CORI

cement-organic-radionuclide-interaction

M. Altmaier/KIT-INE, Berlin, 3-4 December 2018

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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 geological repositories for ILW and LLW/VLLW, 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 the radionuclide sorption.

CORI - Main Objectives

- 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.
- Alkaline pH provides specific conditions under which the organics can degrade, which contributes to increasing their potential impact on repository performance.
- Critical open topics and data needs required to better assess and quantify cement-organic-radionuclide-interactions are reflected in the three R&D oriented CORI Tasks:
  - Organic Degradation
  - Organic-Cement-Interactions
  - Radionuclide-Organic-Cement-Interactions

CORI - Main Objectives

Overarching objectives

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

CORI - Expected impacts

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 of interest at the repository scale identified:

- Improved scientific basis for the Safety Case for L/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.

CORI - Expected impacts

Regarding safety

- Characterizing the effect of the organic plume on the behavior of radionuclides in terms of:
- Solubility (limitation of solubility increase), and
- 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.

- Reduce the uncertainties on the current knowledge, which is mainly based on K_d values.
- Improve the 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).

CORI Participants

Organisations
✓ **Andra**, France ▪ BRGM, France
✓ **CEA**, France
✓ **CIEMAT**, Spain ▪ CSIC, Spain
✓ **CNRS**, France ▪ UOrléans, France
✓ **CVREZ**, Czech Republic
✓ **CPST**, Lithuania
✓ **FZJ**, Germany ▪ HZDR, Germany
✓ **JSI**, Slovenia

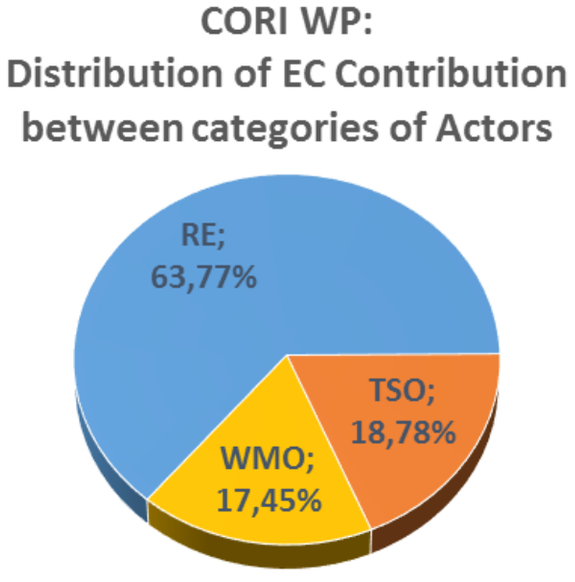
Organisations
✓ **KIT**, Germany ▪ Amphos21, Spain ▪ JGU INC (UMAINZ), Germany ▪ Upotsdam, Germany
✓ **PSI**, Switzerland
✓ **RATEN**, Romania
✓ **SURAO**, Czech Republic ▪ CTU, Czech Republic ▪ UJV, Czech Republic
✓ **SCK-CEN**, Belgium
✓ **UCY**, Cyprus

