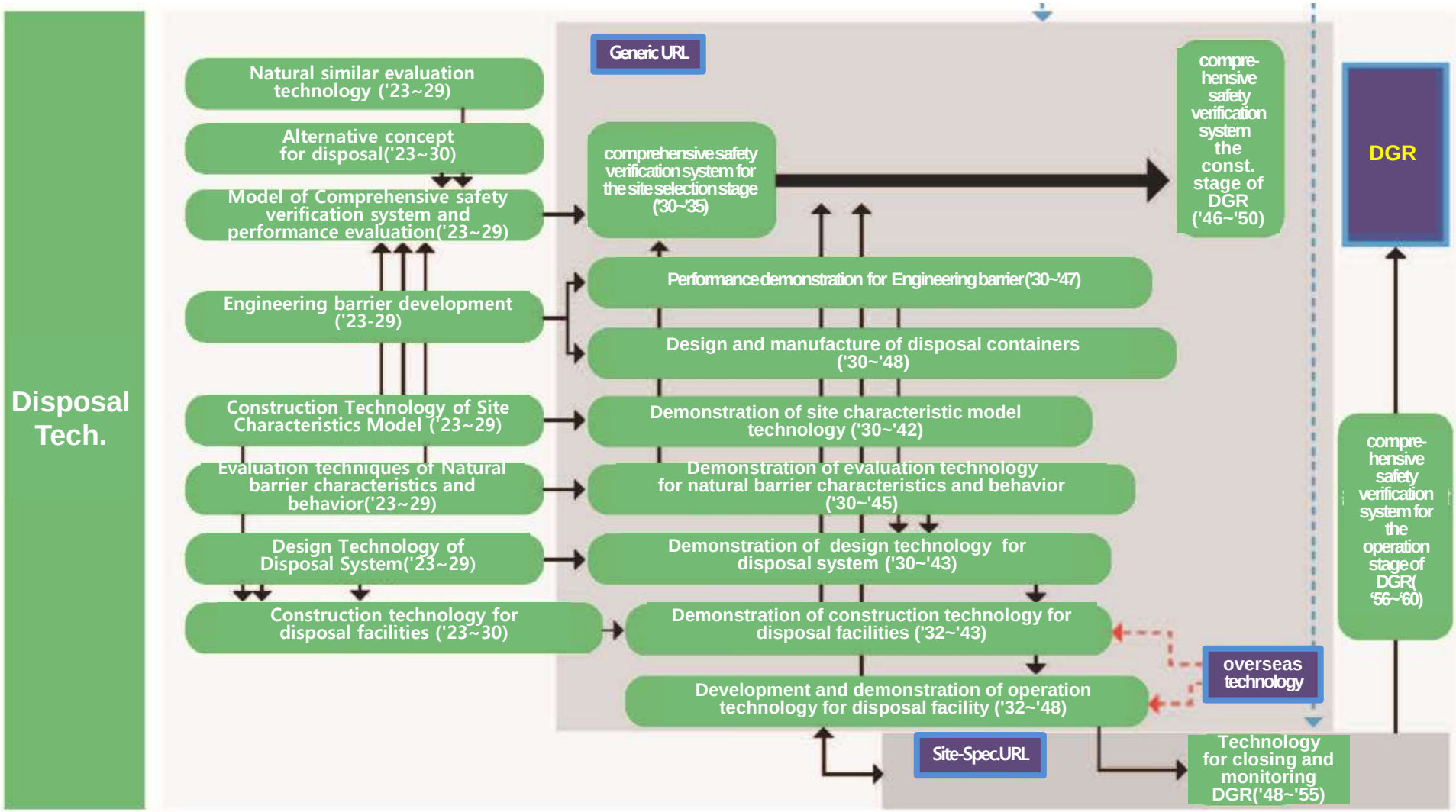
Goal

Having disposal technologies(46 element technologies and 141 detailed technologies) in place through step-by-step development by the 2050s

Strategies

1. The core technologies such as setting up performance and design requirements for disposal systems and conceptual design for disposal systems to be developed by 2029
2. Korea's unique disposal system by conducting demonstration on the safety of engineering and natural barriers in consideration of the characteristics of HLW and bedrocks to be developed by 2040s
3. Domestic production of major materials for such as disposal containers, buffer and sealing to be ensure by the 2050s

R&D Roadmap for Disposal Technologies



Thank You for your attention !

Beishan Underground Research Laboratory for Geological Disposal of High Level Radioactive Waste in China

--update May 2024

中国高放废物地质处置北山地下实验室最新进展(截至 2024年5月）

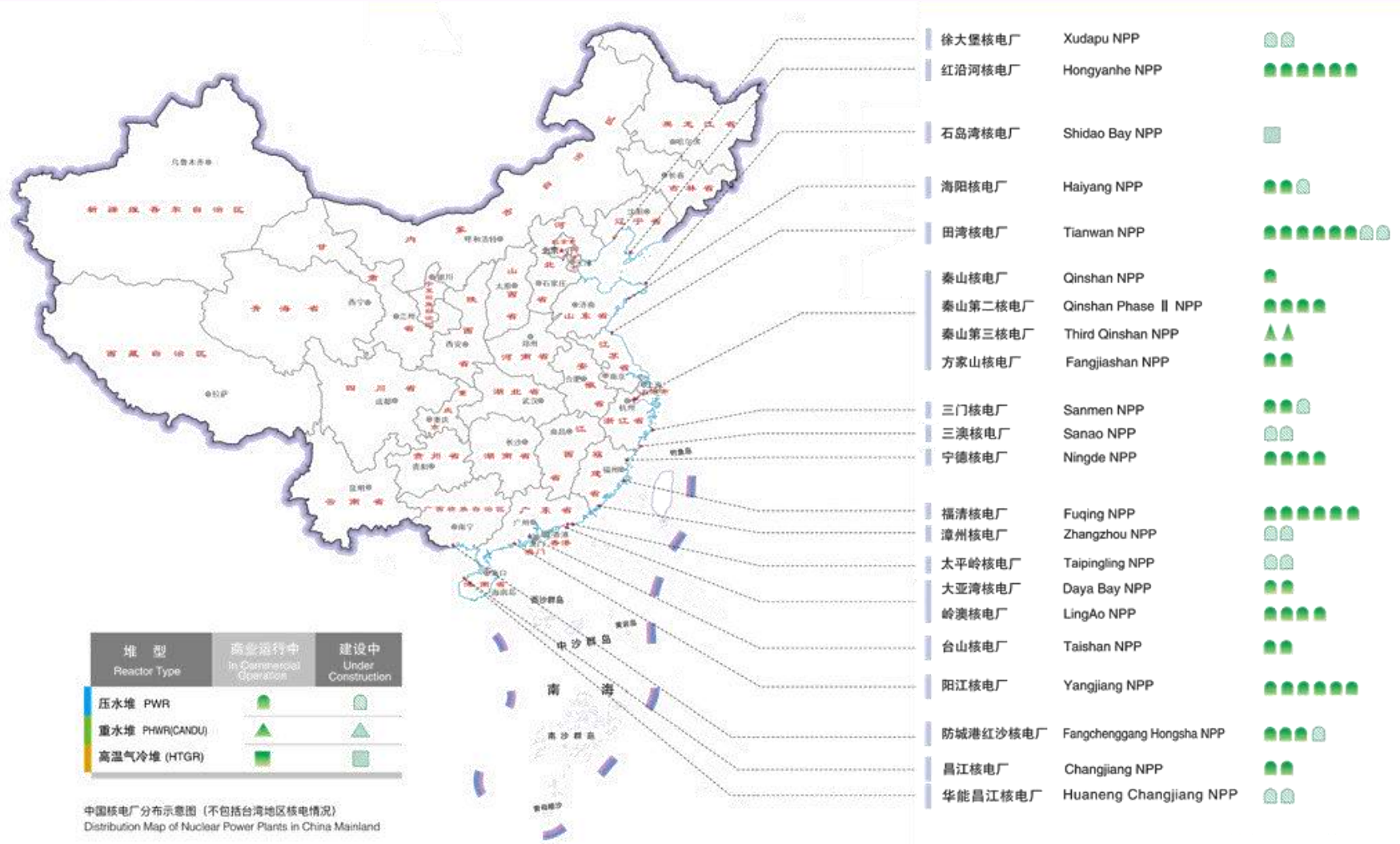
WANG Ju, LIU Jian 王 驹, 刘健

CAEA Innovation Centre on Geological Disposal of HLW
国家原子能机构高放废物地质处置创新中心
Beijing Research Institute of Uranium Geology
核工业北京地质研究院

Outlines

- Background and National Strategy
- Progress on Construction of Beishan URL
- Progress on In-situ Experiments at Beishan URL

Nuclear Power Plants in Chinese Mainland

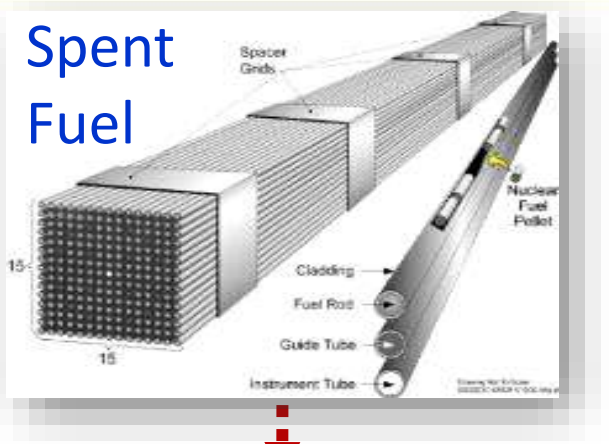


中国核电厂分布示意图（不包括台湾地区核电情况）
Distribution Map of Nuclear Power Plants in China Mainland

徐大堡核电厂	Xudapu NPP	2
红沿河核电厂	Hongyanhe NPP	5
石岛湾核电厂	Shidao Bay NPP	1
海阳核电厂	Haiyang NPP	2
田湾核电厂	Tianwan NPP	6
秦山核电厂	Qinshan NPP	1
秦山第二核电厂	Qinshan Phase Ⅱ NPP	4
秦山第三核电厂	Third Qinshan NPP	2
方家山核电厂	Fangjiashan NPP	2
三门核电厂	Sanmen NPP	2
三澳核电厂	Sanao NPP	2
宁德核电厂	Ningde NPP	4
福清核电厂	Fuqing NPP	5
漳州核电厂	Zhangzhou NPP	2
太平岭核电厂	Taipingling NPP	2
大亚湾核电厂	Daya Bay NPP	2
岭澳核电厂	LingAo NPP	4
台山核电厂	Taishan NPP	2
阳江核电厂	Yangjiang NPP	5
防城港红沙核电厂	Fangchenggang Hongsha NPP	3
昌江核电厂	Changjiang NPP	2
华能昌江核电厂	Huaneng Changjiang NPP	2

Up to now, nuclear power plants in Chinese Mainland :
56 reactors in operation, 36 reactors under construction.

