

ReCosy News

Redox Phenomena Controlling Systems



Newsletter, March 2012



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Introducing ReCosy

The Collaborative Project Redox Phenomena Controlling Systems (RECOsY) started in April 2008 and has extended over 4 years. It fell within the EURATOM (European Atomic Energy Community) program and was implemented within the European Commission's 7th Framework Program. To this aim, the project set up a consortium of 32 Contractors and 6 Associated Groups. The consortium included key European Research Institutes, Universities, National Waste Management Agencies and SMEs (small and medium enterprises) from 13 EURATOM signatory states, Russia, Japan, Korea, USA and one European Joint Research Centre.

The project was initiated to answer the questions still not resolved within the redox phenomena controlling systems and in order to improve the understanding of these processes and to further contribute to acceptance of the Safety Case. 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 have been 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 have been tackled.

The key objectives of ReCosy have been to provide (i) a better determination of the system redox conditions, (ii) understanding of relevant redox processes, and (iii) to evaluate the impact of these processes on the disposal Safety Case. For this purpose, scientific and technical objectives have covered the understanding of redox buffer capacities, redox kinetics and the long-term redox evolution and the relevance of the redox impact on the radionuclide transport.

Coordinator: Marcus Altmaier (Karlsruhe Institute of Technology).

Scientific-Technical Secretariat: Lara Duro and Vanessa Montoya (Amphos 21)

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7th Semi-Annual Newsletter

The main purpose of the Semi-Annual Newsletters is to inform the broader community on the progress of the research carried out within the RECOsY project. The present Newsletter gives a brief overview of the project activities and progress during the project months 35-48 (November 2011- March 2012). It is available at the public project web page (www.ReCosy.eu). It is also distributed by e-mail to a list of recipients. It is furthermore encouraged to use printouts at different events such as workshops, meetings and conferences in order to inform potentially interested persons.

This Semi-Annual Newsletter is less detailed than the 4th Annual Project Activity and Management Report, used for thorough information of project partners, the Commission and project reviewers



EDITORIAL

Dear Reader,

I have the pleasure to present the seventh issue of the RECOSY Newsletter. With this Newsletter, we would like to inform the wider audience on RECOSY's activities and achievements. The Coordinator of the project is the Karlsruhe Institute of Technology (KIT), Germany. The Coordination Team (CT) consists of two organizations, namely KIT-INE and Amphos 21. In addition to work program planning and project management, the CT is also implementing activities on training and education, and management and dissemination of knowledge. The Executive Committee (ExCom) consists of the WP leaders, ensuring adequate operation of the overall project.

The End-User Consultancy Group (EUCG) is established with three representatives from Waste Management Organizations (ANDRA, SKB, and ENRESA) and three organizations with National Regulatory Functions (GRS, HSK and SWRI). It advises 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 project finished on March 2012 and many good achievements have been obtained. A detailed explanation of the results obtained within the project was presented at the Final Workshop in Karlsruhe, Germany, 23rd-26th January 2012. The key objectives of ReCosy have been to provide an improved interpretation of redox potential in all relevant host-rock systems to be used within European Safety Cases. In this issue of the RECOSY Newsletter, we will inform you on major research topics and highlights from the project. Key activities on a project level since the last published Newsletter have been the Final Workshop finalized in January 2012.

I hope you will enjoy reading

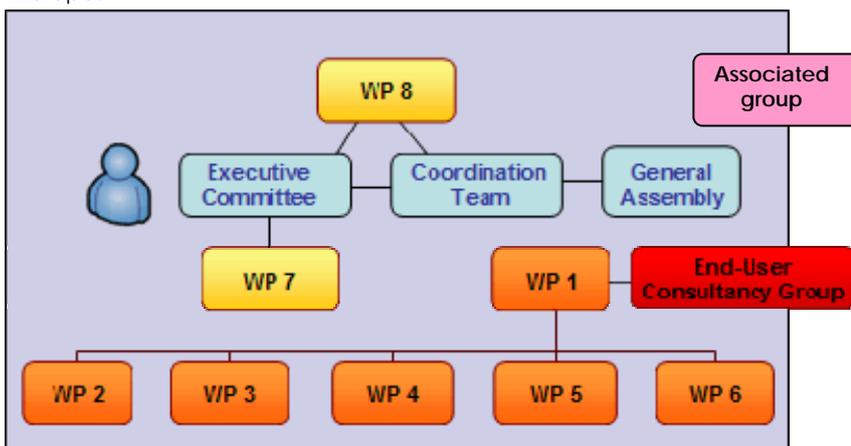
Mireia Grivé (info@recosy.eu)

Knowledge Management and Training RECOSY- Officer

*The experimental
program of the project
finalized end of
October, 2011.*

Recosy's main areas of research

The scientific-technical work program was structured along six Research Technological Development workpackages (WP1-6). They covered near-field and far-field aspects as well as relevant host-rocks considered in Europe.



