

# EURAD ACED

## Assessment of Chemical Evolution of ILW and HLW Disposal Cells

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Work package and task leaders (see below for full consortium)

### Background

The chemical evolution of a disposal cell, i.e. waste packages and their immediate surroundings such as other waste packages or near field components, forms an important input for the evolution of a repository for nuclear waste and the assessment of safety- and performance-related aspects.

### Objective

To improve methodologies for deriving multi-scale quantitative models for the description of the chemical evolution at the disposal cell scale

To derive robust mathematical models including the most relevant processes that drive the chemical evolution at the disposal cell scale

### Aim

A better conceptual and mathematical representation of the chemical evolution in order to:

- Improve the assessment and quantification of generic safety functions such as isolation and containment of waste constituents
- Obtain a better substantiation of conservatism and reduction of uncertainty
- Increase the scientific basis for definition of requirements of materials

### Interface Scale (Task 2)

*Evolution at the interface of  
Steel-Cement or Steel-Clay*

- Under different temperatures and chemical gradients
- Study of presence of heterogeneities at interfaces

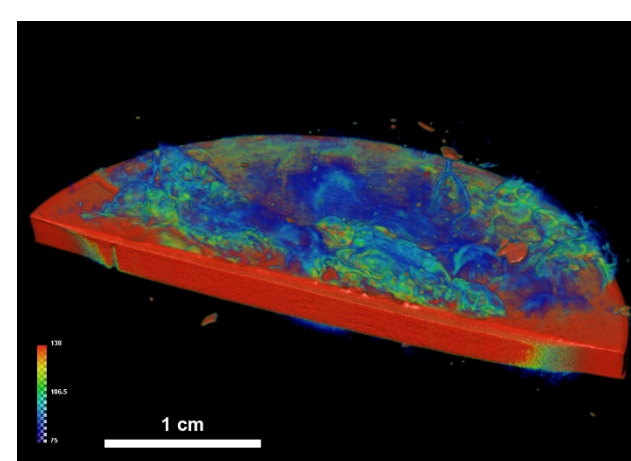
#### Experimental

Dedicated experimental program combining **new** and **existing** experiments with a life-span from a few months up to more than a decade.

Variables: corrosion rate, corrosion products, physical-chemical evolution at interface, transport properties



10-year contact between carbon steel and Toarcian claystone – right picture shows CT of iron diffusion in the argillite (Dauzères et al., 2013)



#### Modelling

Integrate existing knowledge of corrosion at clay or concrete interfaces into reactive transport models  
Validation with experimental studies  
Upscaling information as input to waste package and disposal cell scale

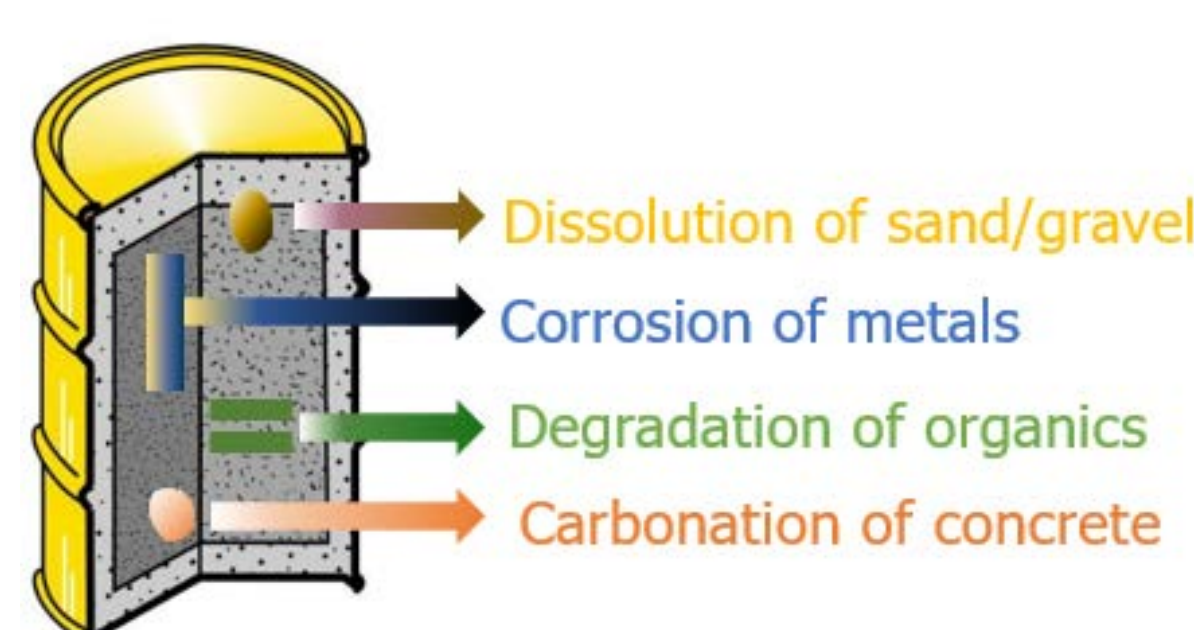
### Waste Package Scale (Task 3)