Closed Nuclear Fuel Cycle



Repository

Reprocessing

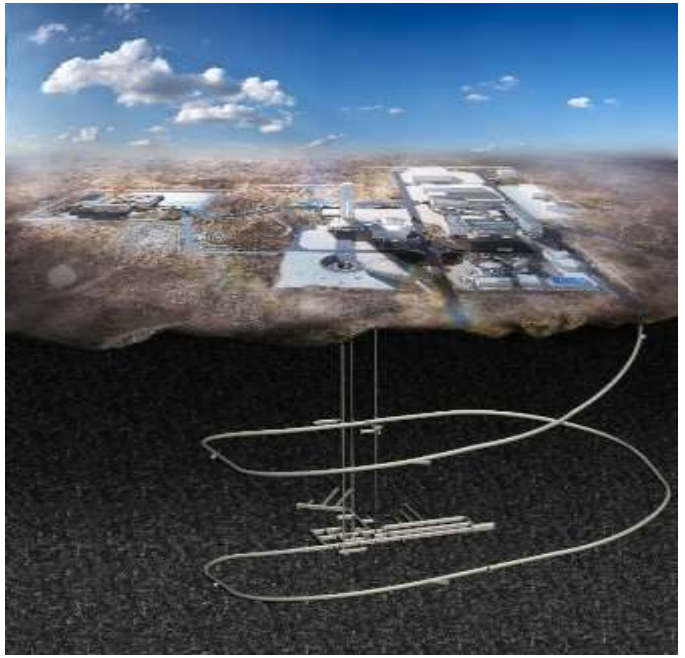
Vitrification

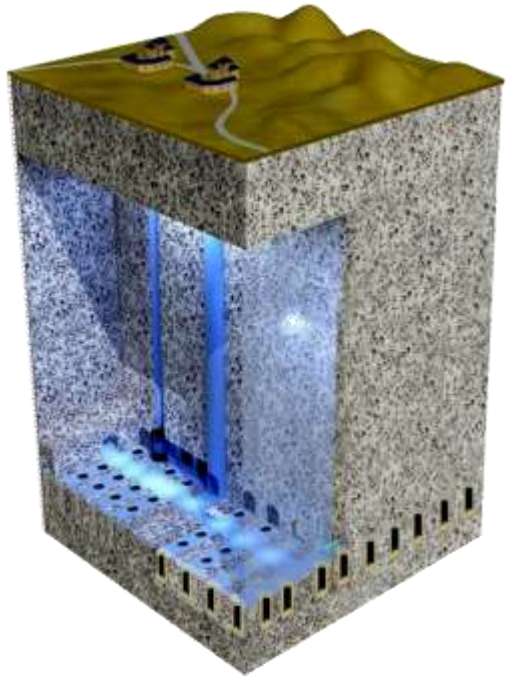
Geological Disposal

3-Step Strategy for China's DGR Programme

1985 → 2020 → 2050

Site Selection and Characterization ⇨ **R&D of Underground Research Laboratory (URL)** ⇨ **Repository**





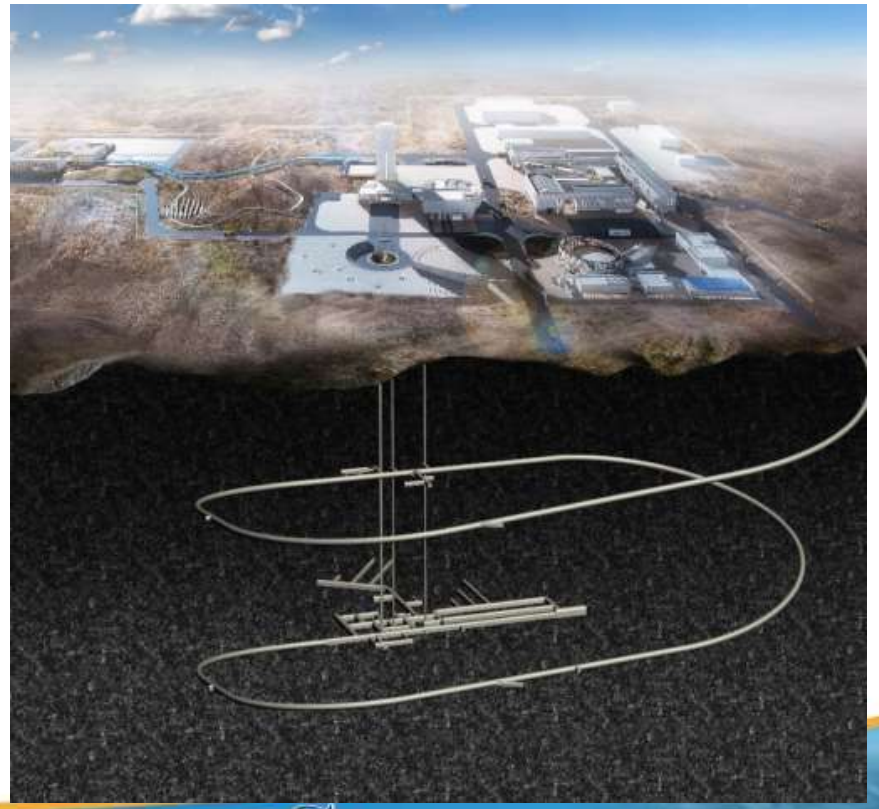
Beishan URL: Strategy

- **To build an "Area-specific URL"**

  — the 3rd Generation URL in Beishan

- **An area-specific or "Generation 3 URL"**

  is referred to as the facility built at a site within an area that is considered as a potential area for HLW repository, or built at a place near the future repository site, and may be a precursor to the development of a repository at the site. It acts both as a "generic URL" and as a "site-specific URL" to some extent.



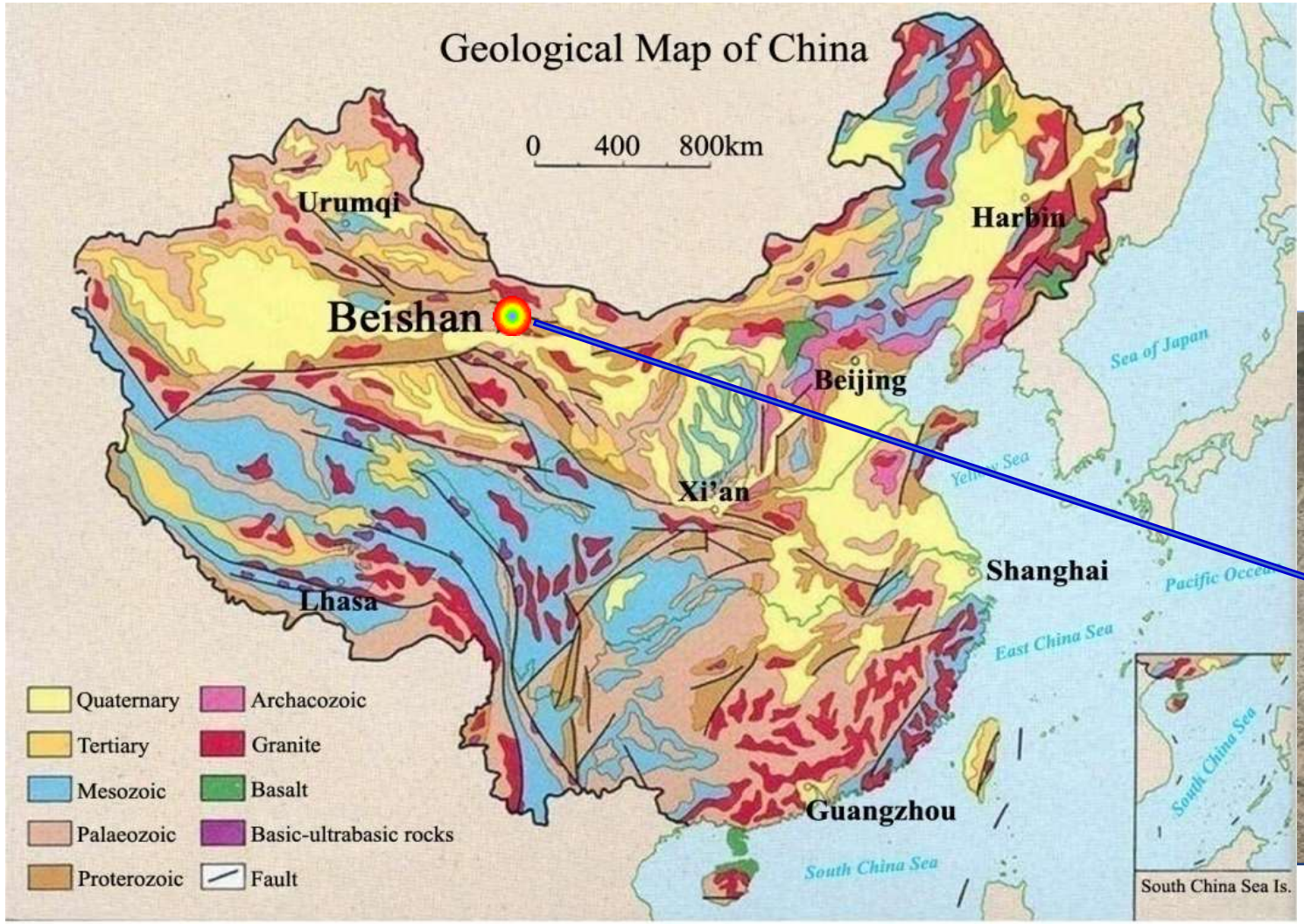
- Widely accepted by experts, government officers, regulators….
- Consensus reached
- So that the Beishan URL can go forward….

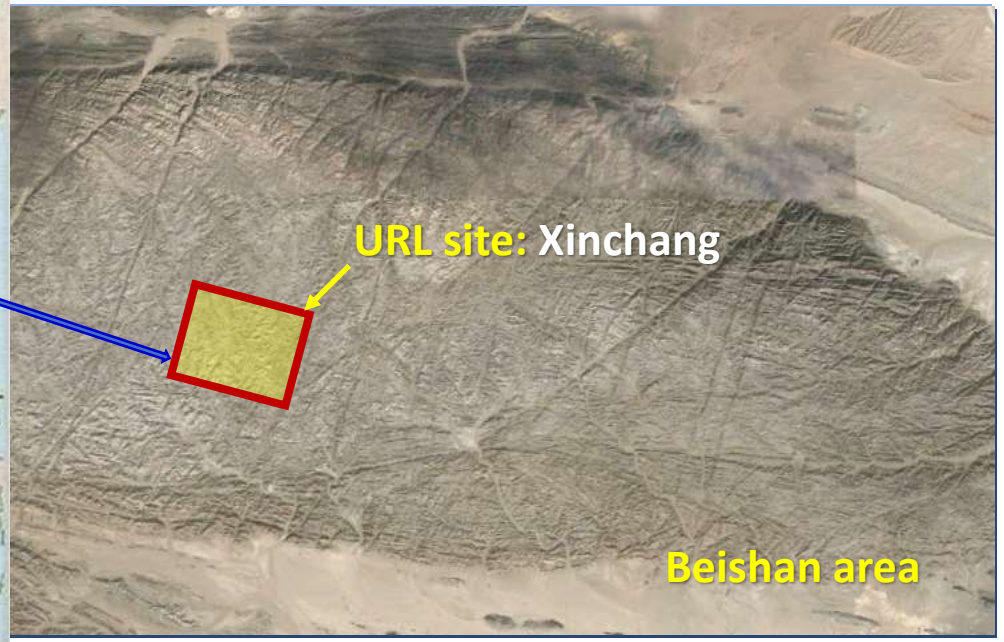
The most important advantages of Beishan URL

- It's built in the most potential area for future DGR
- It may become part of future DGR (it depends on the results from URL and future public opinion)

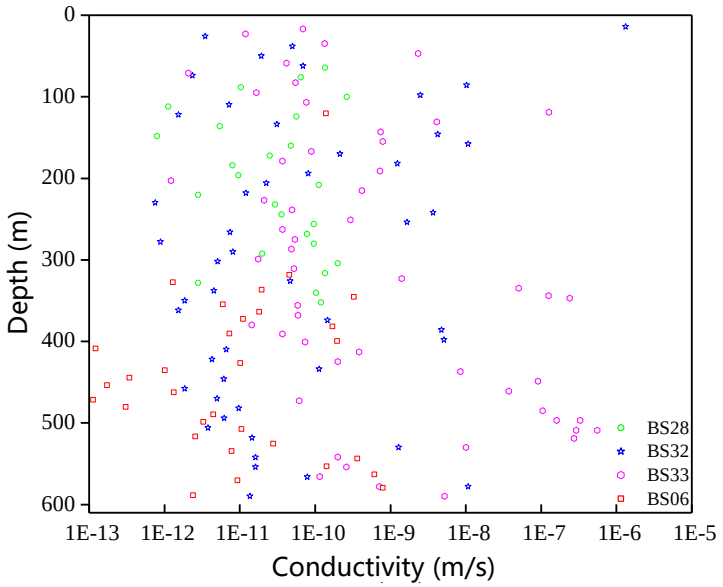
So, the Beishan URL can provide positive energy to the selection of the final DGR site in China

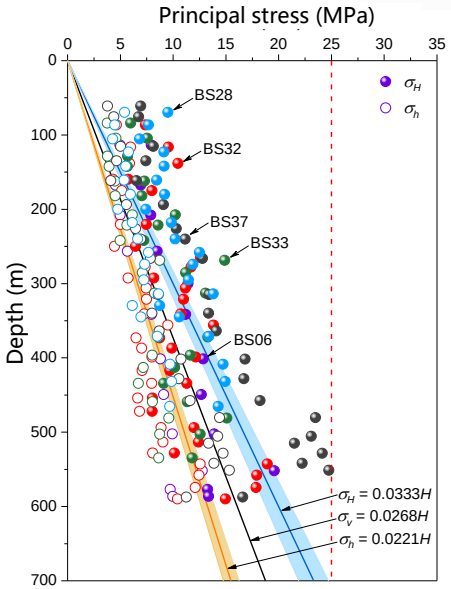
URL site in Beishan selected in 2016, confirmed in 2018

