WG3 – Cement Organics Radionuclides Interactions (CORI)

WMOs priorities & expectations

November 03-04, 2015

CORI framework

- Since beginning of 2015, three meetings between WMOs representatives

- Comparison between WMOs inventories and specific issues arisen

- Improvement in exchanges between WMOs since 2014 (*e.g. gas production rates, organic cement admixtures*)

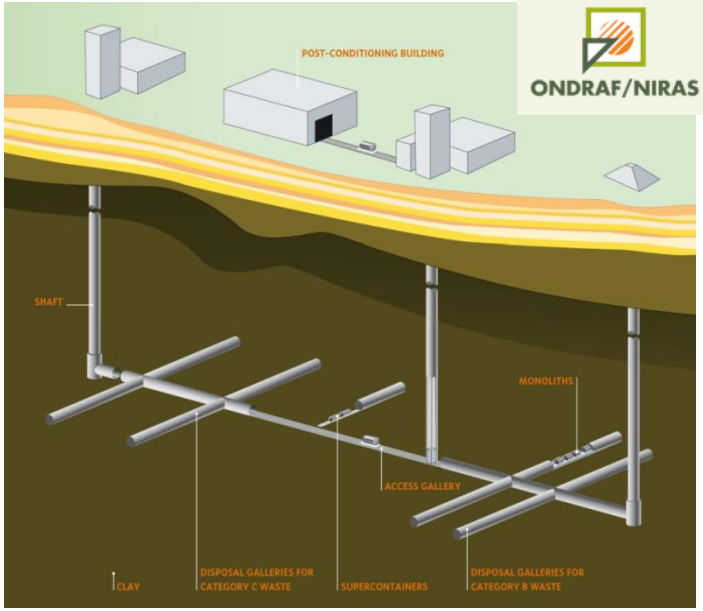
- Definition of common expectations ordering priorities

- Exchanges with topic leaders (to be developed especially for topics 1 and 4)

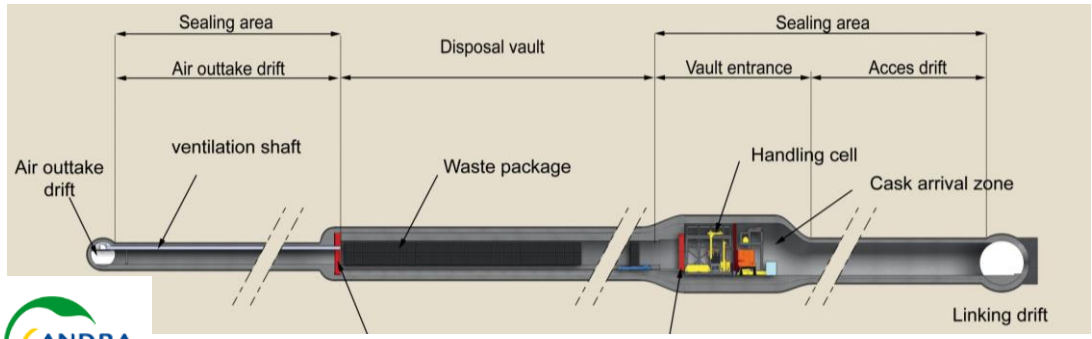
- Framing needs addressed to laboratories

- Identification of complementarity and relevance with other on going European projects

