SEVENTH FRAMEWORK PROGRAMME

EURATOM

REDOX PHENOMENA CONTROLLING SYSTEMS
ReCosy

COLLABORATIVE PROJECT (CP)

Annex I - “Description of Work”

Grant agreement N°.: FP7-212287

Date of preparation: 10th April 2008 (version 1)
Operative commencement date of the contract: 01 April 2008
Duration: 48 months

Table of Contents

Part A

A.2 Project Summary

Main objectives of ReCosy are the sound understanding of redox phenomena controlling the long-term release/retention of radionuclides in nuclear waste disposal and providing tools to apply the results to Performance Assessment/Safety Case. Although redox is not a new geochemical problem, different questions are still not resolved and thus raised by implementers and scientists. From a top-down approach, the reliability of redox measurements for site characterization, redox disturbances by the near-field materials, changes induced by glaciation scenarios or the redox buffer capacity of host-rocks and the kinetics of response to redox perturbations are addressed. From a bottom-up approach, questions concerning the interpretation of mixed potentials, surface mediated reactions, redox states of actinides and long-lived fission products, the source term of spent nuclear fuel in the presence of corroding steel as well as the role of microbes and biofilms on the evolution of the redox state are tackled. Radionuclide redox transformations on minerals are decisive scenarios in the NEA FEP list and in the RETROCK project. In the large FP 6 IPs NF-PRO and FUNMIG, redox phenomena controlling the retention of radionuclides were addressed, although not systematically considered.

The ReCosy concept is innovative in the scientific approach to the redox phenomena. It includes i) advanced analytical tools, ii) investigations of processes responsible for redox control (thermodynamically and kinetically controlled processes, surface reactions and microbial processes, ..), iii) provision of required data on redox controlling processes, and iv) response to disturbances in disposal systems.

The work program is structured along six RTD workpackages. They cover near-field and far-field aspects as well as all relevant host-rocks considered in Europe. In one workpackage the scientific state-of-the-art and its application to Performance Assessment/Safety Case is documented and regularly up-dated. A specific workpackage on knowledge management, education and training is included. The knowledge acquired throughout the project is brought forward to the general scientific community and broader stakeholder communities by active knowledge transfer.

The work plan of ReCosy comprises a combination of the bottom-up and top-down approaches, addressing both key issues for long term safety and key scientific questions. Topics covered by ReCosy are the development of advanced determination methods of redox states, database for interpretation the impact of microbial processes on the redox state of the system and of radionuclides, understanding the processes responsible for redox and the response to disturbances in the near- and far-field, redox processes which are responsible for spent fuel source term and mobility of redox sensitive radionuclides as well as tools and models for application of the achieved knowledge to Performance Assessment/the Safety Case.

The 32 partners of ReCosy include the key European Research Institutes and Universities from 13 European countries, and Russia.

A.3 List of Beneficiaries

Beneficiary Number	Beneficiary name	Beneficiary short name	Country	Date enter project*	Date exit project*
1	Forschungszentrum Karlsruhe G.m.b.H.	FZK-INE	DE	1	48
2	Association pour la Recherche et le Développement des Méthodes et Processus Industriels	ARMINES	FR	1	48
3	Bureau de Recherches Geologiques et Minieres	BRGM	FR	1	48
4	Commissariat à l'Énergie Atomique	CEA	FR	1	48
5	Chalmers University of Technology	CTH	SE	1	48
6	CTM Centre Tecnològic	CTM	ES	1	48
7	AMPHOS XXI Consulting, S.L.	AMPHOS	ES	1	48
8	Forschungszentrum Dresden-Rossendorf e.V.	FZD	DE	1	48
9	Gesellschaft für Anlagen- und Reaktorsicherheit mbH	GRS	DE	1	48
10	University of Helsinki	HU	FI	1	48
11	Joint Research Centre – Institute for Transuranium Elements	JRC	EC	1	48
12	Nuclear Research Institute Rez plc	NRI	CZ	1	48
13	Paul Scherrer Institut	PSI	CH	1	48
14	Graz University of Technology	TUG	AT	1	48
15	University of Potsdam, Physical Chemistry	UPPC	DE	1	48
16	Centre National de la Recherge Scientifique	CNRS	FR	1	48
17	University of Zaragoza	UNIZAR	ES	1	48
18	Studsvik AB	STUDSVIK	SE	1	48
19	Institute of Isotopes - Hungarian Academy of Sciences	II-HAS	HU	1	48
20	University of Cyprus	UCYPRUS	CY	1	48
21	Institute of Physics	IPL	LT	1	48
22	University of Utrecht	UNIUTR	NL	1	48
23	Royal Institute of Technology	KTH	SE	1	48
24	Microbial Analytics Sweden AB	MICANS	SE	1	48
25	LQC S.L.	LQC	ES	1	48
26	Geopoint AB	GEOPOINT	SE	1	48
27	Moscow State University	MSU	RU	1	48
28	Svensk Kärnbränslehantering AB	SKB	SE	1	48
29	Agence national pour la gestion des déchets radioactifs	ANDRA	FR	1	48
30	Posiva Oy	POSIVA	FI	1	48
31	University of Loughborough	ULOUGH	UK	1	48
32	University of Manchester	UMANCH	UK	1	48

*: In project months

Part B

B.1 Concept and Objectives, progress beyond state-of-the-art, S&T methodology and work plan

The scientific-technical quality of the project is described by giving the background and the problem addressed by the project, the scientific quality of the partners and the project, the concepts and objectives, followed by the progress beyond the state-of-the-art that will be achieved, and finally interdependencies of work program components.

<Background and the problem>

The project is based on problems identified within studies related to national nuclear waste disposal implementation programs. All national programs for the disposal of high-level radioactive waste are based on deep geologic disposal, where reducing conditions is a key feature for the safety function. The redox state in principle is a very well defined thermodynamic property and thus one could expect that there are no conceptual or major practical problems involved in:

(i) Determining the redox state of relevant systems.
(ii) Calculating the redox state of the disposal system components (spent fuel, near-field, engineered barrier, far-field, …) with analytical information given.
(iii) Calculating the redox state of concerned radionuclides, and thus obtain the basis for spent fuel dissolution and radionuclide migration modeling.
(iv) Predicting the response and time function of disposal system components to impact from other components, including the impact of the near-field on the near far-field, and the far-field response to change in land-use and climatic conditions.
(v) Implementing this in the safety analysis.

Contrary to this, it is frequently found that:

i. Different redox determination methods respond to different redox sensitive and redox determining components, and are subject to different artifacts.
ii. There are different protocols at different laboratories for the application of redox electrodes, leading to uncertainty concerning comparability and correctness of measured/reported data. This especially refers to pretreatment of redox electrodes and stability/steady state criteria.
iii. Calculation of redox states based on analytical data of presumably coupled redox sensitive components (Fe(II)/Fe(III), …) suffer under uncertainty in the analytical determination methods and the thermodynamic data for solubility determining solid phases/minerals.
iv. In calculations based on analytical data it is unclear which components are in redox equilibrium and under which conditions.
v. This timely response of redox measurements depends on the kinetics of involved reactions and electrode surface properties.

vi. The timely response to external changes of the redox conditions of near-natural and real systems depends on the deviation from equilibration of the overall system and its components.

Consequently, the modeling of the redox state of the system and the involved relevant radionuclides for its application in the safety analysis, especially over long time periods, remains vague, if not rudimentary.

Examples of specific problems identified from Safety Case top-down approach are:

a. Neither analytical data nor measurements, presently allow for determination of the redox state in natural clays, not even in laboratory samples, and consequently the mobility of redox sensitive radionuclides, including long-lived fission products, cannot be satisfactorily assessed.

b. Disturbances by the excavation, repository operation and waste emplacement lead to redox dis-equilibrium. The time function for achieving steady-state and its and nature is insufficiently understood.

c. Glaciation followed by land suppression and subsequent land elevation is expected for sites under consideration for repositories hosted in crystalline rock. In such a cycle the water composition in the host rock is known to vary considerably. One such scenario is intrusion of oxidizing recharge water to considerable depth. The redox response time function is not known and thus long-term predictions concerning stability of the bentonite backfill, corrosion in the near field and redox state of radionuclides in the near- and far-field remains unsatisfactory.

d. Identification of natural buffer capacity in host-rocks is a key issue for Safety Case. Redox determining components in crystalline rock samples from site investigations should be easily identified by comparing analytical data with thermodynamic predictions concerning potential redox couples. Graphical representation of such thermodynamic predictions based on different redox couples and thermodynamic data for different assumed solubility determining solid phases/minerals results in different straight lines fully uncorrelated with the plotted analytical data. Consequently, the redox determining processes are not known and any prediction concerning response to future changes are problematic.

Examples of specific problems identified from a scientific bottom-up approach are:

e. Reliable results of redox potentials require sufficient concentrations of dissolved electro-active species. If this is not the case, unclear mixed potentials are recorded.

f. Measured redox potentials are valid for the solutions. Surface mediated redox reactions frequently govern the system.

g. The redox state of Pu cannot be predicted for brines in salt repositories, and thus it is not possible to determine if the highly immobile Pu(IV) will dominate or the rather mobile Pu(III).

h. The source term from spent fuel dissolution is highly dependent on the occurrence of oxidative dissolution of the spent fuel matrix. In the repository near-field, the capacity of corroded canister iron phases to incorporate radionuclides is not sufficiently well understood. Consequently, the source term used in the safety analysis cannot be determined adequately, requiring the use of potentially over-conservative assumptions.

i. Microbes control the redox system in soils as well as in relatively deep aquifers. Their effect on a HLW repository is not sufficiently understood. This is especially true for the mineral surface biofilms.

For near-field processes unresolved redox processes are listed in various reports including former FP5 and FP6 projects. 5th Framework Program SFS showed a high degree of complexity of spent fuel dissolution with respect to the influence of reducing hydrogen and oxygen. Efficient hydrogen catalysts were found. It was concluded that further mechanistic studies are necessary to understand and quantify interfacial effects (SKB TR-05-09). In other studies, such as, ECOCLAY II the Fe-system and redox processes are neglected. Also the TRANCOM II project addressed the migration behaviour of redox sensitive elements and various species, in a reducing clay environment with special emphasis on the role of the Natural Organic Matter (NOM). It was assumed that observed "slow" sorption-reduction kinetics are still fast compared to geological time-scales used in PA. In the 6th Framework IP NF-Pro it is also concluded for compacted bentonite that further studies are needed to clarify the reactions measured by the Eh electrodes and to find which reactions/processes determine the Eh.

The outcome of finalization of the studies within IP NF-PRO will be monitored carefully in order to ensure that work is not duplicated. Information on the different responses observed from different electrode materials and processes underlying the clay back-fill system redox state will be used within the present project. The objectives of present project, however, are much broader than those of NF-PRO (natural clay rock, development of additional redox measurement methods, inter-comparison of a broad number of determination methods, identification of redox determining phases, response to induced perturbances, ..). The present project thus builds on the outcome of NF-PRO and goes beyond.

The FP6, Euratom IP FUNMIG ("Fundamental processes of radionuclide migration") will last until the end of 2008. Workpackages 2.3 ("Radionuclide redox transformation on minerals") and 3.1 ("Understanding key, basic processes affecting radionuclide transport in clay-rich porous media") deal with some aspects also subject of the present project. The outcome from the studies within IP FUNMIG will also be monitored carefully in order not to duplicate investigations. Reflecting priorities identified at that time, the emphasis of investigations within IP FUNMIG focuses on (i) redox transformation of actinide ions under controlled redox conditions with Fe(II) bearing minerals frequently found in granitic and clay environments and (ii) identification of key processes constraining the redox conditions of clayrock porewaters under natural conditions. The effects of external perturbations (NO_3, H_2…) on the redox environment were not studied. Also, while FunMig RTDC3 focused a great amount of attention on understanding phenomena affecting ion migration in intact clay-rocks, specific coupling to redox conditions was not considered in detail. Thus, the study of the effects of disposal cell induced perturbations on clayrock redox conditions, and on redox sensitive radionuclide migration, has not been addressed, and thus the prerequisite for trustworthy long-term modeling covering relevant near field conditions is missing.

In summary, redox is a key parameter in the Safety Case of nuclear waste disposal. The redox concept is clear, however, (i) determination of the redox conditions, (ii) processes that control the redox state, especially surface reactions, and (iii) processes determining the redox conditions in the disposal systems are not adequately understood. Considerable development is still required in order to provide the necessary confidence in the capability to predict the impact of disturbances and especially the kinetics/time-functions involved.

<Scientific quality of the partners and the project>

The scientific quality of the project builds on joining the best expertise available to tackle these problems and outline how the knowledge can be applied in the safety analysis. A key topic is the development of new redox determination methods. This is done in view of providing methods for determination of the redox conditions under specific conditions, such as in natural clay samples and in saturated brines. Trust in the capability to determine the redox state builds on an interlaboratory comparison exercise on samples of varying complexity and careful assessment of the outcome.

Application of this trustworthy basic redox determination capability to a variety of laboratory studies provides the knowledge about redox determining processes, and the redox state and mobility of concerned radionuclides. It covers redox conditions and response to induced changes of disposal system components from the spent fuel through to the far-field.

The best available scientific expertise in field is involved in the project. The most advanced analytical capabilities are provided by the partners:

1. Competence center for optode developments for remote optical fiber based micro-analytical systems.
2. Frontier competence in the development of redox micro-electrodes.
3. A broad spectrum of laser-induced spectroscopy methods, for determination of chemical state of selected sensor elements down to the nano-molar concentration range.
4. Access to, and frontier expertise in synchrotron radiation based spectroscopy, including surface specific determination of redox state and chemical state of individual components, through to spectro-microscopy for determination of elements, redox state and chemical state in 3D micro-resolution.
5. Chemical species separation techniques in the trace element concentration range by, for example coupling of micro-separation columns with ICP-MS.
6. Infrastructure and expertise for handling of all types of radioactive inventories as required for the studies, including spent fuel.
7. Analytical methods and expertise for determination and spatial distribution of chemical and isotope composition in view of hydrological/hydro(geo)chemical prehistory of real sites.
8. Analytical tools, infrastructure and expertise in the field of groundwater microbiology and associated processes in natural aquatic systems.
9. Modeling competence.

<Implementation of the project outcome wthin the Safety Case>

Several of the project partners posess considerable expertise in the area of Performance Assessment/Safety Assessment/Safety Analysis/The Safety Case. The key instrument for the purpose of insuring that project produced knowledge is relevant for supporting Safety Cases for specific disposal concepts is the End-User Consultancy Group (EUCG). Some project partners are actively involved in the EUCG and will bring in their competence directly. Other partners with expertise in this field will provide this expertise through the reporting and will also be consulted by the EUCG. By this approach the project is structured around making project outcome usefull to various end-users, such as the scientific community, waste management agencies and regulators. The specific importance of the latter two types of end-users is reflected in them establishing the End-User Consultancy Group to the Project.

B.1.1 Concept and objectives

B.1.1.1 Concept

The ReCosy concept is to provide the indispensable process understanding for relevant processes to be addressed within the disposal safety analysis from both top-down and bottom-up perspectives. Contact with ground- and pore-water is inevitable. The overall system is initially away from equilibrium due to post-closure impact, slow conversion of near-field components, and various degrees of changes in the recharge conditions. Consequently, non-equilibrium is observed in natural systems, especially because of the kinetically hindered accessibility of mineral components. Furthermore, transformations over a long time period will take place in the near-field and this will affect the neighboring far-field environment.

In the concept of ReCosy:

- advanced analytical tools for redox determination are developed
- processes responsible for redox in all relevant systems (thermodynamically and kinetically controlled processes, including surface reactions and microbial processes, …..) are determined,
- all relevant systems are studied in view of providing required data on redox determining processes,
- the response to disturbances that will take place in the disposal system is determined,
- processes are verified in real systems, and finally
- the knowledge is brought together for its applicability in the Safety Case.

For the latter purpose, an End-User Consultancy Group is established with representatives from both Waste Management Organizations and organizations with national Regulatory functions. The key contributions of this group are to advise the project in view of ensuring usefulness of the project work for application to the disposal safety case and review of scientific-technical reporting in this respect. The EUCG will be also consulted for agreement on the choice of systems and system conditions to be studied. For this reason, the EUCG will actively contribute to the milestone M1, due project month 3, also one of the key outcomes of the kick-off meeting. They will also provide input to, and reviewing of, a public document on the application of redox processes in the safety case.

Systems to be investigated cover
a. Simple very well defined ones under controlled laboratory conditions,
b. Complex laboratory systems,
c. Near-natural systems in the laboratory,
d. Real systems, and
e. High-level waste repository near-field

The project is planned for a period of four years. Documentation of progress is done via establishing key working documents that are regularly up-dated. Scientific results are documented in the form of Annual Workshop Proceedings and peer review journals. Scientific contributions to the Annual Workshop Proceedings will be subject to review. This external expert review is conducted by the EUCG members. This procedure ensures a high quality of the scientific results and the proceedings.

An important part of the strategy which will be used to tackle management and dissemination of knowledge is the web-portal of the project, which will be implemented at its onset. The website will facilitate communication among project partners, but will especially be a tool for communication with a broader interested community. A Newsletter will also be issued to an interested community. The Newsletter is foreseen to be issued about twice a year in order to inform about key reports becoming available and forthcoming key events, especially the Annual Project Workshops.

B.1.1.2 Objectives

The key objectives of ReCosy are to provide an improved interpretation of redox potentials in all relevant host-rock systems to be used within European Safety Cases. For this purpose scientific and technical objectives cover the understanding of redox buffer capacities, redox kinetics and the long-term predictions relevant for describing the redox impact on the radionuclide transport.

Scientific-technical objectives are:
- Developing advanced methods for determination of redox conditions in the concerned specific systems.
- Identification of components that govern the system redox conditions.
- Identification of the equilibrium and deviation from equilibrium of different redox sensitive components.
- Determination of the kinetics/time function response of system components to perturbances related to relevant scenarios within the disposal Safety Case.
- Determination of redox reactions of sensitive radionuclides and the deduction of their transport/retention properties.

- Determination of the impact of microorganisms on the redox conditions of the overall system and individual components.
- Identification of redox processes driving the spent fuel dissolution, including redox coupling with relevant near-field materials.

Education, training, documentation, communication and dissemination are additional objectives:

- Training of young researchers within the project by scientific mobility measures and workshops on specific topics.
- Documentation, communication and dissemination of the results, addressing the directly concerned community involved in the nuclear waste disposal Safety Case and a broader scientific community.

The objectives of the call to which the present project respond includes:

(i) in situ experiments of diffusion control of radionuclides in clays,
(ii) transport in high pH environments,
(iii) confirmation of mechanisms and associated databases; and
(iv) development of modeling tools.

Reflecting these objectives, ReCosy provides input by mechanistic process understanding, analytical tools, data and information required for modeling.

B.1.2 Progress and monitoring

B.1.2.1 Progress beyond the state-of-the-art

ReCosy will extend the state-of-the-art with respect to integration of key scientific and long-term safety issues.

- Determination of redox state
- Impact of microbial processes on the redox state of the system and of radionuclides
- Processes responsible for redox and the response to disturbances in the near- and far-fields
- Redox processes affecting the spent fuel source-term
- Mobility of redox sensitive radionuclides
- Knowledge base and ‘tools’ for use in Safety Case development.

In the following, past and present activities are discussed and the expected progress from the present project is described in some detail.

<u>Determination of redox state</u>

The redox state of natural groundwater can be determined by electrode measurements and by thermodynamic evaluation following analytical determination of redox determining species. Problems are the different electrodes and different protocols used leading to different answers, and that it is unclear which redox sensitive components are in redox equilibrium. Furthermore, the identity of the solid phases involved and associated thermodynamic data is unclear. In addition, determination of the redox state in natural clay samples presently is not possible because of problems with the design and size of electrode systems as well as lack in access to necessary analytical data.

The general problems in determining the redox conditions and the meaning of redox potentials when obtained are mentioned in various on-going investigations. There is, however, no systematic investigation where a spectrum in types of systems and physico-chemical conditions are used for testing all three principle redox determination approaches. Correspondingly, there are no past or ongoing investigations where conclusions on the reliability, stability and nature of the outcome of redox determination by different methods are systematically assessed.

Progress beyond the state-of-the-art is achieved by introducing optode technology as a third independent approach to redox determination and assessing the different existing and new approaches by inter-laboratory comparison exercise on samples of varying complexity (including natural samples under near-natural conditions). The development of new electrodes with the in-situ reference system and fiber-optics based optode systems will allow direct determination of the redox state in samples where this previously was not possible (for example, natural clay samples or on-line in crystalline fracture columns).

<u>Processes responsible for redox and the response to disturbances in the near- and far-fields</u>

The components determining the redox state and associated processes show inconsistent results when applied to real site investigation data. Because the processes involved are not adequately known, the response to disturbances also cannot be adequately predicted.

There have been some previous experiences of the response of the system to redox disturbances, either induced or natural. This is the case, for example of the investigations within the REX project where, among others, an oxic disturbance was induced in a granitic system and the oxygen consumption with time in a fracture was monitored. Some of the doors that the project opened and were not closed were the influence of microbes on the oxidant consumption and the contribution of CH_4 and H_2 diffusing from deep sources to the reducing capacity of the system.

Progress beyond the state-of-the-art is achieved by studying the redox state and its response to disturbances by a combination of the chemical composition in solution and characterization of the solid phases, especially surface properties (size, composition, redox state, chemical form, mineralogical form and micro-distribution at the surface). The outcome allows identification of responsible processes and quantification of the redox buffering capacity and time functions. The latter is directly required for application to the safety analysis. Combination with real system analysis on (i) the crystalline rock system, including groundwater data and associated knowledge about hydrological prehistory and (isotope-) geochemical and mineralogical data for the rock matrix, and (ii) deep injection site data, the findings can be assessed for their applicability to relevant magnitudes of size and time.

Redox processes affecting the spent fuel source-term

The source term from spent fuel dissolution is subject to considerable uncertainties, both with respect to the presence and extent of oxidative dissolution processes of the spent fuel itself and the coupling with processes associated with the iron canister. The key questions not yet resolved are related to (i) the representativeness and reliability of laboratory data with respect to the impact of unavoidable minor concentrations of oxygen also in inert-gas boxes used, (ii) the potential reactivity and its outcome of hydrogen from container corrosion in combination with high burn-up spent fuel, (iii) possible galvanic coupling of spent fuel and container material and (iv) the retention of redox sensitive radionuclides by relevant minerals, especially by steel container corrosion products.

The spent fuel source term has been intensively investigated throughout the 4^{th}, 5^{th} and 6^{th} Framework programs. Investigations in FP4 pointed to the difficulty of maintaining relevant reducing conditions. The problem was approached by, amongst others, adding reducing components, in the case of metallic Fe also mimicking the impact of container material. In FP5 further investigations were made aiming at quantifying the spent fuel dissolution rates under repository conditions. The observations may be summarized as (i) lowering of release rate upon lowering of redox conditions, (ii) oxidative radiolysis contributes to the release function, and (iii) the canister material will reduce the oxidation-driven release of actinides to solution.

The outcome of these studies was not unambiguous. The reduction of released actinides may be a sink with respect to migration, although at the same time it can enhance the release by lowering the concentration in solution. The lack of mechanistic understanding leads to the incapability of making trustworthy predictions. There was no understanding of the coupled redox system to be expected under relevant conditions. In view of mechanistic approaches, the investigations moved towards the understanding of the impact of hydrogen on the release of radionuclides from the fuel. This process, nevertheless, has not been resolved so far.

In FP6, near-field investigations, among others moved towards backfill oriented investigations. A large set of possible coupled reactions are considered but not delineated by the experiments. The consequences of redox coupled gas generation are also recognized. The basic problems related to determination of redox, the chemical nature of processes reflected in bulk redox and predictability, remain areas of concern. The basic problems for trust in the Safety Case thus remain.

Progress beyond the state-of-the-art is achieved by generating adequate understanding of these processes, allowing for optimization of the spent fuel dissolution source term with important consequences for the entire safety analysis.

Impact of microbial processes on the redox state of the system and of radionuclides

Microbial processes emerge whenever suitable conditions are found. It is well known from real system analysis that microbial processes are involved in the turnover of redox sensitive aquifer system components. This refers both to turnover of dissolved components and formation of new solid phases. Stable isotope fractionation (for example $^{14}N/^{15}N$ and $^{32}S/^{34}S$) gives unambiguous identification of microbial processes. The relevance and conditions required for these processes, however, is still subject to debate. The same is true for the immobilization of radionuclides by microbial formation of minerals.

Investigations within FP6 provide clear indications that microbial activity will be very limited in compacted backfill and compacted clay host rock. In other cases it is recognized that the microbial activity has a strong influence on the redox conditions. This is especially verified by identification of microbial processes in natural systems (site investigation data) and identification of microbes in underground lab investigations. Fundamental problems are associated with the questions of (i) bulk redox conditions driven by the geochemical system composition and catalyzed by microbial activity, (ii) the potential for local deviations from bulk conditions, and (iii) the capability of microbes to drive processes that otherwise will not take place. Definite conclusions, however, are not available and are not expected to become available through remaining FP6 investigations. These investigations have rather contributed to adequate formulation of problems to be treated within the present project.

Progress beyond the state-of-the-art is achieved by studies specifically designed to identify the conditions required for relevant microbial processes, including bio-mineralization of radionuclides. It should, however, be understood, that this field will require additional studies over a longer time-perspective until trustworthy statements can be made for direct application to the Safety Case. The present project supports this initiation process. A key issue in progress through the present project is the application of spatial resolution techniques on a micrometer scale, specifically addressing the question of possible local deviations in the redox conditions.

Mobility of redox sensitive radionuclides

The mobility of redox sensitive radionuclides is strongly dependent on their redox state. One example is the mobility of Pu in brines, where Pu(III) is rather mobile, contrary to Pu(IV) with its very low solubility. This is not an academic question, but a key critical point in the Performance Assessment for the ASSE low level waste test facility with its significant amounts of disposed Pu. Another example is Se where the different redox states show very different diffusion mobility in clay. Finally, the mobilization of uranium in crystalline rock sampling campaigns is related to redox disturbances, however, the involved processes are not understood. In these examples, the critical point is that the mobility of radionuclides is directly dependent on their redox states, and that the present knowledge base is inadequate for trustworthy statements within the Safety Case.

Investigations within previous FP's and the still ongoing FP6 have had three main corner stones, namely (i) specific investigations on the transport/redox coupling, (ii) thermodynamics and the relation to redox transitions, and (iii) natural analogues and analysis of site data. Within the FP4 and 5 projects Trancom-Clay and Trancom-Clay II, the redox state of long-lived fission products as the key parameter for the mobility is clearly demonstrated. Projects on the thermodynamics of actinides (especially JETDEM and ACTAF) show that key redox transitions take place under relevant geochemical conditions. Natural analogue studies (OKLO, PALMOTTU) show the strong interrelation between redox processes and the mobility of radionuclides. In all cases problems are related to determination of the redox states and indentification of processes by experiments with a sufficient analytical back-up for verification of processes.