CORI – Task Breakdown and WP Board

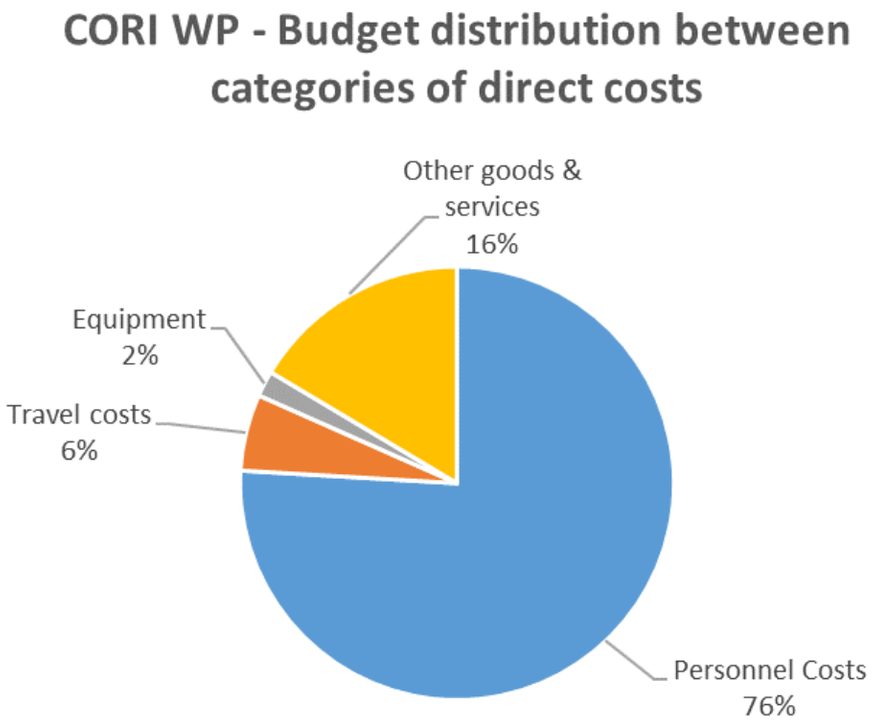
- **Task 1 - S/T coordination, state-of-the-art, training material**
  Start: Month 1 – **End**: Month 48 - **Task Leader:** [**KIT**] (WP Leader).
- **Task 2 - Organic degradation**
  Start: Month 1 – **End**: Month 48 - **Task Leaders:** [**CNRS-SUBATECH**] [**Andra**].
- **Task 3 - Organic-cement-interactions**
  Start: Month 1 – **End**: Month 48 - **Task Leader:** [**KIT (Amphos21)**] [**Andra**].
- **Task 4 - Radionuclide-organic-cement-interactions**
  Start: Month 1 – **End**: Month 48 - **Task Leader:** [**CEA**] [**CIEMAT**].

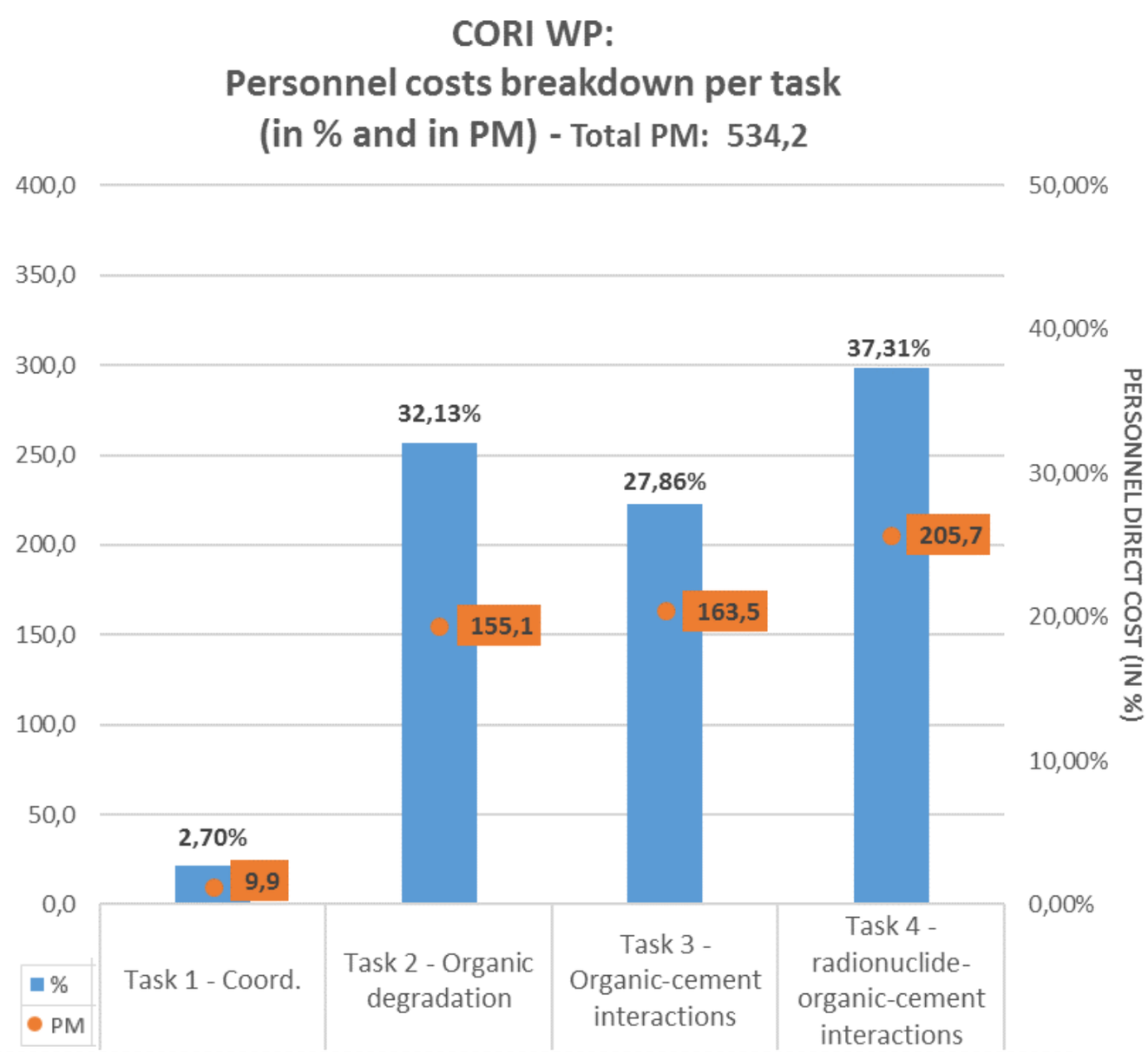
- If you are interested in being connected/associated to CORI, contact WP Leader at: marcus.altmaier@kit.edu

