



# **Mechanistic understanding of gas transport in clay materials (GAS)**

**S. Levasseur, ONDRAF/NIRAS, Berlin, 3-4 December 2018**

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# WP Main Objectives

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## Mechanistic understanding of gas transport in clay materials (WP6, GAS, 60 months)

- ▶ **Objective 1:** Improve the mechanistic understanding of gas transport processes in natural and engineered clay materials, their couplings with the mechanical behaviour and their impact on the properties of these materials;
- ▶ **Objective 2:** Evaluate the gas transport regimes that can be active at the scale of a geological disposal system and their potential impact on barrier integrity and repository performance

# WP Expected impacts

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- ▶ Provide results that are applicable to a wide range of national programmes
- ▶ Transfer knowledge gained from lab and in situ experiments to configurations that are commonly found in current repository designs, to address key questions from the end-users:
  - ▶ How could gas migrate within the repository and which water soluble and volatile radionuclide transport could be associated with it?
  - ▶ How and to what extent could the hydro-mechanical perturbations induced by gas effect barrier integrity and long-term repository performance?

# WP Participants

## Organisations

- ✓ **SCK-CEN** (BE, RE)
- ✓ **ONDRAF/NIRAS** (BE, WMO)
  - Uliège (BE, RE)
- ✓ **PSI** (CH, RE)
- ✓ **NAGRA** (CH, WMO)
  - EPFL (CH, RE)
  - ZHAW (CH, RE)
- ✓ **SÚRAO** (CZ, WMO)
  - CTU (CZ, RE)
  - UJV (CZ, RE)
- ✓ **FZJ**
  - UFZ (DE, RE)
- ✓ **KIT-PTKA**
  - GRS (DE, RE)
  - BGR (DE, RE)
- ✓ **BGE (DE, WMO)**
- ✓ **CIEMAT (ES, TSO)**
  - CIMNE (ES, RE)
  - UPC (ES, RE)

## Organisations

- ✓ University of Helsinki
  - Aalto Uni (FI, RE)
- ✓ **CNRS** (RE, FR)
  - CNRS / ISTerre
  - CNRS / GeoRess.
  - CNRS / IC2MP
- ✓ **IRSN** (FR, TSO)
- ✓ **Andra** (FR, WMO)
- ✓ **CEA**
  - EDF (FR, RE)
- ✓ **LEI** (LT, RE)
- ✓ **COVRA** (NL, WMO)
  - TU Delft (NL, RE)
- ✓ **BGS** (UK, RE)
- ✓ **RWM** (UK, WMO)

# WP – Task Breakdown and WP Board

- ▶ **WP leader:** X. Sillen (ONDRAF/NIRAS, WMO, BE)

[EJPI-WPGas@nirond.be](mailto:EJPI-WPGas@nirond.be); [x.sillen@nirond.be](mailto:x.sillen@nirond.be)

- ▶ **Task 1 – Coordination**

- ▶ **Leaders:** X. Sillen & S. Levasseur, ONDRAF/NIRAS, WMO, BE

- ▶ **Task 2 – Transport mechanisms**

- ▶ **Leaders:** E. Jacops, SCK•CEN, RE, BE

- ▶ (T2.1: L. Truche, ISTERre; T2.2: J. Harrington, BGS)

- ▶ **Task 3 – Barrier integrity**

- ▶ **Leaders:** P. Marschall, NAGRA, WMO, CH

- ▶ (T3.1: P. Marschall, Nagra; T3.2: J. Talandier, Andra; T3.3: O. Kolditz, UfZ)

- ▶ **Task 4 – Repository performance aspects**

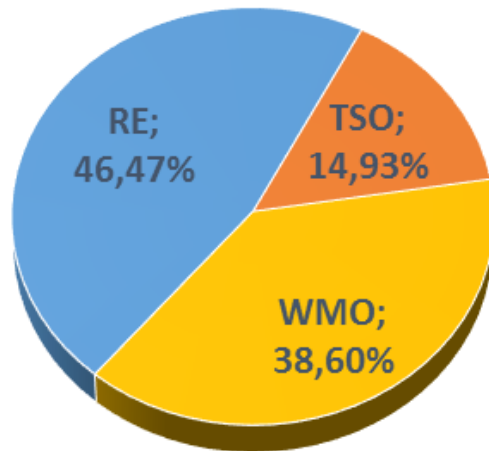
- ▶ **Leaders:** J. Wendling, ANDRA, WMO, FR

