The **CEBAMA** project

Altmaier M. (KIT, D), Bourbon X. (Andra, F), Claret F. (BRGM, F), Granbow B. (Armines, F), Holt E. (VTT, FI), Idiart A. (Amphos21, ES), Mäder U. (UniBern, CH), Perrone J. (Amphos21, ES)

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Cebama - key data

Cement-**ba**sed **ma**terials

properties, evolution, barrier functions

- Research and Innovation action to support the implementation of the geological repositories

Action duration: 48 months

Start: 01-06-2015

Granting authority: European Atomic Energy Community

Grant agreement N° 662147

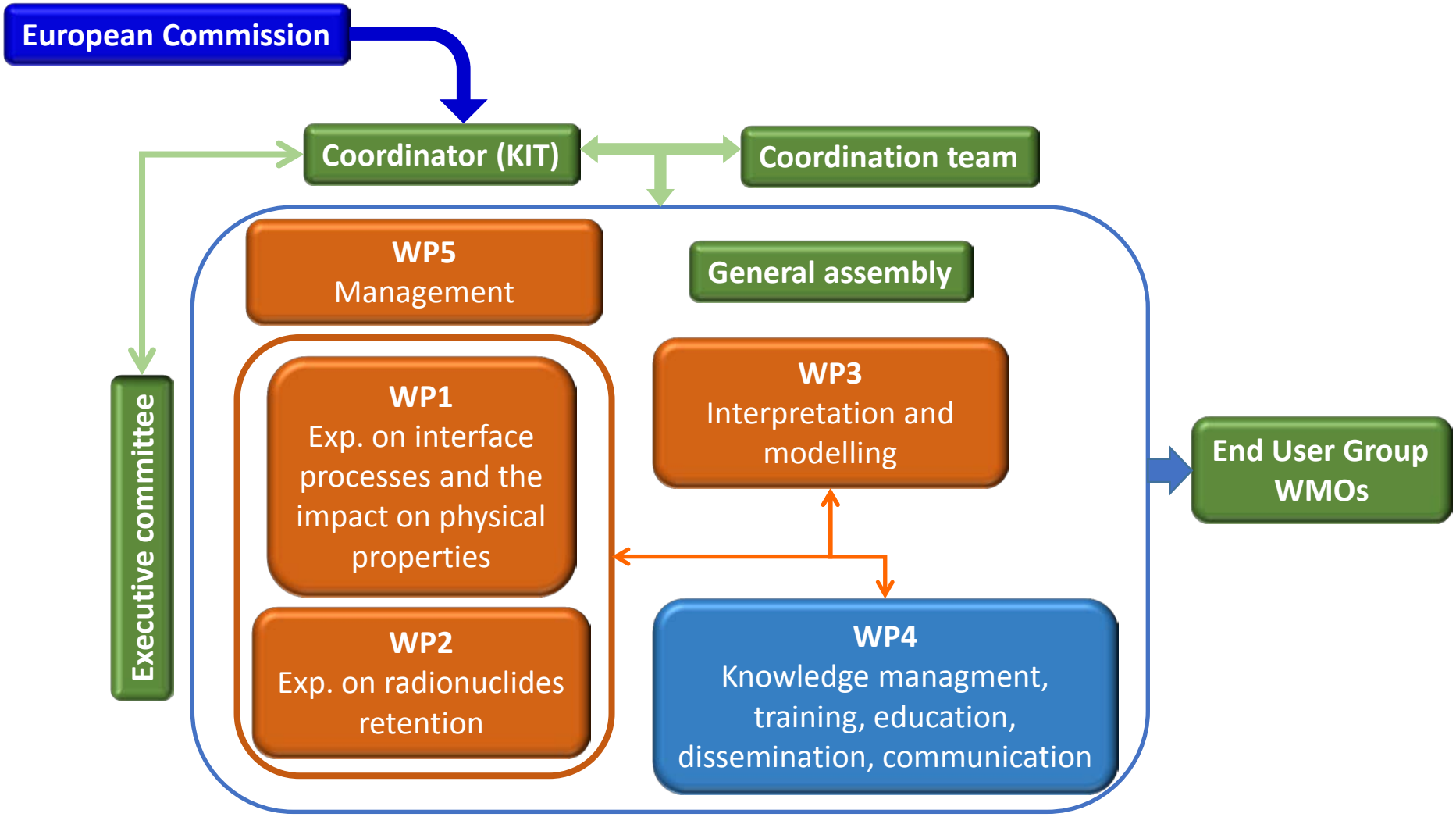
Individual Beneficiaries

27 partners, including non EC members (Japan, Switzerland), from11 countries

KIT	Karlsruhe institute of technology	D
AMPHOS 21	Amphos 21 consulting sl	ES
BRGM	Bureau de recherches geologiques et minieres	F
NERC-BGS	Natural environment research council	UK
CIEMAT	Centro de investigaciones energeticas, medioambientales y tecnologicas	ES
TU Delft	Technische universiteit delft	NL
JUELICH	Forschungszentrum juelich	D
RATEN ICN	Regia autonoma tehnologii pentru energia nucleara	RO
NRG	Nuclear research and consultancy group	NL
RWMC	Radioactive waste management funding and research center	JP
SCK CEN	Studiecentrum voor kernenergie-centre d'etude de l'energie	B
ARMINES	Association pour la recherche et le development des methodes et processus industriels	F
UJV	Ujv rez a.s.	CZ

UDC	Universidad de la coruna	ES
ULOUGH	University of loghborough	UK
CTU	Ceske vysoke uceni technicke v praze	CZ
USFD	The university of sheffield	UK
VTT	Teknologian tutkimuskeskuss	FI
HZDR	Helmholtz-zentrum dresden-rossendorf ev	D
LML	Universite des sciences et technologies de lille – lille 1	F
UAM	Universidad autonoma de madrid	ES
CSIC	Agencia estatal consejo superior de investigaciones cientificas	ES
ANDRA	Agence nationale pour la gestion des dechets radioactifs	F
PSI	Paul scherrer institut	CH
UNIBERN	Universitaet bern	CH
IRSN	Institut de radioprotection et de sûreté nucelaire	F
EMPA	Swiss federal laborattories for materials testing and research	CH

Consortium and organization



Project Structures

- The **coordination team** is shared by two organizations, the **Coordinator** (KIT-INE), and the **Coordination Secretariat** (AMPHOS21)