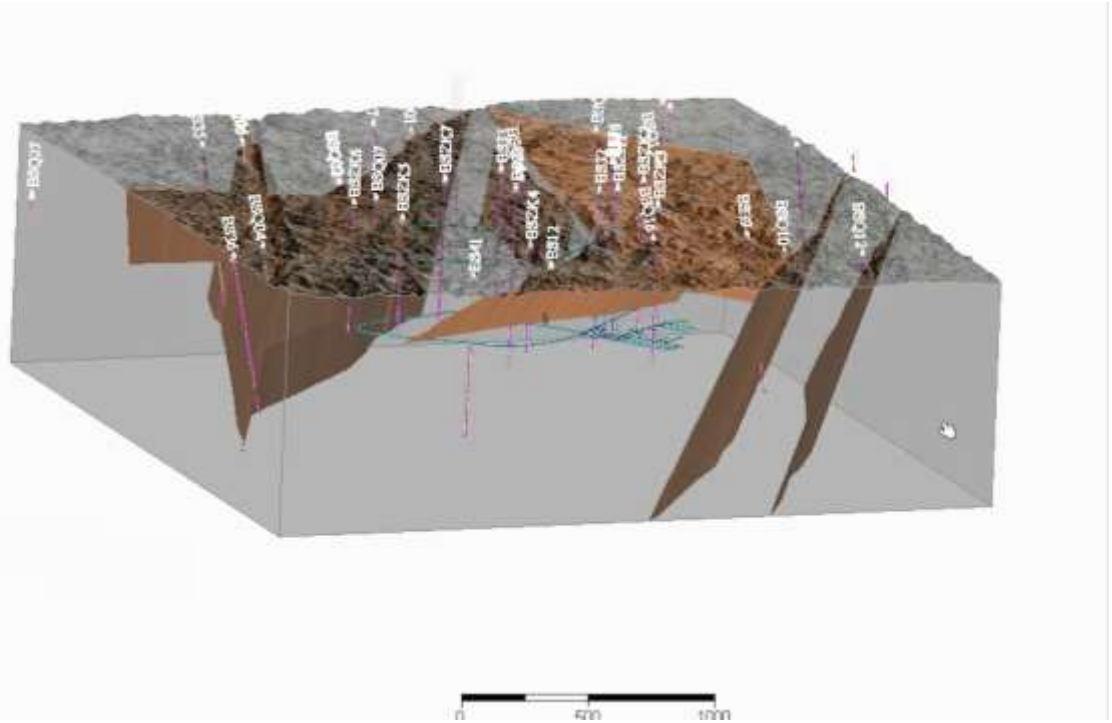




3 D geological model of URL site

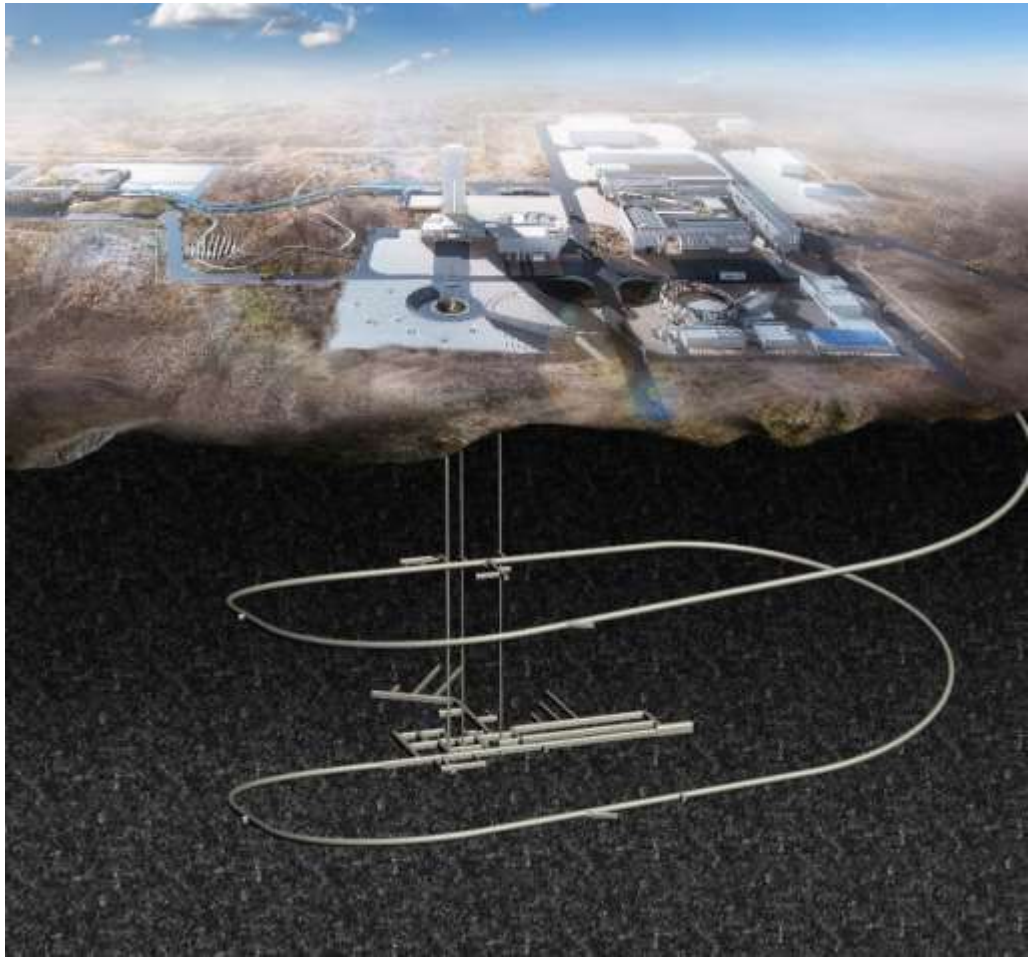






Granite rock masses with high integrity, extremely low permeability, high strength/stress ratio, favorable geochemical conditions, …

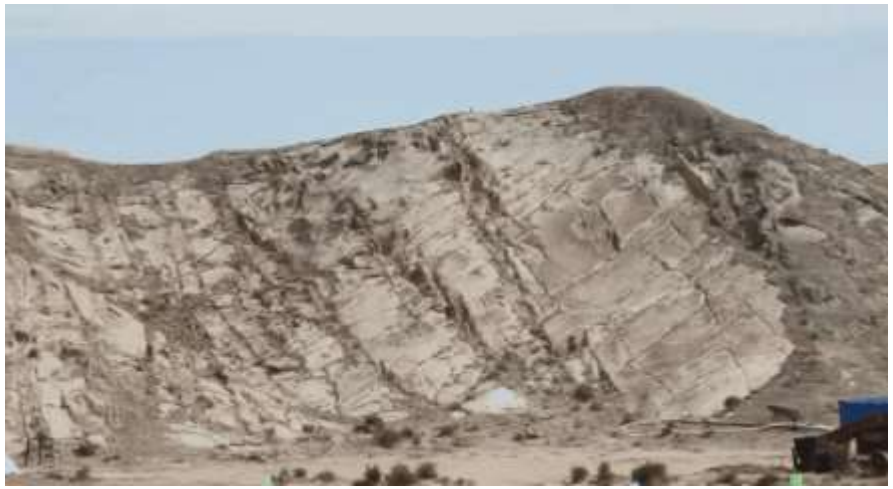
Design of Beishan URL



- **Max. depth: -560 m**
- **1 ramp + 3 shafts + 2 experimental levels**
- Shafts
  - 1 main shaft + 2 ventilation shafts
  - Excavation method: D&B; raise boring
  - Diameter: 6 m, 3 m, 3 m
- Experimental tunnels
  - Auxiliary experimental level at −280 m
  - Main experimental level at −560 m
- **Spiral ramp**
  - Total length: 8 km
  - Diameter: 7 m

Excavation methods

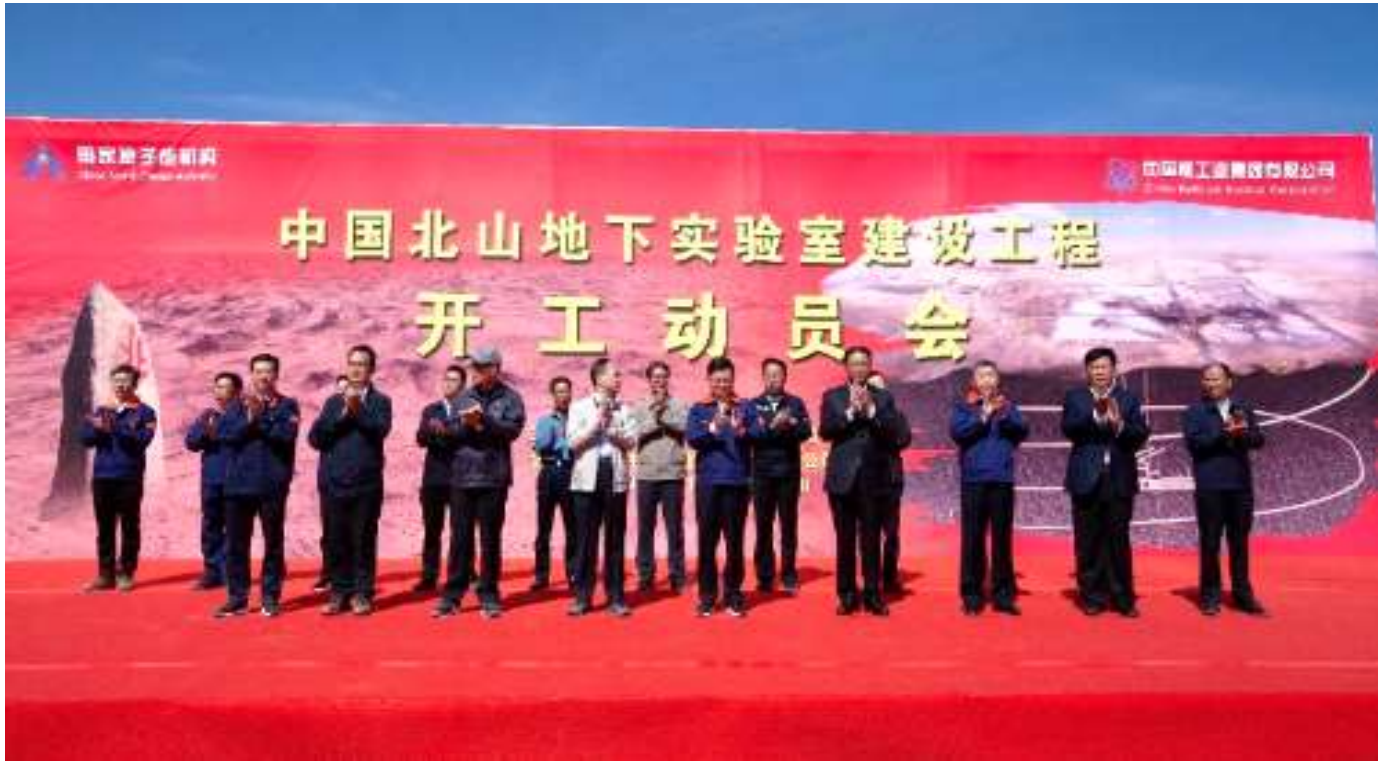
- **Drilling and Blast (D&B) method:**
  - traditional method
  - large excavation damaged zone (EDZ), which is unfavorable for long-term safety of repository



- **Tunnel Boring Machine (TBM):**
  - Highly efficient and environment friendly
  - very small EDZ, which is quite favorable for long-term safety of repository

Important milestone: June 17, 2021

Groundbreaking Ceremony for the construction of Beishan URL was hold, marking that China's efforts on DGR programme has entered a new stage: the URL development stage.