Progress beyond the state-of-the-art is achieved by (i) developing methods for prediction of the redox states of the relevant systems (see above “Determination of redox state”), (ii) providing the basis for predicting the redox state of concerned radionuclides, including identifying weather or not they are in redox equilibrium, and (iii) verifying the findings by radionuclide transport experiments with on-line monitoring of the redox state and identification of mechanisms for radionuclide retention by high-end post-mortem analysis.

Tools for application to Performance Assessment

Performance assessment models generally require relatively large mesh dimensions and long time steps in order to simulate radionuclide migration in the far-field. Redox reactions and related consequences are not considered explicitly, but in the form of element solubility data or sorption coefficients (Kd). However, redox phenomena acting in a disposal (near-field) or in the host rock or far-field are not independent intrinsic properties of the system which can be treated by a simplified reaction schema. Additionally, most of the host rocks formations display heterogeneity, at different spatial scales, regarding physical and chemical parameters which can potentially influence the transfer characteristics of radionuclides.

Most of the data used in PA model calculations are derived from laboratory experiments. For correct interpretation of laboratory experiments and application of the results to real systems, redox reactions have to be modeled taking into account the geochemical boundary conditions, which are influenced by a broad range of parameters.

Tools will be developed for explicit consideration of redox processes in Performance Assessment are mainly based on coupled reactive transport/diffusion modeling. These codes allow predicting of system and radionuclide redox states in the context of sorption, solubility and colloid formation. By applications of time-dependent reaction schemas the question of redox equilibrium/dis-equilibrium of radionuclides and the system response to changes in conditions can be analyzed. Application of such tools will reduce the considerable uncertainties involved in prediction of the system redox state.

A contribution to supporting the trust of a Safety Case will be addressed by establishing and documenting common understanding in application of the different electrodes, protocols, and approaches of describing the redox state. In this context, also solid phases involved and associated thermodynamic data for solid and dissolved species will be indentified.

Application of coupled reactive modeling in PA is not yet state-of-the-art, however coupled reactive modeling is increasingly applied for modeling diffusion of weakly sorbing tracers. In 6th Framework Program IP PAMINA, a zero-dimensional source term model is presented describing redox-sensitive radionuclide transport through corroded canister material providing for redox buffer capacity. ReCosy will go further and will provide a platform where test cases are provided in order to demonstrate under which conditions simplified models may be justified and where more sophisticated approached are required.

B.1.2.2 Performance indicators and Performance Indicators monitoring

Indicators of the performance of the project constitute an important tool for the management and coordination, as well as for review and project follow-up. Performance Monitoring Indicators facilitate the prompt detection of possible deviations from work program and project objectives, and will provide information on how the project advances towards the achievement of the defined objectives.

Within ReCosy several categories of Performance Indicators are defined:

- Scientific-Technical Indicators
- Integration Indicators
- Indicators on the application to the disposal Safety Case
- Indicators on the documentation and dissemination of the project outcome
- Time schedule Indicators
- Knowledge Management Indicators
- Training Indicators

Each one of these categories integrates different individual indicators, which are defined below.

<Scientific-technical indicators>

Measured by the number and quality of the publications generated by the project:
Publications, presentations, reports.
Publications in peer review journals.
Scientific-technical contributions in the Annual Project Workshop Proceedings.

The quality of contributions to the Annual Project Workshop Proceedings is ensured by the EUCG providing scientific-technical review.

<Integration Indicators>

The level of Integration of the project within the project itself and with other external activities and/or groups outside the project is an important benefit that provides:

A general improvement of the competence level of the partners, as well as optimization of the available resources of the different organizations and of the project itself.

- Enhancement of the communication with other scientists and stakeholders, therefore, synergies among different groups and techniques and/or developments that can improve the outcome of the project

<Applicability to disposal Safety Case Indicators>

The applicability to disposal Safety Case will be monitored through the End-Users Consultancy Group (EUCG). The quantitative monitoring of this indicator is difficult to define, although a very good qualitative indication will be provided by the EUGC input to, and reviewing of, the deliverables planned throughout the whole duration of the project within WP1.

<Time schedule indicators>

The time schedule indicator, which is the time deviation with respect to planned activities, will be monitored on a semi-annualbasis (semi-annual and annual reports), percentage of all reports on time, reasons for delays

<Knowledge management and Communication indicators>

Knowledge management indicators will be used to assess how efficiently the knowledge generated through the project is distributed inside and outside the project, as well as the level of accesibility of the information on the project to external stakeholders. To this aim:

- The reports generated in the project will be located on the Intranet with the minimum delay
- A visit counter will be implemented in the website
- The information on events and meeting will be regularly updated
- A record of the presentation of the project outside the project community and outside the scientific community will be held
- A register of external participants in workshops and meetings of the project will be held
- Newsletters to be published at project onset and then twice a year
- Number of subscribers to the Newsletter
- Number of request through Webportal

<Training and mobility indicators>

The training and mobility indicators will be monitored by:

- Quantity of mobility measures implemented through the project resources
- Level of participation of the contractors in different training activities, either internal or external
- Quantity of participants from outside the project in the training activitites organized within the project
- Number of PhD students taking part in the project work programme and in the project training activities

Number of specific actions to attract PhD students to participate in ReCosy training activities

B.1.3 S&T methodology and associated work plan

B.1.3.1 Overall strategy of the work plan

The distribution of the project into Work-packages and the individual monitoring of the work conducted by the respective work-package leaders allows for timely identification of issues and implementation of remedial actions prior to such issues affecting the overall S+T programme.

The review of the overall work plan will be conducted on an annual basis. As necessary, the work plan will be amended in order to ensure that the project objectives are fullfilled.

With respect to the role of redox reactions within the disposal Safety Case, the work plan aims at (i) providing reliable analytic redox determination methods, (ii) providing missing basic understanding on processes determining the redox conditions, (iii) determining relevant redox processes governing then radionuclide transport/retention, (iv) providing modeling tools for application to the Safety Case, (v) education and training, and (vi) documentation, communication and dissemination of the results.

Below topical areas are described, forming the basis for the logical work program and the definition of workpackages.

<Documentation and regular up-dating of the state-of-the-art>

The scientific-technical state-of-the-art, i.e. the scientific and analytical state of knowledge, and the technical implementation in Performance Assessment/the Safety Case, is anchored in the expertise of the project partners and reflected in this project application with its description of work. This is documented at the very beginning of the project, structured in view of final reporting on this topic, including providing the basis for regular up-dating along the project.

<Definition of systems and system conditions>

There are many systems to be investigated within the project. Interpretation of the outcome of individual studies will benefit from having the same systems investigated by a number of different partners with respect to characterization of the systems, identification of redox determining processes, response to system changes and the redox behavior of concerned radionuclides. For this reason, at the very beginning of the project, systems and system conditions are defined in order to avoid inadvertent differences that would have an adverse impact on interpretation of the results.

<Development of redox determination methods>

One key aspect is the development and testing of electrodes and optodes (optical sensors) in combination with chemical analysis and associated thermodynamic assessment for determination of the overall system redox state. Development of advanced redox determination methods, namely electrodes and fiber optics based optodes, and refinement in chemical determination redox sensitive species, is done in order to have:

(i) a broader information base for interpretation of system conditions, and
(ii) redox determination systems applicable to the specific experimental requirements.

The first point reflects that existing determination methods (and new developments) all have potential artifacts, such as poisoning of electrode material, diffusion potentials in electrode bridges, drift through catalytic reactions on electrode material, drift through changes in electrolytes via diffusion, analytical difficulties in determining concentrations of redox sensitive system components or state of involved solids/minerals, and insufficient/inadequate thermodynamic data for calculation of the redox state.

The second point is associated with the potential chemical impact (cf. above) but also with the need to have miniaturized systems, especially for measurements in natural clay rock samples.

The approach is (i) development of new determination methods in different organizations, (ii) comparison with existing methods on different systems at these individual organizations, followed by (iii) an interlaboratory comparison on selected systems. The problem with such an interlaboratory comparison is that relevant systems are sensitive to disturbances from transport and storage. For this reason, the interlaboratory comparison is done at one organization where the different partners involved apply their respective redox determination methods and the outcome is jointly assessed.

<Redox response of defined and near-natural systems>

The response to induced perturbations of defined and near-natural systems under controlled laboratory conditions is monitored by physicochemical and chemical parameters. Systems used range from defined/designed solutions together with defined/designed surfaces, through to natural samples in combination with model water and natural groundwater. Batch, column and diffusion experiments are used. Well characterized thin sections are also used, allowing for well defined system conditions and the application of high-end surface analytical methods for characterization of solid phase/mineral processes. Nano-particles are used for investigation of the potential changes in surface properties on the nano-scale. A series of systems under the influence of microorganisms are also used, including studies on the potential bio-mineralization of system components.

The studies serves several purposes, namely providing (i) insight into components and processes determining the redox state of these systems, (ii) knowledge about the redox state on the (near-) natural systems, and (iii) their redox buffering capacity. The second point is crucial for long-term predictions of the different disposal system components. The third point is the key for predictions concerning both repository induced disturbances on the near- and far-field, as well as impact of change in land-use and climatic changes on the far-field.

Thorough analysis of chemical and physico-chemical composition of the water, high-end analytical methods for solid phase and surface characterization is used in order to obtain the required information about the systems and their response to disturbances. This includes isotope analysis as part of identification of microbial processes. In addition, 3D distribution of minerals/solid phases on a micro scale is used for identification of their role in the processes.

<*Redox reactions of radionuclides*>

The aim of the overall study is related to the redox behavior of relevant radionuclides. Actinides and long-lived fission product (Tc, Se and I) are studied. Specific investigations on the redox behavior of these radionuclides serve several purposes, namely (i) verifying the species assumed for the relevant conditions and the associated thermodynamic data, (ii) identifying where the redox processes take place (solution or surfaces), (iii) determining under which conditions the radionuclides are in redox equilibrium with the overall redox conditions, (iv) determining the mobility associated with the radionuclide redox state and redox transformation processes, and (v) using the oxidation state distribution of radionuclide as a redox determination method.

The objectives are logical continuations of previous investigations reflecting the deep experience of involved groups. Beyond the state-of-the-art is obvious for the investigations under hyper-alkaline conditions and the application of micro-resolution techniques in the investigations on the microbial influence. With respect to the other investigations, the added value is especially given by application of the overall improvement of understanding the basic concepts on these specific and relevant cases.

To a large extent, systems used for determination of redox response (see above) will be used, in order to have a solid fundament for interpretation of the experimental results.

<*Redox processes in Radionuclide transport in natural and near-natural systems*>

Information on the radionuclide transport is obtained by studies in of near-natural systems in the laboratory and identification of transport processes and impact of redox reactions by real system analysis. The former is partly obtained in association with near-natural system studies discussed above.

The focus of the transport in near-natural systems in the laboratory is on identifying processes sensitive to redox reactions. This is done in association with near-natural system studies for the purpose of identifying the system response to disturbances and identification of the redox state of radionuclides and their mobility. Aim of the studies is to provide the basis for interpretation of the radionuclide transport and tools for predicting the behavior in real systems. Special emphasis is given to the mechanisms underlying the transport behavior with respect to redox of the system, the radionuclides and the stability ranges where different behaviors are expected. The findings are brought together with the outcome of real system analysis in order to ensure validity in real systems.

<Real system analysis>

Real system analysis is a key for providing trust in the applicability of the detailed process understanding from laboratory investigations. The real system analysis also allows for determination of processes that cannot be mimicked in the laboratory, especially the long time scales. These studies include (i) analysis of the broad set of analytical groundwater data from the Swedish site investigation program, and (ii) analysis of crystalline rock fractures. The Swedish site investigation program data are coupled with a good understanding of hydrology, including pre-history. Analysis of the data aims at identifying which components determine the redox conditions and which components are in redox equilibrium/dis-equilibrium. The outcome will support predictions concerning the redox, and thus transport, behavior of relevant radionuclides. The granitic fracture analysis includes 3D spatial distribution of relevant minerals. The identification of isotope distribution of natural actinides provides further information concerning the present conditions and their pre-history. In combination with above discussed laboratory studies, knowledge on the long-term impact on redox and the response to disturbances is obtained.

<Impact of microorganisms>

Microorganisms are known to have a great impact on the redox state of the system and the radionuclides therein. The key impacts of the microorganisms are related to (i) defining the system redox state, especially by conversion of redox sensitive system components that otherwise would be non-reactive and by biofilm reactions, and (ii) determining the redox state of radionuclides, including formation of secondary phases. In addition, mobile microorganisms may transport radionuclides. The fraction of microorganisms in the mobile phase, however, is very low and thus the mobilization by this mechanism is not of dominant character.

Within the project, the whole spectrum of microbial processes cannot be thoroughly investigated. The project focuses on the impact of microorganisms on the redox of the system and response function to different types of impact, as well as the key question of processes determining the redox state in biofilms, starting with development of methods for measuring the biofilm redox state.

A close collaboration between groups contributing with microbial studies will be strived for.

<Application to spent fuel source-term>

A set of investigations will be conducted with the aim of getting better insight into redox processes determining spent fuel and iron canister corrosion. The studies are specifically designed for the purpose of identifying key processes. The development of redox determination methods in other parts of the project will be of key importance for this work. The investigations include galvanic coupling of spent fuel and waste canister components as well as spent high burn-up fuel corrosion/dissolution under high temperatures and hydrogen pressures.

A specific aspect is the use of uranium thin films allowing coupling with the high-end analytical methods available through the project in order to gain the desired process understanding for uranium dissolution and the relation to redox processes. Another specific investigation where the entire spectrum of high-end approaches available through the project is applied refers to the corrosion and redox response behavior of Fe with different pre-treatments and different conditions, including high radiation fields. In particular, redox-based retention properties of corroded iron phases with respect to dissolved radionuclides will be investigated under repository relevant conditions.

It should be underlined, that these studies are highly application oriented with respect to the disposal source term, however, are specifically tailored towards extension beyond classical corrosion rate measurements and provide the corrosion redox process coupling for the required reliable long-term predictions. They specifically allow for model predictions under variation of the near-field scenarios, especially considering possible various inventories and partial pressures of hydrogen, and the role of corroded iron phases.

<Structure of the work program>

The scientific-technical work program is structured along six RTD workpackages (WP1-6). There is also one workpackage on knowledge management and dissemination and training (WP7). Training is closely associated with the RTD program by individual mobility measures and training seminars on specific topics, with emphasis on addressing young scientists. The last workpackage is on “Project Management” (WP8).

WP 1: Harmonization of work program and implications of redox for the Safety Case.

WP 2: Development of redox determination methods

WP 3: Redox response of defined and near-natural systems

WP 4: Redox reactions of radionuclides

WP 5: Redox processes in radionuclide transport

WP 6: Redox reactions affecting the spent fuel source-term

WP 7: Knowledge management and dissemination & training

WP8: Project Management

B.1.3.2 Time schedule

The time-schedule of the project is shown in Fig. 1.3.1. The duration of the project is four years. The basic approach of the time schedule is (i) agreement of experimental program details at the very beginning of the project (WP 1), (ii) development of redox determination methods (WP 2), followed by, and partly overlapping with (iii) R&D work providing the information and knowledge to be used within the disposal Safety Case (WP's 3-5). WP 6 on spent fuel dissolution, different in nature with respect to experimental conditions, starts at the very beginning of the project.

Workpackage 1 starts at the very beginning of the project and continue until the project is finalized. Workpackage 2 (broadening of the base for redox system determination, design of specific redox indicators and providing trust in the application of existing methods and new methods) starts at the very beginning of the project and is finalized at mid-term. The key milestone of this work is the interlaboratory comparison exercise, planned for project month 18, and the conclusions thereof. The outcome of this workpackage is essential for the implementation of the application oriented workpackages and thus will brought into investigations under WP's 3-5.

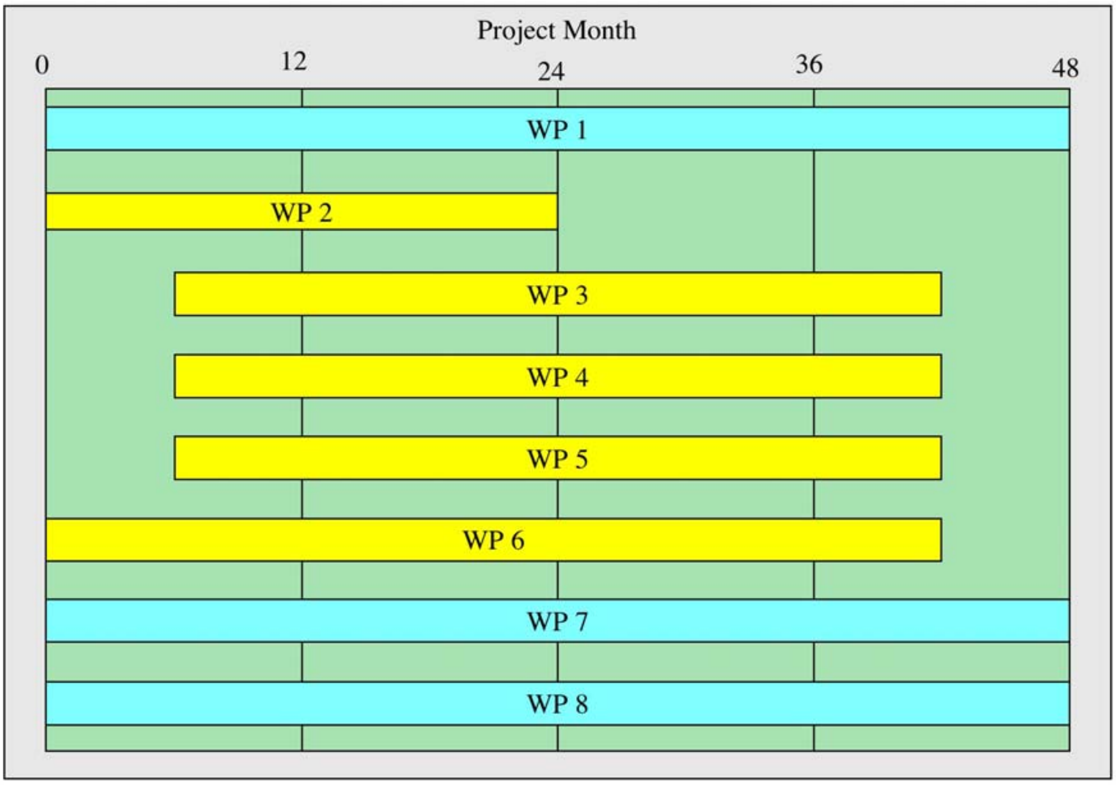

Fig. 1.3.1: ReCosy time schedule

Workpackage 6 ("Redox reactions affecting the spent fuel source-term") with its different experimental framework is started at the very beginning of the project and is finalized together with the other application oriented WP's, namely at project month 42.

Workpackages 7 and 8 (on Management, communication and dissemination of knowledge, and Training and education, as well as Project Management) are implemented throughout the duration of the project.

B.1.3.3 Workpackages

Below, list of all workpackages is given, (including workpackage 7 ("Knowledge management and dissemination & training"), and workpackage 8 ("Project Management"). Information is also given as the type of activity, lead participants, the work effort required for each workpackage and the project period under which the individual workpackages are carried out.

List of workpackages (WP)						
WP No	**WP title**	**Type of Activity**	**Lead partici pant**	**Person - months**	**Start month**	**End month**
WP 1	Harmonization of work program and implications of redox for the Safety Case	RTD	AMPHOS	45	0	48
WP 2	Development of redox determination methods	RTD	UPPC	109	0	24
WP 3	Redox response of defined and near-natural system	RTD	CNRS	199	6	42
WP 4	Redox reactions of radionuclides	RTD	PSI	151	6	42
WP 5	Redox processes in radionuclide transport	RTD	CEA	69	6	42
WP 6	Redox reactions affecting the spent fuel source-term	RTD	JRC	65.5	0	42
WP 7	Knowledge management and dissemination & training	OTHER	AMPHOS	5	0	48
WP 8	Project management	MGT	FZK-INE	12	0	48
			Sum: PM:	**655.5**		

B.1.3.4. Deliverables

The deliverables ("D") are given below. They are numbered along with the different workpackages ("WP-No.x"). The due date is given in project months. The delivery date to the Commission is 45 days after the due date. Deliverables under workpackages 2-6 are related to specific achievements within these RTD oriented workpackages. Management reporting falls under workpackage 8. Reports that are designated as "public" will be established as interim working documents followed by publication as public reports by the respective responsible organization. These public interim and final reports will be posted at the project internet portal and be disseminated over other suitable channels, such as the cordis site, as appropriate.

List of Deliverables					
Del. No	Deliverable name	Lead partner	Nature	Dissemina-tion level	Due date
Workpackage 1 (Harmonization of work program and implications of redox for the Safety Case)					
D1.1	Agreement on, and documentation of, systems and conditions to be studied (with regular updating)	AMPHOS	R	CO	4/24/36
D1.2	Report on the scientific state-of-the-art (with regular updating)	AMPHOS	R	PU	3/24/36/48
D1.3	Report on basis for application of the redox processes in the Safety Case (with regular updating)	AMPHOS / INE	R	PU	12/24/36/48
Workpackage 2 (Development of redox determination methods)					
D2.1	Agreement on details for the inter-laboratory comparison exercise	FZK-INE	R	CO	3
D2.2	Experimental scheme for the inter-laboratory comparison exercise	UPPC	R	CO	12
D2.3	Consolidated report on outcome of the inter-laboratory comparison exercise	UPPC	R	PU	24
Workpackage 3 (Redox response of defined and near-natural systems)					
D3.1	Characterization of the redox determining minerals used in the investigations	CNRS	R	PU	6
D3.2	Effect of microbial processes on the redox systems investigated (Interim and final reports)	UNIUTR	R	PU	24/45
D3.3	Buffer capacity and the redox kinetics of the systems investigated (Interim and final reports)	II-HAS	R	PU	24/45
D3.4	Incorporation of the concept of reducing capacity in reactive transport simulations (Interim and final reports)	AMPHOS	R	PU	24/45
Workpackage 4 (Redox reactions of radionuclides)					
D4.1	Chemical and redox behavior of the investi-gated radionuclides in the different systems	PSI	R	PU	12/24/36/45

List of Deliverables					
Del. No	**Deliverable name**	**Lead partner**	**Nature**	**Dissemina-tion level**	**Due date**
	(progress and final reports)				
D4.2	Chemical and redox behaviour of the investigated radionuclides in the different systems through microbial mediated processes (progress and final reports)	IPL	R	PU	12/24/36/45
Workpackage 5 (Redox processes in radionuclide transport)					
D5.1	Redox processes in radionuclide transport in crystalline rock (progress and final reports)	HU	R	PU	12/24/36/45
D5.2	Redox processes in radionuclide transport in clay rock (progress and final reports)	CEA	R	PU	12/24/36/45
D5.3	Redox processes in radionuclide transport in contaminated systems (progress and final reports)	MSU	R	PU	12/24/36/45
Workpackage 6 (Redox reactions affecting the spent fuel source-term)					
D6.1	Report on redox driven spent fuel dissolution and radionuclide trapping by steel canister corrosion products and other Fe minerals. (progress and final reports)	JRC	R	PU	12/24/36/45
D6.2	Report on redox driven spent fuel dissolution through galvanic coupling (progress and final reports)	JRC	R	PU	12/24/36/45
Workpackage 7 (Knowledge management and dissemination & training)					
D7.0	Plan for using and disseminating the results	AMPHOS	other	PU	3
D7.1	Project presentation	AMPHOS	other	PU	3
D7.2	Establishing and regularly updating public web portal and project internal intranet site	AMPHOS	other	PU	0
D7.3	Poster presentation of the project	AMPHOS	other	PU	0
D.7.4	Electronic Brochures with the annual workshop announcement	AMPHOS	other	PU	8/20/32/44

List of Deliverables					
Del. No	**Deliverable name**	**Lead partner**	**Nature**	**Dissemina-tion level**	**Due date**
D.7.5	Semi-annual newsletters informing on the advance of the project	AMPHOS	other	PU	6/12/18/24/30/36/42
	Training course material (folder, leaflet etc…)	AMPHOS			
D.7.6	Annual and training workshop Proceedings	AMPHOS	R	PU	8/20/32/44
D.7.7	Annual and training workshop programmes	AMPHOS	R	PU	8/20/32/44
D.7.8	Summary of the training and knowledge management activities within the project	AMPHOS	R	PU	14/26/38/48
D.7.9	List of mobility measures and summary of the works undertaken by scientists awarded with the measures	AMPHOS	R	PU	When necessary
Workpackage 8 (Project management)					
D8.1	Semi-Annual management and activity reports	FZK-INE	R	CO	6/18/30/42
D8.2	Annual management and activity reports	FZK-INE	R	CO	12/24/36/48
D8.3	Final Report (EUR)	FZK-INE	R	PU	48

B.1.3.5 Work package description

The Workpackage 1 deals with documentation of the overall project outcome for its implementation in the Safety Case. The RTD workpackages 2-6 contain scientific technical work of the project. Workpackage 7 covers maganement, communication and dissemination of knowledge, as well as training and education. Workpackage 8 contains the administrative management issues. The workpackage descriptions are given in Appendix I, with the type of activities, starting date in project months, project participants and their respective work effort allocation in person months, the objectives, description of work, as well as deliverables and milestones. This Appendix is the basis for update of the workplan following regular reviews.

B.1.3.6 Efforts for the duration of the project

The planned staff effort for each partner for the different work packages is as follows:

No.	Beneficiary	Work Effort (Person months)								
		Workpackage								Total per Beneficiary
		1	2	3	4	5	6	7	8	
1	FZK-INE	4	12	8	12	6	6		12	60
2	ARMINES	1	18							19
3	BRGM	1	11	13						25
4	CEA	1			6	12				19
5	CTH	1			9					10
6	CTM	1		16						17
7	AMPHOS	7		20	8			5		40
8	FZD	1	7		8					16
9	GRS	1	12							13
10	UH	1				18				19
11	JRC	1					36			37
12	NRI	1					11			12
13	PSI	1			31					32
14	TUG	1	6	8						15
15	UPPC	1	23							24
16	CNRS	1	18	80	16					115
17	UNIZAR	1		2						3
18	STUDSVIK	1					5			6
19	II-HAS	1		18		13				32
20	UCYPRUS	1		6		8				15
21	IPL	1			31					32
22	UNIUTR	1		11						12
23	KTH	1					7.5			8.5
24	MICANS	1		15						16
25	LQC	1	2							3
26	GEOPOINT	1		2						3
27	MSU	1				12				13
28	SKB	2								2
29	ANDRA	3								3
30	POSIVA	2								2
31	ULOUGH	1			18					19
32	UMANCH	1			12					13
	SUM:	45	109	199	151	69	65.5	5	12	655.5

B.1.3.7 List of milestones, internal reviews and EUCG meetings

There are two milestones, i.e. a key point with considerable impact on work and progress throughout the work program:

List and schedule of milestones					
Milestone no.	**Milestone name**	**WPs no's.**	**Lead beneficiary**	**Delivery date from Annex I**	***Comments***
1	Agreement and documentation of systems and system conditions to be studied	1	AMPHOS	4	Availability of documented agreement (report/D0.1) on systems and system conditions to be studied.
2	Assessment of existing and the new developed methods for redox determination.	2	FZK-INE	18	Assessment of interlaboratory comparison with the different existing and new methods on systems of varying complexity.

