

# Overview of the outcome of the TSWG CORI “Cement-Organics-Radionuclide-Interactions”

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# OUTLINE

- Summarize activities of TSWG CORI
- Provide overview on main outcome of CORI
  
- General scientific/technical questions driving CORI
- Overview on identified key topics in CORI
- Concept and status for developing CORI proposal for Horizon 2020 call.
- Discuss next steps...

- Summarize activities of TSWG CORI
- Provide overview on main outcome of CORI
- Next steps...

## CEMENT

*Cement based materials very widely used in nuclear waste disposal applications. Cementitious environments relevant!*

## ORGANICS

*Large + highly diverse organics inventories in repositories, especially relevant in LAW-ILW context!*

## RADIONUCLIDE

*High amount of relevant radionuclides present in repository which are chemically sensitive to organics!*

## INTERACTIONS

*Changes in chemical speciation (e.g. via complexation) can significantly affect RN mobility and transport!*

- Topic of Cement-Organics-Radionuclide-Interactions identified as relevant topic by IGD-TP
- **TSWG CORI established within IGD-TP:  
JA6b: Cement-Organics-Radionuclide-Interactions**
- *Joint activity launched in EG15*
- *In 2015: JA leader Marcus Altmaier taking over from B. Kienzler (both KIT-INE)*

- **CORI meeting at KIT (10. + 11. March 2015, Karlsruhe)**
  - 28 representatives from 4 WMOs and 16 Research Institutes
  - Oral presentations from partners on technical/scientific issues related to the CORI topic.
  - Most constructive interaction with WMO representatives!
  - Identification of key topics and key topics leader
  - Preparation and distribution of meeting minutes (IGD-TP website)

# Karlsruhe meeting, partner and key topics...

**(A)**  
**Organics inventories in different countries. Identification of relevant organics in PA**

*NAGRA  
ANDRA, SKB,  
ONDRAF-NIRAS,  
RWM  
=> SURAO,  
ENRESA, ...*

**(B)**  
**Degradation of organics => Result of hydrolysis and radiolysis**

*Subatech  
NAGRA, ONDRAF-  
NIRAS  
Amphos, Loughb.  
Univ. CEA, PSI,  
SCK-CEN  
KIT, ANDRA  
UPPC, UManch*

**(C)**  
**Mobility of organics in cementitious environment and their interaction with Fe**

*Amphos  
ONDRAF-NIRAS,  
CEA, ANDRA,  
Subatech, PSI  
Sheffield, SCK-  
CEN, SKB, KIT,  
UPPC, Ubern,  
Umanch.*

**(D)**  
**Mobility of organics-RN complexes in a cementitious environment**

*CEA  
Heidelb., Amphos  
ONDRAF-NIRAS,  
Loughb. Univ. ,  
Jülich, ANDRA,  
UniMainz,  
Subatech,  
Sheffield, SCK-CEN,  
SKB, KIT  
UPPC, UManch*

**(E)**  
**Modelling Upscaling Application to PA**

*KIT (prelim.)  
BRMG, Amphos  
Jülich, CEA,  
ANDRA,  
Sheffield, SCK-  
CEN, SKB, ENEA*

- **CORI meeting highly productive and constructive, also in view of exchange between partners and with MWO representatives.**
- **Identification of topics for further activities in TSWG CORI.**

- **Spring 2015:** Distribution of **CORI Questionnaire** to partners
- Detailed information requested from CORI partners, in addition to the information already provided at the Karlsruhe meeting.
- Broad basis for identification of systems of main interest, overview of available experimental techniques, overview on modeling interests and expertise...

Additional:

- *Update on TSWG CORI for IGD-TP Master Deployment Plan 2015 (M. Altmaier).*



# Questionnaire on CORI

<b>Objective of your work within CORI:</b>	
Topic 1	
Topic 2	
Topic 3	
Topic 4	
Topic 5	

<b>Which type of organics:</b>	Superplasticizer	
	Plastics	
	Resins	
	Bitumen	
	Simple organics <i>(please specify)</i>	
	Other <i>(please specify)</i>	

<b>Dissolved org. species considered as ligands</b>	
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<b>Type of cement-based materials</b>	
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<b>Cement degradation</b>	
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<b>Radionuclides + relevant elements (e.g. Fe)</b>		
<b>Type of experiments</b>	Degrad. of org. Sorption Thermodynamics Migration Others	
<b>Methods/Analytics available</b>		
<b>Modelling <i>(please specify approach)</i></b>		
<b>Application of the results in PA</b>		
<b>Relevance/Innovative aspects of the work</b>		
<b>Is an ongoing project on issues related to CORI in your organization? shortly describe...</b>		

# TSWG CORI ACTIVITIES

- **Summer 2015:** Discussion on key-topics leader level to **systematize and prioritize topics** (close interaction with WMO representatives)
- Evaluation of submitted CORI Questionnaires
- Follow-up meeting on key topics leader level in Paris
- Follow-up meeting on WP level organized in two cases
- *Preparation of CORI contributions of IGD-TP EF6*

- Summarize activities of TSWG CORI
- Provide overview on main outcome of CORI
- Next steps...