- ▶ (T4.1: S. Norris, RWM; T4.2: M. Dymitrowska, IRSN)

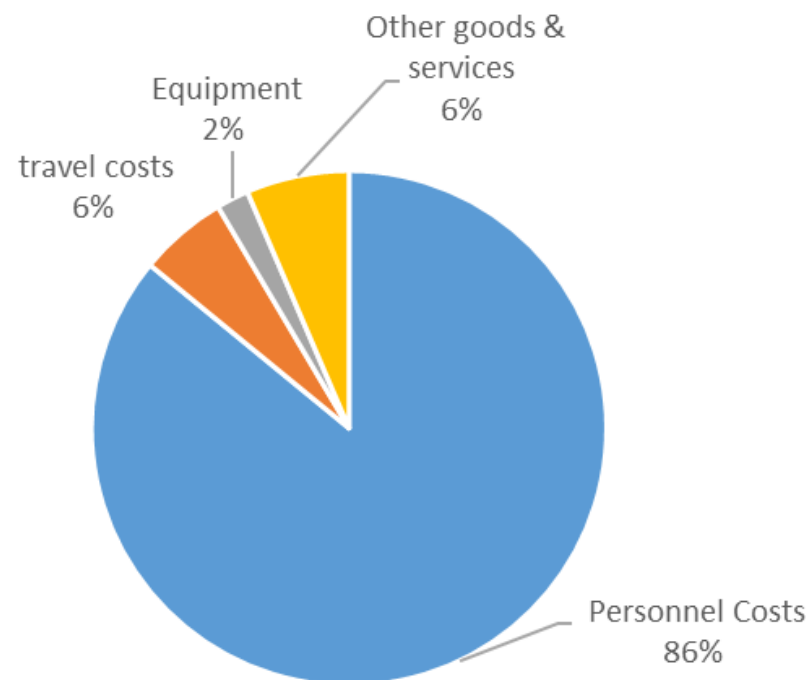
# WP – Planned resources

TOTAL BUDGET	5,6M€
EC requested contribution	2,6M€

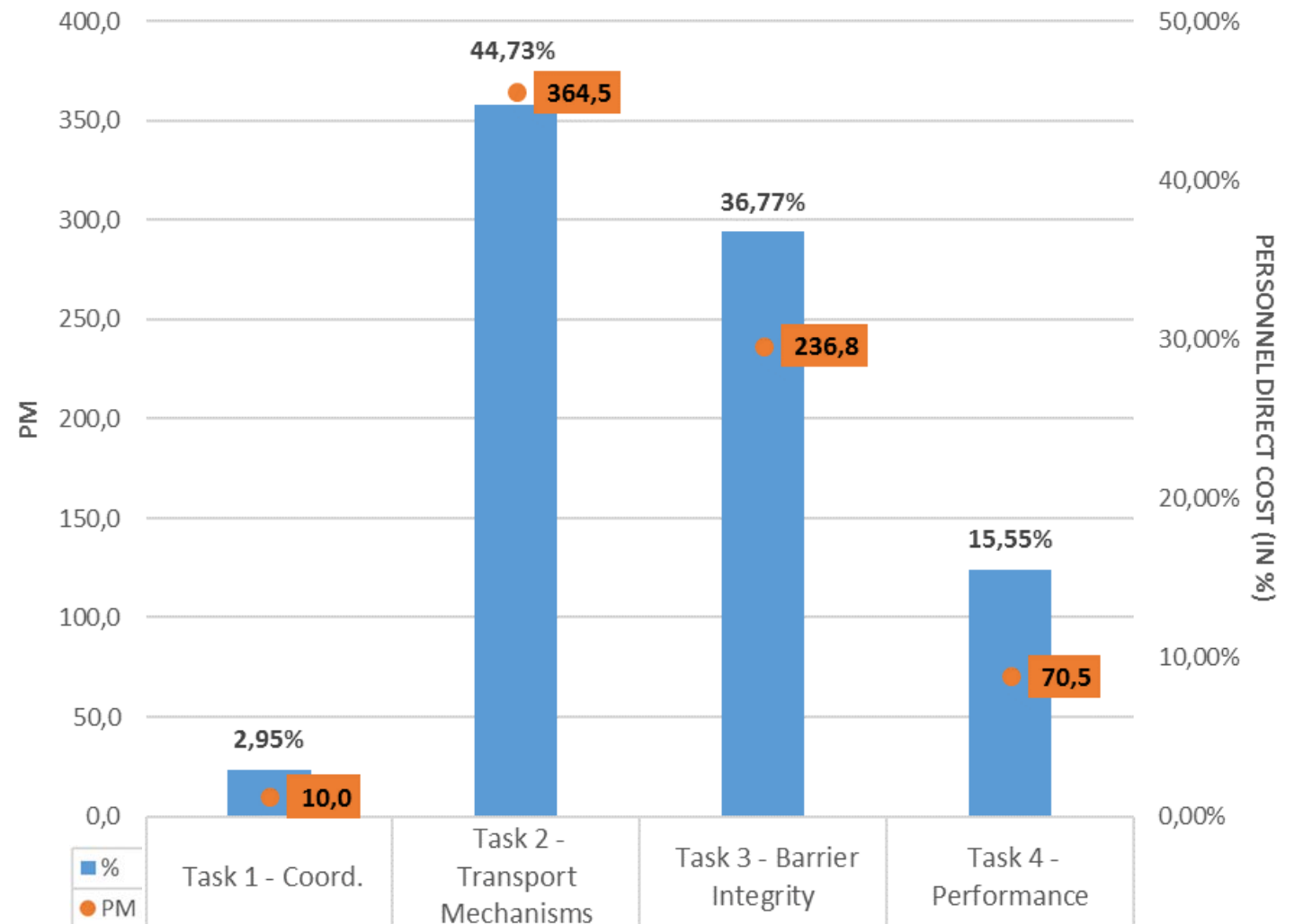
**GAS WP:**  
Distribution of EC Contribution  
between categories of Actors



**GAS WP - Budget distribution between categories of direct costs**



**GAS WP:**  
Personnel costs breakdown per task  
(in % and in PM) - Total PM: 681,7



# WP GAS – Task 1 Coord. SOTA & Training

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## ▶ Objectives

- ▶ Ensure WP follow-up, interactions within the WP, with other EURAD WPs (e.g. HITEC, ACED, DONUT, UMAN, KM) and with other EC Projects (e.g. BEACON) (Subtask 1.1)
- ▶ Provide State-of-the-art report (Subtask 1.2): baseline against which VWP progress can be measured
  - ▶ Deliverable 6.1: month 18, Update – Deliverable 6.2: month 60
- ▶ Organize 2 training workshops jointly with HITEC WP (Subtask 1.3)
  - ▶ Training material – deliverable 6.3, month 6 & deliverable 6.4, month 48

## ▶ Meetings & Workshop

- ▶ GAS WP meetings: 2 per year, once a year jointly with HITEC WP
- ▶ 2 joint meetings with ACED & DONUT WPs
- ▶ GAS WP workshop
  - ▶ Release of main WP finding – deliverable 6.5, month 60



# WP GAS – Task 2 Transport mechanisms

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## ▶ Objectives

- ▶ Diffusion and retardation (Subtask 2.1)
  - ▶ Determine gas diffusion parameters on different clayey materials at different degree of saturation and support experimental data interpretation by pore network modelling
  - ▶ Understand gas physiosorption mechanisms in microporous systems
- ▶ Advection (Subtask 2.2)
  - ▶ Provide reference data for various natural and engineered clay materials under a sufficient broad range of conditions
  - ▶ Improve understanding of the observed gas transport modes and identifying their main control
  - ▶ Conceptualisation of transport mechanisms at micro & macro scales