RECOSY organization

WP 1 dealt with documentation on the overall project outcome for its implementation in the Safety Case. WP2 focused on development of redox determination methods. WP3 focused on redox response of defined and near-natural systems. WP4 studied the redox reactions of radionuclides. WP5 focused on redox processes in radionuclide transport and WP6 dealt with the redox reactions affecting the spent fuel source-term. Specific workpackages on knowledge management, education and training (WP7) and administrative management issues (WP8) were also included in the project.

RESEARCH

Research on Development of redox determination methods (WP2)

The objective of WP2 was the development and testing of redox determination methods using different type of electrodes as well as optodes (optical sensors) in order to provide a broad and solid scientific-technical basis for redox determination.

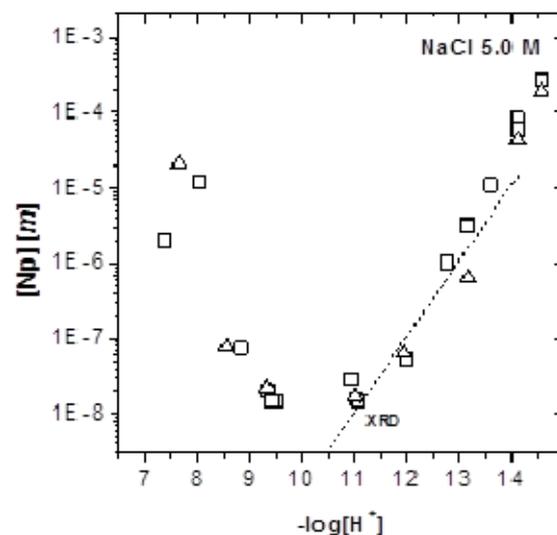
In this context the different participants of this workpackage were working on different issues:

KIT-INE conducted solubility experiments with Np(VI) in dilute to concentrated NaCl solutions ($0.1 \text{ M} \leq I \leq 5.0 \text{ M}$) to assess the thermodynamic properties of the aqueous species and solid compounds forming under alkaline conditions. The solubility controlling solid phases were characterized by XRD, EXAFS, chemical analysis and SEM-EDS which indicated the prevalence of neptunate-like structure. In all the systems studied ($0.1 \text{ M} \leq I \leq 5.0 \text{ M}$), the solubility curve could be divided into three different regions: a: $\sim 7 \leq -\log[\text{H}^+] \leq \sim 9.5$, showing a steep decrease in the Np solubility with a slope between -2 and -3 ; b: $\sim 9.5 \leq -\log[\text{H}^+] \leq \sim 11$, with a nearly pH-independent [Np] and c: $\sim 11 \leq -\log[\text{H}^+] \leq \sim 13.5$, showing an increase in the solubility with a well-defined slope of $+1$.

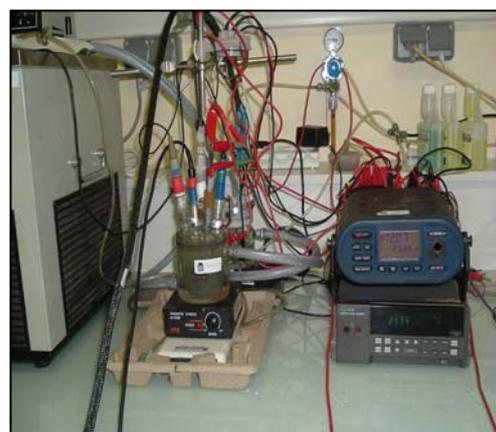
ARMINES determined low level concentrations of Se(-II) species in order to use the speciation of Se(-II) as a probe for a direct redox state determination in hyperalkaline solution representative of cement matrices which could be used for conditioning radwastes. The main results have been the development for the first time of a specific analytical protocol aiming at quantifying the monomer species HSe^- by UV spectrometry at a sub millimolar level (conductimetry cell detector) and at a sub micromolar level by coupling a speciation technique (HPAEC) with a high sensitive elemental technique (ICP-MS). Unfortunately, this protocol was not efficient enough for a direct quantitative analysis of the other reduced selenium species (monomer Se^{2-} and polymer species). Despite many analytical efforts, only partial separations were obtained because of the too close interaction properties developed by those species towards the anion exchange columns which are commercially available.