CORI – Planned resources



TOTAL BUDGET	4,7M€
EC requested contribution	2,3M€





CORI – Task 1

S/T COORDINATION, SOTA, TRAINING MATERIAL

- Coordination of WP CORI and exchange with PMO.
- Ensure that CORI is progressing according to the agreed planning, milestones and deliverables.
- Prepare Annual CORI WP Meetings and the Meetings of the CORI WP Board.
- CORI will prepare an initial state-of-the-art report (SOTA) at Month 6 (**D3.1**) with updating at Month 48 (**D3.3**). Sub-chapters of the SOTA will address
  - *(i) organic degradation by hydrolytic and radiolytic processes.*
  - *(ii) cement-organic-interactions.*
  - *(iii) cement-organic-radionuclide-interactions.*
  - *D3.1 + D3.2 include a critical summary on "fundamental cement chemistry".*
- Develop material for training based on the information detailed in the SOTA reports. With updating at Month 48.
- Specific contributions to Training events (e.g. considering PhD courses) are to be developed in direct exchange with the future Training Event organisers.

CORI – Task 2
ORGANIC DEGRADATION

- Improve knowledge of degradation of organic wastes in conditions representative of disposal facilities.
- Improve understanding of radiolytic/hydrolytic degradation of organic materials.
- Provide characterization and quantification of soluble organic species generated by degradation.

- Degradation studies performed in CORI will focus on two main experimental conditions and include detailed analysis of the degradation products:
  - Radiolytic degradation.
  - Hydrolytic degradation.
  - Characterisation and quantification of soluble organic species.
  - Gas measurements.

CORI – Task 3
ORGANIC-CEMENT-INTERACTIONS

- Improve the understanding of the behaviour of anthropogenic organic molecules within cementitious systems.
- Study 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) main degradation products like ISA, phthalates, (iv) EDTA and low molecular weight molecules, (iii) ^{14}C-bearing molecules from CAST, (iv) degradation products resulting from Task 2.
- Cement. CEM I and CEM V studied at different degradation states (including altered/carbonated states), as well as pure solid phases such as C-(A)-S-H and AFm-phases/ettringite. One partner will study CEM IV.
- Impact of iron and calcium will be studied to elucidate their potential role as competitors in radionuclides in retention or complexation reactions.