The tentative schedule of reviews meetings through the EUCG is as follows (does not replace mid-term and end of the project reviews organized by the EC):

Tentative schedule of internal project reviews (Internal reviews by the EUCG in association with the kick-off meeting and Annual Project Workshops)		
Review no.	**Point in time(in project months)**	**Meeting/Workshop and Place (planned)**
1	3	Kick-off meeting, Barcelona
2	10	1st Annual Project Workshop, Mallorca
3	23	2nd Annual Project Workshop Cyprus
4	36	3rd Annual Project Workshop Not yet decided
5	47	4th Annual Project Workshop Karlsruhe
General comment: The selection of the venues is based on cost efficiency (in agreement with the EC policy) and on the search for places where the right infrastructures are present for a meeting of such characteristics. Previous experiences of the coordination team in organizing annual workshops of big projects indicate that continental europe is more expensive, forcing contractors to use a significant part of the funds in travel arrangements. This will also facilitate the access to the workshops to students and lower income institutions.		

These review meetings will be held in association with the Kick-off meeting and Annual Project Workshops in order to ensure optimum use of time and financial resources. The EUCG will also provide for the review of scientific-technical contributions to the Annual Project Workshop Proceedings. This review will be held directly after the respective Annual Project Workshops, providing for the best point in time for the review and in order not to delay publication of the proceedings.

An additional EUCG meeting will be held in association with the Kick-Off meeting in order to start the process of project monitoring and establishing the first draft of the report on application to the Safety Case.

B. 2 Implementation

Implementation of the project primarily rests on the RTD conducted by individual Contractors, as agreed upon in the Contract. A broad consortium is brought together, integrating the different skills, competences and resources required. It brings together 28 organizations from 13 countries and one JRC. Management structures and procedures are established in order to provide for adequate implementation, communication within the project, reporting, and dissemination and communication of the outcome of the project to interested parties. In this context the roles and responsibilities of different bodies and partners within the project are defined and adequate resources are provided. These topics are described in the following sections.

There are several interdependencies between the different workpackages integrating scientific and long-term safety key issues (see Fig B.2.1). The topics and activities are deduced from combinations of top-down and bottom-up approaches.

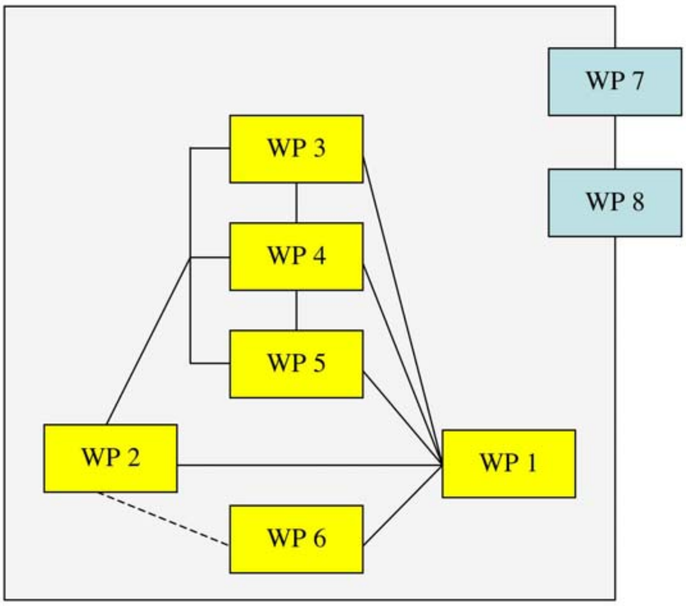

Fig. B.2.1: Project interdependencies

A key point of the project is the development of advanced redox determination methods and assessment of these new and already existing ones, especially by an interlaboratory comparison exercise. Investigations within workpackages 3-5 are very much dependent on the development of new redox determination methods for specific conditions, such as on-line measurements in natural clay samples, and the assessment/verification of the validity of these methods. Workpackage 6 is less dependent on the development of redox determination methods, but will benefit from general improvement in the understanding of underlying processes and determination methods. The state-of-the-art and regular updating in view of application to Performance Assessment/the Safety Case is brought together under workpackage 1, with strong interdependencies with workpackages 2-6. This workpackage also provides for close agreement on systems and system conditions to be used, and thus has a strong impact on workpackages 2-6. Workpackage 7 ("Knowledge management and dissemination & training") is implemented in the context of the RTD work program. Workpackage 8 ("Project Management") also refers to the entire RTD work program. In addition to that, it strongly interacts with the outside community.

Mobility measures are implemented along with the Project. The benefit, duration and objectives of a mobility measure is identified by the two involved project partners and proposed to the ExCom/CT. The ExCom and CT decide upon the request as soon as possible, i.e. by review of the proposal in writing. If accepted, the workpackage 7 leader and the involved partners take care of implementation. Travel costs are recovered through travel application directly with the workpackage 7 leader, according to the duty travel rules of that organization. The outcome mobility measures are reported through the Annual Reporting and are subject to review by the EUCG.

B.2.1 Management structure and procedures

The project is of limited size and thus very elaborate organizational and decision-making structures and mechanisms are not required (Fig. B.2.2). Workpackage leaders head the individual workpackages. Based on their insight and responsibility for the program, they form the Executive Committee (ExCom). The General Assembly represents the interests of all project partners and provides guidance to the project work and activities. The End-User Consultancy Group provides support for the project by review and implementation of the project results for the Disposal Safety Case.

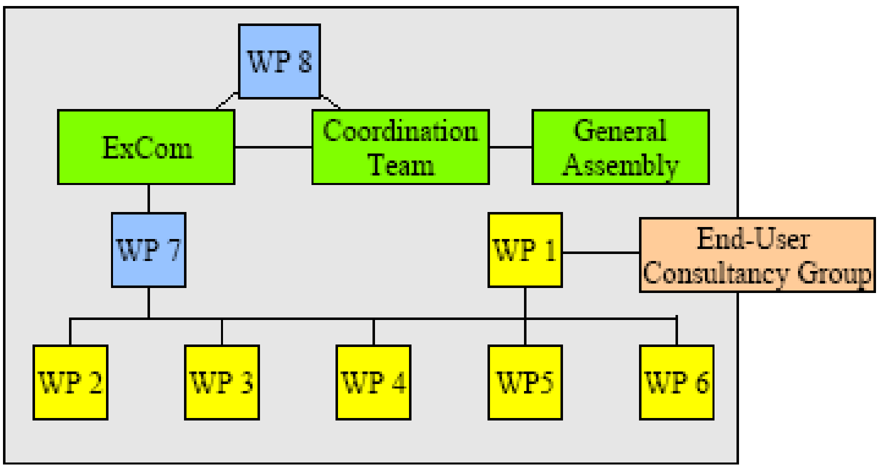

Fig. B.2.2: Elements and bodies of the project providing the basis for adequate project implementation.

Other provisions supplementary to the grant agreement are set out in the consortium agreement to be signed by all the beneficiaries. The consortium agreement specifies the organization of the work between the parties, the Access rights and obligations of the parties.

Coordination Team (CT):

The composition of the CT is based on two organizations, namely the Coordinator (FZK/INE) and the Technical Secretariat (AMPHOS):

- The Project Coordinator (Dr. G. Buckau, FZK/INE)
- Project Coordination support (Dr. B. Kienzler, FZK/INE)
- The Scientific-Technical Secretariat (Dr. L. Duro, AMPHOS)
- Financial Officer (Mr. R. Brannath, FZK/INE), and
- Legal Officer (Ms. K. Sauer, FZK/INE)

The role of the CT is to take overall responsibility for the day to day project management, including technical and administrative management of the project and all issues related to management and communication of knowledge, mobility measures and training activities. Proposals for training activities will be communicated and decided within the ExCom.

The tasks of the CT are:

- Overall functioning of the project work and activities,
- Communication between the project and the Commission,
- Monitoring of the use of resources and transferring financial resources, as appropriate,
- Documentation of the project achievements and outcomes and their dissemination and communication outside the project
- Organize and manage interactions and the tasks of the EUCG,

Executive Committee (ExCom):

The ExCom consists of the workpackage (WP) leaders::

WP 1	Dr. Lara Duro, AMPHOS
WP 2	Dr. Michael Kumke, UPPC
WP 3	Dr. Laurent Charlet, CNRS/LGIT
WP 4	Dr. Jan Tits, PSI
WP 5	Dr. Michael Descostes, CEA
WP 6	Dr. Vincenzo Rondinella, JRC
WP 7	Dr. Mireia Grivé, AMPHOS
WP 8	Dr. Gunnar Buckau, FZK-INE

The role of the ExCom is to supervise and provide co-ordination the technical work within the WP, via the respective WP leaders. The individual WP leaders will report on the activities, progress and, if relevant, problems within the respective work-packages. If problems occur, proposals for solving these problems will also be put forward from the concerned work-package leader to the ExCom. ExCom will also respond to review comments from the EUCG via the CT. Discuss and take decision on the CT proposals for organizing and implementing the annual workshops and training workshops and mobility measures.

The tasks of the ExCom are:

- Providing the basis for proper operation of the respective workpackages, including identification of problems, making suggestions for and supporting remediation measures,
- Providing guidance for the overall implementation of the project, and
- Supporting harmonization of the different project activities towards the common objectives,
- Reporting of the activities within each WP and monitoring of the state of the WP deliverables,
- Prepare and report the project activities as well as any problem arising and remedial actions to and for decision by the General Assembly.

General Assembly (GA):

The GA consists of one representative per project beneficiary as of the grant agreement. GA meetings are organized annually in conjunction with the annual workshops. Attendance in the GA meetings is restricted to the project beneficiaries.

The role of the GA is:

- To discuss the status of the work program and decide on next steps, including deviations from original work planning, if required,
- To prepare for annual reporting, including preparation of a public Annual Workshop Proceedings for effective documentation and communication of the project achievements,
- To approve the deliverables.

The responsibility of the GA is to act as decision making body regarding any of the issues requiring considerable changes to the grant agreement and any other changes as defined in the consortium agreement together with the rules for decision. Thereby, the key function is to ensure that interests of project partners are not violated. It will also be called to provide acceptance of key project implementation issues (administrative and technical).

The GA meets on an annual basis in conjunction with Annual Project Workshops. In this context, issues are raised and decisions taken.

Individual beneficiaries:

With respect to RTD, the role and responsibilities of each beneficiary is defined in the work program. The key responsibility is to conduct the RTD with the resources allocated, as agreed upon within the grant agreement. Each beneficiary is also responsible for contributing to management of the knowledge. In addition, each beneficiary is required to contribute to spreading awareness of the project as a whole and parts of it and its achievements. For spreading awareness of the project as a whole, a generic poster is available at the project intranet site. Furthermore, the frequent use of the EURATOM FP7 and project logos in communicating the project outcome is highly desirable. Finally, each beneficiary is required to contribute to training and education, especially by supporting training on the job through mobility measures vie project internal and external resources. In summery, the beneficiaries are required to:

- Generate knowledge as agreed upon through the description of work
- Contribute to appropriate management of the knowledge by adequate handling, documentation and publication of the outcome
- Contribute to communication and dissemination at various national and international events, making use of both project and additional resources
- Contribute to training and education, especially through training on the job by mobility measures

In order to avoid the growth of problems, each beneficiary is requested to communicate actual or potential problems, as soon as reasonable, to the concerned workpackage leader, the CT, the ExCom and the GA, as appropriate.

End Users Consultancy Group (EUCG): The EUCG is a group specifically set up within the project in order to represent the interests of the end users to the project and its desired outcome. To this aim, the composition of the EUCG includes organizations representing national waste management or national regulatory interests and competence. Amongst others, their role will be to inform the project about the main strategic research interests of the end-users and on how the knowledge generated within the project should be formulated so that it can be integrated within the Safety Case. Within this context, the French B2 and C waste cell concepts (design, inventory, evolution over time…) will serve as specific examples.

The EUCG is composed of three persons representing Nuclear Waste Management organizations interests/expertise, and three persons representing regulatory interests/expertise as follows:

ANDRA, represented by Scott Altmann
SKB, represented by Ignasi Puigdomenech
ENRESA, represented by Pedro Hernan
GRS, represented by Bruno Baltes
HSK, represented by Ann-Kathrin Leuz
SWRI, represented by Budhi Sagar (final acceptance pending)

The tasks of the EUCG are:

- Review and document comments on the choice of experimental systems and associated conditions proposed by each beneficiary for discussion and agreement with the consortium at the project kick-off meeting,
- Provide guidance to the CT and ExCom on how the knowledge generated within the project should be formulated so that it can be integrated within the Safety Case,
- Review and make recommendations on the successive drafts and final deliverable D1.3 "Report on basis for application of the redox processes in the Safety Case",

- Review the scientific-technical papers for the proceedings of the Annual Workshops.

Associated Groups (AG):

The Project will establish specific agreements with Associated Groups. This is done in view promoting integration of an interested community and efficient dissemination and communication of the project activities. Associated Groups are not Beneficiaries to the Project. Consequently, the Associated Groups will not receive any funding and will not have access rights to any non-public project results and IPR, including pre-existing know-how.

All deliverables declared public will be freely disseminated and every effort will be made to communicate these results the broadest scientific community and end-users. Possible access by Associated Groups to information beyond the publicly available one will be agreed upon with the Beneficiaries.

Annual Project Workshops are key elements in the implementation of the Project, amongst others with the aim of:

- Communicating the status of the different project activities, work and state of progress between all project partners,
- Integrating work within the project
- Disseminating the project results to the broader interested community, and
- Preparing for annual reporting, including preparation of a public Annual Workshop Proceedings for effective documentation and communication of the project achievements.

In association with the Annual Workshops, also ExCom meetings and General Assemblies are held.

B.2.2 The Consortium and individual beneficiaries

In Appendix II, brief descriptions are given of the participating organizations, the project activities that they take responsibility for, and previous experience relevant for these activities. In addition, brief profiles are given for staff undertaking the work.

In order to meet the objectives, the consortium needs to cover wide ranges of infrastructure, competencies and skills:

- Basic understanding of the thermodynamics involved in physico-chemical properties of aquatic systems, especially redox determining processes,
- Practical experience with site investigation and the gathering and interpretation of verified analytical data,
- Frontier development of new analytical methods, especially fiber optics based optode technology and in-situ reference micro-electrodes,
- Access to, and experience with, a very broad range of analytical methods, reaching from various types of element and ion quantification, to a variety of laser based spectroscopic methods and synchrotron based spectroscopy methods, especially application to spatial resolution on a micro-scale and surface characterization,

- Infrastructure for, and experience with, handling of the very sensitive near-natural systems under laboratory conditions, including diffusion and radionuclide mobility studies with natural clay samples,
- Infrastructure, analytical tools and experience for handling of, and analyzing, radio-active material, varying from exemption levels to spent fuel,
- Access to data from, and experience with interpretation of, real systems, including isotope-geochemistry, organic geochemistry and groundwater microbiology,
- Understanding of how basic knowledge needs to be formulated for application in the Safety Case, i.e. understanding basic characteristics of Safety Cases, and finally
- Long experience in managing large projects, especially EC projects over the past frame-work programs, including administrative requirements and processes, training, and communication and dissemination of the project outcome.

The project partners cover all these aspects where their respective skills are introduced in an optimized fashion.

The project partners cover all these aspects where their respective skills are introduced in an optimized fashion. The consortium includes 14 research organizations and 9 universities. These partners have the skills and the necessary infrastructures to conduct the highly precision experiments described in the work programme. The implication of very specialized research organizations covers the required frontier technological development needed for the imple-mentation of new analytical techniques and methods. Most of the members of the consortium, including the 4 SMEs have a very strong link with the national radioactive waste management programs, so providing a thorough understanding of the requirements of Performance Assessment and the Safety Case, what will facilitate the focus of the project on the real needs identified at a European level. This is reinforced by the participation of two of the European implementers with an advanced siting program, namely the Swedish and French National Waste management organizations, SKB and ANDRA respectively. Most of the partners of the consortium have previously participated in EC projects. This means that they perfectly under-stand the best way to achieve a successful collaboration between the objectives of the EC in research and development and the interest of the individual partners and the consortium as a whole. Some of the partners have been involved in managing European projects. This will also optimize the workload in terms of reporting requirements.

The consortium remains open to additional organizations that would like to enter based on their own interests and their own funding (Associated Groups). The competence, skills and infrastructure mobilized through the consortium, does not depend on possible contributions from such Associated Groups.

One Contractor is from Russia (Moscow State University). This Contractor is important to the project because it brings in expertise, experience and access to data related to deep injection of radioactive waste. This provides the unique opportunity to assess the validity of redox process understanding in the real situation with its particular size and time scales. This contractor is not asking for EC funding, it will contribute to the project at its own resources.

B.2.3 Subcontracting and 3rd party contributions

No Subcontracting is considered in the project

Matching funding between the project partners is Appendix II.

There are two institutions having contributions from 3rd. parties:

1. ARMINES, a non-profit organisation, administers on behalf of the Ecole des Mines a large part of the contractual research of SUBATECH with particular emphasis on contracts in the context of the european framework programme. The Ecole des Mines de Nantes is a school of engineering. SUBATECH is a mixed research unit (UMR 6457) operated by the Ecole des Mines and the University of Nantes and by the IN2P3/CNRS. The mission of "SUBATECH" is basic subatomic physics and associated technologies: Focus of the research and teaching program is nuclear physics, medicine, environment and waste management. Its radiochemistry group is one of the few research groups worldwide having simultaneously experience in the field of high level radioactive waste forms like glass and spent fuel, performance of engineered barriers such as clay and concrete and the retention of radionuclides in the host rock of geological disposals. The group has long experience in experiment and modelling (geochemical transport, radiolysis, burn up and radioactive decay). It was and is involved in various nuclear waste management and HTR projects of the EC: GLAMOR, GLASTAB, HTR-N&N1, SFS, Actinet5, Actinet6, Raphael, FUNMIG and NF-PRO (as RTDC leader) and is currently coordinating the Coordinated Action MICADO.

Further information on the distribution of tasks between ARMINES and its third party is given in description in page 66. The only third party for ARMINES which is actively participating in the project is Ecole des Mines de Nantes.

2. CNRS, French national centre for scientific research, is a public basic-research organisation. CNRS has 26,080 employees in 1,260 service and research units spread throughout the country and covers all fields of research. Interdisciplinary programs and actions offer a gateway into new domains of scientific investigation and enable CNRS to address the needs of society and industry.

   LGIT - UMR 5559 is a Joint Research Unit (JRU) set up by Centre National de la Recherche Scientifique (CNRS) and Université Joseph Fourier (UJF) Grenoble 1. LGIT (Geophysics and Intern Tectonophysics Laboratory, located in Grenoble) is a Unit dedicated to Geophysics and Geochemistry, with one out of eigth theme related to environmental geochemistry and headed by Prof. Laurent Charlet.

Further information on the distribution of tasks between CNRS and its third party (Université Joseph Fourier) is given in the description in page 89.

B.2.4 Resources to be committed

The scheduled use of resources claimed against the project is given in Appendix III. Major deviations will be reported to the CT for amendment, if justified. The travel costs are indicative and may deviate considerably from original planning by allocation more resources to travel or moving resources originally foreseen for travel to other titles.

< Resources to be committed to the project>

Resources committed to the project are of different nature. They consist of the different (i) competencies of individual partners, (ii) the roles, activities responsibilities that partners take on board for the project implementation, (iii) the allocation of work resources to the different topical areas of the project, (iv) the allocation and use of financial resources, and (v) additional resources brought into the project. The resources brought in by the different partners are discussed in Appendix I.

<Key competencies of the project partners>

The key competencies of the individual project partners are described in Appendix II. All partners have long-standing records with respect to the scientific-technical competencies of the fields they are contributing to within the project. A large number of the partners also have long experience in management and administration of EC projects, especially the organizations of the Coordination Team. This is also true for the organizations and involved individuals taking on board the work package leader responsibility.

<Role, activities and responsibilities of partners>

The resources committed to the project builds on the expertise and project contributions provided by the individual partners. In the below table, the individual partners and the emphasis of their role, activities and responsibilities within the project are briefly summarized. The specific competencies of the different partners are brought together in a complementary fashion.

Partner (no.)	Acronym	Role, activities and responsibilities within the project
1	FZK-INE	Coordinating organization. Contributing to investigation program in WP 1, 2, 3, 4, 5 and 6. Within WP 2, key responsibility for organizing inter-laboratory comparison exercise. Will provide training in high-resolution 3-D characterization of minerals and radionuclides in different oxidation states.
2	ARMINES	Participates in WP 1 and 2. In WP 2, redox determination method is developed for alkaline conditions.
3	BRGM	Participates in WP 1, 2 and 3. Emphasis is on the Callovo-Oxfordian system and redox determination methods.

Partner (no.)	Acronym	Role, activities and responsibilities within the project
4	CEA	Participates in WP 1, 4 and 5. Emphasis is on the Callovo-Oxfordian system, specifically on the diffusion of redox sensitive radionuclides.
5	CTH	Participates in WP 1 and 4. Emphasis is on determination of redox state of the system and radionuclides in crystalline rock environment.
6	CTM	Participates in WP 1 and 3. Emphasis is on system response to induced redox perturbations.
7	AMPHOS	Participates in WP 1, 3, 4 and 7. Leader of both WP's 1 and 7. Emphasis of investigation program is on reducing capacity of different minerals and the application to reactive transport calculations, as well as uranium redox behavior under alkaline conditions.
8	FZD	Participates in WP 1, 2 and 4. Emphasis investigation program is on biofilms, including development and application of micro-sensors for in-situ analysis and determination of radionuclide redox state.
9	GRS	Participates in WP 1and 2. Emphasis is on redox determination in brines.
10	UH	Participates in WP 1and 5. Emphasis of investigation program is on the crystalline rock system with determination of key system components/minerals with respect to their redox states and the impact on the overall system.
11	JRC	Participates in WP 1and 6. Emphasis of investigation program is on mechanisms of redox processes driving the spent fuel dissolution.
12	NRI	Participates in WP 1and 6. Emphasis of investigation program is on Fe corrosion product influence on the redox system.
13	PSI	Participates in WP 1and 4. Emphasis of investigation program is on the redox behavior of Np in the cement system.
14	TUG	Participates in WP 1, 2 and 3. Emphasis of investigation program is on redox determination with iodine as the redox indicator.
15	UPPC	Participates in WP 1 and 2. The investigation program is on development of in-situ fiber-optical redox determination systems.
16	CNRS	Participates in WP 1, 2, 3 and 4. Emphasis of investigation program is on evaluation of amperometric methods for redox determination, redox reactivity determination of the Callovo-Oxfordian system, and redox reactions of long-lived fission products with pyrite.
17	UNIZAR	Participates in WP 1 and 3. Investigation program is on evaluation of redox processes in natural crystalline rock systems from existing site investigation data.
18	STUDSVIK	Participates in WP 1 and 6. Investigation program is on retention of radionuclides on crystalline rock fracture filling by redox reactions and the impact of hydrogen on the spent fuel dissolution mechanisms.
19	II-HAS	Participates in WP 1, 3 and 5. Emphasis of investigation program is on response of the Boda clay system to redox perturbations and the impact on radionuclide mobility.
20	UCYPRUS	Participates in WP 1, 3 and 5. Emphasis of investigation program is on reductive retention processes of uranium in sandy aquifer systems, and the distribution and redox processes responsible for radionuclide distribution in the phosphogypsum system.
21	IPL	Participates in WP 1 and 4. Emphasis of the investigation program is on the impact of microbial activity on the redox state of the system and radionuclides. Training in the field of 3-D high-resolution characterization of element distribution and their chemical state is a key element of the work.
22	UNIUTR	Participates in WP 1 and 3. The investigation program is on microbial reduction processes (sulfate reduction) on the uranium redox distribution and retention.

Partner (no.)	Acronym	Role, activities and responsibilities within the project
23	KTH	Participates in WP 1 and 6. The investigation program is on interfacial redox processes driving the oxidative dissolution of spent fuel.
24	MICANS	Participates in WP 1 and 3. The investigation program is on microbial reduction processes in the crystalline rock system and the impact on redox state of the system and contained radionuclides, as well as its impact on radinuclide retention.
25	LQC	Participates in WP 1 and 2. This partner will bring in its expertise to the development of optode redox determination methods.
26	GEOPOINT	Participates in WP 1 and 3. Investigation program is on evaluation of redox processes in natural crystalline rock systems from existing site investigation data.
27	MSU	Participates in WP 1 and 5. The investigation program focuses on analysis of the actinide redox state in real systems contaminated through deep injection of liquid radioactive waste.
28	SKB	Participates in WP 1. This WMO will assist in defining and documenting the application of the project outcome for the disposal Safety Case.
29	ANDRA	Participates in WP 1. This WMO will assist in defining and documenting the application of the project outcome for Safety Case for specific clayrock disposal concept(s). It will also participate in the End-User Consultancy Group, thereby playing a key role in insuring that the project outcome is applicable to clayrock disposal Safety Case.
30	POSIVA	Participates in WP1. This WMO will assist in defining and documenting the applications of the project outcome for the disposal Safety Case.
31	ULOUGH	Participates in WP 1 and 4. This partner will contribute to the project, including 18 person months to the experimental program (WP4), entirely by external funding. The Redox behavior of Tc will be studied, especially in the context of anthropogenic organics.
32	UMANCH	Participates in WP 1 and 4. The emphasis is on the behaviour of redox sensitive radionuclides in ternary systems of natural organic matter.

<Allocation of work resources>

The work resources brought into the project by the different partners are discussed under Section 1.3. The work resources are divided into the different work packages, including five person months for implementing and organizing training and management and dissemination of knowledge, as well as twelve person months for administrative, legal and financial project management.

All partners contribute with at least one person month to WP 1, showing the key importance of ensuring consistency and joint understanding of the work program and the need for all partners to move the project achievements forward towards application in the disposal Safety Case. The End-users involved as Contractors to the Project (ANDRA, SKB and POSIVA) allocate more work resources to this work package, reflecting the key importance for these organizations in moving the project outcome forward to application in the disposal Safety Case. Two of these organizations also participate in the End-User Consultancy Group with a specific task of ensuring the adequacy of the work undertaken and their use to fulfill the objectives of the European research needs at this stage. To this aim, their participation in the review of the advances of the project is needed.

The distribution of work resources between the different RTD work packages (i.e. not including WP's 7 and 8) is shown in Fig. 2.3.1. Harmonization of the work program and forwarding the project outcome towards application in the disposal Safety Case accounts for 7 % of the work resources. A great problem is the lack in access to verified and trustworthy redox determination methods. This is reflected in the 18 % of project resources used on the corresponding work package (WP2). The response of different systems and system components to disturbances proves to be a key topic in ongoing studies to the disposal Safety Case and advanced national program studies. Consequently, the corresponding work package (WP 3) is the largest one making use of 33 % of the work resources of the investigation program.