In the fourth project year **GRS** continued developing a thermodynamic model for iron, explicitly considering Fe(III) complex species. Therefore, pH titrations with saline solutions (NaCl , MgCl_2 , and CaCl_2) including Fe(II) and Fe(III) were carried out at 25°C . The redox potential and UV spectra were recorded at any titration step.

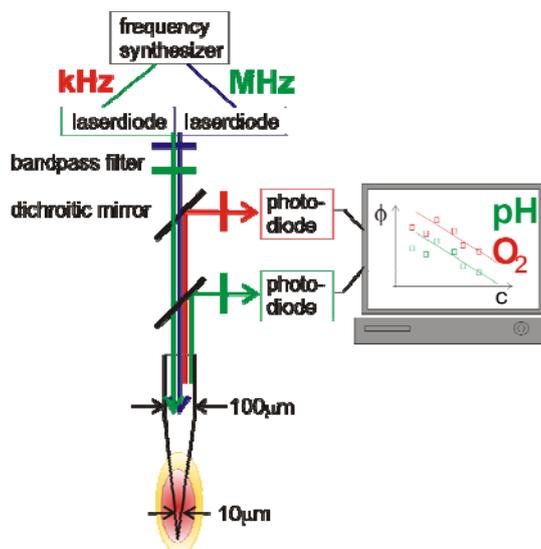
Within the last year **UPPC** continued to work on the development and improvement of multiparameter fiber-optical chemical sensing (FOCS). Especially the integration of optodes for the determination of oxygen concentration and of pH was pushed forward. The research was focused on the evaluation and integration of decay-time based optical sensing scheme, because it offered intrinsic advantages over intensity-based approaches for applications under real-world conditions.



Np(VI) solubility data determined for 5.0 M NaCl solution



Hand-made pyrite electrode was used in different experiments. Photography from BRGM



Scheme of multiparameter fiber-optical chemical sensing (4th ReCoty Annual Workshop)

The main activities of **CNRS/LCPME** during the last project year consisted in: (i) complementary tests performed in the laboratory with a series of commercial instruments usually employed for the measurement of Eh, (ii) researches for fabricating ultramicroelectrodes compatible with concentrated brines and (iii) the presentation of certain results in meetings and workshops.

HZDR used the analytical data of the groundwater sample from underground rock characterization facility, the ONKALO tunnel in Finland, for the calculation of the predominance fields of different uranium species in the pH-Eh diagram for the U-S-O-H-C system at 15°C by using the geochemical speciation code "Geochemist's Workbench"

Finally, contribution of **LQC** was essentially advisory to various other partners on issues in which the principal investigator in LQC has direct experience.

WP leader: Dr. Michael Kumke (University of Postdam, Physical Chemistry)

Research on Redox response of defined and near-natural systems (WP3)

The objective of WP3 was to quantify and develop process understanding for redox buffer capacity and kinetics of response to redox perturbations of defined and near-natural systems. In the last year of the project, the WP3 work have been focused on (i) Field data, (ii) field samples, (iii) microbiology, (iv) sorption experiments, (v) redox experiments and (vi) conceptual modelling. Different participants have worked on:

KIT-INE has examined the interaction of U(VI) with synthetic nanoparticulate magnetite (fresh and partly oxidized) and maghemite nanoparticles under anoxic conditions and exclusion of CO₂ as function of pH, contact time and total U concentration. Short term kinetic batch experiments for four different pH values have been conducted. Moreover, classical batch pH sorption edges have been prepared for two different uranium concentrations for a contact time of 550 d. Spectroscopic techniques (XPS, XAS) were applied to probe for the presence and amount of reduced U on the magnetite surface. Thermodynamic calculations based on the experimentally determined redox potentials corroborate the spectroscopic findings. Overall, the results reflect the importance of structural bound Fe(II) in magnetite as redox agent for U.

