Working Group *Cement*

Status of the proposed CEBAMA* project

IGD-TP Exchange Forum N°4, October 29-30, 2013, Prag

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* Cement-based materials, properties, evolution, barrier functions

Rationale

- Key Topics 2 Waste forms and their behavior
    - 2.2 Release from ILW and their detailed characterization 2012- 2016, H
- Key Topic 3: Technical feasibility and long-term performance of repository components
    - 3.10 Long-term behaviour of seals and plugs   2011 - 2017   H
    - 3.11 Evolution of cement-based seals   2015 - 2023   M
    - 3.12 Interaction of cement with clays   2016 - 2024   M
    - 3.13 Optimisation of low pH cements   2016 - 2022   M

Collecting Ideas

- Responses by:
  - AMPHOS21 (E), ARMINES (F), BGS (UK), BRGM (F), BTECH (FI), CEA (F), CIEMAT (E), CTM (E), KIT-INE (D), NRI-REZ (CZ), PSI (CH), SCK·CEN (B), UNILOUGH (UK)
- Proposed Topics:
  - Waste forms (containers, grouts): 21
  - Repository engineering (seals, support, backfill): 13
  - Geology (grouts, alkaline disturbed zone): 4
- Possible approach
  - *Laboratory and Field scale experiments*
  - *Analogues*
  - *Process and system modelling*

Cement / Concrete in Nuclear Waste Management

- 6th FP IP ESDRED: LOW-pH CEMENT FOR A GEOLOGICAL REPOSITORY, 2005
- Workshops on Mechanisms and Modelling of Waste/Cement Interactions
    - Meiringen, 2005;
    - Le Croisic, 2008;
    - Ghent, 2013.
- International Symposium on Cement-Based Materials for Nuclear Wastes
    - Avignon 2011
    - Avignon 2014
- NEA TDB Phase IV: Initiation Report Thermodynamic Data for Cement Minerals, 2012 ➜ State-of-the-Art Report
- Ideas presented at the IGD-TP Exchange Forum No.3, Nov. 29, 2012 TSWG established.
- Meeting with WMOs and interested R&D groups, May 8, 2013, Ghent

Summary of the Ghent meeting

- 08.05.2013, 13:50 -15:30, Het Pand, Ghent, Belgium
- Participants:
  - WMOs: ANDRA, NAGRA, NDA, ONDRAF·NIRAS, SKB
  - R&D: Amphos21, BGS, BRGM, CEA, FZJ, GRS, KIT-INE, PSI, Res. Center Rez, SCK·CEN, Uni Loughborough
- Agenda:
  - "Discussion Paper" distributed March 20, 2013
  - Presentation of the WMOs' opinions towards above "discussion paper"
  - Discussion on the further procedure.

Agreement on following topics

1. Changes in the porosity and permeability: Transport properties

2. Interactions between waste components and cement phases, especially organics - cement interaction

3. Radionuclide retention and impact of redox conditions especially by radionuclide-organic ligand interactions in alkaline environments regarding both sorption properties and speciation

4. Corrosion (rates / passivation) of steel in cement

5. Thermodynamic databases and modelling: Reactive transport modelling

Potential Structure of a CP Cebama

List of workpackages (WP)						
WP No	WP title	Type of Activity	Lead org.			
WP 1	Transport properties	RTD	PSI (?)			
WP 2	Organics - cement interaction	RTD	UK (?)			
WP 3	Radionuclide retention	RTD	KIT			
WP 4	Steel corrosion	RTD	SCK·CEN (?)			
WP 5	Thermodynamics and modeling	RTD	Amphos (?)			
WP 6	Dissemination, reporting and training	RTD	Amphos (?)			
WP 7	Project management	MNG	KIT (?)			
			Sum: PM:	x		

WP1

WP	Specific Title/Activity	Org.
1	Transport properties	PSI (?)
	Different cement/concrete types, e.g. low-pH cements	
	Carbonation	
	Sulfatisation of CSH/CASH	
	Pozzolano reaction: $Ca(OH)_2 + H_4SiO_4 \rightarrow Ca^{2+} + H_2SiO_4^{2-} + 2\,H_2O \rightarrow CaH_2SiO_4 \cdot 2\,H_2O$ Dissolution of quartz	
	Evolution of pores, permeability, THMC prop.	
	Molar volumes of phases and secondary phases (e.g. CSH as a function of Ca/Si ratios)	
	Microstructure of cement / concrete and relations between physical properties and the changes induced by chemical reactions	
	Dimensional stability (shrinkage, creep, etc.)	
	Impact of competing ions: Trace components	
	Impact of temperature	

WP2

WP	Specific Title/Activity	Org.
2	Organics - cement interaction	UK (?)
	Degradation of organic waste components	
	Degradation products	
	Rates	
	Solubility of organic ligands in cementitious systems	
	Sorption of organic ligands onto cement	
	Organic cement additives	
	See above	
	Microbial processes	
	organics	
	sulfate / sulfide transformation	

WP3

WP	Specific Title/Activity	Org.
3	Radionuclide retention	KIT
	Solubility and complexation of RNs in pore solution	
	- including organics and	
	- silicate species	
	Redox reactions under relatively high pH conditions	
	Sorption / desorption / kinetics	
	Special focus on anionic species	
	Incorporation / solid solutions	
	Specific waste types	