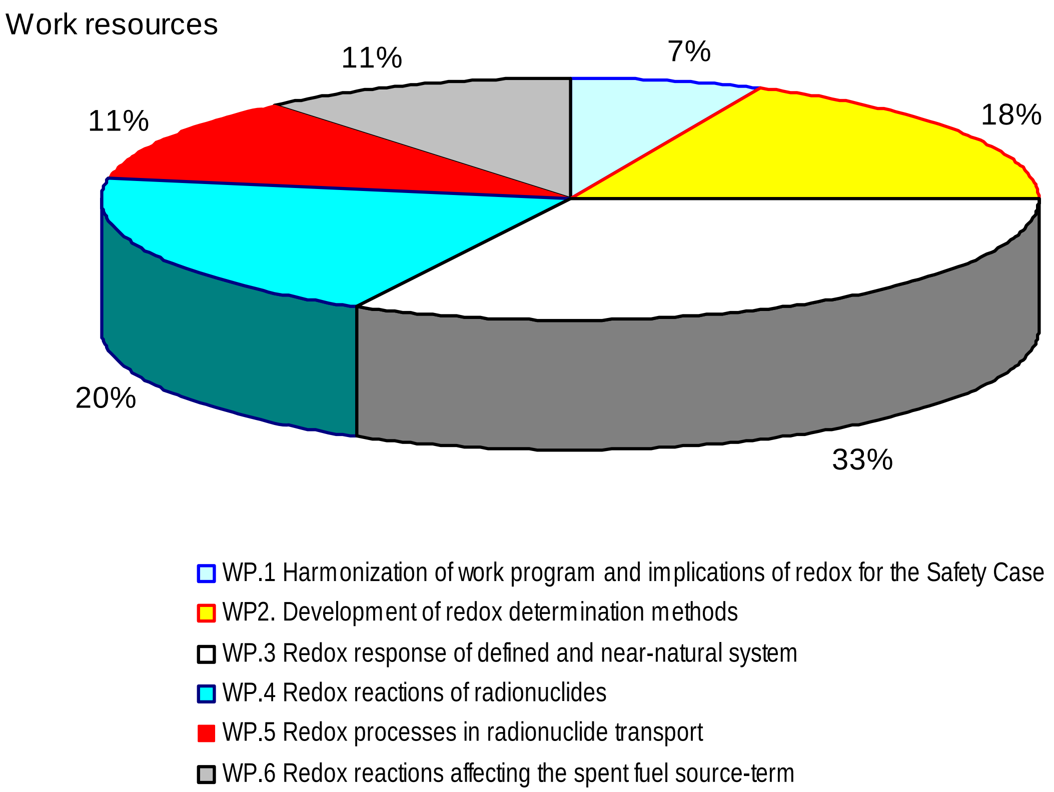

Fig 2.3.1: Distribution of work resources between different RTD work packages.

The aim of the disposal Safety Case is related to the potential impact of radionuclides on living species. Thus, the impact of redox conditions on the redox state of radionuclides and the mobility of the respective redox states and associated complexes are essential. This is treated within WP's 4 and 5, with 20 and 11 % of work resources, respectively.

The prerequisite for radionuclides to leave the near-field is the spent fuel dissolution (in the case of direct disposal). Many investigations over the past years have pointed out that the primary dissolution process is mainly redox driven. Thus, an adequate process understanding of the oxidation driven spent fuel dissolution is required in order to obtain a reliable source term. Reflecting the importance of deducing mechanistic understanding for these processes, 11 % of work resources are used on this topical area.

<Allocation and use of financial resources>

The use of financial resources to a large extent follows the use of work efforts. Some slight deviations are found because work on WP 6 is conducted to a large extent by organizations with high cost profiles, especially related to high infrastructure costs in organizations handling highly radioactive material. Correspondingly, WP's 3 and 4 show lower use of financial resources as compared to the work resources (Fig. 2.3.2 and below table). The direct costs for the participation of the EUCG members are paid by the project. This does not include the work effort. Finamcial resources for travels are coupled with participation in project internal events, such as project workshops and interlaboratory comparison exercise, and external events, such as international conferences. With respect to external events, the use of resources is justified as long as the project or key parts of it is presented and acknowledged in association with the use of the EURATOM FP7 and project logos. Furthermore, such presentations must be documented in the management reporting.

RTD-WP	Work efforts	Financial resources (total costs)
1	7%	9%
2	18%	20%
3	33%	27%
4	20%	21%
5	11%	8%
6	11%	15%

The different organizations allocate widely different financial resources under "Other direct costs". In general, resources are set aside for traveling to the project workshops and expected work package meetings. Some organizations reserve considerable resources for handling of high level radioactive material and associated equipment. Some organizations foresee durable equipment associated with the development of new redox determination techniques. Considerable financial resources are also set aside for training measures. This refers to travel costs for training mobility measures, workshops on project specific topics and training courses. Financial resources are also used for project management, related to three person months per year. In addition, some organizations have foreseen management resources necessary for meeting financial reporting requirements.

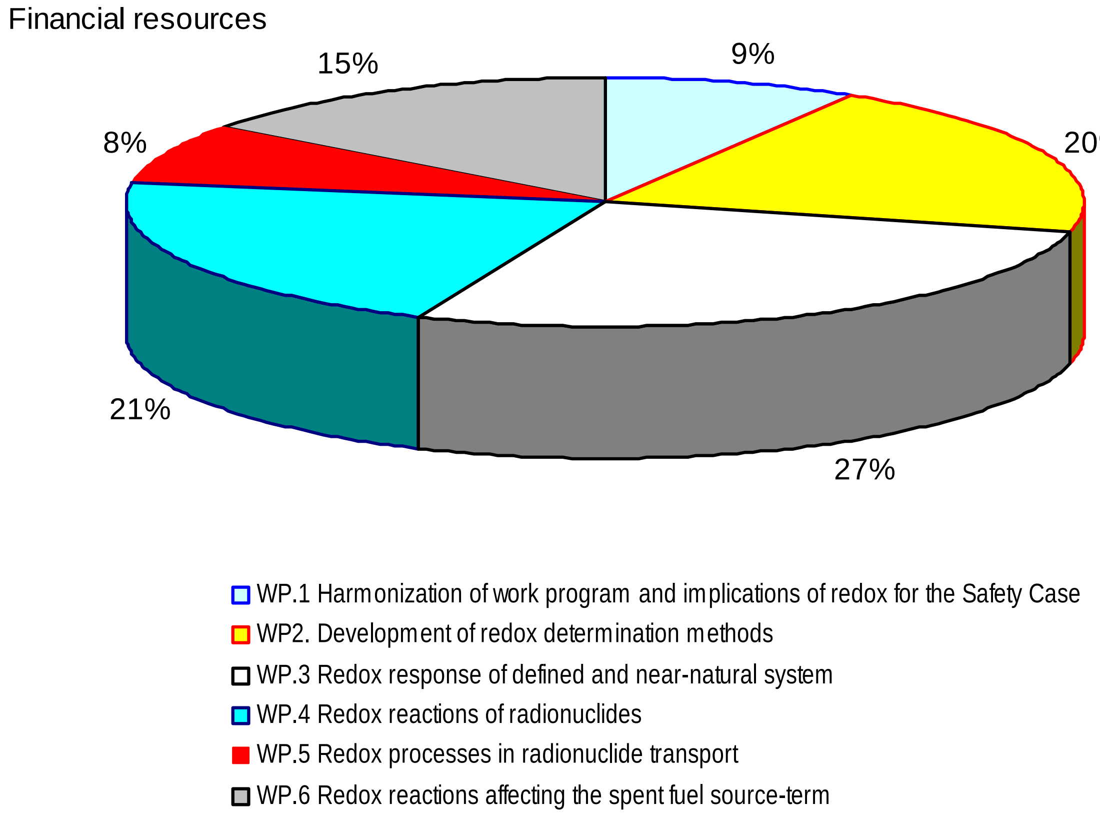

Fig 2.3.2: Distribution of financial resources (total costs) between different RTD work packages.

<Additional resources brought into the project>

There are considerable resources made available to the project, beyond those charged in the financial project budget. For the individual partners, such contributions are discussed in Appendix I. From an overview point of view, some examples are:

- The beam-lines at ANKA and SLS where measurements are conducted without full costs being charged for the use of these large infrastructures. The same is true for use of project partner external synchrotron radiation facilities.
- Access to hot facilities with infrastructure costs and technical support carried by the respective organizations.
- Basic skills for the development of optodes for fiber-optic based redox determinations, where the underlying costs for basic developments and expertise are carried within, amongst others, the emerging competence center for fiber optics in Potsdam.
- Infrastructure for handling and analytics of radioactive material, including technical personnel and training of academic staff, carried through the respective organizations.
- Resources for laser equipments and associated optical instrumentation used for colloid detection and spectroscopic quantification of redox sensitive species are not charged against the Project.
- Samples from real sites are made available through different national programs. The meaningful interpretation of the outcome of investigations relies on the thorough site characterizations and data available for these samples.

<Project resources, summary>

Mobilization of resources builds on 57 % funding support by the Commission to the R&D program for the majority of the partners. Other partners mobilize the full resources for their R&D contributions. Matching funding is either provided by the respective project partners themselves, from other project partners or through external support. Full funding is provided by the Commission for training and project management. The direct travel costs of the EUCG members are also covered by the project. Considerable resources are made available by the use of expertise, R&D infrastructure, including technical staff not charged against the project, and by samples from national site investigations. These are described in Appendix II.

B.3 Impact

B.3.1 Strategic impacts from the project

A key impact from the project is the harmonization between the top-down and the bottom-up approaches. Based on adequate bottom-up understanding of underlying processes and the systems involved, the relevant processes can be extracted for top-down implementation in the Safety Case.

Other impacts from the work program are based on the expected key achievements, namely:

a. Development of new high-end complementary methods for determination of system redox state, namely optical fiber based optode technology and in-situ reference micro-electrodes.

   The impact is the capability to reliably measure the system redox state under conditions previously not possible, especially in natural clay samples.

b. Inter-laboratory comparison exercise of new and existing methods for determination of system redox state, including comparison of different protocols used by different groups.

   The impact is that trust is provided in the capability to adequately determine the system redox state as a prerequisite for adequate regard of redox within the Safety Case.

c. Identification of redox determining processes in natural systems, and the system response to changes.

   The impact is that long-term predictions become possible with respect to the system redox response towards impact of perturbations issuing from specific disposal cell concepts on the near-field and far-field environments. In crystalline rock concepts, an important issue will be improved predictability of the effects on near and far-field redox conditions induced by changes in the recharge conditions induced by changes in land-use and climatic conditions. This will also contribute to the understanding of general geochemistry for other environmental issues.

d. Determination of redox state of radionuclides under different system redox conditions, especially whether or not the radionuclides are in redox equilibrium or disequilibrium with the overall system.

The impact is that the redox state of concerned radionuclides can be predicted also with respect to future system changes, and thus trust is provided in the capability to predict the radionuclide mobility.

e. Determination of key redox processes in the very near-field, i.e. the spent fuel and the container, including process identification, especially with respect to the potential impact of hydrogen and potential galvanic coupling between the spent fuel and the container.

The impact is that the actual dissolution rate of spent fuel and trapping of redox sensitive radionuclides in the near-field can be determined under relevant conditions. This will allow considerable lowering of the release rate used as the spent fuel dissolution source term. In addition, trust is provided with respect to the probability of galvanic coupling influencing the source term, and thus the uncertainty of the source term is lowered.

f. Formulation of the project outcome in a fashion suitable for application of the gained knowledge within the Safety Case.

The impact is the level of use of the project outcome within disposal Safety Cases. Only few Safety Cases are presently under preparation, there is a long time-span of up-dating such a Safety Case and that the majority of such Safety Cases will be initiated in a more or less distant future. Consequently, the actual impact will be estimated based on review comments, especially by the EUCG.

g Providing trust in the capability of safe disposal.

Within the context of re-emerging discussion of the European energy needs, the present project contributes to acceptance of nuclear waste disposal and thus to the continued use of nuclear power as part of a possible energy mix.

Another impact from implementing the work program is that the Consortium members become aware of the respective complementary competencies and thus can jointly tackle follow-up problems in the future.

The expected impact specified in the present call is “Improved understanding of the above processes *(cf. section 1)* at one-to-one scale and the relation with long-term safety will assist in the practical demonstration of geological disposal of high-level and long-lived radioactive waste and facilitate its implementation“. The outcome of the project provides the expected impact by improving required process understanding.

The broad European representation in the Consortium partly reflects that different individual key questions are related specific host-rock types under investigation in different European countries. Solving the underlying problems, however, namely providing an adequate process understanding for interpretation of processes in different host rock types, as well as developing new redox determination methods, can only be done by bringing together different European players. The same is true for providing trust in the overall project outcome through comparison between detailed process understanding, redox buffer time functions of near-natural samples in the laboratory and the situation found in real systems. For these reasons, the project objectives can only be met by the joint effort of a broad European Consortium.

B.3.2 Dissemination and/or exploitation of project results, and management of intellectual property

All results generated by the project are open to use by any interested party. Therefore, there are no intellectual property problems associated with the outcome of the project.

The project must ensure that the results generated are communicated within the project but also to a broader interested community. For this purpose, a large number of activities are included to help knowledge management dissemination and communication, such as:

- Establishing a WEB portal of the project. This will allow all those interested in the results and in the project to access to information and the public deliverables from the project, main achievements and events organized. A reference list of review journal publications with acknowledgement to the project will also be kept at this site. The WEB portal will have a link to an internal workspace ("the intranet")
- The Intranet (project internal workspace) is accessible only for the partners of the consortium. It is used by the contractors to communicate and document results, and exchange information in an easy way.
- Annual workshops: The annual workshops will be used to discuss results among the partners as well as to communicate the results to the attendants, prepare for the progress review, document the outcome of the different activities through the generation of annual workshop proceedings, etc. The proceedings of the annual workshop with scientific results in pre-publication form (workshop proceedings) and high-level descriptions of technical issues will be a key tool for documenting the results of the project. This is an essential element in ensuring dissemination of knowledge and creating the required awareness of the project achievements Hardcopies of the proceedings will be prepared for distribution outside the project consortium.
- Participation of project participants at international conferences, workshops and other types of events where presentation of the project and its results is convenient,
- Communicating the outcome of the project to a broader community. There is a broad spectrum of events, conferences and workshops where the project will be presented, including distribution of brochures and informing about the possibility to request the outcome of the annual workshop proceedings and the public project reports. Representatives of the consortium will be encouraged to represent the project and create awareness of the project activities and achievements.
- Information on organisation of workshops and training activities will be communicated several months before the scheduled event to the IAEA–division of nuclear fuel cycle and waste technology in order to increase the number of participants from third countries in these events. It will also be announced through the European Nuclear Education Network (ENEN).

B.4 Ethical issues

There are no ethical issues in the project.

B.5 Consideration of gender aspects

The project supports the European policy of equal opportunities between women and men as enshrined in the Treaty on the European Union. Specific actions are not foreseen.

Appendix I: Workpackage descriptions

Work package number	**1**	**Start date or starting event:**	**Project Month 0**			
Harmonization of work program and documentation of redox implications for the Safety Case						
Activity Type	**RTD**					
Participant	All					
Person-months	AMPHOS	SKB	FZK-INE	ANDRA	POSIVA	All other
	7	2	4	3	2	1 each = 27

Objectives:

The overall objectives are related to providing structures and regular up-dating of the overall project outcome in preparation for final project reporting:

- Organizing and documenting agreement of experimental programs,
- Documenting the scientific state-of-the-art,
- Documenting the state-of-the-art in reflecting redox processes in PA/the Safety Case and developments becoming available through the project outcome. This is visualized by emphasis on the example of the French B2 waste cell (concept, inventory, evolution over time…).

Reflecting one of the key objectives of the project, all partners are involved in this activity in order to ensure that they are all fully aware of the aim of the RTD program of the project, namely to provide input for improvement of the disposal Safety Case.

Description of work:

After the final negotiation with the Commission, a questionnaire will be sent to all participants asking for specific details on the experimental systems and conditions to be used by each one of the contractors in their research. Answer to this questionnaire will be requested and transferred to the EUCG one month before the kick-off meeting. Discussion and agreement with the EUCG on the experimental systems and conditions will be made during the kick-off meeting This will be the basis for the first deliverable (D1.1.)

This preliminary work will allow optimization of the output of the individual investigations, including ensuring relevance of systems and conditions used, and in view of avoiding inadvertent discrepancies between systems and conditions among the different partners. It is done in association with agreement on the inter-laboratory comparison exercise (see D2.1). As a specific example investigations on samples from the Callovo-Oxfordian formation will be tailored towards applicability for supporting the Safety Case for a B2 waste cell.

Documenting, and regularly up-dating, the scientific state-of-the-art (D.1.2) based on the project application and the knowledge developed during the project work.

Documenting, and regularly up-dating, the state-of-the-art in reflecting redox processes in PA/the Safety case (D.1.3).

ExCom will provide the necessary input for these the activities.

The implementers SKB, ANDRA and POSIVA participate with their full resources in guiding and supporting activities within this workpackage

The specific End-users consulting group (EUCG) formed by regulators and implementers will be actively participating in this project to bridge the knowledge generated within the project to the Safety Case. As an example, the ANDRA will be particularly involved in linking project results to a Safety Case for a specific concept (B2 waste cell). Deliverable D1.3 is established on the application to the Safety Case of the knowledge falling within the context of the project. This deliverable will be edited by the Coordination Team. The key input provided by the EUCG to the document will be through written comments and through meetings in association with the Kick-Off meeting and the four annual project workshops.

Deliverables		**Lead Participant**	**Due date (Project Month)**
D1.1	Agreement on, and documentation of, systems and conditions to be studied (with regular updating)	AMPHOS / ExCom	4/24/36
D1.2	Report on the scientific state-of-the-art (with regular updating)	AMPHOS / ExCom	3/24/36/48
D1.3	Report on basis for application of the redox processes in the Safety Case (with regular updating)	AMPHOS / INE	12/24/36/48

Work package number	2	Start date or starting event:	Project Month 0						
Development of redox determination methods									
Activity Type	RTD								
Participant	FZK-INE	ARMINES	BRGM	FZD	GRS	TUG	UPPC	CNRS	LQC
Person-months for the participant	12	18	11	7	12	6	23	18	2

Objectives:

Application and modification of existing methods as well as development of advanced methods for determination of the redox state of relevant systems. The aim is to provide the necessary scientific-technical basis for redox determination.

Provide trust in the outcome of the studies by an inter-laboratory comparison exercise on samples selected from the relevant host rocks in the project (granitic and clayey rocks) where the different methods are applied and the outcome assessed. The various individual developments thus will be tested against each other and evaluated for their applicability under different conditions.

Description of work:

FZK-INE will establish the thermodynamic basis for determination of system redox state based on actinide and technetium redox species distribution, including formation of colloids. The development of the thermodynamic data is assisted by variation of the system redox state by aeration and addition of hydroquinone. The investigations include high salinity conditions (brines). FZK-INE will provide the infrastructure and will host the inter-laboratory comparison exercise, and will provide a set of reference samples including radioactive ones.

ARMINES will develop a methodology for redox determination in hyper-alkaline systems by the distribution of different Se species. Induced redox state perturbation is achieved by aeration and addition of nitrate and hydroquinone. For this purpose, analytical techniques for unperturbed Se speciation and the thermodynamic basis will be developed.

BRGM will develop existing and new microelectrode methods for redox determination. Pt, Au and glassy carbon electrodes are tested on different laboratory systems. These systems include Callovo-Oxfordian clay stone and/or clay paste as well as different redox relevant minerals found in natural clay. The investigations include induced perturbations by aeration, variation in H_2 partial pressure, nitrate plume and addition of redox sensitive radionuclides. The reliability, time-response behavior and lifetime of electrodes will be investigated, including electrode interface characterization by MET, SEM, FTIR and XPS.

FZD will develop measurement of redox potential (Eh) and dissolved oxygen (O_2) concentration by microsensors (Clark type) in biofilm samples. The microsensor tips are 5-10 µm in diameter. The depth profiles provide information on geochemical heterogeneities in the biofilms, which in turn influence the oxidation state of the redox sensitive radionuclides in the respective system. FZD will also adapt TRLFS of uranium(IV) species in small compartments and test for applicability to biofilms. Additional development is considered for application of LIPAS techniques in these systems.

GRS will develop redox determination in brines. For this purpose, analytical fiber-optics based determination of the Fe(II)/Fe(III) redox couple is developed under variation of salinity up to saturated brines in the temperature range between 25 and 60°C. The goal is the spectroscopic determination of relevant iron species down to the nano-molar concentration range. The thermodynamic basis for interpretation of the system redox state based on the concentrations/activities of different iron species is developed (including aqueous Fe(III) chloro, hydroxo and mixed chlorohydroxo complexes in saline solutions). The correlation between redox electrode signal, Fe(II)/Fe(III) ratio and background salt concentrations will be investigated by systematic variation of the specified variables.

Work package number	2	Start date or starting event:	Project Month 0

Development of redox determination methods

TUG will develop system redox determination based on the distribution of iodine species by CE-ICP-MS. The outcome is tested/verified by comparison with other redox determination methods used and developed within the project. This partner will also cooperate with **FZK-INE** for application of the CE-ICP-MS method for actinide species distribution as a redox indicator.

UPPC will develop the fiber-optical detection scheme for the in-situ monitoring of system redox conditions:
1) Testing different combinations of optical fibers and luminescence probes. Adaption to the specific in-situ measurement conditions like ionic strength or aging of the optical fiber tip polymer matrix (e.g., due to “poising” caused by matrix constituents).
2) Evaluation of excitation conditions (cw, phase modulation vs. pulsed operation mode; Laser, LED)
3) Testing of the fiber-based redox probes in different matrices (artificial pore waters, ground water, real system samples). Determination of analytical parameters (e.g., sensitivity, cross reactions, lod).
4) Miniaturization of fiber-optical set-up (e.g., tapered fiber tips) for direct application in micro-pore volumes.
5) Testing on a) model systems (e.g., columns) and b) at real sites (e.g., in round robin tests etc.).

The basic optode development will be supported by **LQC**.

CNRS will evaluate an amperometric method for the in-situ determination of the redox potential by the quantitative determination of the two components of a redox couple using ultramicroelectrodes.

Inter-laboratory comparison exercise

Five to six samples will be selected and prepared for the exercise. These samples will cover different types of systems and geochemical conditions (clay samples, sediments in contact with groundwater, brines in contact with sediments, ..). The samples are prepared at FZK-INE for their use within the exercise. Needless to say that the samples are kept under inert gas.

Those partners that develop redox determination methods will use their methods on all reference samples. Those measurements are used for documentation of (stability of the redox determination system, (ii) stability of redox reading, (iii) response time and behaviour for obtaining stable readings, (iv) response to induced disturbances (addition of air or oxidizing water), and (v) correctness of the redox reading. The overall outcome of the exercise will be documented in this respect. In addition, conclusions will be drawn on which determination methods can be used under which conditions and which physico-chemical process the different methods are reflecting.

Deliverables		Lead Participant	Due date (Project Month)
D2.1	Agreement on details for the inter-laboratory comparison exercise	FZK-INE	3
D2.2	Experimental scheme for the inter-laboratory comparison exercise	UPPC	12
D2.3	Consolidated report on outcome of the inter-laboratory comparison exercise	UPPC	24

Work package number	3	Start date or starting event:	Project Month 6									
Redox response of defined and near-natural system												
Activity Type	RTD											
Participant	FZK-INE	BRGM	CTM	AMPHOS	TUG	UNIZAR	GEOPOINT	CNRS	II-HAS	UCYPRUS	UNIUTR	MICANS
Person-months for the participant	8	13	16	20	8	2	2	80	18	6	11	15

Objectives: Quantify and develop process understanding for redox buffer capacity and kinetics of response to redox perturbations of defined and near-natural systems..

Description of work:

FZK-INE will characterize redox relevant mineral components in natural systems (thin section crystalline and clay rock samples), including spatial distribution, by XPS, STXM and 3D confocal µ-EXAFS and XRD following induced disturbances with redox response monitoring. For both clay and crystalline systems, the buffer capacity and timely response function will be investigated.

BRGM will conduct work on changes in certain key electrochemical parameters of electrodes (part of the conventional triplet of the electrochemical cell) to the presence of: i) finely ground COX materials, ii) ions naturally present in the porewater (e.g. H^+, SO_4^{2-}, HS^-, Fe^{2+}), ii) redox sensitive radionuclides analogues (e.g. Se(VI), Se(IV), I^-, CH_4 for ^{14}C) and iii) gases (O_2, CO_2, H_2, H_2S), in different situations, both similar to the expected natural situations and to very perturbed conditions. The continuous electrochemical measurements will serve to identify, monitor and compare the electrochemical reactions and kinetics occurring during immersion, both in solution and on the surface of these specific electrodes. The electrochemical behaviour of these electrodes will be compared to those of known inert and unattackable electrodes (Pt, Au, glassy carbon) positioned in the same operating conditions.

CTM will study the redox behavior and response to external perturbation for systems of interest in the near-field. Study of Fe(II)/Fe(III), SO_4^{2-}/S^{2-}, O_2/H_2O pairs will be used as redox indicators. An experimental program that links the determination of relevant reducing capacities and the measurement of redox couples will be undertaken. The systems to study include: FeOOH/Fe(II); FeS/SO_4(-II); Fe(II)-clay/FeOOH and Mn oxides. The methodology to follow will be (1) measurement of the capacity of solid samples to respond to changes in oxygen content, and (2) rate of consumption of oxygen under different granitic groundwater pH values.

AMPHOS will evaluate the results of the work performed by **CTM** together with available results in the literature in order to develop a model that considers the main dynamics of the redox mechanisms on FeOOH/Fe(II), Fe-S/S(VI) and Fe(II)-clay/FeOOH systems. The concept of reducing capacity will be incorporated in a reactive transport model that will i) evaluate the processes responsible for buffering the redox in a specific site, ii) consider possible scenarios leading to modification of the chemical composition of groundwaters, especially affecting the redox of the system, and iii) consider the geochemical long-term evolution of systems according to the different scenarios.

TUG will develop the redox system determination by quantification of fission product relevant and actinide redox couples by high sensitive coupling of electro-migration techniques with ICP-MS. The work is conducted in close cooperation with FZK-INE, especially in view of the partly complex thermodynamics involved in the data interpretation.

II-HAS will study the response of Boda clay-stone to redox disturbances. This emphasis is on system time-response to aeration and addition of hydroquinone. The response is monitored both by the use of electrodes and by changes in solute composition. In addition, the Boda clay-stone samples will be characterized with respect to amounts, composition and spatial distribution of redox sensitive minerals.

CNRS will focus on calcite, pyrite and Bure Callovo-Oxfordian argillite containing both calcite and pyrite.

Work package number	3	Start date or starting event:	Project Month 6
Redox response of defined and near-natural system			

Their redox reactivities are studied by characterization of the clay and by using Se, I and U as redox indicators. The trapping in calcite of redox specific e.g. Fe(II), Se(IV) and Se(VI) species will be studied at a molecular scale (neutron diffraction, XAFS). The redox interaction between Fe(II) present at the surface of calcite or FeS nanoparticles, with aqueous U and Se will be investigated by µXANES and AFM. DFT and XAFS techniques will be applied for the characterization of the nanoparticles which may (i) result from these redox reactions and (ii) induce a radionuclide facilitated transport. In-situ electrochemical methods (amperometric and potentiometric)will be applied to measure the redox potential and evaluate the redox response of the systems studied in front of redox perturbations or exposure towards Se, I or U. The characterization of calcite, pyrite and argillite before and after the induced perturbations will be done by SECM and AFM (surface information) or Voltammetry of MicroParticles in thin Layer (bulk information).