II-HAS compared the results of Mössbauer measurements to monitor the changes in Fe²⁺/Fe³⁺ ratios in clay minerals having exposed to natural or artificial changes in redox conditions. The effects of changes in the natural conditions were clearly reflected, whereas effects originating from changes by artificial treatments cannot be detected (exception: treatment with sodium dithionite).

BRGM investigated the mechanisms of pyrite reduction by hydrogen in NaCl 0.1 M at 90 °C and 25°C using electrochemical techniques and the analysis of solutions and interfaces. Other work performed by BRGM was devoted to model the di-octahedral smectites CEC structural variation versus iron level. Another important work was devoted to investigate the iron electrochemical properties in layered silicates using massive mica electrodes.



Experiments of consumption of dissolved oxygen by mineral as a function of time (Domènech et al., 2011, 3rd ReCoty Annual Workshop)

CTM studied the redox behaviour and response to external perturbation for systems of interest in the near-field. Two series of experiments were conducted adding U(VI) once the pyrrhotite has been equilibrated with 0.01 M NaClO₄ under N₂ atmosphere. In one series, equilibrium pH (around 5.3) was kept while in the second series pH was adjusted with NaOH at around 7.8. Spikes of U(VI) at three different initial concentrations were performed at 2·10⁻⁷, 6·10⁻⁷ and 2·10⁻⁶ M. pH and redox potential were monitored with combined pH-, Au- and Pt-electrodes. Changes in chemical aqueous composition were determined through analysis of Fe(II), Fe_{total}, U_{total}, U(VI), SO₄²⁻ and S₂O₃²⁻ with time, by means of UV-Vis, ICP-MS, IC and TRLFS. Solid phase analysis by SEM-EDX were performed.

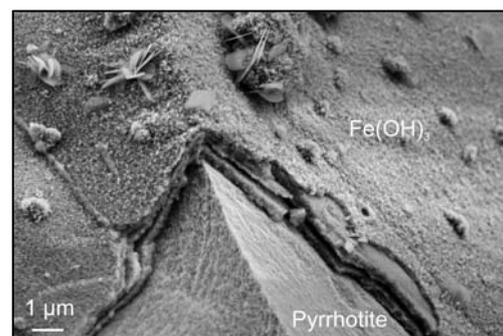
AMPHOS carried out experiments on the dissolution kinetics of natural pyrrhotite (Fe_{1-x}S) and pyrite (FeS₂) under imposed redox conditions at 25°C and 1 bar. Measured data indicated that in both cases, Fe(II) released from kinetic dissolution of Fe-bearing sulphides was kinetically oxidized to Fe(III), precipitating as Fe(III)-oxyhydroxides. While the pH of the system was controlled by the extent of sulphide minerals oxidation, the Eh was controlled by the redox pair Fe(II)/Fe(III)-oxyhydroxides. Pyrrhotite dissolution was faster than that of pyrite but generated less acidity. Consequently, the achieved redox value was more reducing. Experimental data showed that oxidation rates of both minerals was within ± 1 order of magnitude expressed in mol O₂·g⁻¹·s⁻¹. This equivalence can be used to model pyrrhotite behavior for which an oxidation kinetic law is not still well defined.

GEOPOINT delivered data to **UNIZAR** for evaluation and cooperation concerning the Swedish site-specific data. **UNIZAR** developed an integrated methodology for the redox characterisation of crystalline systems and applied it to the study of the Laxemar-Simpevarp area (Sweden). Thermodynamic calculations based on partial equilibrium assumptions were performed in order to clarify the main processes and the role of the microbial activity in the redox features and evolution of the groundwaters. Evaluation of the uncertainties associated with redox data and calculations were included in the studies.

CNRS studied selenium reduction by synthetic nano-sized pyrite/greigite mixture by batch reactor experiments upon adding selenite or selenate to the nano-sized pyrite-greigite suspension at different pH values and with or without the addition of extra Fe²⁺. Both XANES and EXAFS spectroscopy revealed, for the first time, the formation of ferroselite (FeSe₂), the thermodynamically most stable species, as the predominant reaction product along with elemental Se. **CNRS** also studied the interactions of fulvic acids-like compounds with iodide ion in alkaline media using optical spectrometric techniques. Results obtained from UV-visible and fluorescence measurements have indicated that iodide anion weakly interacts with synthetic fulvic acid-like compounds in the 4-12 pH range.