Layout of different repository designs for L/ILW-LL

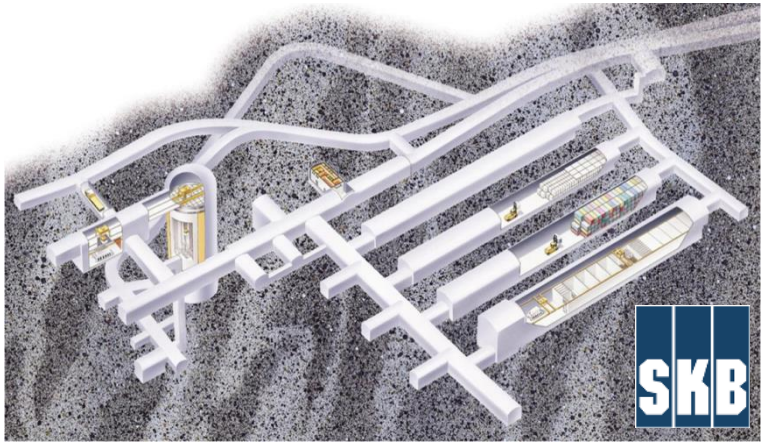


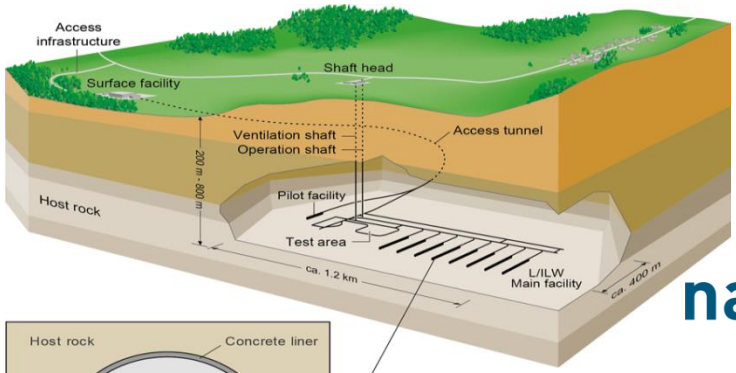
← HLW and L/ILW-LL in separate sections of same repository. Cement backfill

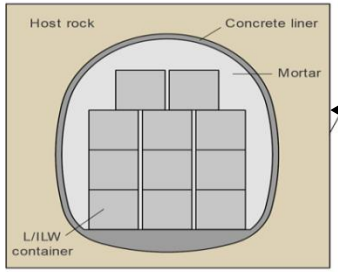


↑ ILW-LL cell: ~ 400m long for disposal vault (backfilled with cement CEM V)

Repository for short-lived LILW (SFR) silo and caverns, cement backfill ↓







← LILW-SL and LL in cement backfilled caverns (100 m long)

Repository conditions and inventories

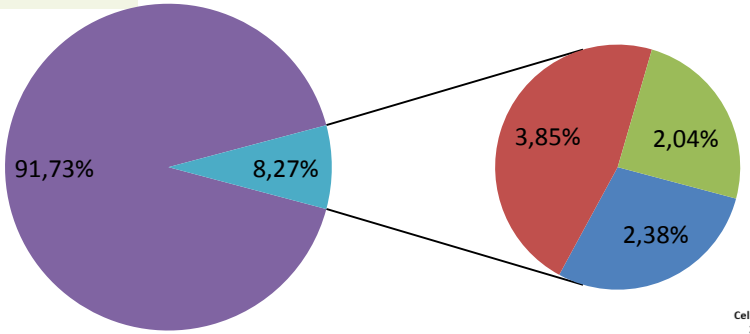
	SKB	ANDRA	ONDRAF	NAGRA	RWM
Total organics (kg)	1E+07	3.6 E+06 Without bitumen Only Cigéo **8.6E+06 in Centre de l'Aube**	2.6 E+06	3 E+06	1.2 E+07 Without bitumen

- **Crystalline and clayey host rock: organics sensitivity may be different**
- **Low Level Short-Lived and Intermediate Level Long-Lived are managed differently**
- **Cement-rich environment applies to all WMO's**

- **Reduce uncertainties and increase confidence regarding organics inventory**
- **Define safety margins**
- **Optimize disposal architecture, operating process, wastes density and distribution versus organic inventories**