## ▶ Outputs

- ▶ Deliverable 6.7, month 57 + Part of deliverable 6.6, month 60

## ▶ Interactions foreseen with other WP tasks & BEACON EC project

# WP GAS – Task 3 Barrier Integrity

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## ▶ Objectives

- ▶ Gain a mechanistic understanding of the hydro-mechanical phenomena and processes, associated with:
  - ▶ the gas-induced failure of clay barriers, i.e. within the engineered barrier system, within the Excavation Damage Zone and within the host rock (Subtask 3.1);
  - ▶ the effectiveness of self-sealing processes along gas-induced pathways in the clay barriers of a geological repository (Subtask 3.2).
- ▶ Evaluate achievements by model-supported data analyses:
  - ▶ predictive modelling and application of newly developed modelling tool on in-situ experiments (Subtask 3.3).

## ▶ Outputs

- ▶ Deliverable 6.8, month 57 + Part of deliverable 6.6, month 60

- ▶ **Interactions** foreseen with other WP tasks, with HITEC WP of EURAD & with BEACON EC project

# WP GAS – Task 4 Repository performance

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## ▶ **Objectives** (end-user oriented)

- ▶ Evaluate gas transport regimes that can be active at the scale of a geological disposal system and their potential impact on repository performance

→ Conceptualizations of gas migration (subtask 4.1) + model assisted assessment of gas induced effects (subtask 4.2) to identify:

- ▶ effects of the presence of gas and its transport on the transfer of soluble and volatile radionuclides
- ▶ consequences of gas-induced hydro-mechanical perturbations on barrier integrity and long-term performance.

## ▶ **Outputs:**

- ▶ Deliverable 6.9, month 57 + Part of deliverable 6.6, month 60

- ▶ **Interactions** foreseen with other WP tasks, with HITEC, ACED, DONUT & UMAN WPs of EURAD & with BEACON EC project

# Key challenges & objectives for Year 1

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- ▶ **Task I – Scientific and Technical coordination, state-of the art and training materials**
  - ▶ Ensure that scientific and technical tasks start in line with the WWP programme and objectives,
  - ▶ Materialize the interactions with other WPs (especially HITEC WWP)
  - ▶ Launch the drafting of the initial state-of-the-art report (D6.1) as input to the KM WWP State-of-Knowledge.
  - ▶ Organize two WWP meetings, one of these organized jointly with HITEC WWP
  - ▶ Organize first training jointly with HITEC WWP (month 6)
  - ▶ Prepare detailed work plan for the second year (month 9)

# Key challenges & objectives for Year 1

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- ▶ **Task 2 - Transport Mechanisms & Task 3 - Barrier Integrity**
  - ▶ Setting up experiments and defining the experimental protocols, ensuring that these are consistent and complementary between the labs involved
  - ▶ Modelling teams participating to these tasks will
    - ▶ review experimental programme and, when required, support experiment designs and the definitions of protocols through scoping calculations
    - ▶ develop new modelling tools for conceptualising transport mechanisms at micro & macro scales
  - ▶ Remark:
    - ▶ Self-sealing studies (subtask 3.2) closely connected to the ones planned in HITEC WP → part of the experimental programme will be elaborated jointly to optimize experiments carried out during the duration of the EURAD under various thermal and chemical conditions for coherency and complementarity.

# Key challenges & objectives for Year 1

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## ▶ **Task 4 – Repository performance aspects**

- ▶ Produce a draft compilation and comparison of current conceptualizations of gas transport through repositories as considered in the Member States (month 12).
  - ▶ Storyboards will be used as tools for communicating the conceptualizations
- ▶ Propose a generic repository configuration and sets of properties and conditions on which subtask 4.2 will test (from year 2) various evaluation approaches (month 12)
- ▶ Summarize the current modelling approaches used to assess the impact of gas on repository performance in the programme of the Member States, highlighting similarities and identifying the rationale for differences (month 12)
- ▶ Remark:
  - ▶ Subtask 4.2 starts month 9 – Specific task 4 working meeting, month 9