MICANS investigated the redox buffering capacity of microbial ecosystems with high concentrations of methane and hydrogen.

WP leader: Dr. Laurent Charlet (Centre National de la Recherche Scientifique)



Fe(OH)₃ layers precipitated on pyrrhotite surface (Arcos et al., submitted)



In situ circulations with flow cells for biofilm formation on crushed rock, with groundwater from -450 m (Photography from MICANS)

Research on redox reactions of radionuclides (WP4)



In the nuclear waste repository research tunnel ONKALO (Finland) massive biofilms are growing in a fracture zone. (Krawczyk-Bärsch et al. 2011, 3rd ReCosy Annual Workshop)

Partition of radionuclides between solid and solution phases in humic/quartz ternary was studied

The goal of the activities within this workpackage was to provide fundamental process understanding of the redox behaviour of radionuclides, including the question of equilibrium / disequilibrium with the system redox conditions. The activities within this workpackage were divided in four main topics: (1) Interactions of radionuclides with pyrite, (2) Interactions of radionuclides with far-field solids, (3) Redox processes under hyperalkaline conditions, (4) Redox behaviour under microbial processes.

CNRS performed voltammetric measurements using massive rotating pyrite electrodes and pyrite microparticles were conditioned with soluble iodine and selenium species. After conditioning, the pyrite microparticles were characterized electrochemically and using XPS, Raman spectrometry. Moreover, the oxidation of pyrite by oxygen was monitored dielectrically.

KIT-INE performed batch-type sorption experiments with Opalinus clay and Callovo-Oxfordian argillite on Tc(VII), Np(V) and Pu(V). The batch experiments were performed at pH 7.6 for OPA and pH 7.2 for COx under argon atmosphere and room temperature. Redox speciation was investigated by X-ray absorption fine structure, UV-Vis/NIR absorption, X-ray photoelectron spectroscopy, capillary electrophoresis and TTA extraction. Modeling has been done with Geochemists Workbench for solution species and with the program ECOSAT by applying a surface complexation model for the sorption species.

CTH investigated the U(IV)/U(VI) and Np(IV)/Np(V) redox state in Äspö synthetic groundwater, with and without Fe(II)/Fe(III) redox buffering and, with and without Äspö rock material present, using the solvent extraction redox state separation method developed within the project.

UMANCH studied the partition of Pu(IV, V and VI) between solid and solution phase in humic/quartz sand ternary systems. A simple mathematical kinetic model was developed to interpret the behaviour of both Pu ions and humic acid. The model performs well in predicting the partition of the humic and that of the metal ions in the systems that show simpler ternary behaviour. Moreover, it was also augmented the database of humic-radionuclide binding constants.

During the last year **AMPHOS** compiled and used the experimental data obtained during the previous years to obtain information on the dissolution mechanism of UO₂(am) under anoxic/reducing conditions. Experimental data consisted on Eh, pH and uranium concentration measured under anoxic conditions using different H₂(g) pressured and set up designs, together with experiments performed using dithionite as a reducing agent. The dissolution mechanism was envisaged through thermodynamic modeling and comparing experimental data from the literature obtained under similar conditions as the performed solubility experiments.

PSI carried out Np(IV) and Np(VI) sorption tests in alkaline solutions with different compositions and pH. The tests indicated that in the case of Np(IV), and Np(V), sorption is independent of C:S ratio and pH. In the case of Np(VI), sorption strongly decreases with rising pH..

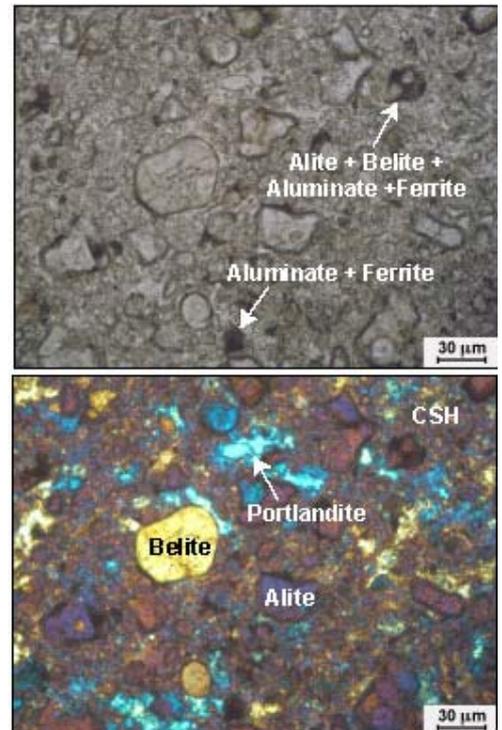
Np(IV/V/VI) sorption tests were carried out on TiO₂ at different pH values between 10 and 14. Rd values for Np(IV) were found to be independent of pH. Rd values for Np(V/VI) were found to decrease with rising pH.