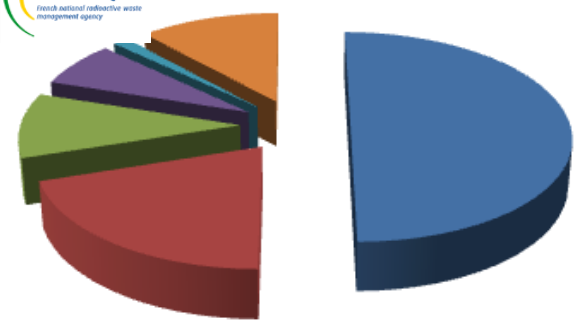
Inventories of organic wastes

ONDRAF/NIRAS



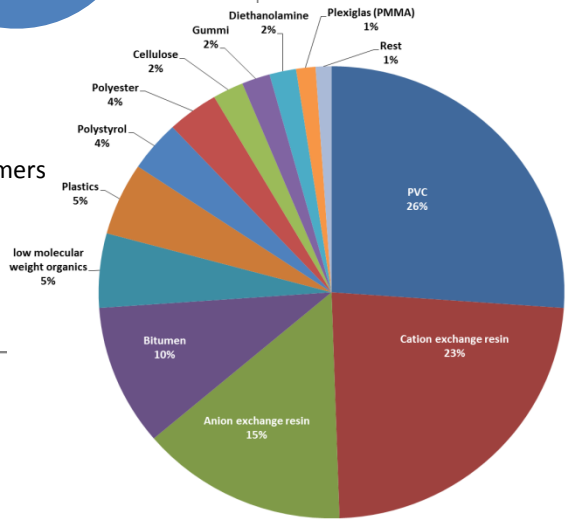
ANDRA French national radioactive waste management agency

Cigéo

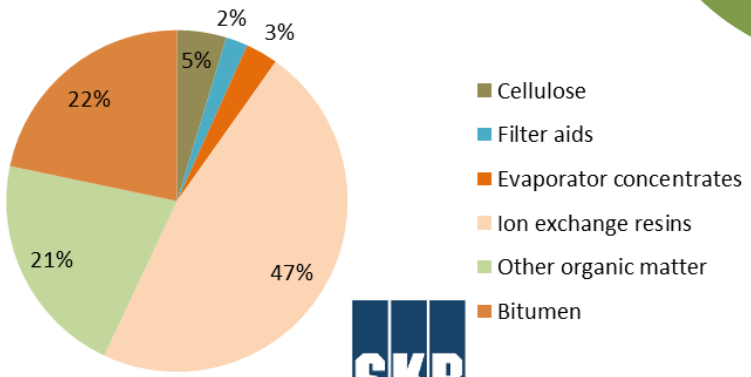


Resins: Low-Level Long-lived disposal project (18% in total mass)

nagra.

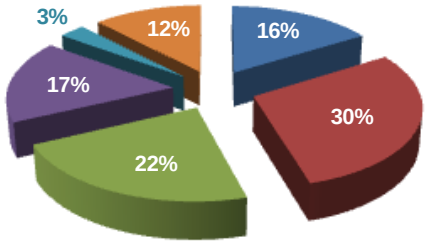


SFR



SKB

Radioactive Waste Management



Identification of relevant organics from 'overall' inventories

NOM	*Site specific* *Non stoichiometric models* *Out of the scope of CORI*
Bitumen	*Largest to significant part of organic inventories* *Good state of knowledge* *Poorly relevant in the CORI framework*
Resins	*Significant part of organic inventories* *Low degradation rates*
Halogenated polymers (PVC mostly)	*Largest part of organic inventories (up to 50% excluding Bitumen & Resins)* *Low degragation rates*
Polyolefins polymers (PE, PP…)	*Significant part of organic inventories* *Low degradation rates*
Cellulose	*Large part of organic inventories (10% to 15% in mass)* *Hydrolytic degradation has been studied extensively*
Polyacrylates	*Large part of organic inventories* *High degradation rates*
EDTA	*Limited part of organic inventories* *Chelating properties (well studied in acidic/neutral conditions)*
Superplasticizers	*Indirect but significant organic inventory* *Ill-characterized*