# OUTCOME OF TSWG CORI

- Investigation of cement-organics-radionuclides-interactions is a highly relevant topic with significant implications for nuclear waste disposal.
- WMO analysis of relevant organics inventories in repository projects!
- The identified key topics, open questions and research tools allow to develop a comprehensive R&D approach for investigating these topics.
- *CORI is considered mature enough to start developing a proposal for the upcoming Horizon 2020 call.*
- CORI topics relevant for several European disposal projects thus and very suitable for a targeted collaborative European research effort.
- Key topics identified allow strong experimental and conceptual synergies (=> sharing of resources, exp. techniques and competences).

# CORI CONCEPT

**CORI proposes a comprehensive approach to answer relevant questions important for understanding cement-organics-radionuclides-interactions**

**Degradation of organics inventories in repository lead to the production of new organic degradation products.**

=> which ones? which substance classes? how fast? how much?

**Organics substances produced will interact with components of the cementitious environment.**

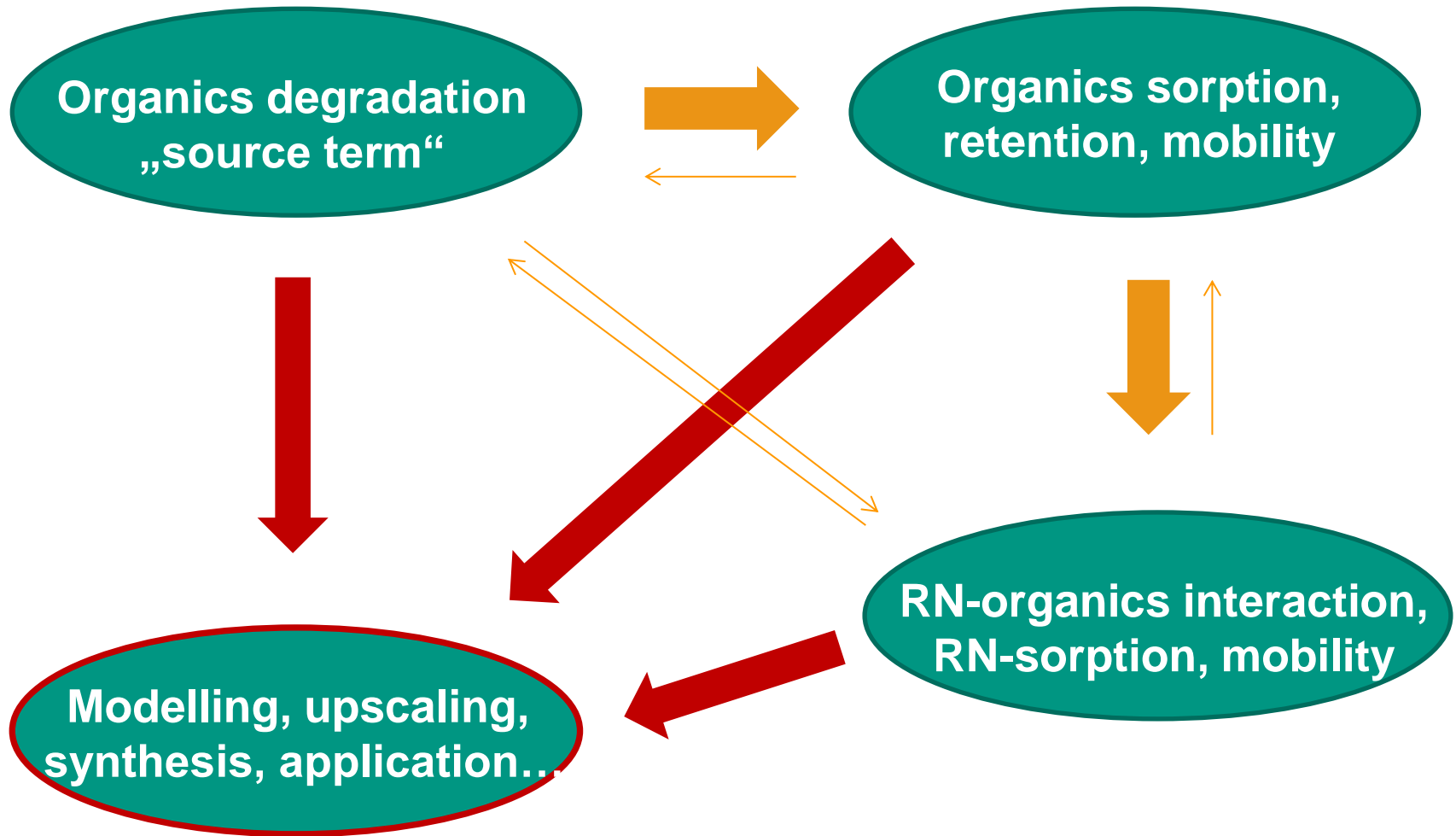
=> how much organics stay in solution? how much is sorbed? how are interactions with Fe?, what limitations on organics mobility?  $^{14}\text{C}$  species?