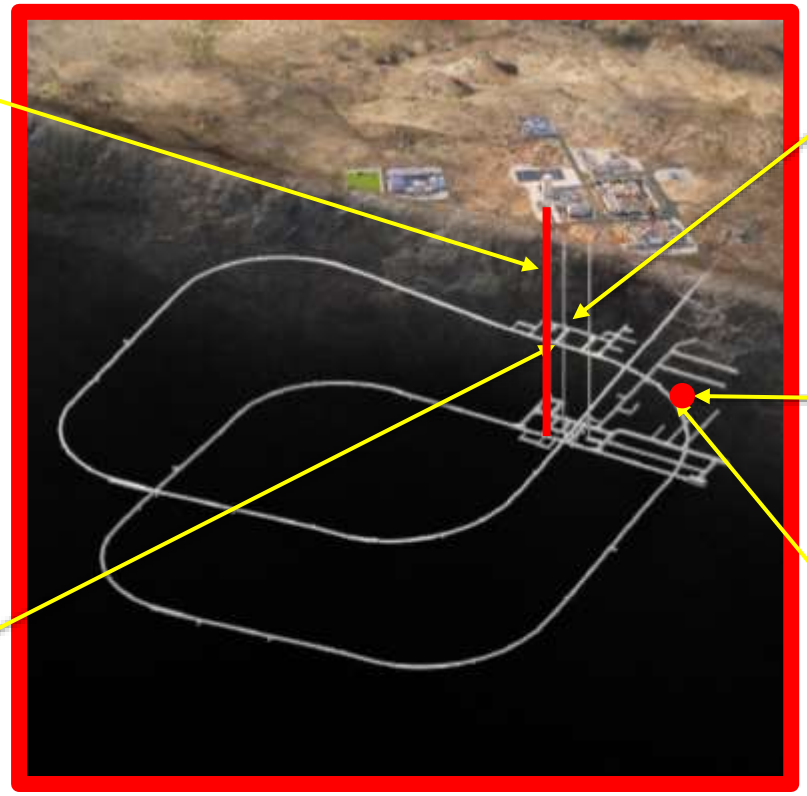


Current Situation at Beishan

(15 May 2024)

Main Shaft
(Completed on 17 Dec. 2023)

Ramp | Experimental tunnel



The auxiliary level at −280 m

TBM (Beishan No.1)

Ramp
(4004 m, 15 May 2024)

The first turning of the Ramp

The horizontal tunnel at -560 m

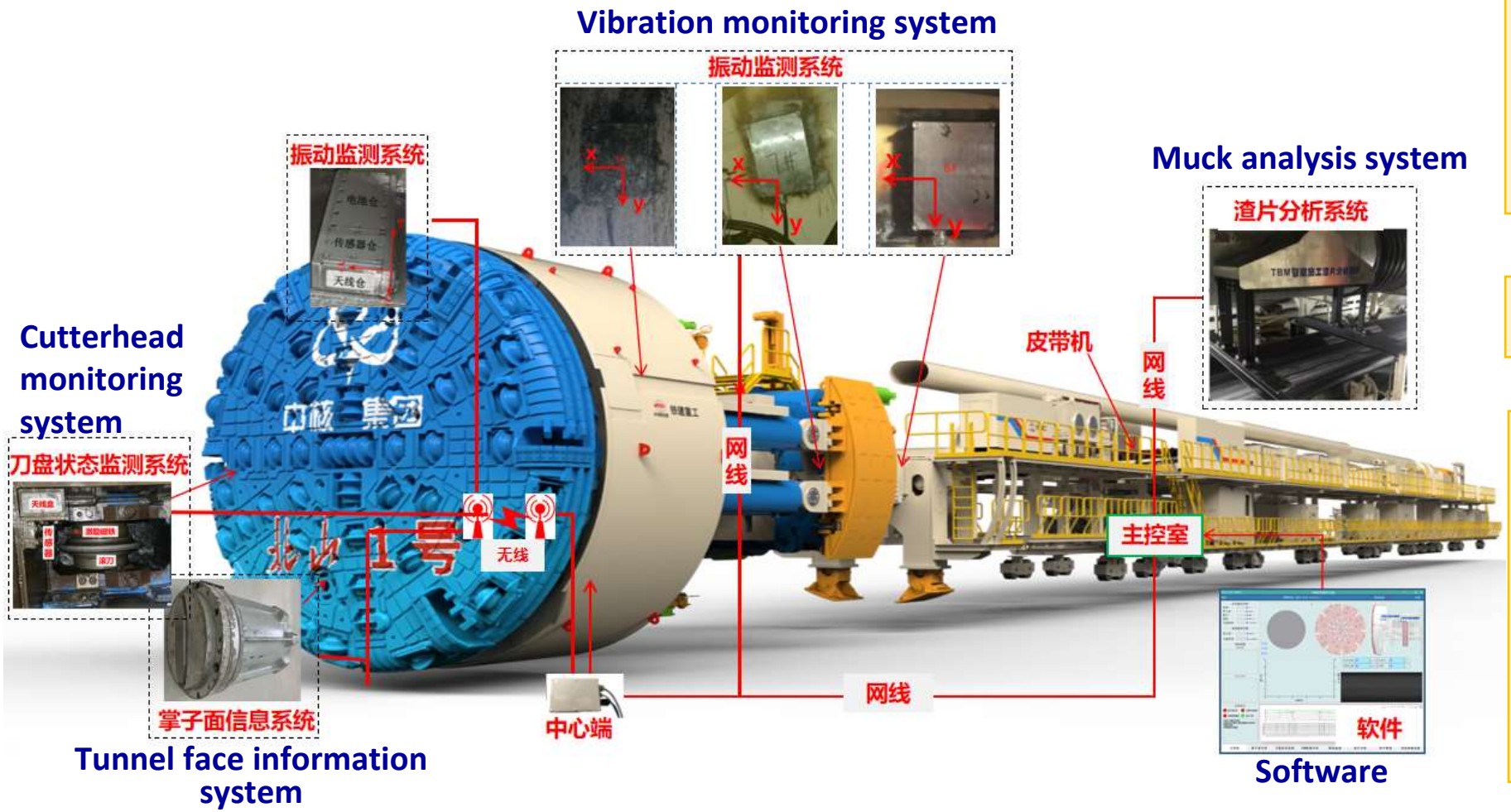
At -280m level, TBM tunnel is connected with D&B tunnel

Ramp
(TBM)

On 30 April, 2024

Auxiliary level at −280 m
(D&B)

AI-assisted tunnelling technology test



Data collection at shallow/ middle-depth section
+penetration test
+cutter optimization test

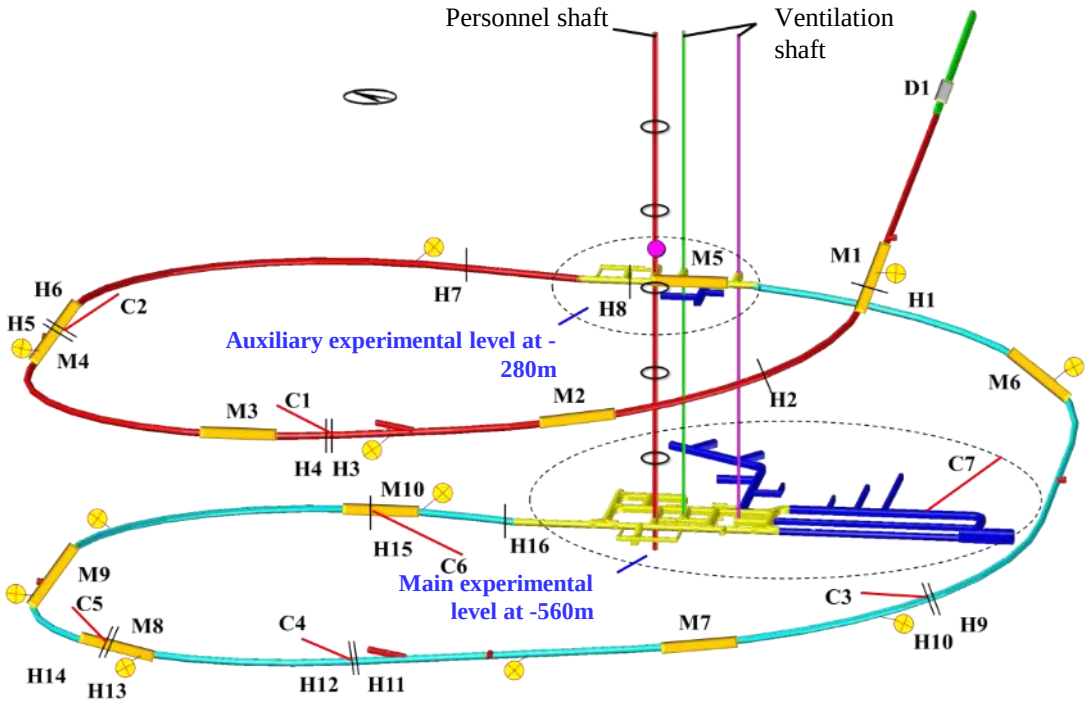
Database of TBM excavation

- Deep learning of big data
- Intelligent characterization of rock conditions
- Real-time optimization system for TBM excavation parameters based on multiple information fusion

Preliminary Conclusion for TBM excavation

- TBM (Tunnel Boring Machine) may will be the game changer for excavation of repository tunnels: ramps, disposal tunnels etc:
  - TBM is available
  - TBM can be operated by experienced teams
  - Experiences in crystalline rock obtained
  - High efficiency
  - Friendly working environment

In situ tests planned in Beishan URL



During ramp construction:

- 3D laser scanning
- Geological mapping
- Geophysical survey
- Rock mass quality evaluation
- Advanced borehole exploration
- Video documentation

Geological condition and depth dependent tests in ramp :

- Blasting vibration monitoring、EDZ evaluation test(D)
- TBM penetration test、Micro-seismic monitoring、EDZ evaluation test(M)
- Water inflow monitoring(H)
- Groundwater pressure、Hydrogeochemical monitoring(C)
- In-situ stress measurement
- Hydraulic interference test
- Rock deformation monitoring
- Rock & groundwater sampling
- Environment monitoring
- Grouting test in fractured &faulted zone

Before construction:

- Baseline test of Hydrogeology
- Baseline monitoring of environment

Personnel shaft construction:

- Water inflow monitoring
- Advanced survey test

Geological mapping：fracture mapping

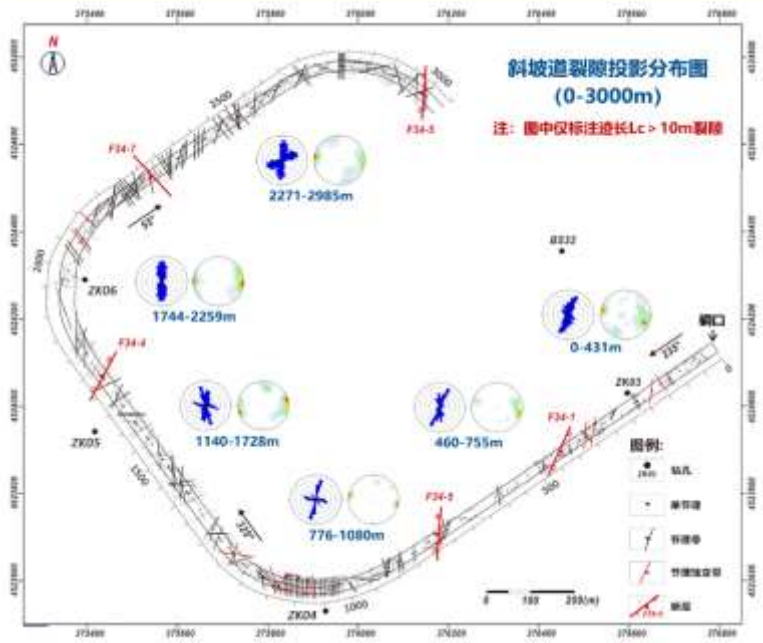
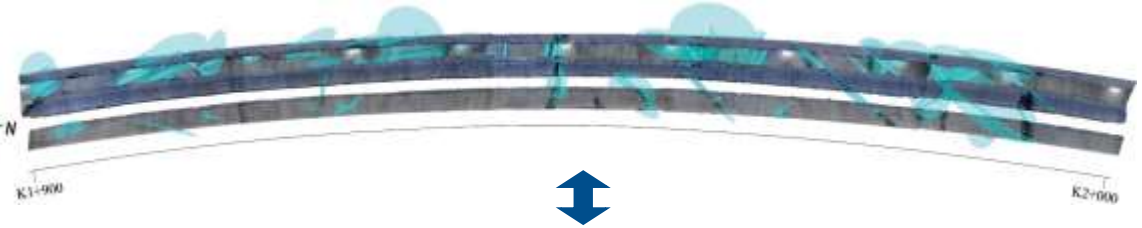
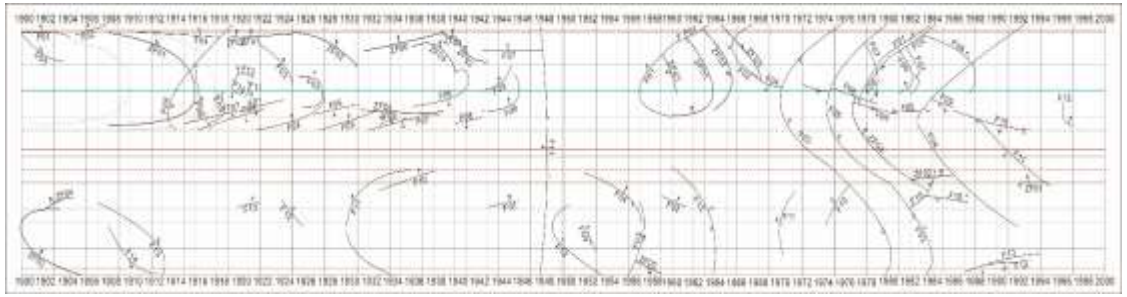
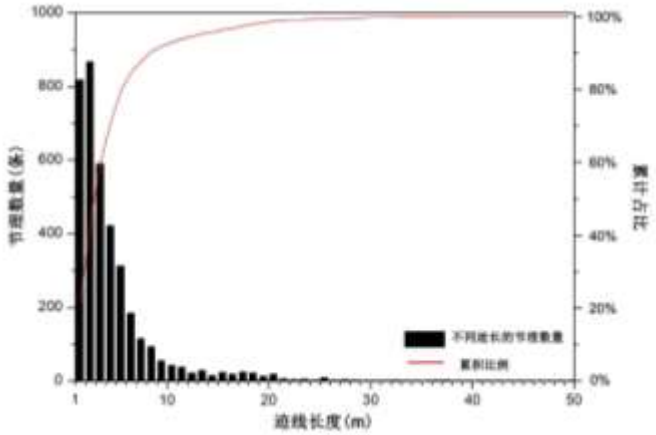