UCYPRUS will study the reductive retention of uranium in sandy aquifer systems. Sample systems of natural sand and synthetic groundwater with reducing uranium phases added, are equilibrated under anoxic conditions. The mobilization function of uranium through oxidative disturbances is studied by monitoring the time function of redox and uranium release.

UNIUTR will investigate changes in redox state and phase distribution of solid phase associated U(VI) in initially oxic systems, in which microbial sulfate reduction will be initiated. Special attention will be paid to: 1) changes in the affinity of solid phases for U(VI) due to reductive transformations by S(-II), 2) availability of U(VI) for microbial reduction 3), competition between U(VI) and other potential electron acceptors for oxidizing S(-II), and 4) formation of potentially abiotic reductants for U(VI). Incubations will be performed with synthetic and natural materials and microbial sulfate reduction will be induced by inoculating with isolated sulfate reducing microorganisms or natural, sulfate reducing communities.

MICANS will study the effect from microorganisms on the redox state of laboratory and natural systems. Pure cultures will be used in the laboratory with different combinations of electron donors, such as hydrogen, methane or short organic acids. Oxygen, ferric iron, manganese(IV) sulphate, carbon dioxide will be the electron acceptors used. The effect of microbial processes on various minerals, such as iron sulphide, iron-oxides and with common types of granites, will be investigated. Microelectrodes, gas chromatography, microscopy, ATP analysis, enzymatic assays and DNA techniques will be used for measurements of biomass, biodiversity, and effects on redox and the added electron donors and acceptors. The most significant effects from various combinations of additions in the laboratory can be further investigated under in situ conditions in the MICROBE laboratory in the Äspö hard rock laboratory at the 450 m depth. This laboratory is equipped with 6 independent biofilm flow cell circulation systems that communicate under in-situ pressure and chemistry with aquifers in the granitic rock. Pressure resistant electrodes will be used for monitoring.

UNIZAR and **GEOPOINT** will evaluate Swedish site-specific data for the role of the sulphur system in determining the redox state of real site crystalline rock systems. The pre-requisite is clear understanding of the origin of different waters for identification of geochemical processes resulting in the present inventories. With respect to sulphur, the two groups will establish the original inventories in present groundwater samples, identify geochemical processes leading to the present inventories and draw conclusions concerning the impact of the sulphur inventory on the redox state of crystalline rock groundwater.

Deliverables		**Lead Participant**	**Due date (Project Month)**
D3.1	Characterization of the redox determining minerals used in the investigations	CNRS	6
D3.2	Effect of microbial processes on the redox systems investigated (Interim and final reports)	UNIUTR	24/45
D3.3	Buffer capacity and the redox kinetics of the systems investigated (Interim and final reports)	II-HAS	24/45

Deliverables		**Lead Participant**	**Due date (Project Month)**
D3.4	Incorporation of the concept of reducing capacity in reactive transport simulations (Interim and final reports)	AMPHOS	24/45

Work package number	4	Start date or starting event:	Project Month 6							
Redox reactions of radionuclides										
Activity Type	**RTD**									
Participant	FZK-INE	CEA	CTH	FZD	AMPHOS	PSI	CNRS	IPL	ULOUGH	UMANCH
Person-months for the participant	12	6	9	8	8	31	16	31	18	12

Objectives:

Provide process understanding for redox states of radionuclides, including the question of equilibrium/dis-equilibrium with the system redox conditions. The objectives of this workpackage result from gaps in the knowledge identified from previous projects dealing with redox processes involving radionuclides.

Description of work:

FZK-INE will characterize Tc, Np and Pu with respect to redox state in fracture filling material and natural clay systems with Fe(II)/Fe(III) phases added. The influence of hydroquinone addition is also studied. Solutions are studied by spectroscopic methods and the radionuclides in solid phases are characterized with respect to chemical state and chemical bond characteristics. One particular aspect is the formation of colloidal species.

CEA will study the reductive sorption properties of pyrite surface. The emphasis is on Uranium (U^{+VI}), but also Iodine (I^{-I} and I^{+V}) will be investigated. The use of radioactive tracers and controlled atmospheres (anoxic and reductive) will allow the reproduction of in-situ conditions. These experiments will be accompanied by a special care devoted to the aqueous speciation but also to the surface composition and the sorbed element distribution according XPS, EXAFS and nuclear microprobe techniques.

CTH will study the system consisting of the redox-sensitive actinides U, Np and Pu, and Äspö minerals and groundwater. The redox-couples Fe(II)/ Fe(III), U(IV)/U(VI), Np(IV)/Np(V) and Pu(III)/Pu(IV)/Pu(VI) will be measured over time and related to measurements of Eh. Spectroscopic and solvent extraction techniques will be used to assess the different redox couples. The oxidation state of actinides sorbed to Äspö mineral surfaces will be analyzed using, e.g. XANES. Redox equilibrium during different stages, including batch experiments and the preparation of groundwater simulants, is monitored with electrode measurements, spectrophotometrically and using selected redox tracers (e.g. Tc, Np and $^{232,233,236}U$) that are added to the system in a mixture of different valence states. Preparation and the study of the stability of redox tracers are separately studied using eg. Potentiostat equipment.

AMPHOS will study the redox behaviour of uranium under hyperalkaline conditions (pH > 12). The transition between aqueous U(IV) and U(VI) hydroxides at high pH values is an issue of relevance for studies in the presence of cement. To this aim, a combination of UO_2 solubility experiments, aqueous and spectroscopy techniques (XANES and XPS) will be applied.

PSI will study the cement system. In the first phase redox conditions in cementitious systems will be assessed and experimental protocols for the redox-controlled sorption measurements will be developed. The latter experiments will allow the uptake of Np by cementitious materials to be determined under reducing conditions at high pH using electrochemical cells and reducing agents (e.g. dithionite and hydrazine). Development of the appropriate experimental protocols further comprises determination of the redox state of the radionuclides under alkaline conditions, as well as control of the redox state of Np in the uptake experiments. In the second phase, Np(V)/Np(IV) uptake by C-S-H and HCP under controlled experimental conditions will be carried out, and the chemical environment of Np in these samples will be investigated using XAS. Batch-type experiments will be carried out to determine uptake kinetics and sorption isotherms, and to test reversibility and dependence of the uptake process on the solid-to-liquid ratio. The effects of reducing conditions on the sorption properties of HCP will be evaluated by following Np uptake in HCP as a function of time using controlled negative redox potentials. Np doped compact HCP will be prepared and analysed using micro-XRF/XAS to determine the coordination environment of Np in hydrating and fully hydrated cement pastes and to assess the potential influence of the

Work package number	4	Start date or starting event:	Project Month 6
Redox reactions of radionuclides			

heterogeneity of the complex cement matrix on Np binding in compact cementitious systems

CNRS will study the interactions of Se(VI) and/or Se(IV), I(-I), I(V) and U(VI), taken individually or in mixtures at various concentrations, with pyrite (micrometric particles and plates taken at different solid/liquid ratios). Conditions will be chosen in agreement with the other contractors.
The influence of the organic matter, taken as fulvic acid (or in another form defined in common), will be considered prior to performing experiments with a pyrite containing argillite instead of the pure mineral. Several techniques will be used. They include electrochemical, thermodynamic predictions, solution analyses and speciation, surface and bulk characterization of the solid phases before and after reaction, and in situ monitoring of the interactions.

IPL will study the impact of microorganisms. Microorganisms from clay and groundwater samples will be isolated, identified and their oxidation ability towards Pu will be investigated. Sorption-desorption of Pu, Tc, Np and Am (as an analogue of Pu(III)) to various minerals, including nano particles, will be studied under oxidizing and reducing conditions. Pu will be used as redox indicator. The innovative character of the work is given by the use of synchrotron radiation based 3-D micro-resolution techniques. For this purpose a young scientist will be sent for training at the FZK-INE. In support, also conventional techniques will be used, including for example monitoring of Pu oxidation state by solvent extraction methods (TTA and HDEHP). Stability and transformation of iron oxides, as well as Fe(II)/Fe(III) ratio in the solid phase, will also be determined by Mössbauer spectroscopy. The coatings of iron oxides present in the clay and their sorption ability will be studied using the sequential extraction and Mössbauer.

FZD will study the oxygen concentration and uranium redox state in-situ in biofilms, with emphasis on biologically mediated redox processes. This includes measurement of dissolved oxygen with 5 to 10 µm microsensors and with optical chemosensors combined with confocal laser scanning microscopy (CLSM). Within the biofilm specimens the dissolved oxygen concentration will be measured in three-dimensional fashion with µm size resolution These results provide information on the oxidation state of actinides in near-natural biofilm samples and therefore also on their mobility. The oxidation state of uranium in biofilms will be measured by coupling TRLFS with CLSM. The use of different excitation wavelengths on precipitated uranium selectively enables the specific fluorescence emission of different uranium oxidation states in heterogeneous biofilms.

ULOUGH will study the effect of anthropogenic organics on the redox behaviour of Tc at high pH (13.3, 12.5 and 12). The organics studied will be EDTA, NTA, Picolinate, ISA, Gluconate and ACDP. The reduction of Tc will be performed in the presence of the organics, and the oxidation state of Tc, after reduction, determined. Any complexes formed will be characterized, where possible, and their solubilities measured.

UMANCH will study the behviour of redox sensitive radionuclides, e.g. Pu, in ternary systems containing the radionuclide, a mineral phase and natural organic matter (NOM). The minerals considered will include quartz-sand and iron oxide phases, including magnetite. Batch experiments will be used to study the partition of the radionuclide between solid and solution as a function of solution conditions (Eh, NOM concentration etc.) and radionuclide oxidation state. The behaviour of the systems as a function of time will be recorded, and these kinetic data interpreted with a kinetic speciation model.

Deliverables		**Lead Participant**	**Due date (Project Month)**
D4.1	Chemical and redox behaviour of the investigated radionuclides in the different systems (progress and final reports)	PSI	12/24/36/45
D4.2	Chemical and redox behaviour of the investigated radionuclides in the different systems through microbial mediated processes (progress and final reports)	IPL	12/24/36/45

Work package number	**5**	**Start date or starting event:**	**Project Month 6**		
Redox processes in radionuclide transport					
Activity Type	**RTD**				

Participant	FZK-INE	CEA	UH	II-HAS	UCYPRUS	MSU
Person-months for the participant	6	12	18	13	8	12

Objectives: Determination of redox impact on transport of radionuclides.

Description of work:

FZK-INE will study the redox state of radionuclides (Tc, Np and Pu) in the effluent of crystalline rock column and clay-rock diffusion cell systems. The possible presence of reduced radionuclides in colloidal form is also investigated. Correlation is made with the system redox state determined by various methods developed and tested/verified under workpackage 2. After the transport experiments, thin slice analysis of the rock material is made in order to determine the responsible redox retention mechanisms.

CEA will study the diffusive behaviour of redox sensitive actinides (U) and long-lived fission products (Se, I) through Callovo-Oxfordian argillite samples. This hard-clay rock can be considered as a redox component according to the presence of the mineralogical buffer defined by $FeS_2/FeOOH/FeCO_3$. The emphasis will be on diffusion experiments with radioactive tracers. Especial care is given to the aqueous speciation (HPLC, EC and TRLIF) and, when feasible, the distribution of each species in the rock using µ-LIBS and EXAFS techniques. The study is divided along with different initial redox states used, namely Iodine (I^{-I} and I^{+V}), Selenium (Se^{+IV} and Se^{+VI}) and Uranium (U^{+VI}). Concentration effects of each studied element will allow to determine the effective diffusion coefficient, porosity and Kd in the argillite rock samples.

HU will study samples of crystalline rock and crystalline rock relevant minerals. To this aim, a combination of different techniques is used. They include total and selective dissolution of the samples and aqueous and surface analyses. Redox equilibrium during different stages, including batch experiments and the preparation of groundwater simulants, is monitored with the electrode measurements and using selected redox tracers (e.g. Tc, Np and $^{232,233,236}U$) which are added to the system in a mixture of different valence states. Preparation and the study of the stability of redox tracers are separately studied.

II-HAS will investigate the reduction driven retention in a redox gradient in clay rock. A cell is constructed where a redox gradient is established by different redox conditions in the respective ends. The cell is equilibrated with radionuclides keeping redox conditions constant along the clay sample. Then one end is subject to strongly reducing or oxidizing conditions. Depending on the radionuclide it will be enriched in the zone where the least mobile phase is formed. Post-mortem analysis, including Laser Ablation ICP-AES provides the information on where which redox sensitive elements are found. Collaboration with other partners will be used for application of different advanced analytical methods for the post-mortem analyses.

UCYPRUS will perform field and laboratory measurements in phosphogypsum stack solutions of different compostion (e.g., pH, salinity, TDS) by means of electrochemical and optical redox sensors. The redox conditions are correlated with the distribution and mobility of redox sensitive radionuclides.

MSU will investigate actinide speciation is samples collected at contaminated sites in Russia that will provide unique opportunity to verify the experimental data obtained under well-defined laboratory conditions with samples collected from contaminated aquifers. They will include: (1) redox speciation of actinides by spectroscopic methods (XPS, XAFS) and membrane extraction, (2) study of possibility of formation of An(IV) eigencolloids by alpha track analysis, TEM, STEM-HAADF, EELS and XAFS and their evolution upon redox transformations, dilution, changes of pH, Eh, ionic strength, interaction with NOM, (3) study of preferential binding of actinides to different colloids by nano-SIMS and their redox speciation by membrane extraction.

Deliverables		Lead Participant	Due date (Project Month)
D5.1	Redox processes in radionuclide transport in crystalline rock (progress and final reports)	HU	12/24/36/45
D5.2	Redox processes in radionuclide transport in clay rock (progress and final reports)	CEA	12/24/36/45
D5.3	Redox processes in radionuclide transport in contaminated systems (progress and final reports)	MSU	12/24/36/45

Work package number	6	Start date or starting event:	Project Month 0		
Redox reactions affecting the spent fuel source-term					
Activity Type	**RTD**				
Participant	FZK-INE	JRC	NRI	STUDSVIK	KTH
Person-months for the participant	6	36	11	5	7.5

Objectives: Determination of redox impact on the spent fuel source-term.

Description of work:

FZK-INE will study reductive trapping of actinides in canister corrosion products as a driving force for spent fuel dissolution. The system consists of magnetite that has been in contact with spent fuel for seven years in concentrated NaCl solution. The magnetite, including the surface properties, and the trapped U and Pu is characterized by XPS, Raman spectroscopy, XRD, SEM-EDX and optical spectroscopy.

JRC will use new and innovative approaches to investigate processes governing the redox driven spent fuel dissolution. This includes (i) the potential for galvanic coupling between spent fuel and iron canister material, (ii) galvanic coupling with spent fuel fission product inclusions (especially ε-phases and Cs), and (iii) the role of hydrogen and associated redox processes in spent fuel dissolution. The former two topics are investigated on various systems, including designed thin films, with correlation measurements of contact corrosion potentials and the corrosion rates. The latter key process determining the HLW repository source term for the Safety Assessment is studied on rim fragments from high burn-up fuel and designed thin films, where the partial pressure of hydrogen (and oxygen) is varied in association with analysis of solid and gaseous corrosion products and the resulting corrosion rates. In collaboration with **STUDSVIK**, solutions of redox sensitive radionuclides will be exposed to corroded Fe(II) phases under anoxic conditions. ICP-MS, and pH and Eh electrodes will be used for solution analysis. XRD, SIMS, SEM-EDS, TEM-EDS, XPS, AES, UPS and micro-XAS will be used for solid phase characterization.

STUDSVIK will study the immobilization/remobilization of radionuclides under simulated near-field conditions with relevant crystalline rock fracture filling Fe(II) minerals (ÄSPÖ). A newly developed system is used for ensuring that no significant oxygen intrusion takes place. The time function of redox sensitive radionuclide concentrations in solution is monitored by ICP-MS. Radionuclides in the solid phase are characterized by SEM, TEM, XRD, SIMS, Raman and XAS. By this analytical characterization, the redox state and chemical bond environment is characterized and the reductive retention process is deduced. (Collaboration with **JRC**)

NRI will measure redox potential by different methods. The experiments are performed in a cell in the presence of corroding iron. Potential and current noise of iron or uranium oxide electrodes is measured by using zero resistance ammeter. The measurements or redox state evolution due to corroding iron will be performed under various conditions, changing (i) quantity of added iron in different forms (iron powder or carbon steel plates), (ii) composition of water (synthetic or real granite groundwater and synthetic bentonite porewater, and (iii) physicochemical conditions. Corrosion products on carbon steel plates will be analysed using Mössbauer techniques. Scanning microscopy of carbon steel electrodes will be performed at NRI to determine precipitated elements. The amount of iron dissolved in water will be measured at the end of experiments and redox potential calculated from Fe(II)/Fe(III) ratio. Electrochemical response of UO_2 and Fe electrodes will be compared.

KTH will perform kinetic studies on interfacial redox processes involved in the oxidation and dissolution of spent nuclear fuel with particular focus on the effects of redox sensitive metals present in the fuel, size and composition of metallic alloy particles and the effect of energy deposition in the fuel matrix from α- and gamma-radiation. These studies will be performed in close collaboration with **STUDSVIK**.

Deliverables		**Lead Participant**	**Due date (Project Month)**
D6.1	Report on redox driven spent fuel dissolution through galvanic coupling	JRC	12/24/36/45
D6.2	Report on redox driven spent fuel dissolution through galvanic coupling (progress and final reports)	JRC	12/24/36/45

Work package number	7	Start date or starting event:	Project Month 0
Knowledge management and dissemination & training			
Activity Type	**Other**		
Participant	AMPHOS		
Person-months for the participant	5		

Objectives:

The objectives are (i) management, communication and dissemination of knowledge, (ii) organization of the program to the annual project workshops, and (iii) handling and ensuring implementation of training and education activities within the project.

Description of activities:

A wide set of activities will be developed within this work package. They are divided into:

-Activities related to knowledge management:

Creation and maintenance of an internal webspace ("intranet") with access restricted to the project partners. The intranet will serve as a tool for internal project communication and information exchange among the partners. The intranet will be operative from the kick-off meeting of the project.

Edition of the proceedings of the 4 annual workshops and 4 training workshops. The proceedings will include papers reviewed by the EUCG. The objective is to finish the electronically edited proceedings 5 months after the respective annual workshop, although this will depend on external conditions. Proceedings hard copies will be prepared and distributed to the workshop participants.

-Activities related to knowledge dissemination and communication

Implementation and continuous up-dating of a WEB portal of the project. It includes regular up-dating of information on relevant project events, public deliverables with interim reports, and reference list of review journal publications with acknowledgement to the project. This portal will thus be used as a key communication tool with the external community. It will be operative from the kick-off meeting of the project.

Preparation of a generic poster presenting the project (from the start of the project and updated when needed)

Edition of semi-annual newsletters informing on the advance of the project tailored to hit external interesting communities (every 6 months)

Organization of the program for the 4 annual workshops, including edition of electronic brochures for the announcements and the workshop programmes.

-Activities related to training

Providing training by:

Scientific mobility measures for young researchers active within the project. Mobility measures are proposed by involved parties, accepted by ExCom/CT and the travel costs associated with the measures claimed directly from the workpackage 7 leader.

Organization of specific training workshops of interest for the project including the logistics and reporting on the outcome (proceedings). Training workshops will be organized in association with the annual project workshops. Training course material will be provided to the trainees, including folders, leaflets, others... The subjects will be selected in agreement with the ExCom and with the objective to serve the young researchers and the scientists involved in the project to acquire the desired knowledge so as to understand the advances achieved and provide specific insights on the state of the art of redox processes, redox monitoring techniques and their applicability.

In the case that one year for whatever reason, the training workshop cannot be organized, the resources will

Work package number	7	Start date or starting event:	Project Month 0
Knowledge management and dissemination & training			
be allocated to the implementation of additional mobility measures. A detailed list of the deliverables scheduled is presented below			

Deliverables		Lead Participant	Due date (Project Month)
D7.0	Plan for using and disseminating the results	AMPHOS	3
D7.1	Project presentation	AMPHOS	3
D7.2	Establishing and regularly updating public web portal and project internal intranet site	AMPHOS	0
D7.3	Poster presentation of the project	AMPHOS	0
D.7.4	Electronic Brochures with the annual workshop announcement	AMPHOS	8/20/32/44
D.7.5	Semi-annual newsletters informing on the advance of the project	AMPHOS	6/12/18/24/30/36/42
	Training course material (folder, leaflet etc…)	AMPHOS	As required
D.7.6	Annual and training Workshop Proceedings	AMPHOS	8/20/32/44
D.7.7	Annual and Training workshop programmes	AMPHOS	8/20/32/44
D.7.8	Summary of the training and knowledge management activities within the project	AMPHOS	14/26/38/48
D.7.9	List of mobility measures and summary of the works undertaken by scientists awarded with the measures	AMPHOS	When necessary

.

Work package number	8	Start date or starting event:	Project Month 0
Project management			
Activity Type	Project management		
Participant	FZK-INE		
Person-months for the participant	12		

Objectives:

Provide for administrative, legal and financial management of the project. It includes overriding topics such as the final reporting system. It does not include RTD coordination or issues related to management and dissemination of knowledge and training (covered under WP7).

Description of activities:

The Project Coordinator, supported by the Legal and Financial Officers, will take all actions required in order to:

- Monitor and follow-up compliance of overall project activities with the overall project objectives
- Ensure proper functioning of the different bodies established for the purpose of ensuring proper administrative, legal and overall functioning of the project (ExCom, EUCG and GA).
- Provide communication between the project and the Commission, including submission of the required management and activity reports and other reports/contributions, which may be requested by EC services.
- Monitor of the use of resources and transferring financial resources.
- Take co-responsibility for the Annual Workshop proceedings (D7.6), with respect to its use for overall activity reporting.
- Take any other action required in support of project implementation, especially continuous efforts to streamline scientific-technical, administrative and legal reporting.
- Plan, organize and implement final reporting system.

Deliverables		Lead Participant	Due data (Project Month)
D8.1	Semi-Annual management and activity reports	FZK-INE	6/18/30/42
D8.2	Annual management and activity reports	FZK-INE	12/24/36/48
D8.3	Final Report (EUR)	FZK-INE	48

Appendix II: Role, responsibilities, key persons involved and description of the resources of individual beneficiaries

	No	Name	Acronym
Contractor	**1**	**Forschungszentrum Karlsruhe GmbH**	**FZK-INE**

Description of the organization

Forschungszentrum Karlsruhe is one of the biggest science and engineering research institutions in Europe and funded jointly by the Federal Republic of Germany and the State of Baden-Wuerttemberg.Its research and development program is embedded in the superordinate program structure of the Hermann von Helmholtz Association of National Research Centers and concentrates on the five research areas of Structure of Matter, Earth and Environment, Health, Energy, and Key Technologies.

The institute involved in the project ("Institut für Nukleare Entsorgung") is dealing with immobilization of high-level radioactive waste, partitioning and geochemical processes relevant for demonstration of the long-term safety within the disposal Safety Case.

Since many years, the involved institute is one of the driving organizations for development of the geochemically based long-term safety assessment for radioactive waste disposal. The competence covers, amongst others, basic actinide thermodynamics, the behavior of long-lived radionuclides in the geosphere, radionuclide transport properties in all media considered to host nuclear waste repositories in Europe, isotope-geochemistry and hydrology and rock mechanics. In the area of the disposal Safety Case it provides support in various national advisory bodies, such as the national reactor safety commission.

FZK-INE is the key organizer of the international "Migration" conference where all scientific-technical aspects of radionuclide migration are treated.

Role, responsibilities and activities within the Project

The FZK-INE is coordinator to the Project and thus follows all legal and administrative aspects throughout the project. It participates at all EUCG and ExCom meetings. It takes active part in organization of the four Annual Project Workshops. Within this context also the review of scientific-technical contributions to the Annual Workshop Proceedings are organized. It carries responsibility for all key administrative reporting towards the Commission, an activity taking part throughout the project. As the overall project coordinator, FZK-INE also carries responsibility for communication between the Project and the Commission. Finally, it is expected to support the project and its partners in various types of reporting and constantly work on possible reporting simplifications. Communication of the project and the project outcome at different international events is another important aspect, reflected in planning for several travels and presentations at such events.

Reflecting previous experience with coordination of large projects, work on establishing a final reporting system and then implementing it will start already at the onset of the project.

With respect to the RTD program, FZK-INE participates in all such workpackages (1-6).

Within workpackage 1, FZK-INE is taking active part in ensuring that the state-of-the-art and the progress is documented. The main responsibility is carried by AMPHOS as the workpackage 1 leader. Another very important role is played by the EUCG. FZK-INE as the project coordinator will also use considerable work resources in contributing and actively supporting the overall functioning of this key project work, including integration of the different partners involved and ensuring proper documentation and dissemination.

Within workpackage 2, RTD is conducted for the purpose of developing redox determination techniques. More important, FZK-INE is organizing the intercomparison laboratory exercise. This means that after agreement on samples to be prepared, these samples are prepared, characterized, stored and monitored until the exercise takes place. The exercise itself is hosted by FZK-INE including organization of the work associated with application of the different redox determination systems. Documentation of the outcome is done by the workpackage 2 leader, namely UPPC. The agreement on the systems to be used for the exercise, however, is lead and documented by FZK-INE. A proposal is circulated to all project partner and the EUCG in due time for a well considered final decision during the ExCom, EUCG and kick-off meetings. The aim of this activity is to ensure functioning of the intercomparison exercise and its usefulness for the purpose of the project but also for a broader community.

Within workpackage 3, FZK investigates the system response to redox disturbances in combination with micro-analysis of relevant phases and minerals. The purpose of the work is to provide process understanding on how natural systems respond to redox disturbances. In other words, not bulk measured data but specific chemical processes are identified. This knowledge contributes to trust in the capability to predict the redox response of different systems, a key parameter in some Safety Cases.

Within workpackage 4, basic chemical knowledge is attained for how, when, where and why radionuclides appear in which redox state. The purpose of the work is to provide knowledge allowing for trustworthy prediction of redox driven radionuclide retention and mobilization processes. This aim is achieved by using high-end analytical approaches in combination with further development of the thermodynamics involved.

Within workpackage 5, the transport properties of radionuclides are investigated in view of redox processes.

	No	Name	Acronym
Contractor	**1**	**Forschungszentrum Karlsruhe GmbH**	**FZK-INE**

Here, the work of the foregoing workpackages and direct transport studies is brought together for an integrated analysis. The aim of the investigation, thus are both to conduct, analyze and document radionuclide transport experiments, but also to verify/falsify the basic process knowledge related to workpackages 2-4.

Within workpackage 6, FZK-INE is conducting investigations on near-field relevant iron corrosion samples that have been stored for seven years in contact with actinides. The aim of the work is to provide new additional data for the long-term retention of radionuclides on corrosion material in the near-field. More important, however, reflecting the age of the samples, confidence in basic process understanding can be supported and thus confidence in reference to such incorporation/retention processes in the Safety Case is considerably improved. At the end this serves to justify a more realistic near-field to the far-field source term within the Safety Assessment.