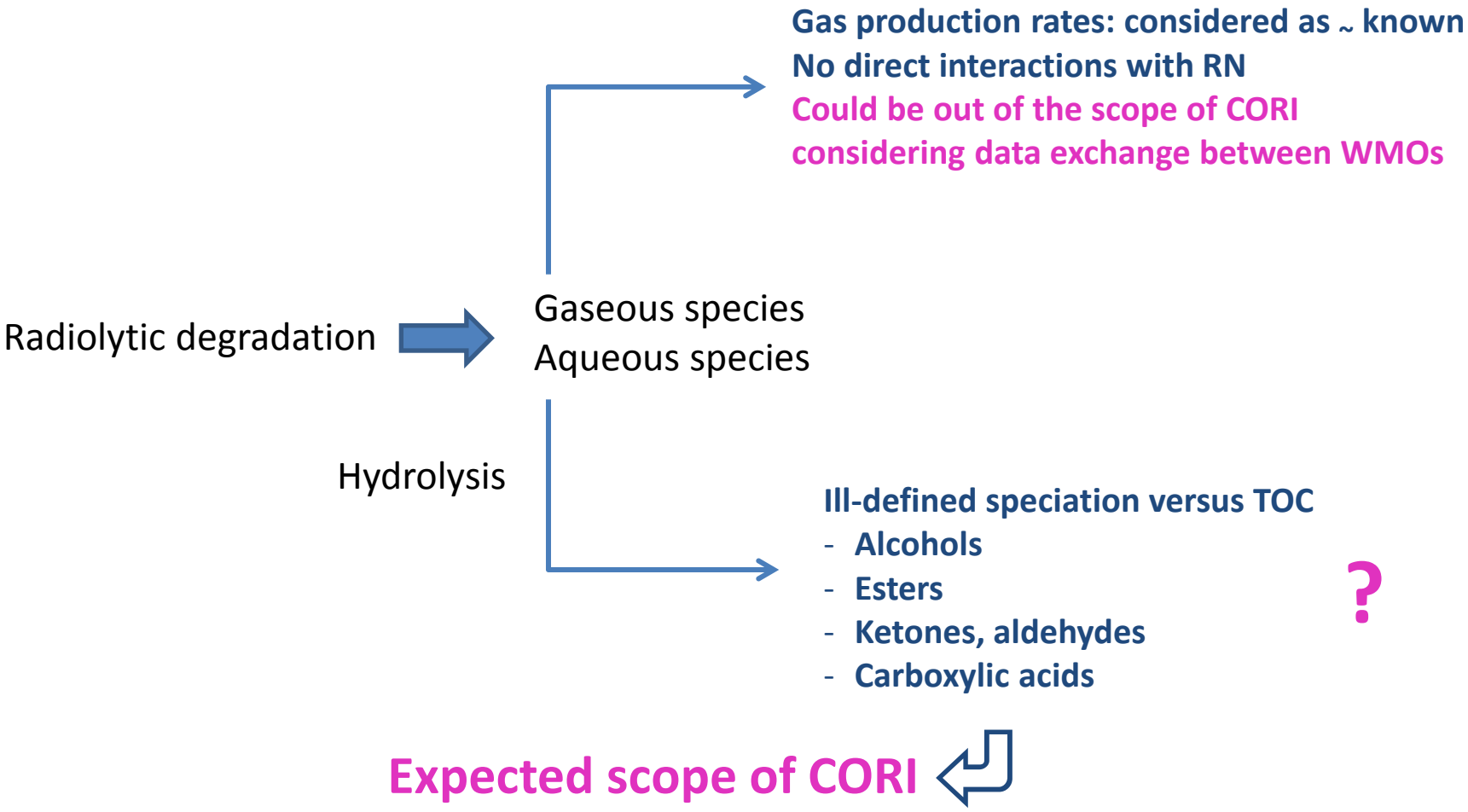
priorities

From organic compounds to organic species

Halogenated polymers (PVC mostly)	*High phthalate source term + Low weight carboxylic acids ?*
Polyolefins polymers (PE, PP…)	*Poorly characterized Low weight carboxylic acids ?*
Resins	*Rather well characterized C1-C2 carboxylic acids + methylated amines + SO_4 + NH_4…*
Cellulose	*Isosacharinic acid + Low weight carboxylic acids*
Polyacrylates	*Poorly characterized Low weight carboxylic acids ?*
EDTA	
Superplasticizers	*Polycarboxylates*

Need of characterization of relevant dissolved species for RN
Include studies on kinetics whenever possible

From organic compounds to organic species



How are dissolved organics treated in PA ?

- Kinetics of dissolved organics release: kinetic of cellulose degradation only
- Sorption on cement (Kd) and use of sorption reduction factor for RN that form complexes with organics (ISA and GLU) used by Andra, SKB, RWM and Nagra
- Solubility enhancement factor (ISA) used by RWM and Andra
- ONDRAF/NIRAS: Solubility of RN in high pH environment – up to now, no organics from waste are taken into account: Clay will be the main retention barrier (but including natural organic matter)
  - Assumption: natural organic matter >> organics in waste
- Degradation of organics can also contribute to gas production (H_2, CO_2, CO, CH_4)

Uncertainties arising ⇒ Threshold effects vs. Nature & content of organics
Consistency of correction factors
Sensitivity to uncharacterized organics

General expectations

From organic wastes inventory to dissolved species under cementitious conditions

→ Characterization / Quantification of dissolved TOC from main organic waste compounds (radiolysis/hydrolysis)
Focusing on complexing species

↓ *

From dissolved organic source terms to organic plume