CORI – Task 4
RADIONUCLIDE-ORGANIC-CEMENT-INTERACTIONS

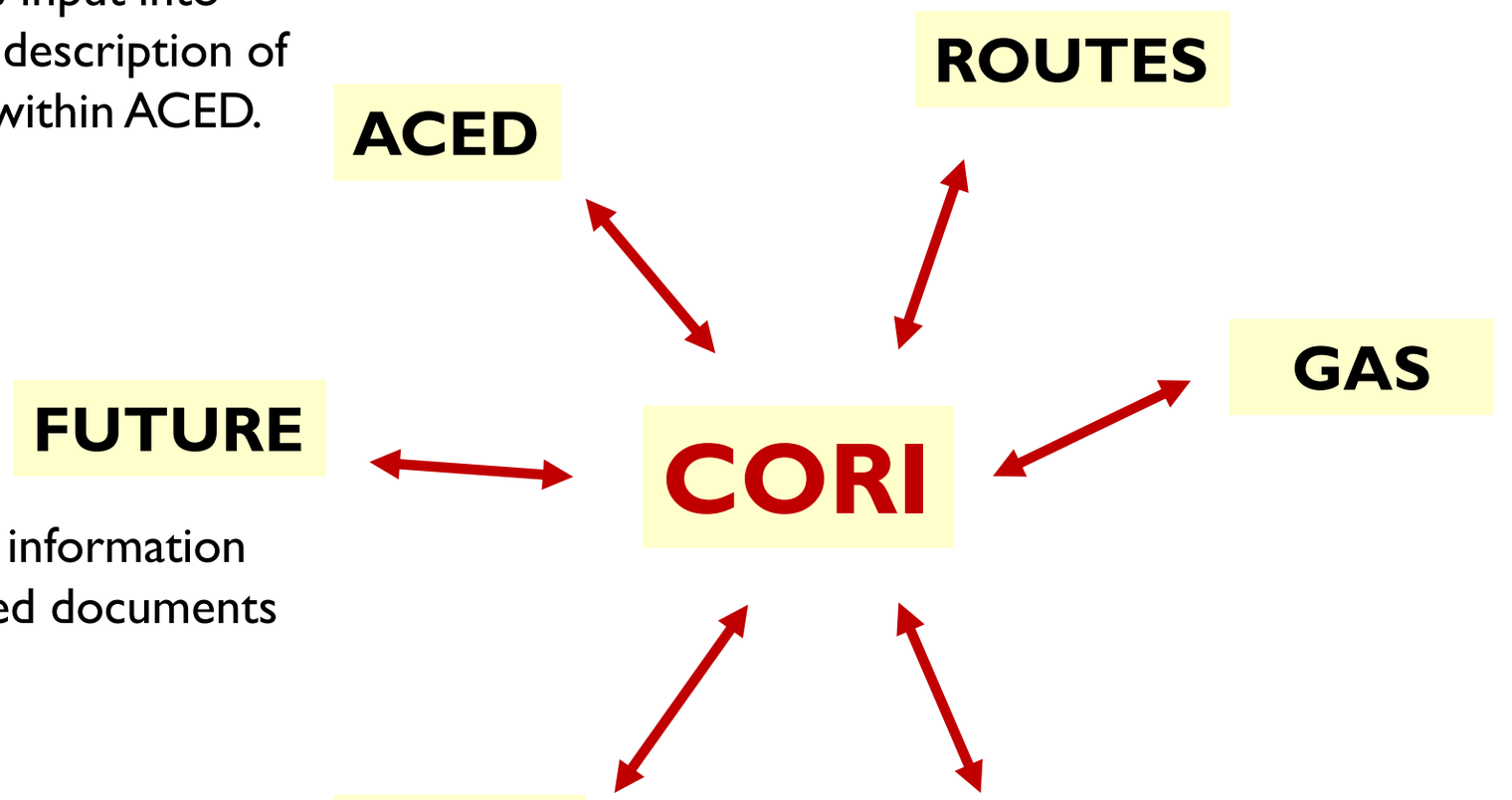
- Improving the knowledge on organic-radionuclide complexes mobility in cement-based systems.
- Studying the competition or synergetic effect in ternary systems (*i.e.* organic/ radionuclide/ cement).
- Providing a mechanistic understanding of radionuclide interactions and quantitative transfer data in cementitious environments.