Specific Role and profile of staff members involved in the Project

Dr. Gunnar Buckau:
Project Coordinator with experience in EC project coordination since beginning of the 90's.
The scientific profile focuses around natural organic matter, its origin, stability and mobility as well as interaction with long-lived radionuclides.

Dr. Bernhard Kienzler:
Long-standing experience in actinide geochemistry, with emphasis on application to geochemically based safety analysis and all aspects thereof in relation to application in the disposal Safety Case.

Dr. Volker Neck:
Scientific work since end of the 80's in the field of aquatic chemistry and thermodynamics of actinides and fission products, contributions to the OECD Nuclear Energy Agency reviews of the series "Chemical Thermodynamics" and to the EC projects MIRAGE, ACTAF and ACTINET.

Dr. Thorsten Schäfer:
Geochemist with EC experience as RTDC leader of IP FUNMIG. Special focus of his research is on radionuclide mobility including colloid migration and the role of mineral surfaces as well as natural organics using micro-focusing synchrotron based techniques (i.e. XANES).

Dr. Christian Marquardt:
Geochemist with long-standing experience and expertise in the field of actinide chemistry, especially thermodynamics, spectroscopic speciation, interaction with natural organic matter and redox reactions.

Dr. Andreas Loida
PhD mineralogy, working field on the alteration behaviour of spent fuel (INE program on spent fuel corrosion), experience over more than 20 years on experimental work with high radioactive material and hot cell techniques.

	No	Name	Acronym
Contractor	**2**	**Association pour la Recherche et le Développement des Méthodes et Processus Industriels**	**ARMINES**

Description of the organization

ARMINES, a non-profit organisation, administers on behalf of the Ecole des Mines a large part of the contractual research of SUBATECH with particular emphasis on contracts in the context of the european framework programme. The Ecole des Mines de Nantes is a school of engineering. SUBATECH is a mixed research unit (UMR 6457) operated by the Ecole des Mines and the University of Nantes and by the IN2P3/CNRS. The mission of "SUBATECH" is basic subatomic physics and associated technologies: Focus of the research and teaching program is nuclear physics, medicine, environment and waste management. Its radiochemistry group is one of the few research groups worldwide having simultaneously experience in the field of high level radioactive waste forms like glass and spent fuel, performance of engineered barriers such as clay and concrete and the retention of radionuclides in the host rock of geological disposals. The group has long experience in experiment and modelling (geochemical transport, radiolysis, burn up and radioactive decay). It was and is involved in various nuclear waste management and HTR projects of the EC: GLAMOR, GLASTAB, HTR-N&N1, SFS, Actinet5, Actinet6, Raphael, FUNMIG and NF-PRO (as RTDC leader) and is currently coordinating the Coordinated Action MICADO.

Role, responsibilities and activities within the Project

In WP1 ARMINES will participate in the harmonization of the work programme and will contribute to the evaluation of redox implications for the safety case

In WP2 ARMINES will develop a methodology for redox determination in hyper-alkaline systems by the distribution of different Se species. Induced redox state perturbation is achieved by aeration and addition of nitrate and hydroquinone. For this purpose, analytical techniques for unperturbed Se speciation and the thermodynamic basis will be developed.

Specific Role and profile of staff members involved in the Project

Catherine LANDESMAN is a research ingenieur (1st class) CNRS. She got her PhD in Radiochemistry, Université Paris XI at Orsay in 1990 and her DEA-diplome at Orsay 1986. Her competences are in radiochemistry, nuclear waste, cimentitous materials, radioanalytics. She has about 30 publications in peer reviewed journals. Her role in the project: leader of ARMINES/SUBATECHS contribution to RECOSY
Bernd GRAMBOW is Professor (1st Class) at l'Ecole des Mines de Nantes, director of Radiochemistry at SUBATECH since 1998 at the Ecole des Mines de Nantes (ENSTIMN). He obtained his diplôme in chemistry 1979 and PhD 1984, Freie Universität Berlin. His Competences are in radiochemistry, nuclear waste, geochemistry, thermodynamics and materials properties . He has about 150 publications in peer reviewed journals. He participitates in the project by modelling.

Massoud Fattahi is since 2006, professor of radiochemistry of the university of Nantes. PhD 1990 at Orsay. Since 1994 researcher at the Ecole des Mines de Nantes. Competences are in radiochemistry, solution speciation and radiolysis. In the project he is responsible on speciation of Se.

	No	Name	Acronym
Contractor	**3**	**Bureau de Recherches Geologiques et Minieres, Environment and Processes Division**	**BRGM**

Description of the organization

Address: BRGM, Environment and Processes Division, Modelling of Deep Storage Impacts Unit, 3, Avenue C. Guillemin, BP 36009, 45060 ORLEANS, CEDEX 2 France. Contact person: Dr. Ioannis IGNATIADIS; phone: 00 33 2 38 64 35 59 ; fax 00 33 2 38 64 36 80; e.mail: i.ignatiadis@brgm.fr

BRGM acts as the French Geological Survey, public institution with industrial feature, and embraces activities in the field of applied Earth Sciences, e.g. geology, hydrology, hydrogeology, geochemistry, geophysics, biotechnologies, hydrometallurgy, and analytical chemistry. The BRGM Modelling of deep Storage Impacts Unit (MIS) has acquired internationally renowned experience in several fields including coupled geochemistry-transport modelling, development of biogeochemical modelling, validation of the concepts of storages (in particular for the nuclear waste), transfers of pollutants in the environment, performances of the barriers and durability of materials of the artificial barriers (clay, concrete) and electrochemistry. Its main activity is oriented to the characterisation of the nuclear waste storage environment, in France as well as in other European countries.

Role, responsibilities and activities within the Project

With respect to the RTD program, BRGM participates, as a project partner, in three workpackages (1to 3).

Within workpackage 1, BRGM is taking energetic part in ensuring that the state-of-the-art and the progress is documented. BRGM will utilize 1 personmonth work resources in contributing and vigorously supporting the carrying out of this key project effort, including assimilation of the proposals from different partners involved. BRGM will try hard to facilitate the coordinators to ensure their role particularly in ensuring proper documentation and dissemination.

BRGM will be essentially involved in Workpackage 2 (development of redox determination methods: 11 personmonths) and Workpackage 3 (redox response of defined and near-natural system: 11 personmonths) in order to:

1. Elaborate electrodes that allow retrieving electrochemical kinetics of the Callovo-Oxfordian (COX) system in contact with different plausible redox perturbations.
2. Develop or adapt reliable electrochemical methodology with the appropriate formalism to follow the electro-chemical reactions occurring during immersion, both in solution and on the surface of these specific working electrodes.
3. Assess the electrochemical kinetics of the COX system in contact with different plausible redox perturbations with its simulation and/or extrapolation at authentic exploitation conditions.
4. Design sensors, based on reliable and robust redox concepts and able to observe evolutions in the underground environment during part of its planned secular duration, and data for their qualification.

Within these two workpackages BRGM will actively participate in the intercomparison laboratory exercise and will possibly provide process understanding on how natural systems respond to redox disturbances.

BRGM adopts an inciting policy of collaboration. In the framework of RECOSY project four partners will be concerned with a close cooperation.

	No	Name	Acronym
Contractor	**3**	**Bureau de Recherches Geologiques et Minieres, Environment and Processes Division**	**BRGM**

Specific Role and profile of staff members involved in the Project

Mr. Ioannis Ignatiadis (1956) is expert and project manager and will be the ReCosy principal investigator with regards to BRGM activity. He holds an HDR (Accreditation to supervise research) in Physical Sciences since 1985 and a Ph.D in Analytical Chemistry (1983) at Univ. of Paris VI. He carries out fundamental, instrumental and applied research in multidisciplinary fields and he was acquired internationally renowned experience especially in analytical chemistry, electrochemistry, environmental technology, soil and water restoration. (82 articles; citation index about 450 in 2006). Project manager since 1993, he supervised several research projects and ensured the responsibility and supervision of several decades of students. He coordinated two projects of the 3rd FP of the Commission of the European Union (CEU) relating to the control of corrosion, scaling and bacterial development in the geothermal systems (PECO 1993 N° CIPDCT93-0314 and JOU2-CT92-0108) and of one project of the 5th FP on the bio-reduction of metals and metalloids in the polluted groundwater and soil (EVK1-CT-1999-0003). He participated as scientist in fifteen (15) European projects.

Mr. Christophe Tournassat (1976) is project manager, Ph.D. Univ. Grenoble in environmental Science. Specialist of surface phenomena (surface complexation, cation exchange) and related redox sensitive reactions (e.g. reactivity of sorbed Fe(II)), he is currently responsible of a workpackage of the FP6 FUNMIG program that is partly dedicated to the study of the redox reactivity of the COX clay rock.

PhD-student: new contracted person will carry on the experimental studies under the supervision of Dr. I. Ignatiadis.

	No	Name	Acronym
Contractor	**4**	**Commissariat à l'Energie Atomique**	**CEA**

Description of the organization

The Nuclear Energy Division of the commissariat à l'Energie atomique (CEA) performs Research and Development for nuclear energy as support of nuclear industrial partners. Within this context, the Laboratory of Migration Studies (L3MR) is in charge of measuring and modelling the migration of radionuclides in porous media by taking into account the coupling between the transport processes (diffusion and advection) and the chemical reactivity of the system (RN speciation, retention at the solid surface). The main domain of application is the characterization of the transport properties of the engineered barriers (concrete, bentonite) and host rock for deep geological disposal of radioactive wastes. Hence the laboratory has developed important skills on the coupling between chemistry and transport processes of RN such as I in clay host rocks.

Role, responsibilities and activities within the Project

CEA contribution to the RECOSY project focuses on the understanding of migration of redox sensitive radionuclides such as I or U in different rocks such as clays or limestone. Iodine is one of the major safety relevant radionuclides. The understanding of the coupling between chemistry and transport properties will ensure the robustness of parameters and transport models used in performance assessments.

CEA will coordinate the WP5 "redox processes in radionuclides transport".

As for the scientific and technical work, a part of the studies will focus on the sorption properties of pyrite surface which can reduce sensitive redox elements. These studies are performed in the framework of WP4. The emphasis will be on Uranium (U^{+VI}) or on Iodine (I^{-I} and I^{+V}) sorption experiments, depending on the priorities defined by the project. They will start in 2008.

The results of these studies will be used for the interpretation of diffusion experiments performed in the framework of WP5 (end of 2008 to the beginning of 2011). The aim of these experiments is to determine the transport properties, distribution coefficient and effective diffusion coefficient of the investigated redox sensitive radionuclides and understand the role of redox conditions on these transport properties. These data are used in the models of transport.

Specific Role and profile of staff members involved in the Project

M. Descostes, Ph.D. in geochemistry

Involved in field experiments (diffusion and polluted site), laboratory experiments (diffusion and sorption), development of new techniques dedicated to the measurement and migration of redox sensitive element.

C. Ferry, after Ph.D on the migration of radon in the unsaturated soils (Orsay University) is the head of the Laboratory for studies on Radionuclides Migration.

	No	Name	Acronym
Contractor	**5**	**Chalmers University of Technology**	**CTH**

Description of the organization

Nuclear Chemistry and Industrial Recycling: two closely collaborating subdivisions of the Department of Chemical and Biological Engineering at Chalmers University of Technology in Göteborg, Sweden, are institutions with excellent facilities for radiological work.

Some of the laboratories/equipment that is at our disposal include an alfa-box laboratory, a gamma laboratory with hot cell, radiochemical laboratories, several inert-boxes, a number of HPGe-detectors with and without sample changer, a NaI-detector with sample changer, a SiLi-detector, alfa-spectrometers, two liquid scintillation counters, AKUFVE-units of Pd impregnated Ti as well as in PEEK, a gamma-cell irradiator, gas-MS, ICP-MS for active samples, IC for an- and cat-ions as well as organic molecules, scanning as well as diode-array type spectrophotometers with fiber-optics and up to 5 m cuvettes , a potentiostat, numerous electrodes of different kinds, manual and automated titrators.

Role, responsibilities and activities within the Project

Nuclear Chemistry has previously collaborated in related EU-projects, e.g. NF-PRO and FUNMIG. Experiences from our participation within these projects will be used.

Within WP 4, dealing with the basic understanding of redox reactions and states, we will first determine Eh agreement between various redox-couples in bulk water to that of electrode measurements.

Thereafter redox-sensitive actinides U, Np and Pu will be added to various minerals and groundwater. Fe(II)/ Fe(III), U(IV)/U(VI), Np(IV)/Np(V) and Pu(III)/Pu(IV)/Pu(VI) will be measured over time and related to measurements of Eh. To assess the different redox couples, liquid-liquid extraction and spectrophotometrical techniques will be used. Preparation and study of the stability of redox tracers are also investigated using potentiostats.

During different stages, including batch experiments and the preparation of groundwater simulants, the redox equilibrium is monitored with electrode measurements, spectrophotometrically and using selected redox tracers (e.g. Tc, Np and 232,233,236U) which are added to the system in a mixture of different valence states.

Specific Role and profile of staff members involved in the Project

Prof. Gunnar Skarnemark (Nuclear Chemistry)

Prof. Christian Ekberg (Industrial Recycling)

Adj. Prof. Kastriot Spahiu (Nuclear Chemistry)

Dr. Stellan Holgersson (Nuclear Chemistry)

Dr. Stefan Allard (Nuclear Chemistry) – Coordinator at Nuclear Chemistry, e-mail: stefane@chalmers.se

M.Sc. Arvid Ödegaard-Jensen (Nuclear Chemistry).

In this group a wide variety of skills and knowledge is represented including:

redox chemistry, actinide chemistry, solvent extraction chemistry, speciation and dissolution, sorption and complexation chemistry, silicate chemistry, radioanalytical chemistry, concrete chemistry, nuclear fuel dissolution, electrode construction to name a few. The areas of expertise of the staff members are overlapping and complementing.

	No	Name	Acronym
Contractor	**6**	**CTM Centre Tecnològic**	**CTM**

Description of the organization

CTM Centre Tecnològic is a non-profit private foundation which concentrates its research activities on two main areas: Environmental Technology and Materials Technology. The Center has a Quality Assurance System according to UNE-EN-ISO 9001.

The **Environmental technology** unit is specialised in industrial and nuclear waste management, contaminated soils and development of clean production technologies through applied research and technological innovation to contribute to sustainable industrial and social development through the enhancement of environmental quality. The unit has high-tech modern chemical analytical equipment.

The area belongs through UPC to the European network of excellence ACTINET-6, focused on actinides, and also to the NICOLE network, focused on contaminated soils. The unit collaborates with the Department of Chemical Engineering at the UPC and the Institut Jaume Almera (CSIC).

Role, responsibilities and activities within the Project

CTM is a contractor that participate in workpackages 1 and 3 with the emphasis on system response to induced redox perturbations.

It participates in all Annual meetings and will present the obtained results at international events, helping to disseminate the project.

Within WP1, CTM participate actively to determine the systems to be studied and collaborates with the preparation and revision of all documents involved.

Study within WP3 the response of systems of interest in the near-field to induced redox perturbations. The link between the determination of the relevant reducing capabilities with the measurement of redox pairs will help to reduce the uncertainties to model the behavior of the near-field systems. These results make a contribution to increase the confidence in the prediction of Performance Assessment exercises.

Specific Role and profile of staff members involved in the Project

Prof. Dr. Joan de Pablo (born 1955). He obtained the degree of Chemistry by the Autonomous University of Barcelona in 1977. After one year of fellowship in The Royal Institute of Technology (Stockholm, Sweden) he got his Ph.D. in Physical Chemistry in the Autonomous University of Barcelona (1984). He is currently the chief of the Department of Chemical Engineering at the Polytechnic University of Catalonia where he works as Professor of Environmental Chemistry since 1986. He is the Chief of the Environmental Technology Division of the CTM Centre Tecnològic and leads research projects on: characterization of the spent nuclear fuel chemical behavior for final geological disposal, heavy metal and radionuclide transport in the environment and industrial waste management. He has co-authored more than 80 publications, including 50 in SCI journals. He has organised two international workshops and participated in seven international research projects. Role: Project coordinator

Dr. Miquel Rovira (born 1969) holds a degree in chemistry (1992) from Barcelona University and a Ph.D. (1998) from Polytechnical University of Catalonia (UPC) focused on precious metals recovery. He performed part of the experimental work at McGill University (Canada) and Nagoya Municipal Research Institute (Japan). Since 1998 he is Assistant Professor at the Chemical Engineering Department (UPC) and he extended his research interests to nuclear and industrial waste management. Currently he is senior research scientist of the Waste Management Division at the CTM Centre Tecnològic. He has co-authored around 50 publications, including 20 in SCI journals and 15 communications to international conferences. Role: design of experiments and data interpretation.

Dr. Frederic Clarens (born 1974) had a degree in Chemistry from Barcelona University (1998) and a PhD from Polytechnical University of Catalonia (2004). PhD studies were focused on the dissolution kinetics of UO_2. Joined to CTM in 2005 as junior scientist, during 2005-2006 he performed the experimental work in JRC-ITU (Karlsruhe, Germany) as a National Detachment Expert, working on Spent Fuel dissolution studies. He has co-authored 13 publications, including 6 in SCI journals and 16 communications to international conferences. Role: support on experimental design and analytical data analysis.

Dr. Isabel Rojo (born 1976) had a degree in Chemistry (1999) and a PhD (2003) from Autonomous University of Barcelona. PhD studies were focused on the synthesis of new extractants of radionuclides based on boron clusters. Joined to CTM in 2005 as junior scientist, working on sorption phenomena on cementitious materials and iron corrosion products. Role: support on experimental studies and analytical data analysis.

	No	Name	Acronym
Contractor	**7**	**AMPHOS XXI Consulting, S.L.**	**AMPHOS**

Description of the organization
AMPHOS Consulting S.L. is an SME that provides scientific and technical consultancy services to address a range of environmental issues mainly associated with the management and disposal of radioactive and hazardous wastes, contaminated groundwater and soils as well as environmental planning and management. The main output is expert advice to national radioactive waste management agencies and regulators. To this aim the SME counts with a team of highly qualified professional specialized in scientific and technical disciplines related with the management of radioactive wastes.

Role, responsibilities and activities within the Project

AMPHOS will be in charge of the technical secretariat, leader of WP1: Harmonization of work program and implications of redox for the Safety Case, and leader of WP7: Knowledge management and dissemination & training.
As technical secretariat the main responsibility will be to contribute to the good performance of the project and the proper reporting to the commission.
This work will be strongly related to the leadership of WP1 which is a monitor of the appropriateness of the work program to fulfill the research needs at a national and international level.
Besides these responsibilities, the technical contribution will be reflected in WPs 3 and 4, mainly related to the interpretation of experimental results on the reducing capacity of solid phases in the geosphere as well as the understanding of the uranium hydrolysis under hyperalkaline conditions. The planning of the experiments and the interpretation of the data will feed the reactive transport models within WP3 developed to assess the role of the geosphere as redox buffer. Therefore, a very intimate link with those groups contributing to the data generation within WP3 will be fostered and this will feedback the conclusions in WP1 to improve the planning of further steps within the project.

	No	Name	Acronym
Contractor	**7**	**AMPHOS XXI Consulting, S.L.**	**AMPHOS**

Specific Role and profile of staff members involved in the Project

Dr. Lara Duro: She will be the leader of WP1, Scientific-Technical Coordinator of the project and part of the Coordination Team. She will be actively involved in the technical work of AMPHOS under WP3 and WP4. Managing Director of AMPHOS XXI Consulting S.L. and Head of the Radioactive and Special Waste Management Department. She has a Ph.D. in Chemistry by the Universitat de Barcelona and specializes in the geochemical modeling of radionuclides, heavy metals and trace elements in natural waters. She has experience in EC projects since the 4th EC FP both at a technical and managerial level. She is currently part of the Coordination Team of the 6th FP IP-FUNMIG and is involved in several other 6th FP projects (PAMINA, MICADO)

Dr. David Arcos: He will be very actively involved in the development by AMPHOS within WP3 dealing with reactive transport model. He is responsible of the Barrier Geochemistry line of AMPHOS. He has a Ph.D. in Geology by the Universitat de Barcelona and has fifteen years of experience in the field of the geochemistry of natural waters (characterization, analysis and modeling). He is specifically competent in the area of characterization and geochemical modeling of natural systems and waste disposal systems, especially in the buffer/backfill system and geosphere. He has been involved in EC projects since the 5th EC FP and is currently involved in several other 6th FP projects (FUNMIG, NF-PRO)

Dr. Mireia Grivé: She will be the leader of WP7, and will be in charge of organizing the knowledge management and dissemination and the training activities. She will be very actively involved in the modelling development by AMPHOS under WP3 and WP4. She is responsible of the Waste and Contaminant Characterization line of AMPHOS. She has a Ph.D. in Chemistry by the Universitat Politècnica de Catalunya. She works in projects focused on the geochemical behaviour of radionuclides and trace metals. Her main areas of expertise are the thermodynamics and kinetics of iron minerals, solubility of radionuclides in laboratory and natural systems. She has been involved in EC projects since the 5th EC FP.

Dr. Jorge Molinero: He will be very actively involved in the development by AMPHOS within WP3 dealing with reactive transport model. He is a senior consultant of AMPHOS. He has a Ph.D in Engineering. He specializes in hydrogeochemical modeling, specifically in the development and application of numerical reactive transport codes. He is very actively involved in the modeling of the data gathered within the Swedish site investigations programme.

Prof. Jordi Bruno: He will act as senior scientific advisor in WP1 and in the technical work of WP3 and 4. He is President and C.E.O. of AMPHOS. He has a Ph.D. in Chemistry (KTH, Stockholm) and has more than 25 years of experience in the field of radioactive waste management. His main areas of expertise are: geochemical kinetics and thermodynamics of natural waters, thermodynamics of trace elements and actinides, dissolution of spent nuclear fuel, performance assessment of nuclear and toxic/hazardous waste repositories. He is Director of the Enresa- AMPHOS Chair of Sustainability and Waste Management at the Technical University of Catalonia (UPC).

	No	Name	Acronym
Contractor	**8**	**Forschungszentrum Dresden-Rossendorf e.V.**	**FZD**

Description of the organization
The Forschungszentrum Dresden-Rossendorf (FZD) is engaged in application-oriented basic research using photon and particle radiation. The main topics are:

- Studying matter down to the nano-range
- Protection of humankind and environment from technical risks
- Tumor research.

The Institute for Radiochemistry (IRC) is part of the Forschungszentrum Dresden-Rossendorf (FZD). FZD is equally funded by the Federal Republic of Germany and the Free-State of Saxony. The research activities of the Institute of Radiochemistry are focused on an improved understanding of radionuclide transport in the environment through basic and applied research. The institute has ample experience with the characterization of environmental problems (mostly in connection with former uranium mining and processing facilities). This includes applied radiochemistry, low-level nuclear radiation measurements, laser fluorescence and photoacoustic spectroscopies, modeling of thermodynamic equilibria and migration processes, interactions between microbes and radionuclides, sorption phenomena on mineral surfaces, formation and distribution of colloids, synchrotron radiation based X-ray absorption spectroscopy, and solubility and speciation studies.
New laboratories for working with α-activity and the license to handle transuranium elements have been into operation since 1998. Time-resolved laser fluorescence and laser-induced photoacoustic spectroscopies are being used to obtain the radionuclides` solution behavior and their speciation in environmental matrices at very low concentrations. Special designed laser systems are available for detection of luminescent species with short luminescence decay times (uranium(IV), organic compounds). This equipment can also be utilized for concentration determination in solution (together with conventional UV/Vis-spectroscopy and ICP-MS). Also facilities for solid phase characterizations are available (XRD, TG, DTA, ICP-MS, α-and β-spectroscopy, XAS). EXAFS (Extended X-Ray Absorption Fine Structure Spectroscopy) studies are performed at the European Synchrotron Radiation Facility (ESRF) in Grenoble/France, where IRC/FZD established a Rossendorf beam-line laboratory to handle radioactive samples (ROBL). For investigations of colloids, Photon Correlation Spectroscopy and Laser-Induced Breakdown Detection (LIBD) is at hand. In addition the ELBE Source for spectroscopy with IR –Laser (Photothermal Beam Deflection, MIRAGE-Effekt) and Confocal Laser-Scanning Microscopy are powerful methods available at IRC for Studies of redox systems.
A wide variety of chemical speciation codes and coupled transport models is in use and has successfully been applied to describe the source term development and possible effects of remediation measures at radioactively contaminated sites.

Role, responsibilities and activities within the Project

The focus of the FZD contributions is directed to the WP 2 Development of redox determination methods where FZD plans to contribute significantly to the development of methods to determine redox systems. Secondly the Institute for Radiochemistry has great experience in studies of the interaction of actinides with biota and the focus within this project will be in this field (WP 4). Especially interactions in biofilms will be investigated.

Specific Role and profile of staff members involved in the Project

Dr. T. Arnold:	Experience in geologic questions and interaction of actinides with biofilm.
Dr. E. Krawzyck-Bärsch:	Scale reduction of electrode based measurement
Dr. A. Scheinost:	XAS and EXAFS spectroscopy, Selenium redox chemistry
Dr. H. Moll :	Interaction with microbes
Dr. K. Viehweger	Biochemistry
Dr. M. Merroun:	Biomineralisation
Dr. G. Geipel:	Laser-Induced Spectroscopy, Actinide chemistry

	No	Name	Acronym
Contractor	**9**	**Gesellschaft für Anlagen- und Reaktorsicherheit mbH**	**GRS**

Description of the organization

The GRS is Germany's central scientific-technical expert organization for nuclear safety and waste management and acts as independent expert to the Federal Government. The Final Repository Safety Research Division in Braunschweig performs long-term safety analyses and conducts research in geochemistry and geomechanics in two own laboratories and URLs.

Role, responsibilities and activities within the Project

Within workpackage 1, GRS will actively participate at the kick-off meeting and the annual project workshops for planning and discussing the interlaboratory comparison exercise and presenting the results of the experiments conducted.

Within workpackage 2, a reliable determination of the redox state of saline solutions will be undertaken by measuring the Fe^{II}/Fe^{III} -ratio and -species. This approach is adopted due to the not a priori quantifiable influence of high salt concentrations and the responding behaviour of the platinum electrode on the one hand and the assessment of Fe^{II}/Fe^{III} as the governing redox couple for the redox state on the other hand. The Fe^{II}/Fe^{III}-species are measured at temperatures from 25 °C to 60°C because of higher temperatures in the vicinity of a nuclear repository. The established technique is designed for in-situ measurements of the redox potential.

GRS takes also part at the interlaboratory comparison exercise to compare our method against the methods of the other project partners in saline systems. The outcome will be documented.

Specific Role and profile of staff members involved in the Project

Thomas Brasser: Geologist, PhD. Project manager with 25 years experience in hydrogeology, hydraulic conductivity of low-permeable rocks; hydrogeochemistry of deep groundwaters, waste-rock-groundwater – interactions; ecotoxicology; natural analogues and safety regulations.

Sven Hagemann: Chemist, PhD. Project manager with 12 years expertise on the field of geochemical modeling, uncertainty analysis and thermodynamics of aqueous systems.