*Evaluation of process knowledge integration  
and model abstraction techniques*

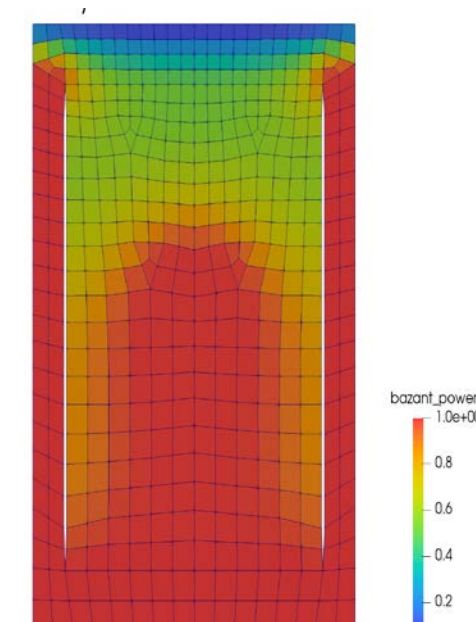
- For representative ILW and HLW waste packages
- ILW concrete degradation – metal corrosion – organic matter degradation
- HLW glass alteration rate – chemistry of buffer – nature of corrosion products

#### Experimental

Existing long-running experiments for HLW and ILW will be analyzed to provide additional data for model validation



Modelling of interacting processes at waste package scale – right picture shows chemical reactivity (Kosakowski, 2019)