→ Organics sorption as a function of
- Cement types / cement degradation
- From dispersed to consolidated cement materials
- From cements to armoured concretes (interactions with iron steel and corrosion products)
- From single organic to organics mixtures

↓ *

From organic plume to sensitivity on RN behaviour

→ RN sorption / diffusion as a function of
- sensitive single organics
- sensitive organics mixtures
- Cement types / cement degradation

↓ *

From Organics / RN / Cement materials interactions to PA assumptions

→ From interaction models to
- Threshold effects
- Correction factors
- Modelling applications

* Important gaps in TDBs for organics and RN complexes under cementitious conditions.
Acquisition of thermodynamic data is expected from TDB developments: exchanges in this field is encouraged, but should be out of the scope of CORI

Systems of interest

Relevant dissolved organics

Priorities towards complexing capacity

- Monocarboxylic acids (formic, acetic, propionic…)
- Dicarboxylic acids (oxalic, malonic, glutaric…)
- Aromatic carboxylic acids (phthalic…)
- Aminocarboxylic acids (EDTA)
- Hydroxicarboxylic acids (ISA, gluconic…)

Single organic species: well known (uncertainties under cement conditions)
Organics mixtures: less defined (especially for sorption/diffusion)

Relevant Radionuclides

- Transition elements
- Lanthanides
- Actinides

Relevant Toxic Element

- Pb

Relevant cementitious systems

- CEM I/II
- CEM V
- Armoured concrete systems

} vs. Long term evolution

Relevant degradation conditions

- Oxic / dried conditions for radiolysis
- Anoxic / water saturated conditions

Organic species: ^{14}C carrier molecules

^{14}C is released under

- Gaseous species
- Inorganic dissolved species
- Organic dissolved species

Need to improve current knowledge
on organic ^{14}C behaviour in cementitious barriers