Barbara Vester: Geoecologist (Geoökologin), PhD. 6 years experience in the range of geochemical analytics in different matrices (aqueous systems, sediments, soils, particles).

	No	Name	Acronym
Contractor	**10**	**University of Helsinki**	**UH**

Description of the organization

The University of Helsinki (UH), established in 1640, is the largest and most versatile university in Finland. It includes nine faculties: Theology, Law, Medicine, Arts, Science, Education, Social Sciences, Agriculture and Forestry and Veterinary Medicine; and has around 37000 students and 7000 employees. High-level research is conducted at the departments of the faculties and departmentally affiliated research stations, as well as at independent research institutes.

The Laboratory of Radiochemistry is one of the five laboratories of the Department of Chemistry in the Faculty of Science. Other laboratories are Analytical Chemistry, Inorganic Chemistry, Organic Chemistry, Physical chemistry, Polymer Chemistry and the Laboratory of Swedish language education. The research activities of the Laboratory of Radiochemistry are focused on (1) the behavior of nuclear waste and natural radionuclides in the geosphere, (2) behavior of transuranic and fission fall-out nuclides in the environment, (3) ion exchange processes in purification of nuclear waste solutions and industrial waste effluents and ground waters and (4) the radiopharmaceutical chemistry. Several facilities for measuring radioactivity in environmental and geological samples are available in the Laboratory (α-, β- and γ-spectroscopy, LSCs, ICP-MS with LA). The Laboratory has a Cyclotrone (IBA 10/5 MeV Proton/Deuteron) which has been used for preparing radio tracers (particularly ^{18}F). The Laboratory has also equipments for versatile sample characterization (FESEM+EDS and Malvern Nano Series Zeta-Sizer).

Role, responsibilities and activities within the Project

The Laboratory of Radiochemistry participates to the workpackage 5 where its main task is to investigate and develop chemical methods used to study redox reactions related to glacial meltwater induced redox-perturbation in the bedrock. Wet chemical methods are developed to determine U, Fe and Mn redox states in solid sample materials. Relevant information is searched for by investigating U series disequilibria, analyzing U(IV)/U(VI), Fe(III)/Fe(tot) and Mn(IV)/Mn(tot). To quantify oxidized Fe and Mn Fe(III)-specific reagents are used. Special attention is focused on uranium dissolution from sample materials because interfering redox reactions are possible and can change original uranium redox balance. Uranium isotopic ratio $^{234}U/^{238}U$ in U(IV) and U(VI) fractions is used to get an insight into the impact of interfering redox reactions. Sample materials are from the Finnish and Swedish study sites where glacial meltwaters are known to have penetrated into the bedrock. The purpose of the work is to provide process understanding on how the bedrock responds to redox disturbance introduced by glacial meltwaters. This knowledge contributes to trust in the capability to predict the redox response of the bedrock, a key parameter in the Finnish safety case.

Specific Role and profile of staff members involved in the Project

Juhani Suksi, Radiochemist, PhD, Docent. Project manager with 20 years experience in studying various uranium migration related problems; U –series disequilibrium, redox state, isotope fractionation. Expert in radiogeochemistry, radiogeochemical analytics; natural decay series applications and modelling and natural analogues.

Susanna Salminen, PhD-student. Expert in radiochemical separation methods. Special expertise in analysing uranium isotopes and oxidation states from environmental and geological samples (organic/inorganic sediments, U ore and minerals, rocks), separation of Pu, Am, Cm, Np and Sr from environmental samples (air filters, vegetation, peat) by extraction chromatography. Expert in α-, γ-spectrometry and LSC.

	No	Name	Acronym
Contractor	**11**	**Joint Research Centre – Institute for Transuranium Elements**	**JRC**

Description of the organization

The Joint Research Centre (JRC), is a Directorate General of the European Commission. It operates different laboratories, special equipment collaborating with European research laboratories, authorities and industries. The Institute for Transuranium Elements (JRC) in Karlsruhe, Germany, participates in Recosy. JRC will investigate various aspects of redox reactions relevant to the corrosion behaviour of spent nuclear fuel under repository conditions and using different techniques (WP6). The activities carried out at JRC cover different aspects related to the nuclear fuel cycle, from fuel fabrication to post-irradiation examination in hot cell to storage and disposal studies. JRC has been and is currently involved in several international programs on nuclear waste storage and disposal issues, and collaborates with research centres and agencies worldwide. The Institute is core member of the Actinet6 Network of Excellence on actinides.

Role, responsibilities and activities within the Project

All the activities are concentrated in WP6, where the partner is also the workpackage leader.

The focus will be on redox processes and mechanisms affecting the waste form itself, i.e. spent fuel in the geologic repository. This will constitute a significant effort, given the difficulties and the restrictions associated with working with highly radioactive substances in hot cell or in glove box. ITU is one of very few laboratories in Europe that can cover these highly demanding tasks. The tests will extend over multi-year time periods.

The most challenging aspect of the activities that will be performed in ITU is the fact that the experiments will include sophisticated and innovative approaches, as the "simple" experiments have already been performed. In particular, to test spent fuel under geologic repository conditions implies achieving essentially oxygen-free conditions, and/or high overpressure of hydrogen. This poses demanding requirements to design and implement the necessary experimental facilities in glove box and in hot cell. Moreover, in addition to leaching tests, original, multidisciplinary approaches will be pursued, involving fabrication and use of ad hoc deposited thin films reproducing relevant properties of the systems to be investigated, and also advanced electrochemistry techniques. The amount of characterization will be maximized and will include all tools available in house to study surfaces and phases. This multi-angle approach, including real spent fuel and model materials under representative conditions shall allow maximizing the quality of the information collected, hence the level of understanding of the phenomena considered.

Specific Role and profile of staff members involved in the Project

Dr. **V.V. Rondinella** will coordinate JRC's contributions to Recosy. He is Action Leader for the Nuclear Waste Disposal activities in JRC and is involved in several research programs on storage and disposal of HLW, on the characterization of high burnup fuel, and on the properties of advanced fuels.

Dr. **D. H. Wegen** is a specialist in electro- and radiochemistry with more than 20 years experience in R&D projects in the field of nuclear waste management and electrochemistry. He was responsible for corrosion investigations on steels and valve metals used for LAW containers and electrodes in the PUREX process (FU Berlin). At JRC he is responsible for electrochemical investigations on spent fuel. He was also in charge for the electrochemical testing of spent fuel in the Source Term Assessment project SFS during FP5. In FP6 he coordinates JRC's contributions to the projects NF-PRO and MICADO.

Dr. **Paul Carbol** has worked since 1986 as nuclear chemist, dealing with different aspects of radionuclide mobility in the biosphere and geosphere. For the last seven years he has studied the corrosion of spent nuclear fuel. He has participated in the EU/SFS-project and is responsible of the task “Irradiated fuel corrosion studies”, at JRC.

Dr. **Thomas Gouder** is in charge for the surface and interface science activities at JRC.

Dr. **Laura Aldave** will follow the experiments on immobilization of radionuclides in contact with rock fracture iron minerals.

	No	Name	Acronym
Contractor	**12**	**Ústav jaderného výzkumu Řež a.s. (Nuclear Research Institute Rez plc)**	**NRI**

Description of the organization

Nuclear Research Institute Řež plc (NRI) is the immediate successor of the Nuclear Research Institute that was founded back in 1955 as a part of R&D base for the Czechoslovak nuclear programme within the Czechoslovak Academy of Sciences. The NRI main mission is to remain the key technical-engineering body contributing to the development of long-term sustainable power supply in the Czech Republic and to be a significant part of the European Research Area in the field of nuclear energy. Its services for State Office for Nuclear Safety and Czech nuclear power plants in operation play a considerable role in ensuring safe, reliable and economic operation of these plants, in their fuel cycle efficiency and radioactive waste management safety.

Role, responsibilities and activities within the Project

NRI will be participated mainly in work package 6 and partly within work package 1.

Within workpackage 6, NRI will be conducting experiments focused on determination of redox potential evolution in near field due to corrosion of iron. The effect of addition of different amount of iron powder, representing different ratio of carbon steel and contacting water in the repository, on redox and also corrosion potential of iron electrodes will be measured. Redox potential will be measured using different types of electrodes (Pt, Au, etc). Corrosion potential of carbon steel electrodes will be evaluated using electrochemical noise analysis. The experiments will be performed in synthetic bentonite or granite pore water and compared with the results achieved in distilled water. The experiments will be performed at different temperatures and different content of oxygen in surrounding environment. The experimental results will be interpreted using geochemical models. Scanning microscopy will be performed to determine elements formed on carbon steel plates.

Electrochemical response of UO_2 electrodes on the presence of iron powder in bentonite porewater solution will be tested. The effect of rotating electrode and possibly galvanic coupling between UO_2 and iron will be also tested. Scanning microscopy will be used for investigation of UO_2 electrodes after corrosion at different conditions.

The impact of the results on performance assessment will be evaluated in the framework of WP 1.

Specific Role and profile of staff members involved in the Project

Antonín Vokál is a graduate of Prague Institute of Chemical Technology where he obtained Ph.D. in 1983. Now he is Head of Waste Disposal Department of Nuclear Research Institute Rez plc. In the project he will coordinate studies focused on the investigation of the impact of corroding iron on near field redox state evolution (WP6) and its impact of performance assessment (WP1)

David Dobrev is a graduate of Czech Technical University in Prague (MSc. in nuclear chemistry, 2007). In the project he will be key researcher focusing on experimental investigation of the effect corroding iron on Eh evolution in near field.

Václava Havlová is a graduate of Prague Charles University, Faculty of Science (MSc, in geochemistry, 1993). In the project she will be working in WP6 on modeling and interpretation of experimental results on geochemical evolution of near field

Radek Červinka is a graduate of Prague Charles University, Faculty of Science (MSc, in geochemistry, 2006).In the project he will be working in WP6 on modeling and interpretation of experimental results on geochemical evolution of near field

	No	Name	Acronym
Contractor	**13**	**Paul Scherrer Institut** **Laboratory for Waste Management (LES)**	**PSI**

Description of the organization

The Paul Scherrer Institute (PSI) is a multi-disciplinary research centre for natural sciences and technology. In national and international collaboration with universities, other research institutes and industry. PSI is active in solid state physics, materials sciences, elementary particle physics, life sciences, nuclear and non-nuclear energy research, and energy-related ecology.

The Laboratory of Waste Management of PSI carries out a nuclear waste management R+D programme on behalf of the Federal Government and Nagra. The emphasis is on fundamental geochemistry, speciation, sorption and radionuclide transport. PSI is the only research institute in Switzerland where larger amounts of actinides can be handled. The Lab has PhD students and members are also involved in university teaching. Further, LES is responsible for the operation (together with the SLS team) of the microXAS beamline, which allows for measurements of radioactive samples.

Role, responsibilities and activities within the Project

Within workpackage 1, PSI will actively take part in ensuring 1) the synchronization of its own experimental programs in WP4 with the programs of the other partners, 2) documentation and updating of the state-of-the-art in reflecting redox processes involving radionuclides (neptunium) in PA.

Within workpackage 4, PSI is conducting investigations on the influence of redox conditions on the immobilization of neptunium in highly alkaline cementitious environments. The purpose of the work is 1) to obtain sorption values for Np in its different relevant redox states for the compilation of sorption databases as a contribution to PA; and 2) to obtain a better understanding, also on a molecular level, of the chemical processes controlling the Np uptake to allow for long-term predictions of the Np retention in cementitious environments.

This project consists of three phases:

1) In the first phase experimental procedures will be developed to control oxidizing/reducing conditions in highly alkaline systems

2) In a second phase series batch sorption experiments are set-up under various controlled redox conditions to determine neptunium sorption values on important cementitious materials, in particular calcium silicate hydrates and hardened cement paste.

3) In parallel EXAFS studies will be carried out on samples of Np sorbed on cementitious materials to obtain information about the coordination environment of Np sorbed on cementitious materials under various controlled redox conditions.

As workpackage leader of WP4, PSI will coordinate the different RTD programs within the workpackage and coordinate the preparation of the annual progress reports and the final reports for WP4. As workpackage leader, PSI will actively participate in all ExCom meetings.

Specific Role and profile of staff members involved in the Project

Dr. J. Tits

Education: Ph.D. in Agronomy with specialisation in soil chemistry at the Catholic University of Leuven, Belgium (1990). Postdoctoral fellowship at The Commissariat à l'Energie Atomique, Fontenay-aux-Roses, France. In 1992, he joined the Laboratory for Waste Management at the PSI. He has experience in surface chemistry and cement chemistry applied to the issues of radioactive waste disposal, and application of laser-induced fluorescence spectroscopy for speciation studies. He will be actively involved in the technical work of WP4 and act as work package leader of WP4.

Dr. E. Wieland

Education: Ph.D. in Environmental Sciences at ETH Zürich (1988). Postdoctoral fellowship at Stanford University (USA). He has been working at PSI's L aboratory for Waste Management since 1994 as a senior scientist and project leader in studies on cement investigations and colloid chemistry. Expertise: Experiences in surface chemistry, cement chemistry, the application of X-ray absorption spectroscopy for speciation studies and studies on near-field colloids. He will act as senior scientific advisor in the technical work of WP4.

	No	Name	Acronym
Contractor	**14**	**Graz University of Technology**	**TUG**

Description of the organization

The Graz University of Technology has a long tradition in teaching (since 1811) is one of four universities in Graz with nearly 9000 students more than 30 study paths. In world-wide competition with comparable institutions, Graz University of Technology pursues top teaching and research in the fields of the engineering sciences and the technical-natural sciences. An integral part of putting together excellent education and training programs is knowing about the needs of society and the economy. Ultimately, the quality of the education and training at Graz University of Technology is carried by the strength of its knowledge-oriented and applied research. Numerous competence centers, the Christian-Doppler laboratories, special research fields, research focuses, and large EU projects are only a few examples of the University's extremely active and successful research.

The institute of analytical chemistry and radiochemistry of the TU Graz is a well equipment institute with two main research fields: inorganic and organic trace analysis on the one hand and bio and chemo sensors on the other. The group of inorganic trace analysis is well equipped with modern analytical techniques like sample digestion, continuum source AAS, ICP-OES and ICP-MS. The field of speciation analysis is in the start up phase and will be enlarged during the next years.

Role, responsibilities and activities within the Project

The work is performed around the development of redox determination as well as interpretation of system response towards disturbances, in both cases building on thermodynamic calculations of relatic´ve species involved. The work is conducted in close cooperation with FZK-INE, with respect to handling of radioactive material and the use of a broad thermodynamic interpretation basis. The role thus focuses on bringing in the actinides as redox sensors into the context of the project.

The own work consists of refining the analytical determination of redox sensitive elements, especially the actinides, followed by thermodynamic interpretation of the system and component redox state. A key corner stone in this process is participation at the interlaboratory comparison exercise at FZK-INE where the method is tested on a set of defined systems and compared to other approaches.

Following this assessment of the own approach, investigations on the response to system disturbances will dominate the experimental program.

Specific Role and profile of staff members involved in the Project

Beside the applied post doc position in this project, there will be involved a proposed PhD student and 1-2 diploma students (applied at the Austrian science foundation FWF) working in the field of environmental behaviour of iodine and a employee of the TU Graz.

Dr. B. Kuczewski

He is the applicant of both proposals and will be the local project manager. He is working on the field of speciation analysis of actinides and long-lived fission products since his diploma thesis in 1999 and developed a speciation technique with CE-ICP-MS for Pu und Np in his PhD thesis. He is now assistant professor at the TU Graz. He was involved in two Actinet proposals and several national projects in Germany during his thesis.

For the post doc position a young scientist with experience in the field of analytical techniques, but also with clay minerals, is planed. She is finishing her PhD thesis during this year at the German Max-Plank Institute.

	No	Name	Acronym
Contractor	**15**	**University of Postdam**	**UPPC**

Description of the organization
The University of Potsdam (UP) is a governmental owned foundation for higher education and is divided into 5 faculties. The department of Physical Chemistry (UPPC) belongs to the Institute of Chemistry. UPPC has broad range experience in laser spectroscopy, optical sensing and application to chemical and bioprocess analysis, biological and environmental monitoring with special emphasis on the time-resolved and steady-state detection of luminescence and light scattering phenomena in condensed and gas phases. Application of fiber-based spectroscopy techniques for optical sensing is one of the main foci of UPPC.

For more information regarding equipment and laboratories please refer to http://www.chem.uni-potsdam.de/pc/.

Role, responsibilities and activities within the Project
UPPC participates in work package (WP) 1 and 2. In WP 1 UPPC will be involved in the definition of the key systems investigated and actively supports the work package leader AMPHOS ensuring that state-of-the-art techniques and progress within the project is properly documented. In WP 2 UPPC develops and tests innovative redox sensors. Moreover, UPPC is the leader of WP 2. In addition to the experimental work on the development of optical fiber-based sensors for investigation of redox processes, UPPC as the WP2 leader will allocate a considerable amount of time into the organization of RTD meetings and documentation of the scientific outcome of WP2. The different techniques applied will be compared for their performance. In semi-annual and annual RTD meetings the scientific results will be discussed by the partners of WP2 and the work plan will be detailed and adjusted according to the latest developments. The outcome of these meetings will be reported to the coordinator and to the consortium, e.g., at the annual meetings in form of oral presentations. Furthermore, the scientific results will be published in joined papers to a broader scientific community. UPPC will actively stimulate the preparation of such joined manuscripts for submission to international journals.

Specific Role and profile of staff members involved in the Project

PD Dr. habil. Michael Kumke:

Physical chemist with a long standing experience in national and international projects and scientific collaborations. The scientific profile focuses around natural organic matter, its origin, stability and mobility as well as time-resolved laser spectroscopy with special emphasis on lanthanide ion probe spectroscopy and optical sensing. He will be responsible for the work package coordination and scientific steering.

Dr. Elmar Schmälzlin:

Physical chemist with a strong background in fiber optics and tailor-made sensors. Dr. Schmälzlin will support the work packaged coordination and the development of the new optode system.

Dipl. Chem.. :Susanne Eich

Physical chemist experienced in optical fiber-based spectroscopy. She will be responsible for the performance of the experiments. She has a standing experience in optical-time domain refractometry (OTDR) and the remote sensing of CO_2 and O_2 using fiber-based spectroscopy.

Dipl. Chem.: Dörte Steinbrück
Physical chemist with broad experience in optical spectroscopy, especially luminescence-based techniques. She has a strong background on fiber-based luminescence applications for the detection of analytes such as oxygen.

	No	Name	Acronym
Contractor	**16**	**Centre National de la Recherche Scientifique**	**CNRS**

Description of the organization
CNRS, French national centre for scientific research, is a public basic-research organisation. CNRS has 26,080 employees in 1,260 service and research units spread throughout the country and covers all fields of research. Interdisciplinary programs and actions offer a gateway into new domains of scientific investigation and enable CNRS to address the needs of society and industry. One Research Unit will participate in RECOSY :
LGIT - UMR 5559 is a Joint Research Unit (JRU) set up by Centre National de la Recherche Scientifique (CNRS) and Université Joseph Fourier (UJF) Grenoble 1. LGIT (Geophysics and Intern Tectonophysics Laboratory, located in Grenoble) is a Unit dedicated to Geophysics and Geochemistry, with one out of eigth theme related to environmental geochemistry and headed by Prof. Laurent Charlet and
LCPME - UMR 7564 is a Joint Research Unit (JRU) set up by Centre National de la Recherche Scientifique (CNRS) and Université Henri Poincaré Nancy 1. LCPME (Laboratory of Physical Chemistry and Microbiology for the Environment, located in Nancy) is dedicated to the study of physicochemical and microbiological reactions at the solid/water interfaces in the environment.

Role, responsibilities and activities within the Project

With respect to the RTD program, CNRS participates in work-packages 1, 2, 3, and 4.

Within work-package 1, Prof Charlet is WP Leader for WP3, and participates in the cross-cutting WP 1

Within work-package 2, CNRS/LCPME will evaluate an in situ amperometric method for the redox potential determination. The quantitative determination of the two components of a redox couple is likely to provide in situ measurement of the solution potential. This can be performed electrochemically by means of voltammetric techniques using ultramicroelectrodes (UMEs). The method has as advantages: i) a linear response with the concentration instead of the logarithmic one for potentiometric determinations, ii) a possible instability or drift of the reference electrode have virtually no influence on the measurements, iii) signal/noise-ratio is significantly increased when UMEs are used and the measurements can be performed, whatever the ionic strength (even in pure deionised water), iv) UMEs may be polarized for cleaning purposes or for avoiding the biofilm development. The method performance will be evaluated first in the LCPME with model electroactive species and with redox couples in the system and potentiometric indicators chosen in common with the other contractors during the kick-off meeting, and then in the interlaboratory comparison exercise.

Within work-package 3, CNRS will focus on calcite, pyrite and Bure Callovo-Oxfordian argillite containing both calcite and pyrite, more especially:

CNRS/LGIT will study the structural environment of Fe(II) sorbed or coprecipitated in calcite and in Callovo-Oxfordian argillite by means of µFluoX, XAFS and AFM methods. It will show by neutron scattering that U and Se trapping into calcite is a redox selective mechanism, i.e. that for instance Se(VI) and Se(IV) are trapped differently in this solid. Molecular modeling of the unit cell expansion will be performed. The group will also characterize the redox reaction between selenium aqueous species and various Fe(II)-containing carbonates by XAFS and Mössbauer spectroscopy. The specificity of the different faces of calcite crystals, grown in a pressure chamber, will be investigated by µFluoX, µXANES. Since another important redox reactive system, e.g. in the Callovo-Oxfordian argillite, is constituted of nano Fe(II) sulfide particles (mackinawite, FeS clusters), these nanoparticles will be reacted with selenium. Kinetics and products of the reaction, i.e. selenium based nanoparticules formed by these reactions, will be investigated by XAFS. DFT techniques will be applied to further characterize the size and thus the relationship size/solubility of these nanoparticles.

CNRS/LCPME will study the pyrite (with and without the presence of organic matter) and the Bure Callovo-Oxfordian argillite response to induced redox disturbances, chosen in common with the other contractors, as well as the reactivity of Bure argillite towards Se, I and U species buy means of batch and column experiments. The experiments will be monitored using in situ electrochemical and dielectric techniques in combination with speciation, solution analyses and solid phase characterization using electrochemical and spectrometric techniques in the micrometric range. The main aim of the work is to specify the role of pyrite and its gradual transformation during the disturbances. The importance of this additional knowledge is clear if one considers the fact that very small amounts of pyrite will be responsible for the low redox potential of soils planned for the storage of the spent fuel. This work is in direct connection with that in work-package 4.

Within work-package 4, CNRS/LCPME will investigate the reactivity of selenium, iodine and uranium, soluble species and their mixtures towards pyrite (with and without the presence of organic matter) by means thermodynamic predictions, electrochemical, spectrometric (mainly XPS and Raman microspectrometry) and in situ spectroelectrochemical techniques. In this area the literature is poor and there are neither bibliographic references concerning the reactivity of Se, I and U mixtures towards this mineral, nor characterizations of the solids by means of voltammetric techniques. The objective of this study is the identification of the reaction products and to provide information on reaction kinetics and local reactivity.

	No	Name	Acronym
Contractor	**16**	**Centre National de la Recherche Scientifique**	**CNRS**

Specific Role and profile of staff members involved in the Project

Prof. Laurent CHARLET (CNRS/LGIT): WP3 Coordination and Surface chemistry
Delphine TISSERAND (CNRS/LGIT): chemical experiments and measurements
Nicolas GEOFFROY (CNRS/LGIT): Diffraction and XAFS spectroscopic measurements
Jerôme CORTOT (CNRS/LCPME): solution analyses by ICP
Dr. Mathieu ETIENNE (CNRS/LCPME): solid surfaces reactivity and characterization (AFM/SECM).
Dr. Michel PERDICAKIS (CNRS/LCPME): E_H determination and in situ voltammetric measurements
Dr. Alain WALCARIUS (CNRS/LCPME): mechanisms of the adsorption/desorption phenomena

	No	Name	Acronym
Contractor	**17**	**University of Zaragoza (Spain)**	**UNIZAR**

Description of the organization

The University of Zaragoza is the main centre of technological innovation in the Ebro Valley (northeastern Spain) and has great prestige among the group of both Spanish and European universities it has relations with. Through the Vice-Rectorship for International Relations, the University of Zaragoza participates in various exchange programs, collaborating with universities and research centers from Europe, Latin America and the USA, thereby strengthening its international standing.

The group involved in the project (Geochemical Modelling Group, GMG) belongs to the Earth Sciences Department. The main expertise of the group is in the field of geochemical modelling, mainly related to the deep geological disposal of high-level radioactive wastes, and the long-term safety assessment within the disposal Safety Case.

Since 1999, this group has been participating in national and international projects (funded by ENRESA and CSN in Spain and by SKB in Sweden) as the modelling group for the geochemical processes associated to the safety assessment for radioactive waste disposal.

Role, responsibilities and activities within the Project

The main role of this group is to give support to this study by using the results obtained in the Swedish Site Characterization Program. The work developed by this group for SKB in the characterization program has covered mainly the geochemical modeling of the waters, including mixing and water-rock interaction processes. Among them, the redox modelling of the system has been one of the main aims. The activities that will be developed here are related with workpackage 3. Therefore, the UNIZAR group will contribute with the methodology and results developed and obtained with respect to the system response to redox disturbances and their effects on the water chemistry, the mineralogy and the microbiology.

Specific Role and profile of staff members involved in the Project

Dr. María J. Gimeno:

Geochemist with long-standing experience and expertise in the field of geochemical modelling applied to lanthanides, uranium, deep geological disposal, acidic waters and geothermal systems. Group leader.

Dr. Luis F. Auqué:

Geochemist with long-standing experience and expertise in the field of geochemical modelling applied to lanthanides, uranium, deep geological disposal, acidic waters and geothermal systems. Specialist in PHREEQC.

Dr. Javier B. Gómez:

Geochemist with long-standing experience and expertise in the field of geochemical modeling applied to deep geological disposal and geothermal systems. Modeler and software developer.

Dr. Patricia Acero:

Geochemist with long-standing experience and expertise in the field of geochemical modeling applied to deep geological disposal and acid mine waters. Specialist in PHREEQC, RETRASO, and in laboratory experiments.

	No	Name	Acronym
Contractor	**18**	**Studsvik Nuclear AB**	**STUDSVIK**

Description of the organization

STUDSVIK is a leading supplier of services to the international nuclear industry. The company has more than fifty years of experience of nuclear technology and services in a radiological environment. Studsvik operates in a high-growth market and provides qualified services through four Strategic Business Areas (SBAs): Operating Efficiency and Safety, Service and Maintenance, Waste Treatment and Decommissioning. Studsvik has 1,200 employees in 7 countries. The group of nuclear fuel chemistry has more than 30 years research experience on spent fuel leaching and nuclear environmental chemistry.

Role, responsibilities and activities within the Project

Studsvik will conduct investigations on how different features of the nuclear fuel affect its redox reactivity. The ultimate target is to create a model that describes the dissolution of spent fuel where these features are accounted for.

Studsvik will also investigate the kinetics and mechanisms of Redox sensitive radionuclides (RSRN) immobilization processes under simulated near-far fields conditions in contact with canister components (Fe(0), Fe(II) corrosion products) and Fe(II) minerals collected from deep rock fractures. The stability (reversibility) of immobilized radionuclides (re-mobilization) will also be studied.