Sorption tests were carried out on fresh and degraded hardened cement paste. In both cases high Rd values (>1E5 L/kg) Np(IV) were measured.

FTMC carried out batch sorption experiments with ^{243}Am onto wustite/magnetite, hematite and soil. The sorption of this radionuclide onto wustite/magnetite showed a negative linear relationship with pH while its adsorption onto hematite increased with pH. This institute was also focused on the study of $^{99}\text{Tc(VII)}$ in the system iron-bearing mineral-Na brine-microorganism under aerobic conditions. Differences in Tc (VII) sorption processes onto hematite due to microbial activity of microorganisms isolated from the groundwater borehole were observed as well. Presence of microorganisms in the tested system induced Tc (VII) sorption onto hematite up to 80-85%.

HZDR focused their activities on biologically mediated redox processes of biofilms growing in the nuclear waste repository research tunnel ONKALO (Finland) before and after the addition of uranium to the fracture water in an experimental setup. The results of the microsensors clearly demonstrate that the geochemistry inside a biofilm is totally different compared to the surrounding water/environment.

WP leader: Dr. Jan Tits (Paul Scherrer Institute)



*Sulfate-resisting cement: CEM I 52.5 N HTS
(Lothenbach and Wieland, C&CR 2006)*

Research on Redox processes in radionuclide transport (WP5)

The goal of the activities within this work package was to study the behaviour of redox-active radionuclides Tc, Np, U, Pu, I and Se with the aim to determine the redox impact on their transport through crystalline rocks, clay rocks and contaminated systems.

KIT-INE continued studies on radionuclide desorption kinetics from FEBEX bentonite colloids and subsequent sorption onto fracture filling material. Results show that tri- and tetravalent radionuclides are clearly associated in contrast to Tc(VII), U(VI) and Np(V). U(VI) and Tc(VII) showed no interaction neither to colloids nor to the fracture filling materials. In the case of Np(V), a decrease in concentration was observed and explained by slow reduction to Np(IV) and subsequent sorption to mineral surfaces in accordance with evolution of pe/pH and/or by a slow sorption onto the surface fracture filling material.

CEA finalized their experimental work by testing the effect of mineralogical heterogeneity on iodide retardation during diffusion in Callovo-Oxfordian clstones. The retardation of iodine was still observed for the lowest concentration ($<10^{-4}\text{M}$) and a diffusive behaviour was underlined.



*Diffusion and batch experiments were performed in a N₂/CO₂ glove-box
(Photography from CEA)*

UH continued development of chemical extraction method for U oxidation states in rock and sediment samples. Redox effects of the sample material itself were particularly studied. These redox effects represent certain complexities while analysing true U valent form composition in the original solid material. Possible impact of radiation-induced effects in the sample material was studied in an annealing experiment where sample was heated at different temperatures at the range of 200-1000°C. Most of the results obtained are validated by XANES spectroscopy.

II-HAS studied in collaboration with UH the redox state of the sorbed uranium component. U oxidation states were determined using a dissolution technique where sorbed U was extracted in anoxic 4.5 M HCl extraction. U(VI) was found to be the predominant species, which points out that the sorption process is not linked to simultaneous redox processes.

UCYPRUS focused their work on data evaluation obtained during project.

MSU investigated the actinide speciation, mainly U and Pu, in organic-rich bottom sediment from the Mayak site by the combination of alpha track analysis, SEM-EDX and various synchrotron based methods with microfocusing beam, i.e. μ -XAFS, μ -XRF.

WP leader: Dr. Juhani Suksi (University of Helsinki)

Research on Redox reactions affecting the spent fuel source-term (WP6)

A set of investigations has been conducted with the aim of getting better insight into redox processes determining spent fuel and iron canister corrosion.

