Research within the CORI WP in EURAD: optimized understanding of cement-organics-radionuclide-interactions

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CORI - Main Objectives

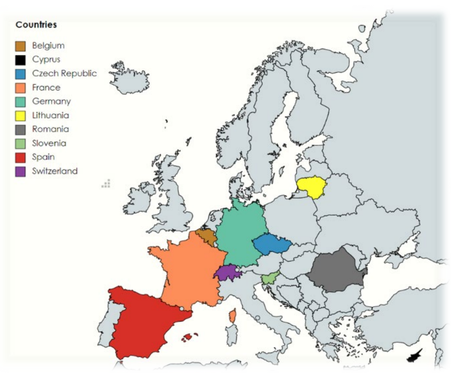
- **Improve the knowledge on the organic release issues which can accelerate the radionuclide migration in the the post-closure phase of repositories for ILW and LLW, including surface/shallow disposal.**
- CORI objectives are addressing topics in the context of cement-organic-radionuclide-interactions.
- Organic materials are present in some nuclear waste and as admixtures in cement-based materials and can potentially influence the performance of a geological disposal system.
- Potential effects of organic molecules are related to the formation of complexes in solution with some radionuclides of interest (actinides and lanthanides) which can (i) increase the radionuclide solubility and (ii) decrease radionuclide sorption.
- Cement-based materials will be degraded with time in the context of waste disposal inducing a large range of alkaline pH conditions according to their degradation state.
- Irradiation and alkaline pH provides specific conditions under which the organics can degrade, thus increasing their potential impact on repository performance.
- Critical open topics and data needs required to better assess and quantify cement-organic-radionuclide-interactions are defining the three R&D oriented CORI Tasks 2, 3, 4:
  - Coordination, SOTA, training material (Task 1)
  - **Organic Degradation (Task 2)**
  - **Organic-Cement-Interactions (Task 3)**
  - **Radionuclide-Organic-Cement-Interactions (Task 4)**

Overarching objectives:

- Support member states to further develop their national RD&D programms and support programms at an early implementation stage.
- Enhance cooperation between the different participating groups and countries.
- Knowledge transfer and training of young researchers in view of future demands for qualified staff is a key aspect of CORI.

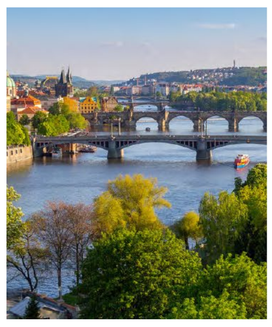
CORI Partner

Organisations	Organisations
✓ **Andra**, France ▪ BRGM, France	✓ **KIT**, Germany ▪ Amphos21, Spain ▪ JGU INC, Germany ▪ Upotsdam, Germany
✓ **CEA**, France	✓ **PSI**, Switzerland ▪ EMPA, Switzerland
✓ **CIEMAT**, Spain ▪ CSIC, Spain	✓ **RATEN**, Romania
✓ **CNRS**, France ▪ UOrléans, France ▪ Subatech, France	✓ **SURAO**, Czech Republic ▪ CTU, Czech Republic ▪ UJV, Czech Republic
✓ **CVREZ**, Czech Republic	✓ **SCK-CEN**, Belgium
✓ **CPST**, Lithuania	✓ **UCY**, Cyprus
✓ **FZJ**, Germany ▪ HZDR, Germany	
✓ **JSI**, Slovenia	



CORI – Dissemination / Workshop

- CORI will hold the final Project Meeting in connection to the 6th International Workshop on Mechanisms and Modelling of Waste/Cement Interactions, hosted by the Czech partners in 20th to 24th November 2023 in Prague.



6th International Workshop on Mechanisms and Modelling of Waste / Cement Interactions
PRAGUE, CZECH REPUBLIC
NOVEMBER 20TH – 22ND, 2023

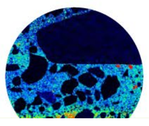
For information or questions regarding the workshop on "Mechanisms and Modelling of Waste / Cement Interactions", please contact: **Petr Večerník (ÚJV Řež)**

EURAD WP CORI Final Workshop
PRAGUE, CZECH REPUBLIC
NOVEMBER 23RD, 2023

Information on the Final Workshop of the WP CORI integrated in EURAD HERE will be made available at a later time. For information on CORI please contact the project coordinator **Marcus Altmaier (KIT)**

Excursions optional
NOVEMBER 24TH, 2023

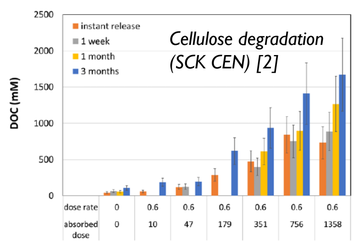
Laboratories: CTU, ÚJV, CVŘ SÚRAO facilities



