

H-eXPLORE [2026-2029]

Exploratory workflow for gaseous subsurface resources (He, H₂)
with a focus on Helium-Nitrogen (He-N₂) systems



PROGRAMME
DE RECHERCHE
SOUS-SOL

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Helium is a critical yet scarce resource, essential to science and industry, but still poorly explored in France. H-eXPLORE addresses this gap by developing innovative, interdisciplinary exploration strategies, including research drilling, to tackle key scientific questions and inform the assessment of carbon-free N₂-He systems.

PROJECT OUTLINE

He in France: Challenges and potential

Supply and sovereignty

- Rising demand; added to EU critical raw materials list (2024)
- Almost exclusively imported → national supply is a strategic issue
- Current production is mainly a by-product of fossil energy → energy transition calls for new exploitation pathways

Generation and geology

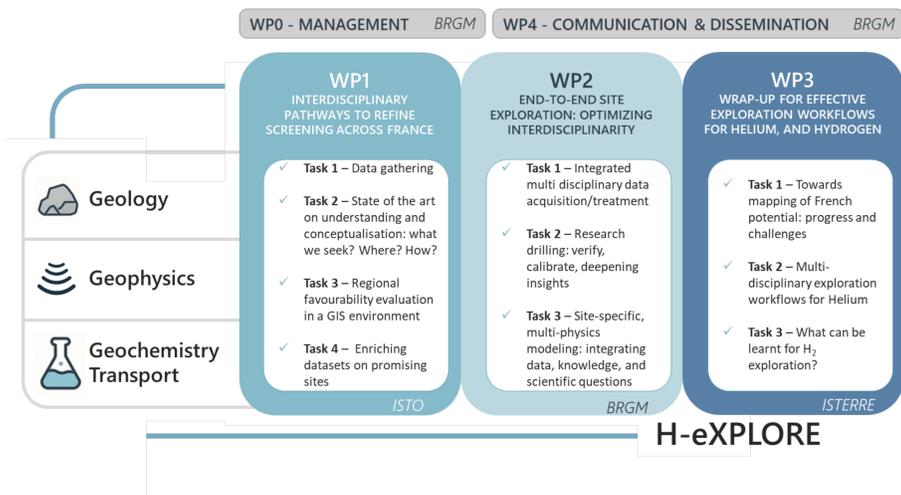
- Produced over geological time via radioactive decay in deep crust
- Migrates to surface with CO₂, N₂ ± H₂
- Chemically inert → no microbial or geochemical reactions
- Favorable French geology: CO₂-He systems vs N₂-He systems

Link with Hydrogen

- He & H₂ sometimes co-located
- Similarities in transport and accumulation → study migration & accumulation processes before H₂ complexity
- Provides a first step toward robust, integrated exploration workflows

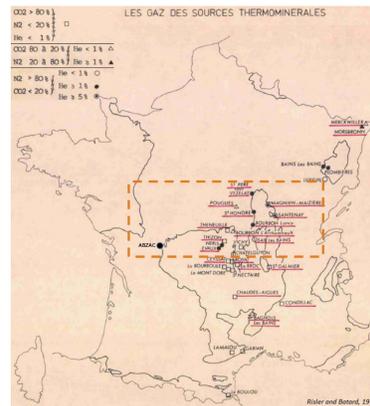
Objectives driven by INTERDISCIPLINARITY

- Develop innovative workflows for subsurface gas exploration.
- Improve understanding of He-N₂ systems.
- Investigate underexplored regions.
- Assess if this He can be viewed as a decarbonized He resource with potential for medium-term exploitation.
- Extrapolate to H₂ subsurface exploration.



FUNNEL-SHAPED EXPLORATION

Screening at France scale



Define state of the art on He-N₂ systems

- Bottom-up (favorable geology → source → migration → storage)
- Top-down (surface measurements → what lies beneath)

Compile existing data on a Large Area, and provide new perspectives by integrating acquired data on other topics + targeted sampling + latest insights available in the literature.

→ Choose a *Focus area* and a *Drilling site*

Favorability mapping at medium-scale (*Focus area*)

Test the relevance of favorability mapping (data & expert driven) for He exploration for a Focus Area.

Use results to guide targeted sampling on site.

Use new field data to assess predictive performance.

In depth exploration and drilling for the *Project site*

Proven and experimental geophysical methods:

- “big-picture” methods (passive seismic, magnetotellurics, electromagnetism, gravimetry),
- site-scale methods (active seismic, resistivity),
- monitoring methods (passive seismic, time-lapse resistivity).

Geochemical techniques: noble gas isotopes, in-situ analysis of He/CO₂ and He/N₂, flux + soil gas monitoring, water + gas sampling & analyses.

Conduct research drilling (100-200 m depth) :

Target the basement-cover transition.

Considered locations: Poitou, Morvan, western Massif Central.

Acquisitions during drilling (cores/cuttings, groundwater sampling, mud gas logging, monitoring of aquifer degassing) and after (geophysical parameters, long-term water/gas monitoring).

Multi-physics imaging and modeling

ILLUSTRATION OF SOME SCIENTIFIC QUESTIONS / CHALLENGES



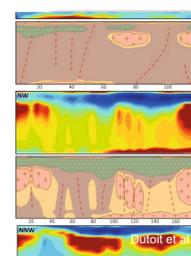
Post-doc BRGM-Geolinks

Can dynamic gas flow be inferred from geophysical signals (electrical resistivity, passive/active seismic...)?



Post-doc ISTO

How can gas isotopes characterization contribution to understanding and exploration?



Post-doc ISTERre – 45-8

What can be expected from multi-physics imaging and 3D subsurface model to guide understanding and exploration?

Bibliography

- Risler J. Description et classification géologique des sources minérales et thermales du massif central. BRGM, Service des eaux minérales et thermales. 1971
- Dutoit H, Donzé FV, Cardoso C, Charroy J, Riba Pereyra C, Taillefer A, et al. 2024 Assessing the Helium Potential of Variscan Batholiths: Insight From Corsica Island..

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