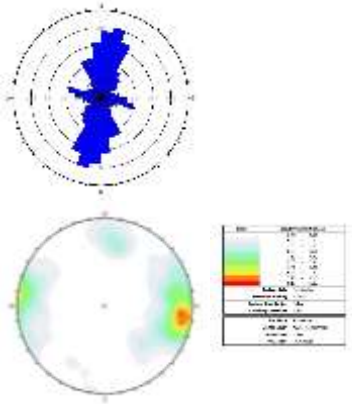
Photo-grammetry



Manual sketching





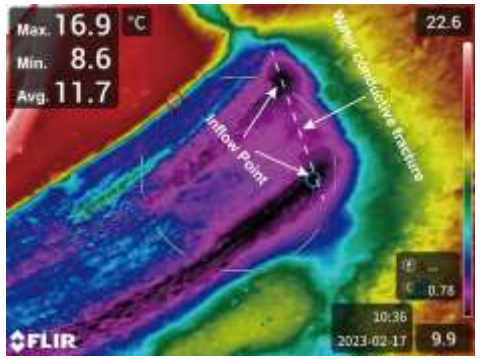


- **The wall rock of the personnel shaft has very good integrity**

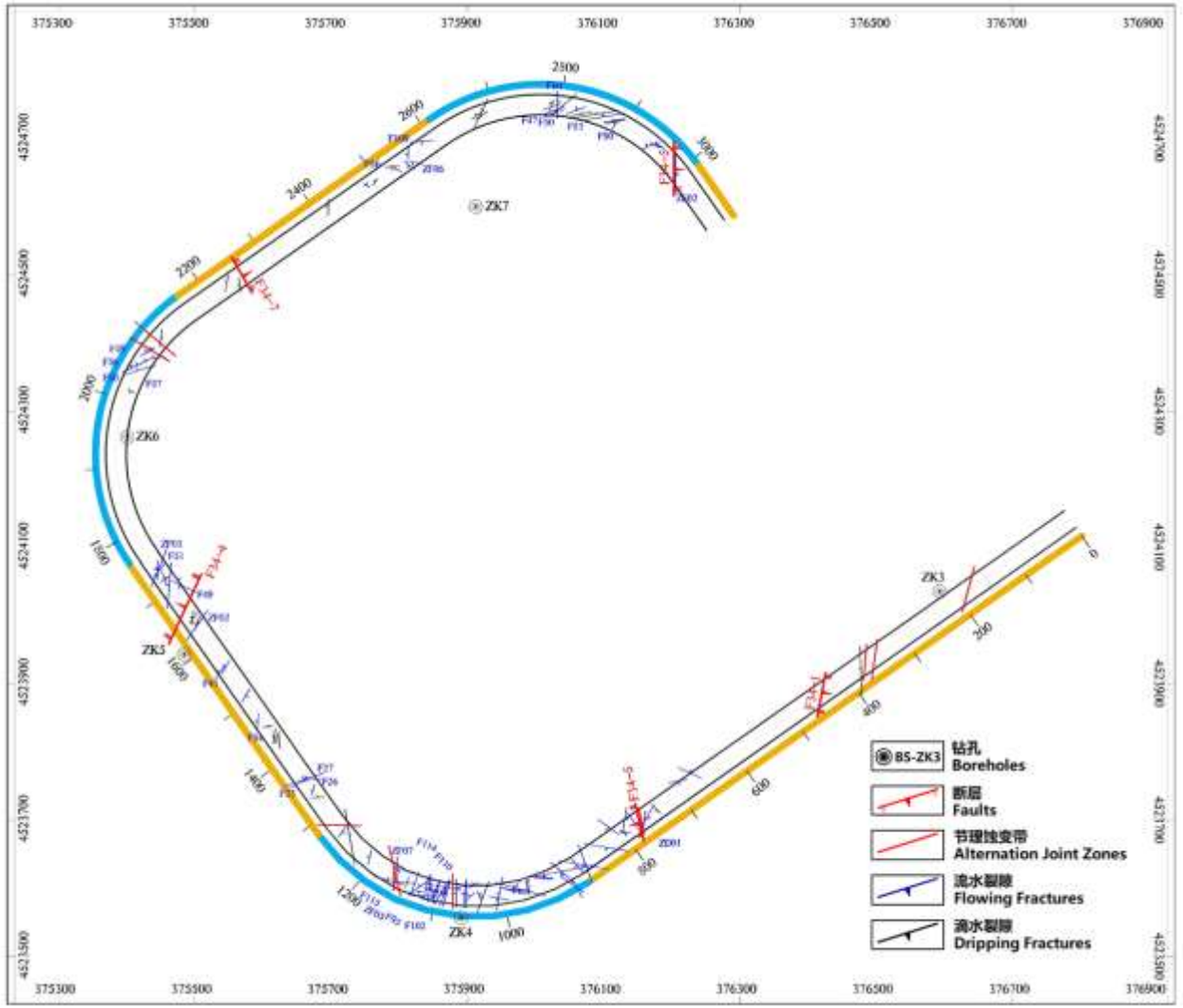
Hydrogeological mapping in tunnels

- The number, density, and spatial distribution of hydraulic fractures in the ramp have been well measured and recorded.

Actual Photograph

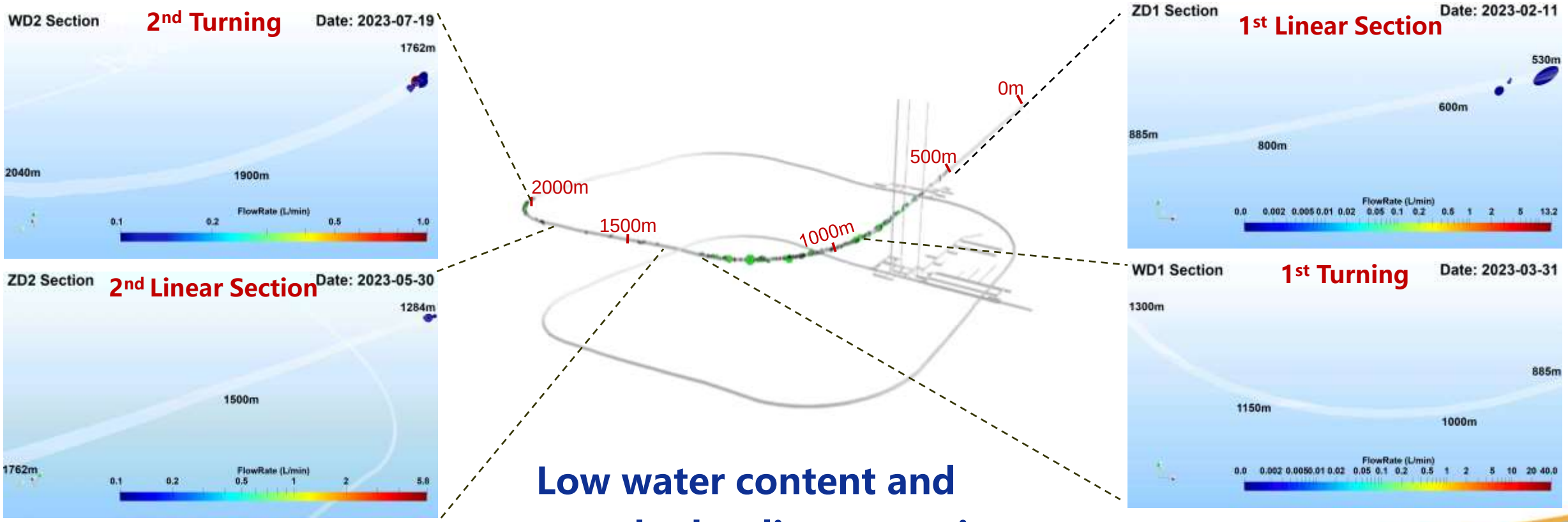


Infrared View



Hydrogeological investigation

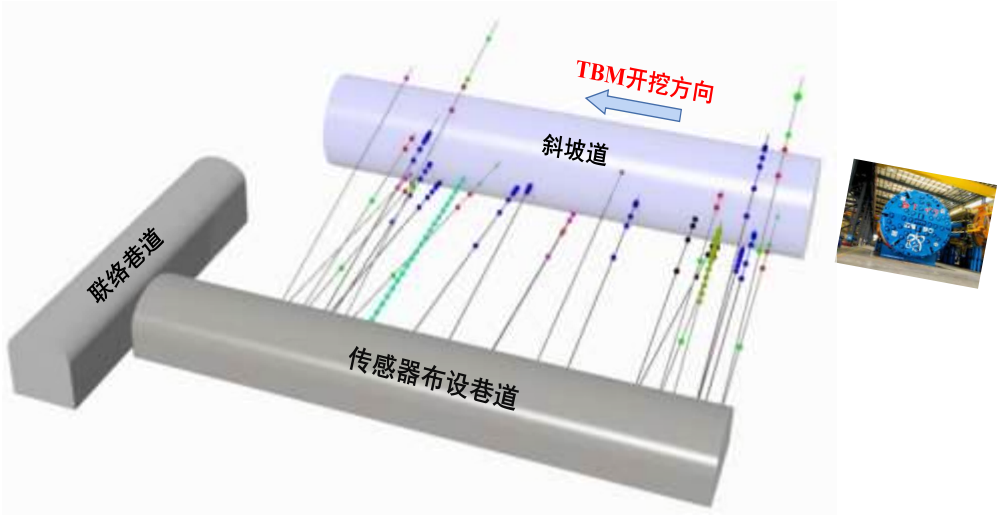
- **Evolution of water-conducting features: limited flow rate （<5L/min），decreases along with time (less than 7 days)**



Low water content and poor hydraulic connections

Monitoring experiment during TBM excavation

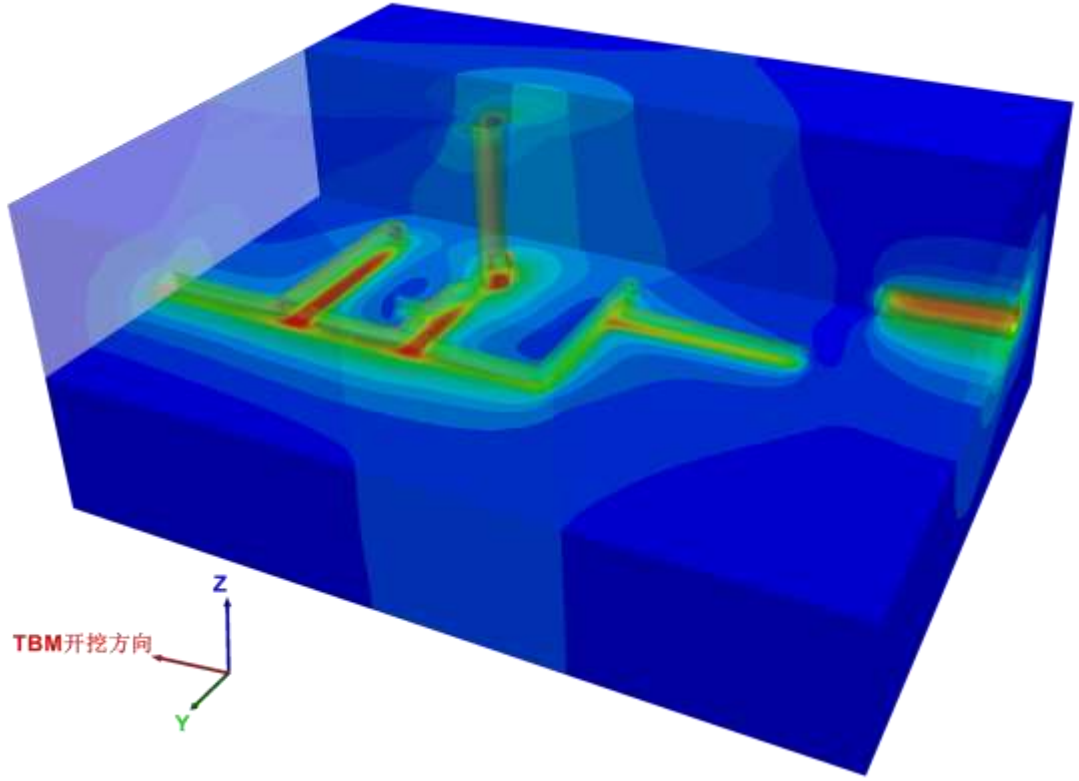
- The first-ever study on the real-time disturbance of host rock by TBM
- The first large scale in situ experiment in Beishan URL