WP4

WP	Specific Title/Activity	Org.
4	Steel corrosion	SCK·CEN (?)
	Corrosion rates in pore water (including organics)	
	Corrosion products	
	Redox reactions (in presence of organics)	
	Specific waste forms	

WP5

WP	Specific Title/Activity	Org.
5	Thermodynamics and modeling	Amphos (?)
	Coupled thermodynamic, kinetic models/ reactive transport modeling	
	Barrier function	
	Benchmark exercise	
	Interaction between cement, canister and bentonite	
	Modeling (tools for application in performance assessment	
	Natural Analogue modeling	

Structure of Cebama

End User
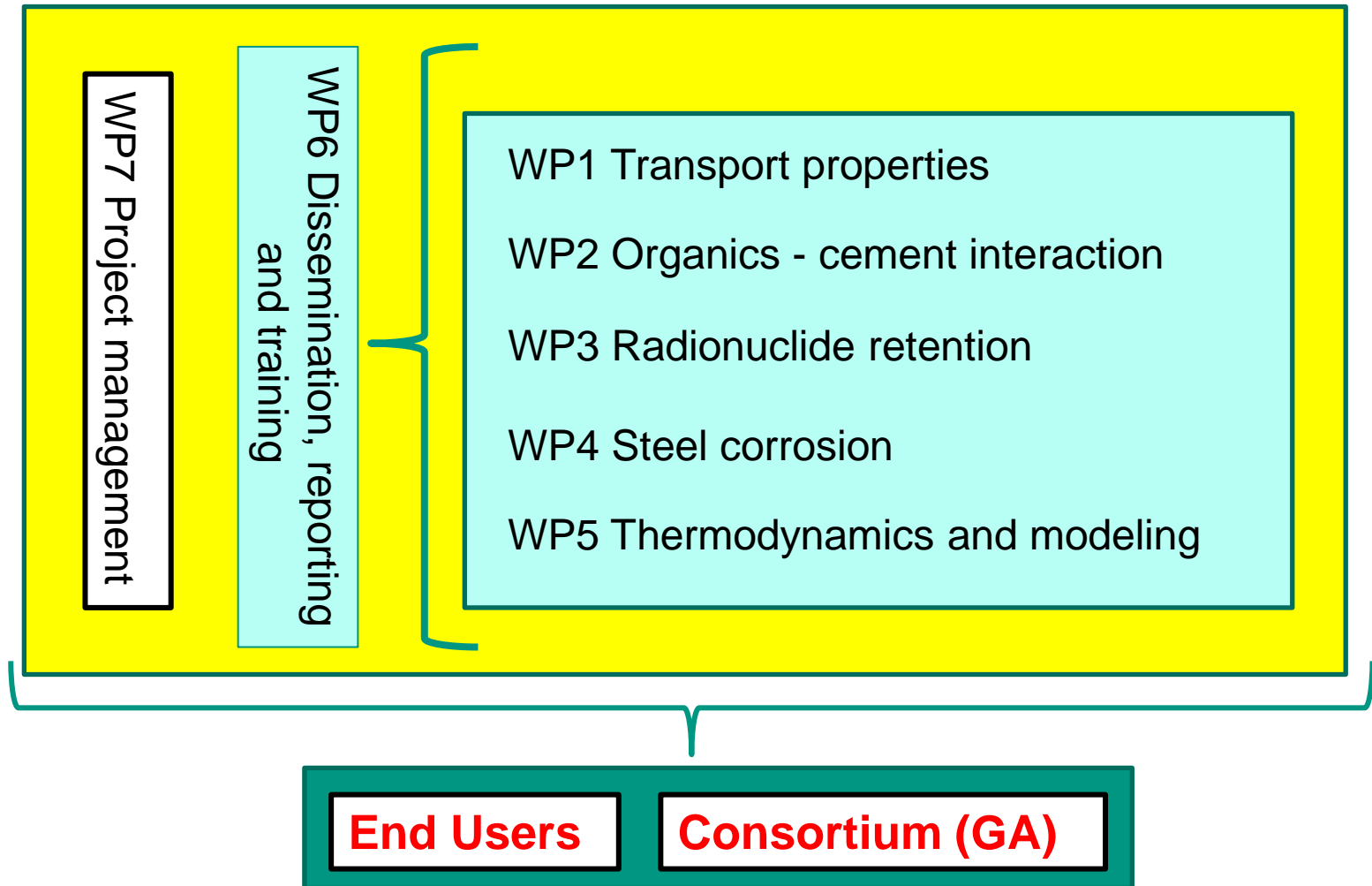
Representatives from **IGD-TP**

Roles and Tasks within CP **Cebama**

- Review the work program
- Review the scientific-technical progress and contributions to the proceedings
- Provide recommendations for the work program
- Review the plan for dissemination of the final results.

Project details

- Duration: 3 yrs. of experimental time
- Methods/Analytics: based on existing tools in the different labs
- Training / education / exchange

Total Costs: **6 000 k€**

- Funding Schema according Horizon 2020:
  EC contribution direct costs up to   100 % of R&D
             indirect costs   25 % of direct costs (flat rate)
             (based on KIT: 15 PhD à 3 years + 15 × 6 months advisor)

Application to the Safety Case

- Reduction of uncertainties and quantitative description of processes

- Advanced process understanding (microscopic scale)

- Improved coupled reactive transport models (microscopic)

- Tools for application of the advanced process understanding in PA models (microscopic - macroscopic)

- Demonstration of the improved process understanding by modeling historic cases / natural / man-made analogues (macroscopic scale)