**Radionuclides interact with the organics in the aqueous phase or on the solid phase (in the ternary cementitious system).**

=> how much RN stay in solution? which impact on RN sorption? how assess consequences on RN chemistry? impact on transport processes and mobility?

**Workable tools required to support assessment of the potential impact of cement-organics-radionuclides-interactions on disposal projects. => YES!**

# CORI CONCEPT



## ***WP 1: “Degradation of organics - result of hydrolysis and radiolysis”***

- CORI has identified that degradation of organics products by radiolysis and hydrolysis at high pH is insufficiently known.
- Dedicated studies focusing on the radiolytic and/or hydrolytic degradation of selected organics of interest are proposed.  
*(bio-degradation not studied as this is included in MIND)*
- Key studies: kinetics of degradation rates (hydrolytic and radiolytic), measurements vs. time (irradiation or chemical), identification and quantification of the resulting organic substances.  
Overall aim: constitute source terms for relevant organic molecules.
- Impact of degradation processes on gas production is studied.
- CORI prioritises range of investigated organics materials (inventories)!

## ***WP 2 “Mobility of organics in cementitious environment and their interaction with Fe”***

- Possibility to improve the description and quantification of anthropogenic organic molecules in cementitious systems.
- Reliable quantification of aqueous organics concentrations in pore water => concentrations, chemical interactions, transfer properties.
- Studies include analysis of Fe containing cementitious systems.
- Work includes quantification of  $^{14}\text{C}$  retention processes. (=> CAST)
- Aim: (i) understanding of the competitive effect of organic ligands on sorption and transfer properties in cement systems, (ii) assess impact of iron in ternary systems Fe-org-cement, (iii) prediction of  $^{14}\text{C}$  retention in cementitious environments.



## ***WP 3 “Mobility of organics-RN complexes in a cementitious environment”***

- Improved understanding of radionuclides/organics complexes mobility in cement-based systems required.
- In the ternary systems studied, RN mobility influenced by several processes under investigation in CORI:
  - Radionuclide complexation in the aqueous phase by organic molecules acting as ligands;
  - Competition effects for the surface adsorption sites of cement-based materials or potential synergic processes.
- Aim: combined experimental and modelling work to assess and quantify mechanisms at microscopic scale in relevant ternary systems to support calculations on RN mobility.

## ***WP 4 “Modelling, upscaling, application to PA”***

- Need to summarize and systematize results generated in experimental WPs 1,2,3 to allow application in waste disposal projects.
- *WP 4 is not focusing on the modeling required to analyze and directly evaluate the studies performed in WP 1,2,3.*
- Work in this WP will address:
  - mobility of radionuclides and organics in cementitious environments (tool: reactive transport modelling).
  - Upscaling of CORI results (lab-scale to real systems analysis).
  - Synthesis and application to PA (source term definition, threshold effects, sensitivity analysis, validate simplifications supporting PA assumptions...).

# INTERACTION WITH OTHER PROJECTS

- CORI topics allow strong synergies with ongoing EC projects.
- Complementarity of approaches and complementary research results.
- Tools to ensure effective flow of information between projects will be implemented in CORI!

## MIND

*Organics degradation via bio-mediated processes studied.  
=> Synergy with CORI WP1.*

## CAST

*Chemical speciation and concentrations of  $^{14}\text{C}$  from irradiated materials. => Synergy with CORI WP2.*

## CEBAMA

*Transport processes and RN sorption studied and modelled in cement based systems. => Synergy with CORI WP4.*

# CONCEPT FOR CORI PROPOSAL

- **CORI proposal includes four R&D oriented Work Packages:**
  - WP 1 “Degradation of organics - result of hydrolysis and radiolysis” (*Subatech*)
  - WP 2 “Mobility of organics in cementitious environment and their interaction with Fe” (*Amphos21*)
  - WP 3 “Mobility of organics-RN complexes in a cementitious environment” (*CEA*)
  - WP 4 “Modelling, upscaling, application to PA” (*SCK·CEN*)
- Additional WPs on Management (Coord. KIT) + Training/Dissemination
- WPs estimated to receive similar PM and funding.
- **Total requested EC contribution: < 4 M€**

# POTENTIAL CORI PROJECT PARTNERS

## Potential CORI Beneficiaries

Amphos21 (ES), Bern Univ. (CH), BRMG (F), CEA (F), CTU (CZ), ENEA (IT), Heidelberg Univ. (DE), Juelich (DE), KIT-INE (DE), Loughborough Univ. (UK), Mainz Univ. (DE), Manchester Univ. (UK), NNL (UK), NRG (NL), Potsdam Univ. (DE), PSI (CH), SCK·CEN (BE), Sheffield Univ. (UK), Subatech (F), TERAMED (CZ), UJV (CZ).

**At present:** 21 potential partners from 8 countries

*CORI is open for additional proposals from new partners focusing on the identified key issues in CORI.*

## End User Group (WMOs)

ANDRA, NAGRA, ONDRAF/NIRAS, RWM, SKB, SURAO, (ENRESA), ...