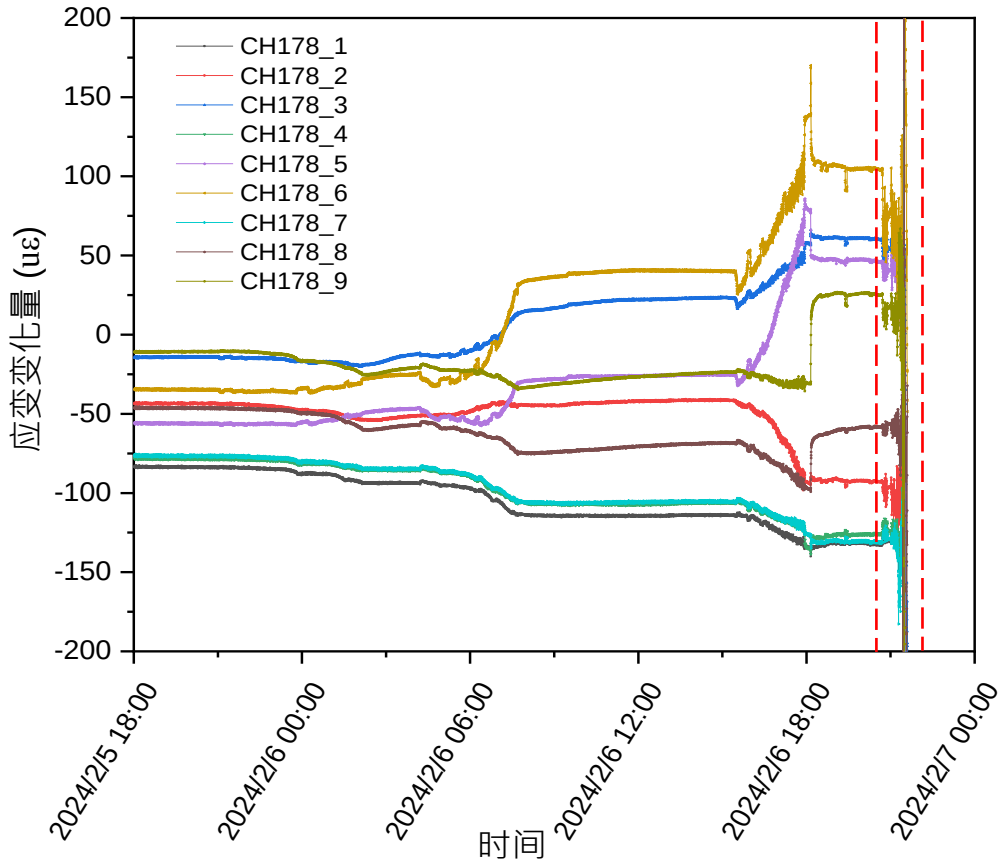
- 23 Feb. 2023: Start design of experiment
- 22 Dec. 2023: Finish installation of sensors
- 2~8 Feb. 2024: Monitor the response of surrounding rocks when TBM is going through

Monitoring at -280m tunnel

Monitoring experiment during TBM excavation



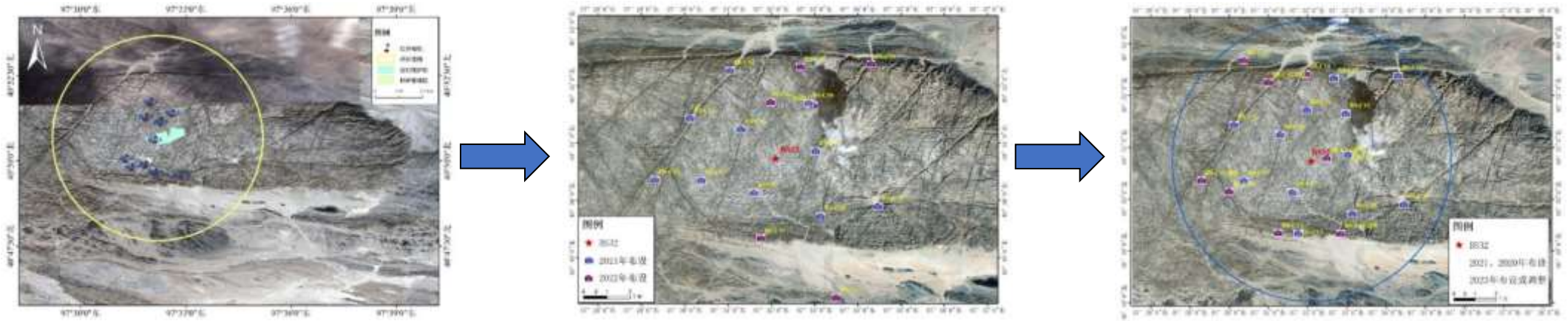
Modeling of the experiment (stress and strain)

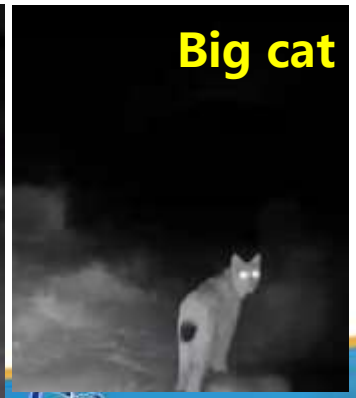


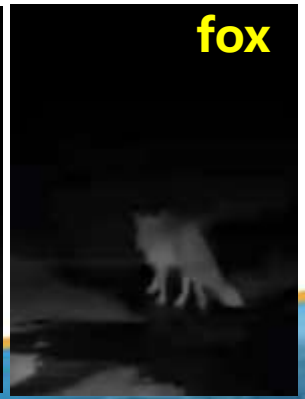
Dynamic Data Management System

Ecological environment monitoring

Infrared monitoring camera network established







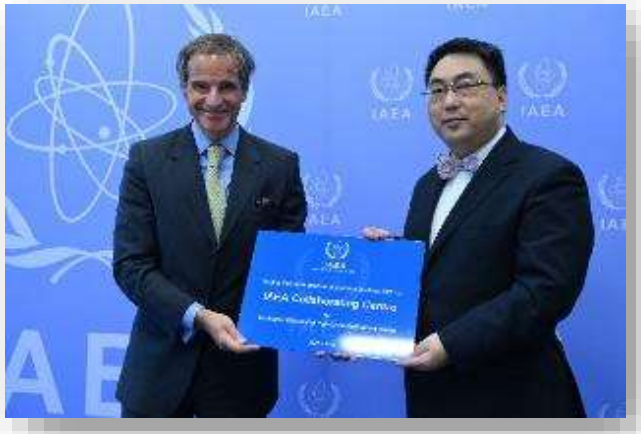
IP figures for public communication: A-Fu and his friends

Carton: A-Fu and his friends to find their new home

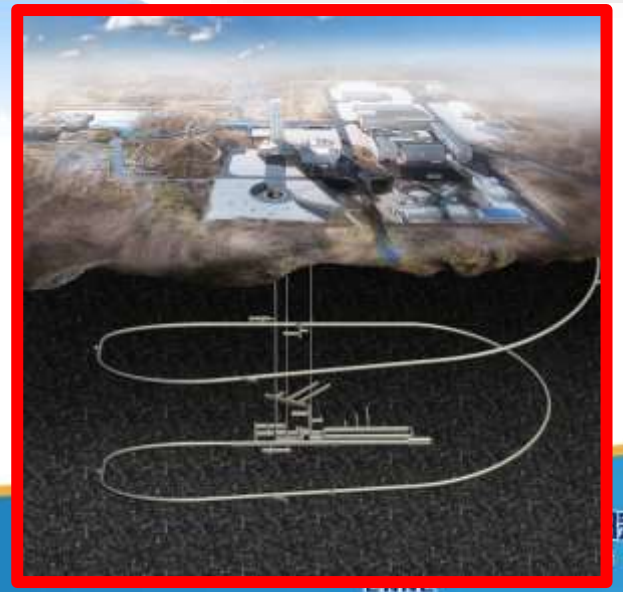
Visitors in 2023： 1800+ people

IAEA has designated BRIUG as the

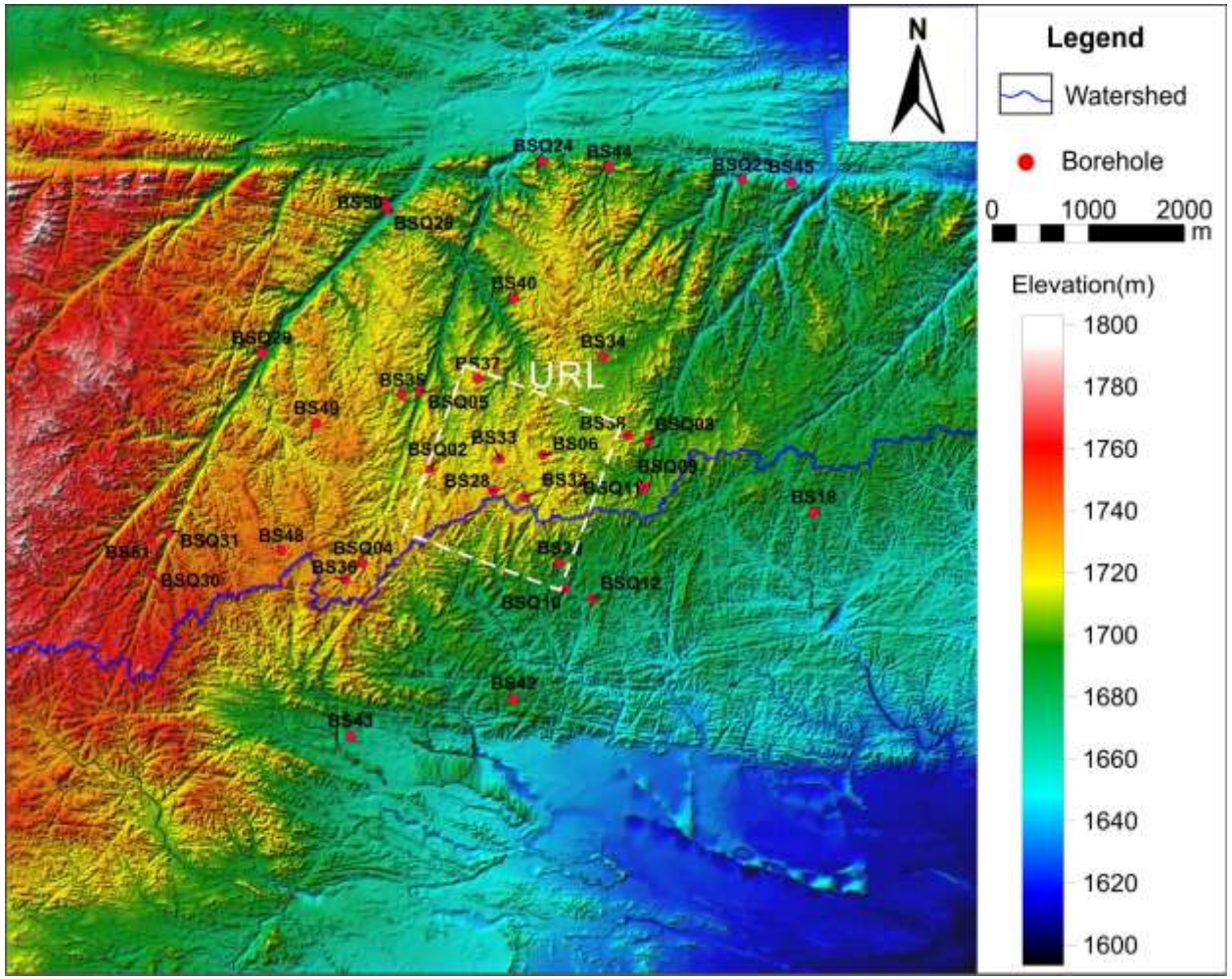
IAEA Collaborating Centre for Geological Disposal of HLW