Specific Role and profile of staff members involved in the Project

Dr. Ella Ekeroth has experience from previous redox studies at KTH (2001-2006) on UO_2 from a kinetic and mechanistic perspective. E Ekeroth will be responsible for designing and conducting the experiments performed at Studsvik Nuclear AB and for evaluating and compiling data together with Mats Jonsson at KTH.

Dr, Daqing Cui has the experience from previous research activities (1982-2007) on near-field redox chemistry, immobilization of redox sensitive radionuclides at near-field and far-field conditions in CNNC, China (1982-1989), KTH, Sweden (1989-1999) and Studsvik, Sweden (1999-2007). He will play a main role for proposing, designing, conducting research and reporting.

	No	Name	Acronym
Contractor	**19**	**Institute of Isotopes – Hungarian Academy of Sciences**	**II -HAS**

Description of the organization

The main tasks of the institute are i/ to develop and apply nuclear analytical methods, ii/ to provide expertise related to safe-guard aspects of nuclear materials, iii/ to develop and apply various methods for personal and industrial dosimetry, iv/ apply radiotracers in various fields. Heterogeneous catalytic studies are also performed in a modest extent. The research personnel is ca. 50 persons, the total staff is ~ 90. The institute has accumulated wide expertise since its foundation in 1959. The institute is separate legal entity as a non-profit research institute and is a member of the network of the institutes of the Hungarian Academy of Sciences

The institute possesses a wide variety of the nuclear analytical methods, the most unique among them is the Promt Gamma Activation Analysis (PGAA) facility operated jointly at the Budapest Neutron Centre. Other nuclear (Mössbauer, gamma-ray) spectroscopies are also routinely applied. The institute acquired a high resolution ICP-MS apparatus recently, too.

For further information the home page can also be consulted (www.iki.kfki.hu).

Role, responsibilities and activities within the Project

The main role of the project contractor is to collect and provide samples, information and data on preliminary characterization on one of the selected types of claystone involved in the Project, namely on the Hungarian Boda Claystone. (As earlier studies show, this particular claystone has extreme mineralogical properties from several aspects, thus studies on this claystone may broaden the background available for the generalization of data obtained in the project.) Furthermore, the contractor should perform experiments on Boda Claystone samples as specified and described in workplans WP3 and WP5.

In order to achieve these task, the following measures are to be undertaken,
(1) in the start: (0 – 5 pm:)
- various samples selected and acquired from the entrusted Company (Mecsekérc Ltd.)
- the corresponding data should be analysed with particular emphasis on redox features,
- complementing screening measurements should be performed to characterize tthe redox stage
- design and manufacture the appropriate measuring cells,
- mount the appropriate measuring set-ups.
(2) in the further stages: (further on from 6th pm:)
- carry on by repeating the data acquisition, evaluation and setting novel experimental conditions cycles.

Specific Role and profile of staff members involved in the Project

Károly Lázár (chemist): local coordinator and contact person and he is in charge for the Fe^{2+}/Fe^{3+} determination by Mössbauer spectroscopy,

János Megyeri (chemist): would contribute by most of the experimental work, sample preparation, handling the radioisotopes, soluton chemistry, detection of activities by liquid and regular scintillation detection for ^{99}Tc and U, etc.

Katalin Gméling: (geologist): has collected expertise on the characterisation of Boda Claystone samples by determining the trace- and accompanying elements by PGAA and she is supposed to provide the geochemical approach to the interpretation of data,

Zsolt Stefánka (chemist) a researcher in charge with the Laser Ablation ICP-MS characterisation of spent samples

	No	Name	Acronym
Contractor	**20**	**University of Cyprus**	**UCYPRUS**

Description of the organization

The University is a public corporate body. It is governed by the Council and the Senate. The Faculties and Departments are administered by Boards. The investigations within RECOSY will be carried out by the Radioanalytical and Environmental Chemistry Lab of the Chemistry Department of UCYPRUS. The two main objectives of the Department of Chemistry are: the creation and promotion of new scientific knowledge via research in Chemistry, and the creation of highly skilled graduates, who will work as scientific personnel in industry, private enterprise, the public sector and education.

Role, responsibilities and activities within the Project
UCyprus participates in following RTD workpackages: WP 1, WP 3, WP 5:

After interaction with the other partners and detailed work planning (WP1), UCyprus is going to perform laboratory (WP3) and field measurements (WP5) in solutions of different compostion (e.g. phosphogypsum stack of different pH, salinity, TDS) by means of conventional electrochemical and sophisticated optical redox sensors developed and provided by the project partners. Evaluation of the experimental data will ensure stability and reliability of the sensors in natural systems and extreme conditions.

The redox sensors will be tested and calibrated under anoxic and oxygen-rich conditions in well defined laboratory solutions and the data obtained will be correlated to corresponding data obtained from field measurements or the stack solutions under similar conditions.

Specific Role and profile of staff members involved in the Project

Mrs Stella Antoniou (MSc in Radiochemistry, PhD candidate) will carry out the experimental work and evaluate the results.

Dr. Ioannis Pashalidis (http://www.ucy.ac.cy/~chemweb/Faculty/Paschalides/paschalides.html) is supervisor of the Radioanalytical and Environmental Chemistry Lab and will coordinate the investigations and co-evaluate/ assess the results.

	No	Name	Acronym
Contractor	**21**	**Institute of Physics**	**IPL**

Description of the organization

Institute of Physics is a wide profile institution of physical sciences which carries out fundamental scientific and applied research in such scientific fields as molecular physics and biophysics, chemical physics, modern laser spectroscopy and nonlinear optics, nuclear physics as well as nuclear and radiation protection, environment radioactivity, environment physics and chemistry.

Radiochemical laboratories, a number of HPGe-detectors, alfa-spectrometers, one liquid scintillation counter, Mossbauer spectrometer with the closed cycle helium cryostat, an atomic absorption spectrometer as well as ICP-MS will be at the disposal of this group.

Role, responsibilities and activities within the Project

IPL participates in workpackage 4, radionuclide interaction with pseudocolloids and minerals in groundwater is investigated. The purpose of this study is to better understand how microorganisms, minerals including clay, iron oxide and organic coatings, usually present in natural systems, can affect redox speciation of redox sensitive radionuclides and how these processes can result in remobilization and retention of radionuclides.

The knowledge of how radionuclides behave in complicated, heterogenous natural systems is attained. The aim is achieved by experiments as close as possible to the natural systems which provide data for the long-term prediction of radionuclide migration.

Specific Role and profile of staff members involved in the Project

Dr. Sci. D. Baltrunas (group leader, Mossbauer spectroscopy)

Dr. R. Druteikiene (radiochemistry)

Dr. A. Gudelis (physics, LSC)

Dr. G. Lujaniene (biochemistry, radiochemistry)

Dr. B. Luksiene (radiochemistry)

Dr. K. Mazeika (Mossbauer spectroscopy)

Dr. V. Remeikis (nuclear physics, ICP-MS)

Dr. S. Vaitekonis (microbiology)

Group members have a wide variety of skills and knowledge in:redox chemistry, actinide chemistry, solvent extraction chemistry, speciation and dissolution, sorption and complexation chemistry, radioanalytical chemistry, different kinds of spectroscopy. The group members complement each other by their experience.

	No	Name	Acronym
Contractor	**22**	**Utrecht University**	**UNIUTR**

Description of the organization

Utrecht University is a governmentally owned foundation. It offers the broadest spectrum of disciplines available in the Netherlands and liaises with universities and research centers all over the world. The Biogeochemistry Group is part of the Faculty of Geosciences and its research aims at advancing the mechanistic understanding and quantitative modeling of coupled biological-geochemical processes in natural environments.

Role, responsibilities and activities within the Project

The main activities of UNIUTR are allocated to workpackage 3, which is dedicated to the response of systems to redox perturbations. In many systems redox perturbations are closely related to microbial activity. Microbial activity is often the driving force behind changing redox conditions or bacteria might catalyze redox reactions, which become thermodynamically feasible upon externally caused perturbations of the system. UNIUTR will, in particular, contribute to workpackage 3 by providing expertise on microbial mediated redox reactions of metals. The latter include redox sensitive radionuclides, such as uranium, but also metals which are involved in radionuclide mobility by acting as sorbents, oxidants, or reductants depending on redox state. Iron is a prominent example for this group of metals and within the project the focus will be laid on redox transformations of iron interacting with those of uranium. Within the project the establishment of microbial sulfate reduction, as one possible perturbation in redox conditions, and its effect on the fate of uranium adsorbed on iron oxides will be experimentally studied.

Specific Role and profile of staff members involved in the Project

The research will be performed under the guidance of Dr. T. Behrends. Dr. T. Behrends is Assistant Professor of Experimental Biogeochemistry at the Faculty of Geosciences at Utrecht University. His research focusses on microbial mediated redox transformations of metals in natural environments. Additionally, Prof. dr. P. Van Cappellen will be involved in the project. Prof. Dr. P. Van Cappellen has initiated a strong research program on the biogeochemical dynamics of redoxstratified environments at the Faculty of Geosciences. Within this program rates and coupling of redox processes in different environments are investigated in a multidisciplinary approach by combining modeling, field oriented research, and experimental biogeochemistry.

	No	Name	Acronym
Contractor	**23**	**Kungliga Tekniska Högskolan**	**KTH**

Description of the organization

The Royal Institute of Technology (Kungliga Tekniska Högskolan), KTH, is responsible for one-third of Sweden's capacity for engineering studies and technical research at post-secondary level. Our university has over 12,000 undergraduate students, 1,600 active postgraduate students and a staff of 3,000 people.

The division of Nuclear Chemistry has conducted research related to deep geological repository for spent nuclear fuel for almost 30 years

Role, responsibilities and activities within the Project

KTH will investigate how the different features stated below affect the redox reactivity of nuclear fuels:

- The effect of redox sensitive metals in the fuel
- The size and composition of metallic alloy particles present in spent nuclear fuel
- Surface structure properties such as porosity and grain sizes
- The effect of energy deposit in the fuel matrix from α- and γ-radiation)

All these characteristica are directly related to the catalytic properties for redox reactions and thus key elements in driving the redox processes.

The purpose is to find relationships between the parameters listed above and the redox reactivity of nuclear fuels. The ultimate target is to create a model that describes the dissolution of spent fuel where different parameters can be considered. KTH will perform experimental studies on UO_2. Studies on spent nuclear fuel will be performed in collaboration with Studsvik.

Specific Role and profile of staff members involved in the Project

Prof. Mats Jonsson has more than 15 years of experience in radiation chemistry and radical chemistry (in particular kinetics and thermochemistry) using radiation chemical, photochemical and electrochemical techniques. Since 2000, Mats Jonsson has focused his interest on the dynamics and mechanisms of interfacial processes of relevance in nuclear technology (e.g. the elementary processes involved in radiation induced dissolution of spent nuclear fuel and reactor chemistry).

Martin Trummer is a new PhD student who will work in the project (both at KTH and Studsvik).

	No	Name	Acronym
Contractor	**24**	**Microbial Analytics Sweden AB**	**MICANS**

Description of the organization

Microbial Analytics Sweden AB (MICANS) is a company performing research and analyses. MICANS was founded 2005 by scientists at Göteborg University, Sweden. One very important mission of the company is to perform and deliver microbiological analyses of groundwater with ISO 9001 quality grade for the radioactive waste disposal organisations in Finland and Sweden. The company also takes on research missions related to radioactive waste disposal. MICANS is staffed with 9 persons; one professor, two PhD, and 5 B.Sc. plus one analytical biochemist. They cover expertise in biology, microbiology, molecular biology and chemistry.

MICANS has a very well equipped laboratory for the purpose of the tasks. Microelectrode systems for redox, sulphide, oxygen and pH from Unisense A/S are available. The lab also has two gas chromatographs, and one mass spectrometer, 2D-autoradiography system, fluorescent microscopes, anaerobic boxes and all items needed for cultivation of anaerobic microorganisms such as a gas mixing bench and anaerobic tube systems. Basic equipment for all types of microbiology is at hand. They have a complete set-up for DNA technology work such as polymerase chain reaction (PCR) amplifier, quantitative PCR, temporal gradient gel electrophoresis (TTGE), cloning, digital gel documentation system, laminar air flow box, and -85 C freezer. In the field, 450 m underground, MICANS has a set up of 6 independent, remotely controlled biofilm flow cell circulation systems that communicate under in situ pressure and chemistry with aquifers in the granitic rock of Äspö hard rock laboratory.

Role, responsibilities and activities within the Project

Within workpackage 3 Micans will focus of laboratory research on the effect from microbial processes of redox reactions. Many redox reactions in natural systems are in dis-equilibrium due to the activity of microorganisms. Micans will study systems under sterile and non-sterile conditions. A microbial process of particular importance for safety cases is the reduction of sulphate to sulphide, where microorganisms are a prerequisite for the process to occur at low and intemediat temperatures. This process will be investigated in both laboratory environments and in natural environments 450 m underground in the Äspö hard rock laboratory

Specific Role and profile of staff members involved in the Project

Professor Karsten Pedersen has over 20 years of experience working in the field of microbiology and radioactive waste disposal. He is regarded as a world leading scientist in the field of intra-terrestrial microbiology. He will lead the work.

Dr Lotta Hallbeck defended her thesis 1993 on iron oxidizing bacteria. She is responsible for modelling of microorganisms, gas and colloids in deep groundwater at the Swedish sites investigated for a possible future waste repository. She has also worked with the effect of sulphate reducing bacteria and acetogenic bacteria on the redox of laboratory systems. Dr Hallbeck will instruct the laboratory work.

Dr Sara Eriksson defended her thesis 2005 on petroleum degrading microorganisms in granitic, anaerobic groundwater. She is well trained for the purpose of investigating the effect from organic electron donors on redox systems. Dr Eriksson will work on the natural systems underground.

Lisa Karlsson (Analytical biochemist) is responsible for the company archive of microorganisms from the underground in Sweden and Finland. She will produce the media and the strain cultures needed.

	No	Name	Acronym
Contractor	**25**	**L.Q.C. s.l.u.**	**LQC**

Description of the organization

LQC is a small Spanish company dedicated since 1997 to the design and integration of optoelectronical and nuclear instrumentation: see www.chemitech.com for details on products and principals.

Of relevance to the Project is the experience (both technical and commercial) derived from being official representative of Ocean Optics in Spain. Ocean Optics is one of the few manufacturers of pH and oxygen sensors based on luminescent materials deposited on the tip of fiber optic probes.

Role, responsibilities and activities within the Project

From a resource point of view, this partner has a very limited project contribution. The role within the project is to make the great experience in designing analytical equipment available to the partners, both with respect to the great variety of different electrode concepts but especially with respect to the use of optical instrumentation. The partner will participate in setting up these analytical systems, participate in the intercompaison exercise and contribute to reporting of the overall outcome. With respect to the latter, the emphasis is on assessment of practical aspects in view of instrumentation.

The second half of the project, this partner will continue following the project developments and finally contribute to the final reporting.

Specific Role and profile of staff members involved in the Project

The owner and manager of LQC, Dr Caceci will be directly responsible for performing in the Project.

He holds a doctoral degree in chemistry, specialty photochemistry, and has some experience as a nuclear chemist in actinide thermodynamics: see details of CV and list of publications on www.isihighlycited.com.

Of relevance to the Project is also the experience of Dr Caceci in patent issues including performing patent searches, and writing and defending patent applications (notably with EPO, The Hague).

	No	Name	Acronym
Contractor	**26**	**Geopoint AB**	**GEOPOINT**

Description of the organization

Geopoint AB is a consultancy company specialized in hydrogeochemical modeling associated with spent nuclear fuel. Leading national and international research projects associated with hydrogeochemical modeling.

Role, responsibilities and activities within the Project

From a resource point of view, this partner has a very limited project contribution. The partner is coordinator for the hydro-geochemical investigations within the Swedish site investoigation program. The role of the partner is to extract main findings within the Swedish site investigation program for interpretation of results gained within the present project. This work is closely associated with the data analysis done by partner No. 17 (University Zaragoza). The practical activities thus consists of following the relevant achievements of the experimental program and document the joint analysis of these results with the findings in the real system.

Specific Role and profile of staff members involved in the Project

<u>Dr. Marcus Laaksoharju:</u> Is in charge of the SKB's ongoing hydrogechemical modeling and has 20 years of experiences in groundwater modeling and project management.

	No	Name	Acronym
Contractor	**27**	**Lomonosov Moscow State University**	**MSU**

Description of the organization

Chemistry department of Lomonosov Moscow State University is a state higher educational establishment that also has a license to conduct research work in different fields including nuclear chemistry and radiochemistry.

Role, responsibilities and activities within the Project

The role of the partner is to bring in real contaminated site information to the project, especially in view of assessing the applicability of the knowledge from more detailed and laboratory oriented investigations to the real situation.

The activities cover a broad range, including analysis of the broad set of available site data. Within the context of the project, a broad set of activities aimed at broadening the process understanding are carried out, including in close cooperation with partners with access and expertise in the different high-end analytical methods and approaches used.

Specific Role and profile of staff members involved in the Project

Dr. Stepan N. Kalmykov (Nuclear and Radiochemistry),

Prof. Boris F. Myasoedov (Nuclear and radiochemistry, consultant from Russian Academy of Sciences),

Dr. Olga N. Batuk (spectroscopic and microscopic methods),

Dr. Ramiz A. Aliev (accelerator based methods),

Dr. Elena V. Zakharova (Nuclear and radiochemistry, consultant from Russian Academy of Sciences),

Dr. Yuri A. Sapozhnikov (low-level counting techniques),

In this group a wide variety of skills and knowledge is represented including:

Actinide speciation at tracer and macroconcentrations using membrane extraction and spectroscopic methods, batch sorption tests, radioanalytical chemistry, actinide complexation, modeling.

	No	Name	Acronym
Contractor	**28**	**Svensk Kärnbrenslehantering AB**	**SKB**

Description of the organization

The Swedish Nuclear Fuel and Waste Management Co. is in charge of handling and disposing spent nuclear fuel and other radioactive waste. The company is envisaging to construct a final repository for nuclear fuel in granitic rock at about 500 m depth. To this aim several lines of research and demonstration experiments are pursued to demonstrate that reducing groundwater conditions prevail at depth and that they will continue to do so during future glacial cycles.

Role, responsibilities and activities within the Project

Coordinating project activities in Sweden. Incorporation of the projects results in the Swedish nuclear management programme

Specific Role and profile of staff members involved in the Project

Ass.Prof Kastriot Spahiu:

Chemist in charge of the spent fuel research program of SKB. Part-time associated professor at the department of nuclear chemistry of the Chalmers university of technology (Göteorg, Sweden).

Dr. Ignasi Puigdomenech:

Chemist in charge of the geochemistry program of SKB and of geochemical aspects of the safety assessment produced within the company.

	No	Name	Acronym
Contractor	**29**	**Agence national pour la gestion des déchets radioactifs**	**Andra**

Description of the organization

The Andra is in charge of handling and disposing of all French civilian radioactive waste. In accordance with the mandate given by a law passed in 2006, the company is continuing its comprehensive program of research, engineering feasibility demonstration projects, environmental impact studies… aimed at demonstrating the safety and feasibility of a final repository for high level, long lived radioactive waste constructed at about a 500 m depth in the Callovo-Oxfordien clayrock formation at some yet-to-be-identified position in the 'transposition zone' associated with the Bure URL. The objective of the current phase of the program is to provide a solid basis for a Request for authorization to construct a repository to be presented to the government in 2014. An important issue addressed in this phase of work will be to improve understanding of phenomena governing the redox conditions within, and near to, the waste storage cells, in particular those containing 'bituminous' waste packages (B2 cells).

Role, responsibilities and activities within the Project

Andra will be primarily involved in assuring that a clear and coherent linkage exists between Andra's knowledge concerning B2 waste cell design and evolution and project research activities carried out on Callovo-Oxfordian rock samples (and analog materials). Specifically, this will entail:

- presenting to pertinent research groups the essential elements of the knowledge base for B2 cell (concepts, APSS…), in particular as regards evolution of redox-determining components and redox-sensitive Rn source terms over time (within waste cell, in near field),
- providing consultancy to research teams in order to insure that the proposed experimental protocols are coherent with reasonable waste cell evolution scenarios. This is critical in order to insure the utility of project output for safety case use,
- contributing to the 'Report on basis for application of the redox processes in the Safety Case' identified as Delivrable for WP1, especially as regards the B2 waste cell example.
- Providing research groups with pertinent information generated by complementary research and modeling activities carried out in other Andra programs.
- Contribution, as member, to the 'End User Group'

Specific Role and profile of staff members involved in the Project

Dr.Scott Altmann:

Geochemist and transport physics specialist in charge of Andra's research group (Transfer Group) responsible for radionuclide speciation and transport from the waste cells to the biosphere.

Dr. Achim Albrecht:

Geochemist in charge of research activities addressing the redox conditions within and near waste cells (theme within Andra's geochemistry program). He is also responsible for modeling Rn transfer in the biosphere.

	No	Name	Acronym
Contractor	**30**	**Posiva Oy**	**POSIVA**

Description of the organization
Posiva Oy is a nuclear waste management company whose main task is the disposal of the spent uranium fuel of the Finnish nuclear power plants. Posiva is carrying out a research, development and technical design programme for disposal and later it will be in charge of constructing and operating the disposal facility in Finland. At present Posiva's main tasks are the characterisation of the bedrock in Olkiluoto and design and construction of the underground rock characterisation facility ONKALO. Posiva also offers consulting services in the field of nuclear waste management.

Posiva is owned jointly by Teollisuuden Voima Oy (60%) and Fortum Power and Heat Ltd. (40%), the two nuclear operators in Finland. Posiva started operations in the beginning of 1996 and has over 30 specialists engaged in research, development and technical design for an environmentally acceptable disposal solution. Posiva's programme brings together the resources of Finnish research institutes, universities and consulting and contracting companies.

Posiva's unique specialisation in the sector in Europe is related to site characterisation and selection, since there is a Decision in Principle of the site for the final disposal facility unlike in almost any country in the world. This has provided Posiva also with competence related to EIA (Environmental Impact Assessment) and public acceptance creation. Also ONKALO will offer a site for practical learning experiences related to repository characterisation and this will be utilised e.g. also in other international projects in the future.

The construction of ONKALO and subsequently the construction of the repository, will affect the surrounding rock mass and the groundwater flow system as well as the environment. In December 2003 a programme for monitoring at Olkiluoto during construction and operation of ONKALO was presented. A summary of the observations and measurements is reported annually for five disciplines: Rock Mechanics, Hydrogeochemistry, Hydrology and hydrogeology, Environment and Foreign Materials. Posiva need to update the monitoring programme to cover repository construction and operation phases before the license for construction of repository is applied.

Posiva has been a participant in several EU projects related to spent nuclear fuel management and related research since its foundation. The most recent projects are ESDRED, NF-PRO, FUNMIG, CARD, PAMINA, THERESA, OBRA, CETRAD and ENEN II.

Role, responsibilities and activities within the Project

Posiva will participate with their full resources in guiding and supporting activities within workpackage 1.

Specific Role and profile of staff members involved in the Project

Juhani Vira, D.Sc. in Engineering, Vice President for Research at Posiva. Key qualifications include thirty years of experience with RTD related to the back-end of the nuclear fuel cycle, decommissioning and nuclear waste management.

Anne Lehtinen, M.Sc. in Geology, coordinator of Posiva's hydrogeochemical investigations. Key qualifications include management of different levels of projects related to Posiva´s research programme, expertise in Posiva's site investigations (especially in hydrogeochemistry).

	No	Name	Acronym
Contractor	**31**	**University of Loughborough**	**ULOUGH**

Description of the organization

Loughborough University is one of the top Universities in UK. It has a high profile and an enviable reputation for outstanding teaching and research. The Radiochemistry Section of the Department of Chemistry has a license to conduct research work in radiochemistry, and has been contributing to European Projects for more than 20 years.

Role, responsibilities and activities within the Project

Loughborough University will participate in WP 4, 'Redox Reactions of Radionuclides'. Specifically the effect of anthropogenic organics present in various types of nuclear waste in UK, on the redox behaviour of technetium will be studied. In the intermediate level waste, expected to be disposed of in a deep geological repository in the UK, there willl be considerable quantities of cellulose, which will degrade to form complexing ligands. Also present in the waste will be decontamination agents such as EDTA. These organics may affect the redox behaviour of Tc in a potential repository, and so their effects need to be understood and, if possible, quantified. Within the overall responsibility of contributing to the overall planning of the Project, 1 person month is also used for WP1.

Specific Role and profile of staff members involved in the Project

Dr Nick Evans is a radiochemist who is experienced in the behaviour of organics in the near-field of a cementitious repository, and the redox behaviour of Tc.

Tara Lewis, who has just completed her PhD at Loughborough, is another experienced radiochemist, particularly in the area of modeling the effects of orgaincs on radionuclide migration.

Ricky Hallam (MChem) is a new PhD student, who has been working with radionuclides at Loughborough for 3 years.

	No	Name	Acronym
Contractor	**32**	**University of Manchester**	**UMANCH**

Description of the organization

The Centre for Radiochemistry Research within the School of Chemistry at the University of Manchester is dedicated to the research of the chemistry of the radioactive elements. The Centre has well equipped and modern radiochemistry labs that allow it to handle the actinides and fission products safely. Equipment and facilities within the Centre include radiometric counting techniques, controlled atmosphere boxes, various spectroscopic techniques (UV/vis, NMR, Raman etc.) and standard chemical analysis (ICP-AES/MS, CHNO etc.).

The Centre and its staff have participated in previous European Union projects and activities, including HUMICS, CARESS, HUPA, FUNMIG and ACTINET.

Role, responsibilities and activities within the Project

The main contribution of the University of Manchester will be to Work Package 4.

Batch experiments will be used to study the partition of redox sensitive radionuclides, including Pu, between the solid and solution phase in systems containing mineral phases (quartz-sand and iron oxides, including magnetite) and NOM. The behaviour will be studied as a function of solution conditions (Ionic strength, Eh and ligand concentration, etc.). The result of changing Eh during the experiment, for example by the introduction of air, will also be studied as will the effect of the initial oxidation state of the radionuclide. The order of addition of the ternary system components will be addressed, and so separate experiments will study the behaviours when pre-equilibrated radionuclide and NOM are introduced to the mineral phase and when radionuclide and mineral phase are allowed to equilibrate before NOM is introduced. In all cases, the kinetics of the reactions will be studied, since slow reactions are expected. The data will be interpreted using a kinetic speciation model.

Specific Role and profile of staff members involved in the Project

Dr. Nick Bryan is a lecturer within the School of Chemistry at the university of Manchester. He was task leader in mathematical modelling and radiological performance assessment (RPA) in the 4th framework HUMICS project and work package leader in mathematical modelling and RPA in the 5th framework HUPA project. He has experience of radiochemical techniques, the interactions of radionuclides with humic substances/NOM, reaction kinetics, kinetic and equilibrium speciation modelling , coupled chemical transport modelling and general colloid chemistry

Mr Nigel Li is a postgraduate student under the supervision of Nick Bryan.