Consistency with 2nd topic in CORI: organic mobility

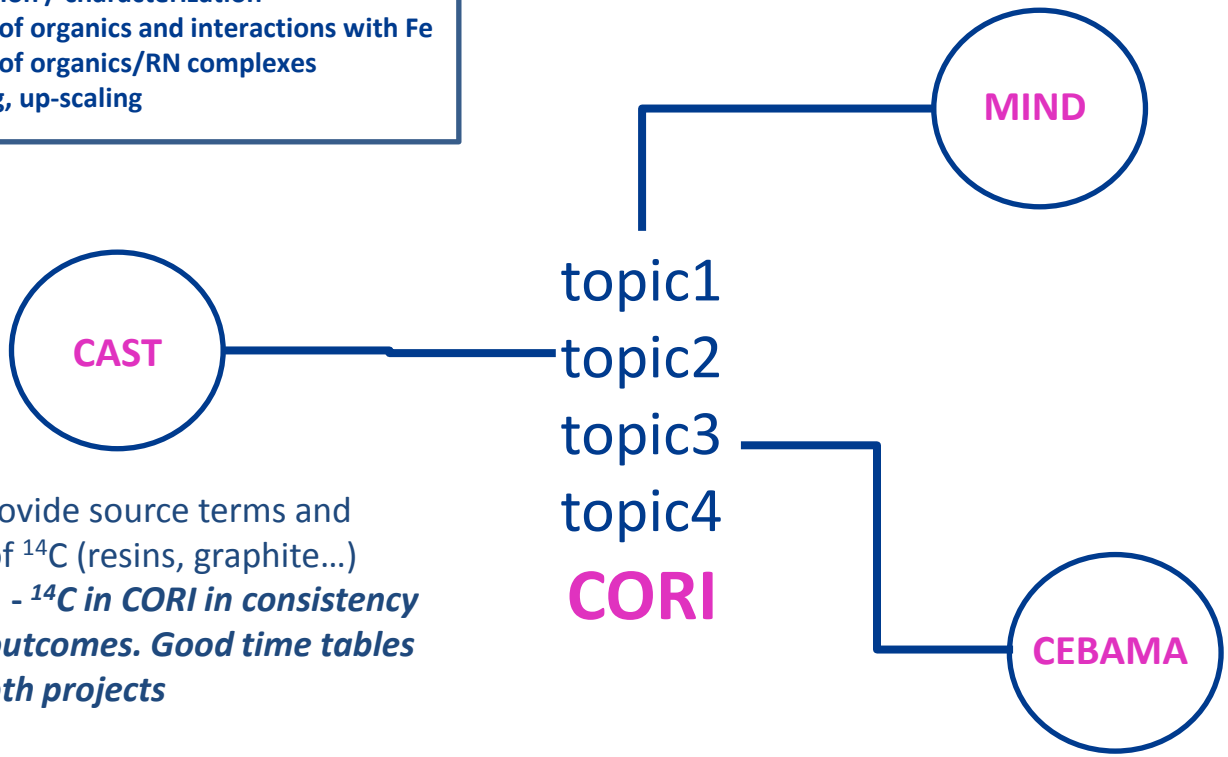
^{14}C topic is recommended in CORI

General view: CORI and on going projects

MIND WP1 will focus on biodegradation from irradiated materials/effluents

- ***Consistency of organic materials between MIND and CORI***
- ***Consistency with realistic degradation conditions***

CORI
Topic1: degradation / characterization
Topic2: mobility of organics and interactions with Fe
Topic3: mobility of organics/RN complexes
Topic4: modeling, up-scaling



CAST will provide source terms and speciation of ^{14}C (resins, graphite…)

- ***^{14}C in CORI in consistency with CAST outcomes. Good time tables between both projects***

CEBAMA WP2 will focus on sorption/transfer mechanisms in cement materials

- ***Consistency of cement materials between CEBAMA and CORI***

CEBAMA will develop sorption and transfer models for mobile RN

- *Consistency in modelling approaches*

Thank You !