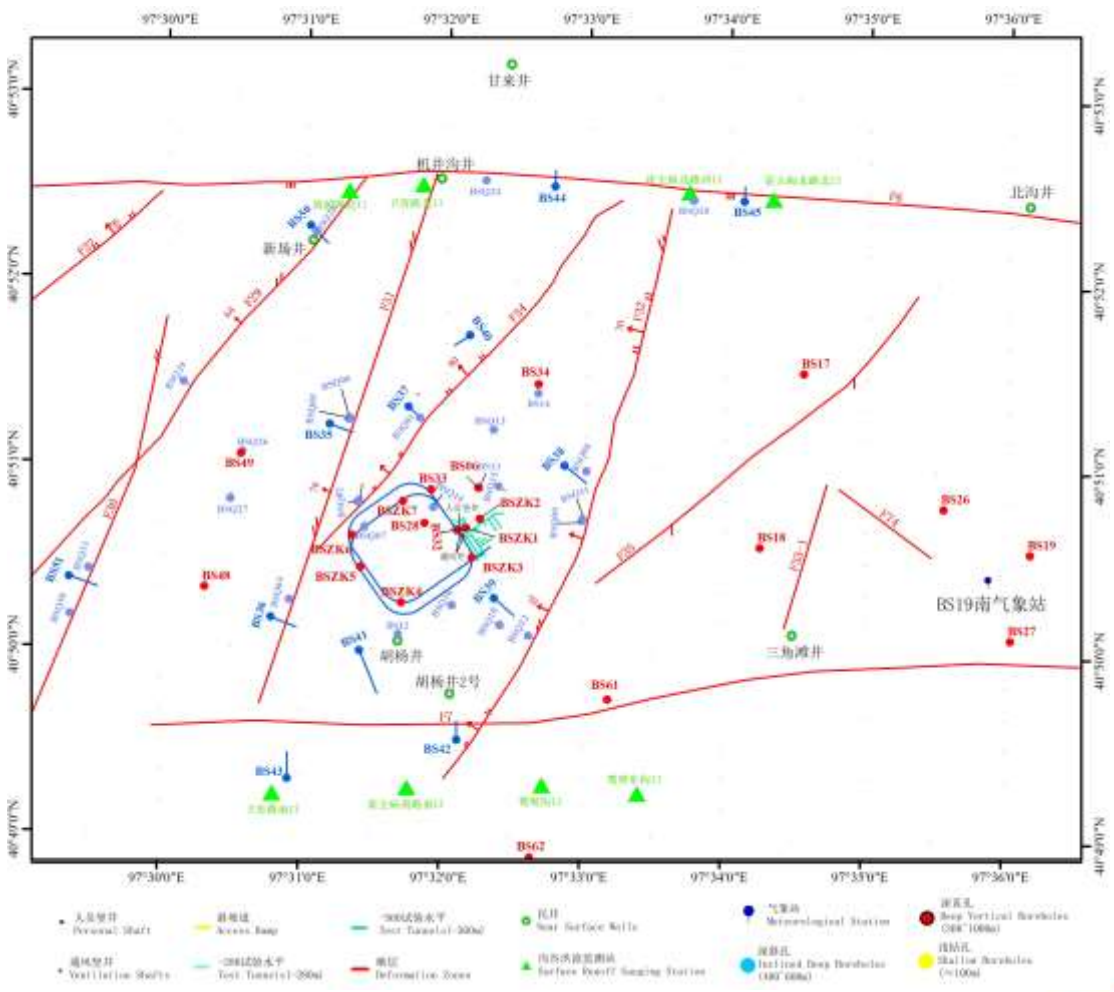


The agreement was signed on 12th Oct. 2021.



Monitoring and Evaluation Techniques of Hydrologic Response during Excavation of Beishan URL (**MONEH**)





MONEH international cooperation project

Contact Person: ***Ms. GAO Min***

Deputy Director of Project Management for HLW,

Beijing Research Institute of Uranium Geology

Email: ***gaomin820@163.com***

Tel: ***+86-10-64960822***

Add: *No. 10 Xiao-guan-dong-li, Chaoyang District, Beijing 100029, China*

IAEA Technical Workshop on Planning and Implementing Construction of Underground Research Facilities and Deep Geological Repositories.

will be held at the Beishan URF Site in the Gobi Desert of China from 08-12 July 2024.

Welcome to Beishan URL!

Status of DGR Program in Japan
−Earning Public Confidence−

Masaaki Yamaguchi

Ministry of Economy, Trade and Industry, JAPAN

May 28, 2024

METI
Ministry of Economy, Trade and Industry

Timeline of DGR Program in Japan

Research & Development

Recent Progress in Literature Surveys

1976 JAEC "Report on Radioactive Waste Management"

PNC and JAERI (now JAEA) started R&D for HLW geological disposal

1999 JNC (now JAEA) "H12 report"

JNC summarized geological disposal concept, and engineering technology etc. to technical feasibility of DGR in Japan

2000 Final Disposal Act

NUMO was established as an implementer

2015 Revision of the basic policy based on the Final Disposal Act

Government should take leadership for public understanding, by publicizing scientifically favorable areas for geological disposal

2017 Nationwide Map of Scientific Features

2020 NUMO launched literature survey in two municipalities

2021 NUMO Safety Case Report

2023 Evaluation guideline for Literature Survey

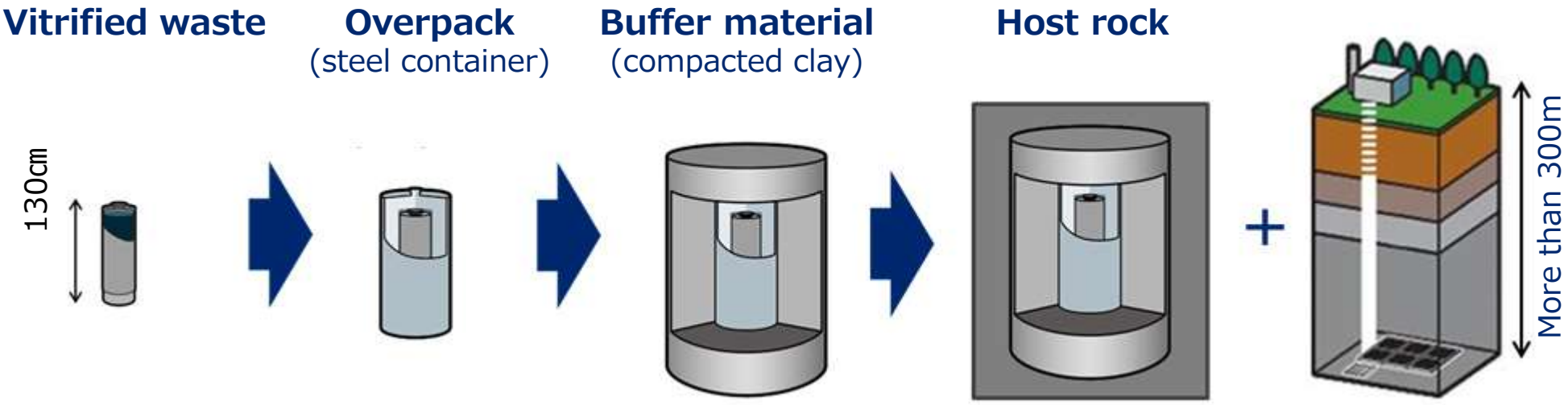
2024 Discussion of draft report in public working group

1980 1990 2000 2010 2020

Government Policy/ Implementation

Basic Concept of Geological Disposal in Japan

- A **multi-barrier system** consisting **engineered** and **geological barriers**
- **Host rock** provides **favorable geothermal**, **chemical**, **mechanical** and **hydrological environment** to maintain the stability and performance of the disposal system for over tens of thousands of years.
- Special consideration is given to the long-term stability of the geological environment since Japan is in a **tectonically active zone**.



Vitrified waste	Overpack (steel container)	Buffer material (compacted clay)	Host rock	
• Solidify radioactive materials with glass • Difficult to dissolve in water	• Prevent vitrified waste to contact with ground water	• Restrict groundwater flow in the buffer • Retard nuclide migration by sorption	• Reducing condition to prevent alteration • Low flowrate of groundwater	• Isolation from human environment

Engineered barriers + **Geological barrier**

Site Investigation Processes in Japan

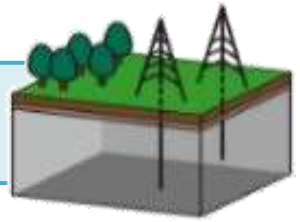
- Site investigation processes consist of three stages, such as literature survey, preliminary investigation, and detail investigation.
- If the local government opposes to next investigation, **METI and NUMO will not progress the investigation process**.

Apply from a municipality

A municipality accept GOJ's offer

Literature Survey

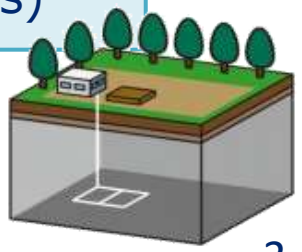
Listening to opinions from local government



Preliminary Investigation (borehole survey, etc.)

Listening to opinions from local government

Detail investigation (construction & studies in underground facilities)



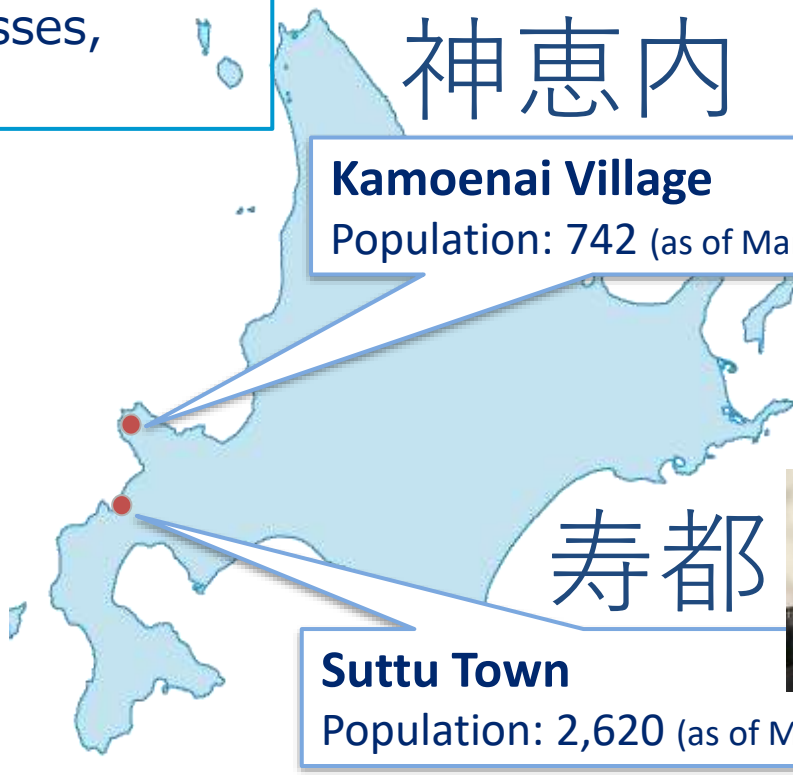
Listening to opinions from local government

Decision of final disposal site

Recent Progress in Literature Survey

NUMO started **Literature Survey (LS)**, in 2020, the first stage of site investigation processes, in two municipalities in Hokkaido.

- ✓ **Kamoenai village** made the decision to accept the offer of national government for LS, after discussions among the village council and the residents.
- ✓ **Suttu town** made the decision for the application of LS after discussion among the town council and the residents.



Mayor Takahashi

Mayor Kataoka

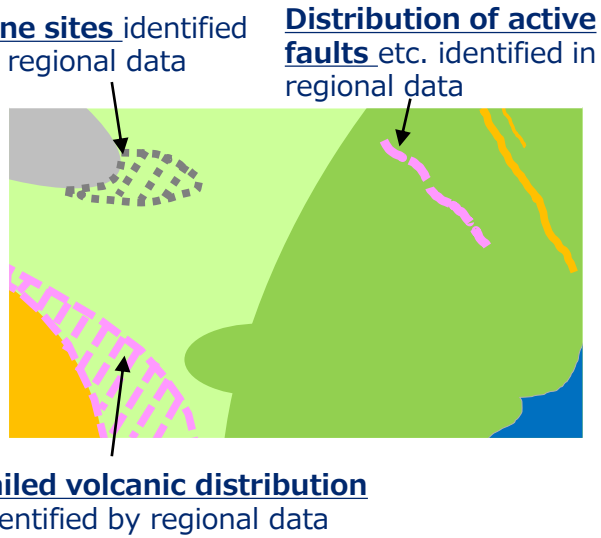
- METI released **Evaluation Guideline for Literature Survey** (November 2023)
- NUMO published **Drafts of literature survey reports** on Suttu Town and Kamoenai Village (February 2024)
- **Geological Disposal Technical Working Group** (hereinafter "WG") started discussing the drafts of literature survey reports from a technical and professional perspective. (February 2024)

Overview of the Literature Survey

- Literature survey involves desk-based survey of regionally specific documents and data, such as geological maps and mineral resource maps.
- Results of the survey are to be evaluated based on the guideline formulated in November 2023 after discussions at WG.