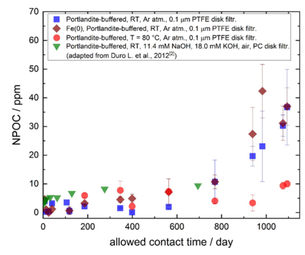
CORI – RD&D Work at Task Level

ORGANIC DEGRADATION *(J.Vandenborre, D. Ricard)*

- The following organic materials are studied: polyvinyl chloride (PVC), cellulose, ion exchange resins (IER) and superplasticizers.
- Degradation studies performed in CORI focus on two main degradation process and include detailed analysis of the degradation products:
  - Radiolytic degradation,
  - Hydrolytic degradation,
  - Degradation products characterization.

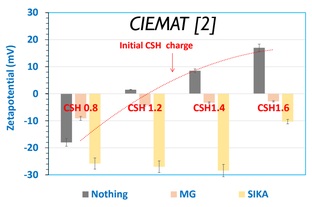


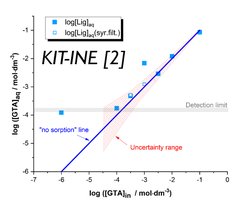
UP2 Resin material (KIT-INE) [2]

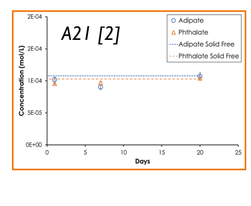


ORGANIC-CEMENT-INTERACTIONS *(D. García, P. Henocq)*

- Studies on the sorption and transfer properties of organic molecules that might be released from the organics inventories (including polymers and superplasticizers) present in cement-based materials.
- Investigated organic molecules are (i) degradation products from IER, Superplasticizers, PVC and cellulose (Isosacharinnate (ISA), Phthalate, glutarate, etc.), (ii) low molecular weight molecules (Acetate, etc), (iii) ^{14}C-bearing molecules from CAST, (iv) degradation products resulting from Task 2.
- Cement. CEM I, CEM II and CEM V are studied at different degradation states, as well as pure solid phases (CSH, C-(A)-S-H, AFm-phases/ettringite).

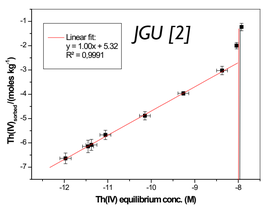




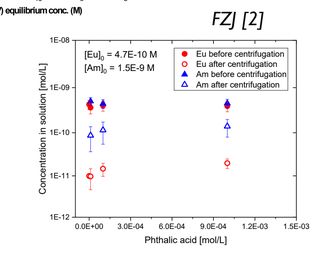


RADIONUCLIDE-ORGANIC-CEMENT-INTERACTIONS *(T. Missana, N. Macé)*

- Investigation of competition or synergetic effects in ternary systems (*i.e.* organic/ radionuclide/ cement).
- Mechanistic understanding of radionuclide interactions and quantitative transfer data in cementitious environments.
- Experimental work combines batch sorption, diffusion, column, speciation, solubility and advanced spectroscopic studies to allow fundamental model development and application-oriented analyses.
- The main radionuclides studied are: ^{63}Ni, Uranium, Actinides(III/IV) and/or homologues.



FZJ [2]



CORI - Expected Impact

Improved quantification of radionuclide solubility and sorption phenomena in cementitious environments to provide input for improved predictions of radionuclide transport.

Regarding RWM implementation needs. Issues at the repository scale identified:

- Improved scientific basis for the Safety Case for LWL/ILW waste repositories featuring high organic content.
- Co-storage of waste: support decisions on whether or not a mix of various wastes (organics, soluble salts, exothermic waste) can be foreseen.
- Optimization of vault design: limitations of interactions between the vaults regarding their content. CORI will provide information on the organic plume by characterizing the transfer behaviour in cement-based materials.
- Optimization of concrete formulations as regards the potential effect of superplasticizers on radionuclide transfer properties.

Regarding safety

- Characterizing the effect of the organic plume on the behavior of radionuclides in terms of:
- Solubility (limitation of solubility increase).
- Sorption (limitation of retention decrease) in terms of K_d values.
- Retention of potentially ^{14}C-bearing organic molecules (determined in CAST project) in cementitious environments in the case of specific waste.
- Reduction of uncertainties on the current knowledge, which is mainly based on K_d values.
- Improved knowledge on the known organic molecules present in degradation solutions (not considered so far) with their complexing properties: better definition of the organic inventory regarding the waste and the concrete vault (geological and surface repositories).

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References: *[1] Altmaier et al. (2020) SOTA D3.1 (https://www.ejp-eurad.eu/) ; [2] 2nd WP CORI Annual Workshop, November 2020*

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