- Experimental work is combining batch sorption, diffusion, column, speciation, solubility and advanced spectroscopic studies to allow fundamental model development and application-oriented analyses.
- The main radionuclides studied are: Nickel, Uranium, Actinides(III/IV) and/or homologues.
- Organic and cementitious materials investigated are consistent with those studied in Task 2 and Task 3 of CORI and includes Fe and Ca competition.

CORI interaction with other projects

degradation processes of organic materials within cementitious environment, as input into phenomenological description of these processes within ACED.

exchange of information
review selected documents



End of year 3: interactions are intended between CORI and GAS to clarify if the organics degradation studies in CORI can provide new input on volatile molecules production.

- Regular exchange of information
- SOTA reports in CORI at months 6 should include a section describing uncertainties.

exchange of information
review selected documents

Deliverables in CORI

Task 1

- **D3.1 CORI - SOTA on cement-organic-radionuclide-interactions in the content of L/ILW disposal.** Chapters include: (i) Organic degradation by hydrolytic and radiolytic processes; (ii) Organic-cement-interactions; (iii) Radionuclide-organic-cement-interactions; (iv) Fundamental Cement Chemistry. [**KIT**] (Months 6)

- **D3.2 CORI - SOTA UPDATE on cement-organic-radionuclide-interactions in the content of L/ILW disposal**. Chapters include: (i) Organic degradation by hydrolytic and radiolytic processes; (ii) Organic-cement-interactions; (iii) Radionuclide-organic-cement-interactions; (iv) Fundamental Cement Chemistry. [**KIT**] (Months 48).

- **D3.3 CORI - Training Materials.** [**KIT**] (Month 8).

- **D3.4 CORI - Training Materials UPDATE.** [**KIT**] Month 48).

- **D3.5 CORI - Final Report integrating the RD&D performed in CORI, including application to the Safety Case**. [**KIT**] (Month 48).

Deliverables in CORI

Task 2

- **D3.6 CORI - Final Report on results generated in Task 2 of CORI** on (i) Degradation of organic materials by hydrolytic and radiolytic processes, and (ii) identification and quantification of degradation products. [**CNRS-SUBATECH**] (Month 44).

Task 3

- **D3.7 CORI - Final Report on organic retention in cementitious systems. [Andra]** and [**KIT (Amphos21)**] (Month 44).

Task 4

- **D3.8 CORI - Final Report on radionuclide mobility in cementitious materials in the presence of organics,** including (i) Radionuclide speciation under alkaline conditions in presence of organics, and (ii) Evaluation of radionuclide mobility in cementitious materials in the presence of organics. [**CEA**] and [**CIEMAT**] (Month 46).

CORI key challenges & objectives for Year 1

- WP Board meetings scheduled for months 1, 6, and 12, and the continuous communication with the CORI partners and the PMO.

- CORI prepares a state-of-the-art report on cement-organic-radionuclide-interactions as D3.1,(month 6). Related milestone documents on Task level which focus on the state-of-the art for specific topics feed into D3.1: (i) organic degradation by hydrolytic and radiolytic processes, (ii) organic-cement-interactions, (iii) radionuclide-organic-cement-interactions, and (iv) fundamental cement chemistry.

- Additional Technical Report as milestone in Task 4 (month12) on (i) radionuclide retention on CSH or CASH or AFm/AFt in the presence of organics, and (ii) radionuclide retention on HCP in the presence of organics

- Deliverable on Training Materials D3.3 developed until month 8.

- Preparation of the RD&D programme - starting at month 7 is relevant for Task 1, 2, 3. (includes recruiting PhD students, setting up experiments, …).

- First Annual CORI Workpackage Meeting (at month 12) is important focus of activities at the end of Year1. 1AWS to be organised as cluster meeting, including exchange with End User Group., first Technical Meetings on Task level and targeted exchange between Tasks. Contributions for 1AWS Proceedings.

Thanks for your contributions !!!

Thank you for your attention !!!