Survey conducted by NUMO

- NUMO collects literature and data on volcanoes, faults, mineral resources, etc.
- NUMO excludes places where obviously unsuitable for the site.



Evaluation Guideline for literature survey

- After discussion at WG, the guideline released in November 2023.
- METI materialized standards for areas to be avoided and methods of confirmation.

Report of survey results

- NUMO reports the survey results to prefectural governors and mayors, as well as residents, and listen to their opinions and compile them.
- After that, National government listens to the opinions of prefectural governors and mayors. (will not proceed against the opinion)

Place for Dialogue in Survey Areas

- METI and NUMO are making efforts to support the **place for dialogue** in which local residents can take part in survey areas.
- In the survey areas, NUMO and METI provide **detailed information** on the **progress of literature survey** and **local development plans**, listening to the **community's request** at the place for dialogue.

<Operation of the place of dialogue>

Host: municipalities (+ NUMO)

Facilitator

Local Stakeholders

- **Local council members**
- **Local residents**
- **Local groups**

⋮

- **Prefecture**
- **Neighboring municipalities etc.**

Secretariat: NUMO

Presentation/Q&A: GOJ, NUMO, Experts

<Topics of discussions>

DGR Project

- Provide detailed information of DGR
- Report on the progress of literature survey
- Site Visit to relevant facilities etc..

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Local Development Plan

- Discuss community development
- Research on social impact of the Project etc.

Place for Dialogue in Suttu Town and Kamoenai Village

- In April 2021, "**Place for Dialogue**" was established in Suttu Town and Kamoenai Village. **Local residents** participate in discussions with **neutral facilitators**, and other **activities** developed based on discussed ideas.
- Diverse opinions are raised including **concerns and positive views** about DGR.

"Place for Dialogue"

●Suttu Town (17 times held)

<Main Topics>
- Thoughts on the DGR project
- Overview of the DGR project
- Safety of the DGR
- Progress of the Survey
- Ideas to involve local residents
- Radiation effects on humans etc.

●Kamoenai Village (18 times held)

<Main Topics>
- Thoughts on the DGR project
- Overview of the DGR project
- Safety of the DGR project
- Progress of the Survey
- What is expected for the dialogue etc. * As of April 2024

Activities

● "Workshop for local future"

✓ Workshops for voluntary participants (Topics: DGR project, local development)

● Site Visits

✓ Nuclear fuel cycle facilities @Rokkasho, Aomori

✓ Underground research center @Horonobe, Hokkaido

● Site Visits

✓ Underground research center @Horonobe, Hokkaido

Typical Opinions

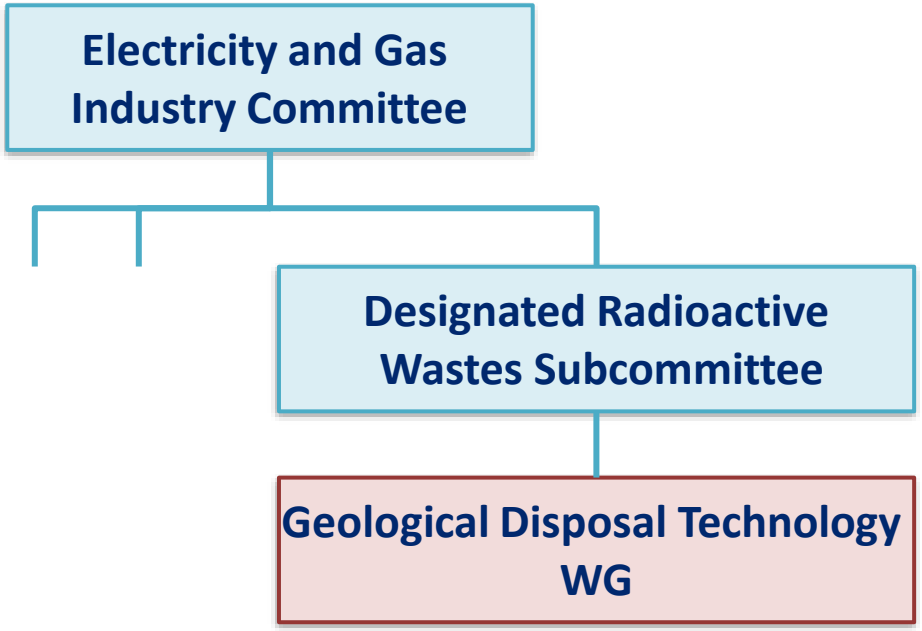
✓ Concerned that everything goes as planned by NUMO no matter what we say

✓ Who is NUMO? Is DGR really safe?

✓ Site visit is important to understand DGR project. We should first understand the project regardless of pros and cons

Discussions for NUMO's Drafts of Literature Survey Reports

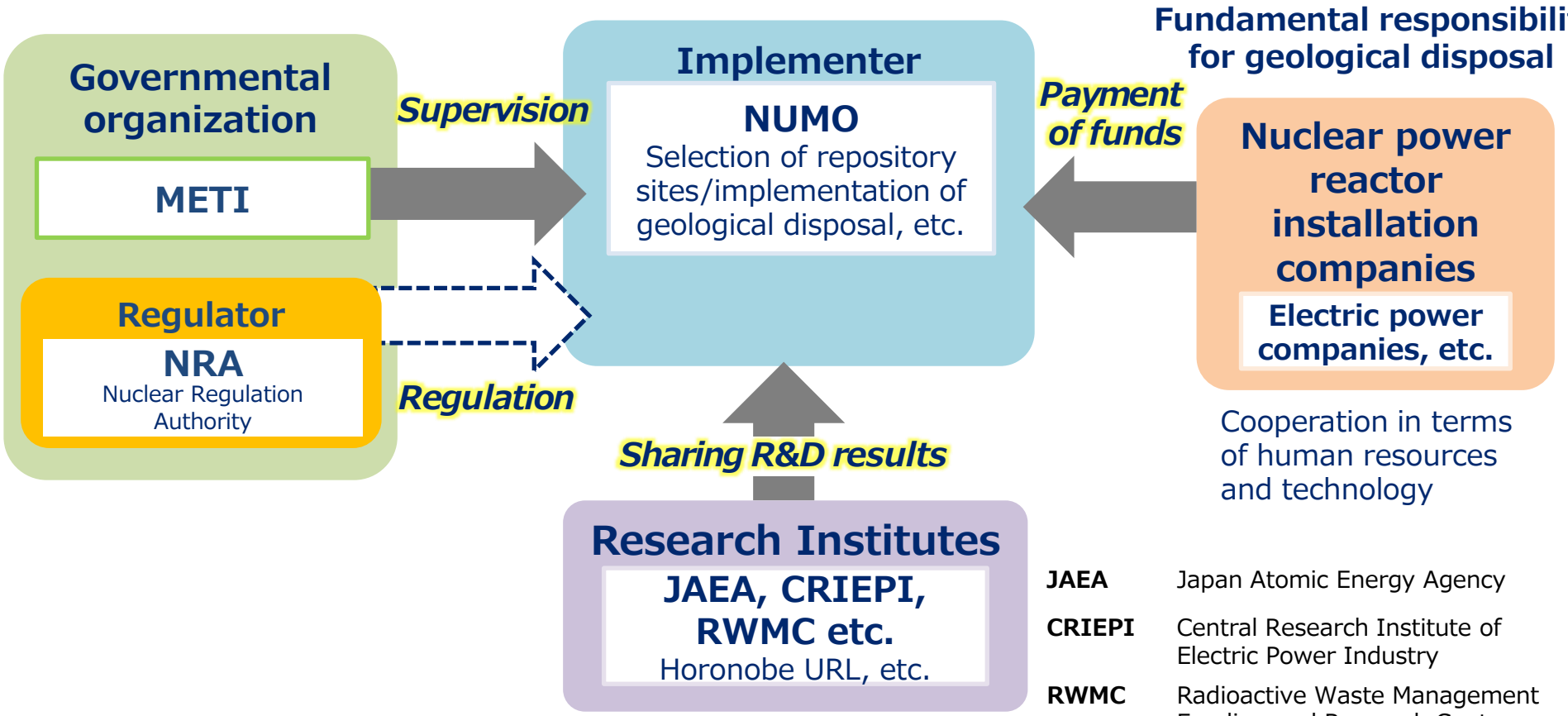
- On February 13, 2024, the **drafts of literature survey reports** on Suttu Town and Kamoenai Village prepared by NUMO was published.
- On the same day, the **Geological Disposal Technology Working Group (WG)** began to discuss the draft of literature survey reports.



- The WG discuss technical issues tasked out by the Subcommittee from a technical and professional perspective.
- From the perspective of ensuring the **neutrality** and **transparency** of discussions, experts were selected by **recommendations from related academic societies** on the geological environment, in addition to the technical experts of the subcommittee.

Implementation System for Geological Disposal

- **METI supervises** and **NRA regulates** the disposal project.
- **NUMO** is established under the Final disposal act and is the **implementing entity for final disposal.**
- In addition to **METI, NRA** and **NUMO,** several **research institutes** be involved in fundamental R&D and for technology development to **improve the reliability** of **final disposal technology**.



JAEA Japan Atomic Energy Agency

CRIEPI Central Research Institute of Electric Power Industry

RWMC Radioactive Waste Management Funding and Research Center

Summary

Recent progress in DGR program in Japan

- Since NUMO launched **literature survey** in two municipalities in 2020, major progress has been made in Japan.
- METI released **Evaluation guideline for Survey** in 2023.
- NUMO published **Drafts of Literature Survey Reports** in 2024.
- **Geological Disposal Technology Working Group** began to discuss the drafts in 2024.

Various measures to gain public confidence

- **The WG is carefully discussing technical issues** on the drafts of **literature survey reports.**
- To ensure **neutrality** and **transparency** of discussions, experts were selected by **recommendations from related academic societies** on the geological environment.
- METI and NUMO are making efforts to support the **place for dialogue** in which local residents can take part in survey areas.
- In addition to **METI, NRA** and **NUMO,** various **research institutes** be involved in the fundamental R&D and for technology development to **improve the reliability of final disposal technology**.

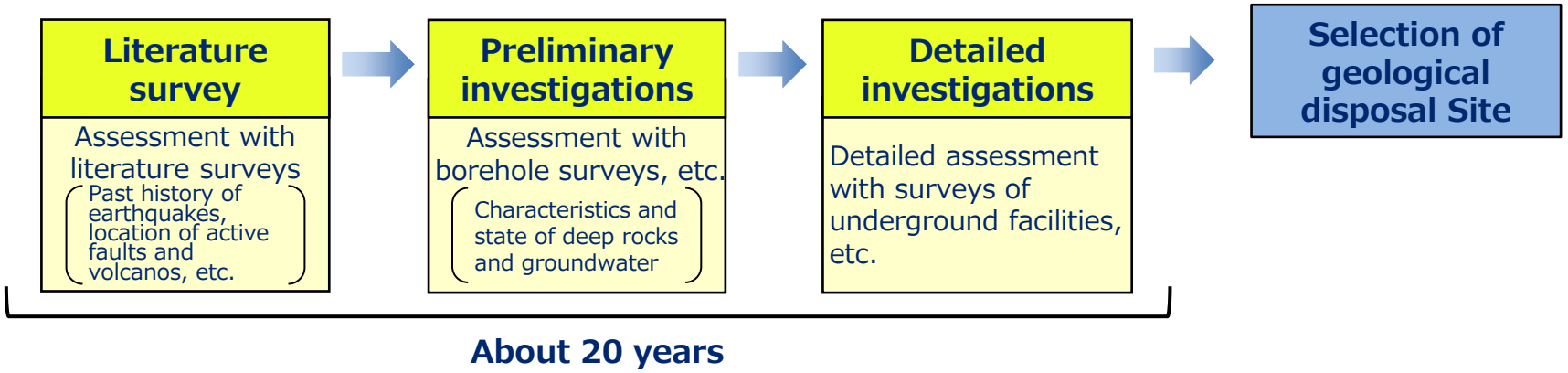
Reference

Overview of the Final Disposal Act

◆ **The followings are included in the "Final Disposal Act"** (enacted in 2000) in order to systematically and reliably conduct the final disposal (disposal in a stratum more than 300m deep underground) of high-level radioactive waste generated after the reprocessing of spent fuel used in nuclear power generation.

- Minister of Economy, Trade and Industry states a basic policy for final disposal of specified radioactive waste (Cabinet decision).
- Nuclear Waste Management Organization (NUMO) is established as an implementer for geological disposal.
- Three-stage selection investigation process is set for selection of repository sites, etc.

◆Selection process outlined in the "Final Disposal Act"



※The government will hear the opinions of local municipalities in each stage of the investigation process
(not proceed to the next stage if local municipalities oppose).