- The **Executive committee** consists in the different WP leaders and coordinator:
  - WP1: VTT, BRGM, UniBern
  - WP2: Armines
  - WP3, 4: Amphos21
  - WP5: KIT
- 9 WMOs are represented in the **End User Group:**

ANDRA (F)	NAGRA (CH)	RWM (UK)
COVRA (NL)	ONDRAF/NIRAS (B)	SKB (S)
ENRESA (ES)	POSIVA (FI)	SURAO (CZ)

- The **General Assembly** consists in one member from each partner organization to the project, including also the non-EU organizations (GA chair: N. Maes, SCK-CEN).

WP 1: interface processes

Objective: Understand how chemical reactions at cement/host rock affect physical (i.e. transfer) properties at these interfaces.
To support long term performance and safety assessment calculations for deep geological nuclear waste repositories implementation

These aspects are investigated by laboratory tests and up-scaling by utilization of *in-situ* tests (both ongoing and new tests) at the interface for the following systems:

. Low pH and/or high pH cementitious component *vs* crystalline rock
. Low pH and/or high pH cementitious component *vs* Opalinus Clay, Callovo-Oxfordian argilite, Boom clay, Toarcian mudstone
. Low pH and/or high pH cementitious component *vs* bentonite

WP Coord. : VTT, BRGM, UniBern
19 of 27 partners participating
WP1 part of the project (budget/effort) ~48 %

WP 1: interface processes

Project Scope: experiments

- Analyses of the **interface reactions** in contact with different solutions (salinity, pH, redox, carbonates) with respect to **changes in mineralogy** and porosity evolution
- **Characterization** of **aged cement/mortar/concrete** samples in contact with natural host rocks or bentonite with respect to their **changes in physical transport parameters**, mineralogy and microstructure affecting transport due to mineralogical alteration (e.g. Ca leaching, carbonation), at ambient temperature up to 70°C.
- The **mechanical behaviour** and the related transport properties of the **interface Cement/ Clay**, (e.g. OPA, COX).
- Diffusion/column experiments to **quantify transport parameters** including time-lapse experiments (electromigration, periodic tomography).