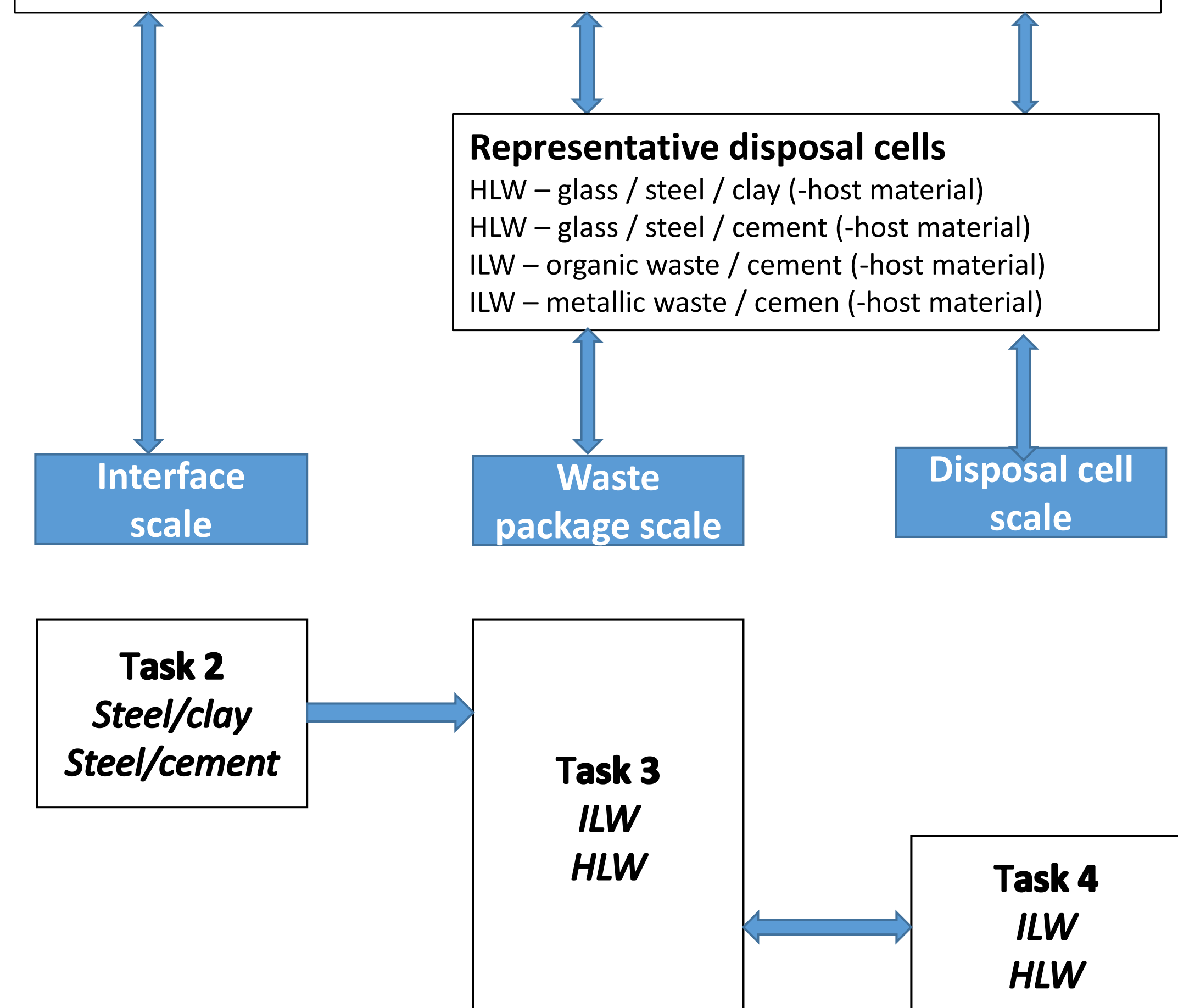
#### Modelling

Stepwise approach

- First model step using existing information
- Second model step update with new knowledge and data
- Derivation of abstracted models, upscaled processes and effective parameters

### Task 1.1, 1.3 Coordination and Training material

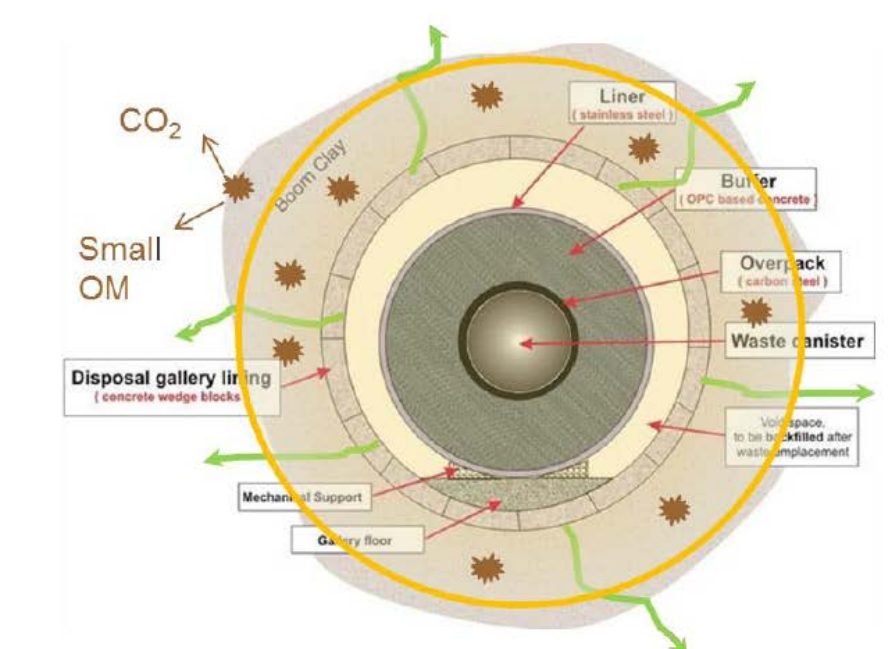
**Task 1.2, 1.4, 1.5 – State-of-the-art – Current practices – Experiments – Models on 6 interfaces**  
Glass-steel, cement-granite, cement-clay, steel-clay, steel-cement, steel-granite  
HLW and ILW disposal cells



### Disposal Cell Scale (Task 4)

*Integration of state-of-the-art in full model  
to simulate the chemical evolution of  
ILW and HLW disposal cells*

- Upscaling information from other scales
- Assessment of interaction of degradation processes
- Benchmark for abstraction methodologies



Waste package and its immediate surrounding - Schematic picture of possible chemical alterations (Maes, 2014)

*Abstraction – turning full model  
in robust and manageable modules*

- That reflects the current state-of-the-art
- That reflects the key features of the complex model

*Identify key interactive processes, parameters  
and features affecting chemical evolution*

- Sensitivity analysis of parameters
- Mapping critical parameters to performance targets or risks
- Analyzing the response of the system to different environmental conditions

### Consortium

Budget: 5.1 k€ 25 partners from 11 countries – 2019-2023

Andra (FR), Bel-V (BE), BRGM (FR), CEA (FR), CIEMAT (ES), CNRS/GeoReSS (FR), COVRA (NL), Ecole des Mines (FR), EDF (FR), FZJ (DE), IRSN (FR), LEI (LT), MTA-EK (HU), NRG (NL), PSI (CH), SCK•CEN (BE), SUBATECH (FR), SURAO (CZ), UAM (ES), UDC (ES), UFZ (DE), UJV (CZ), Uebern (CH), VTT (FI), ZAG (SI)