WP 2: radionuclide retention

Objective: radionuclide sorption in alkaline media.

To give input data on radionuclide behaviour at cement/host rock interfaces, in alkaline media

Solubility and sorption investigated by laboratory tests for the following systems:

. Cementitious materials: CEM I and CEM V type, low pH cement, NRVB

. Cement hydrates: C-S-H, AFm, AFt, LDH

. Radionuclides on interest: Be, Se, Mo, I, Ra, ^{14}C, ^{99}Tc, ^{45}Ca

WP Coord. : Subatech

10 of 27 partners participating

WP2 part of the project (budget/effort) ~ 15 %

WP 2: radionuclide retention

Project Scope: experiments

- To produce input data for **solubility** and **sorption** of radionuclides:
  - Solubility in cementitious conditions (CEM I or CEM V cement type, low pH cement and NRVB) for **Be, Mo, Se, Tc, I** and **Ca**
  - Sorption on hydrated cement pastes and cement hydrates for **Be, Ra, Mo, Se, I** ; specific impact of the **C-S-H**, **AFt** and **AFm** phases (sorption, incorporation, substitution)
  - Reactive transfer **^{14}C** through unsaturated CEM I and CEM V concretes

- Thermodynamic approach **to model the reactive transfer**

WP 3: interpretation and modelling

Objective: radionuclide reactive transfer at cement/host rock interfaces and in alkaline media.

- To improve the validity of numerical models to predict changes in transport properties
- To give support to the advanced data interpretation and process modelling of WP1, 2 experiments:

  Provide improved interpretation of experiments by mechanistic modelling on chemically-induced changes in water and gas flow and transport properties in the cement matrix and at the interface with host rock
- To contribute to our capacity to extrapolate models of system-level to modelling for Safety Case application (length and time upscaling)

WP Coord. : Amphos21
13 of 27 partners participating
WP3 part of the project (budget/effort) ~ 26 %

WP 3: interpretation and modelling

Project Scope: modellings

- **Process modelling in connection with WP1 & WP2**
  - Calibration and test of reactive transport models and inference of the reaction scheme and database for chemical/transport processes
  - Derivation of transport parameters and uptake of radionuclides from experiments with non-sorbing and sorbing tracers in cement, altered cement and interface systems by reactive transport modelling
- **Model developments**
  - Improvement of reactive transport models and codes for modelling concrete and the concrete-clay interaction: chemical, hydrodynamic and mechanical couplings
  - Multi-scale approaches to describe the physico-chemical processes in order to upscale the effects of microstructure evolution (from microstructure to *in-situ* tests)
  - Electrostatic surface complexation models to describe the cement minerals/pore water interface
  - Implementation of electrically coupled multi-species transport in reactive transport codes
- **Up-scaling**
  - Multi-scale coupled reactive transport processes and modelling of radionuclide transport through (aged) concrete and concrete/host rock interfaces in the repository environment
  - Validation of macro-scale (continuum) transport predictions by experimental information at the micro-scale
  - Validation of micro-scale flow and transport models by predicting macroscopic transport properties based on microstructural information
  - Guidelines for continuum scale modelling of interface processes

Conclusion

A project within the IGD-TP JA 6: Material interactions

CEBAMA project official start: June 1st, 2015 (kick-off meeting 1st/2nd July 2015).

Synopsis

27 organisations from 11 countries (including Switzerland and Japan),

Budget : total cost ~6 M€ ; EC funding ~3.8 M€,

Duration: 4 years

Involvement of 9 WMOs

Specific **goals of Cebama** project are:

- (WP1) experimental studies of interface processes between cement based materials and (cristalline or clay) host rocks or bentonite, and assessing the specific impact on transport properties,
- (WP2) quantifying radionuclide retention under alkaline (i.e. cement) conditions,
- (WP3) developing comprehensive modelling approaches. Modelling will support interpretation of results and prediction of the long-term evolution of key transport characteristics such as porosity, permeability and diffusion parameters especially in the interface between cement based materials and the engineered and natural barriers.
- (WP4) Cebama website : www.cebama.eu ; annual workshops