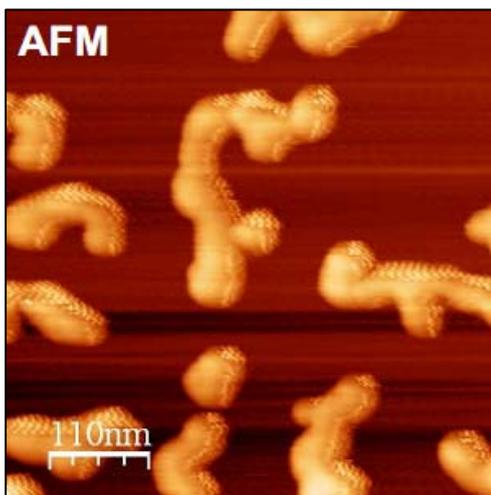
The last year of the project has been devoted mainly to finalise the experiments and make the final evaluation of the results so far obtained. The outcome of WP6 has been very promising, as briefly summarised below.

Studies on the behaviour of spent fuel in the presence of corroding iron showed that uranium oxide film on the steel surface was reduced to UO₂ and this UO₂ layer was in contact with steel stabilized even in the case of pre-oxidation (**ITU**).

Studies on thin films as Spent Fuel Models for Surface Corrosion, the inhibition of surface corrosion by molecular hydrogen was studied, and a particular focus on the role of the ϵ -particles to the activation of hydrogen was made. Different experiments were made, including thin films deposition studies, electrochemical investigations or gas adsorption experiments (**Studsвик**).

Redox reactivity of doped UO_{2(s)}. The effects of catalytic formation of hydroxyl radicals on the doped UO₂ materials has been studied by means of dissolution yield, the rate of H₂O₂ consumption, hydroxyl radical formation, reactivity of different oxidants towards doped UO₂ etc. (**KTH**)

Reductive trapping of Actinides in Container Corrosion Products during Spent Fuel Corrosion. The capacity of corroded canister iron phases to incorporate radionuclides has been investigated. The presence of CO₂ in the gas phase has been explained by the carbon/carbonate content of the magnetite, reacting with oxygen released during magnetite dissolution. Results have shown that a hematite layer is present onto the surfaces and therefore, the trapping of the actinides cannot be attributed to the reductive process alone, but sorption reactions may influence the retention (**INE**).



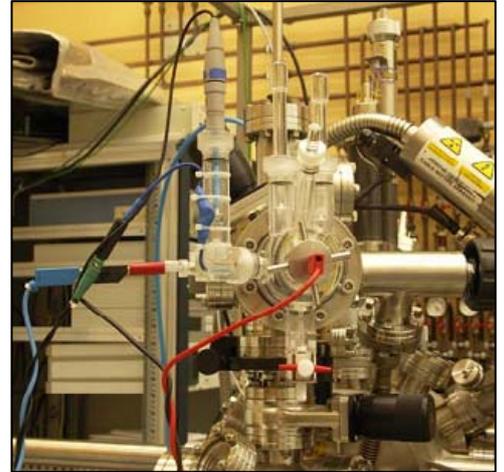
*Magnetite characterisation
(PhD thesis Florian Huber)*

Corrosion of spent fuel in presence of H₂. The aim of this work was to study the influence of dissolved H₂ on corrosion of the high burn-up rim fraction of spent nuclear fuel. The rim fraction was selected as it contains a higher concentration of Pu as well as fission products and the first water will contact in case of water penetration. The variation of redox sensitive natural elements, present in the leachate as contaminants from the autoclave setup, were studied in order to confirm the redox state of redox sensitive actinides and fission products. Out of the inactive elements studied, only Ti and Fe seem to be able to influence the redox conditions (ITU, INE).

On the redox chemistry at the NF, the influences of iron canister material and hydrogen. The main study in this case was focused on Pu reductive immobilization by iron canister material, the mechanisms of the hydrogen influence on radionuclide migration by D/H isotope exchange method

Studies on the effect of iron corrosion on redox potential concluded that the firmly adhering corrosion product layers formed on the carbon steel surface, containing a high amount of oxygen and carbon have an important impact on the development of geochemical conditions in a repository, protecting the carbon steel against fast corrosion (Studsвик).

WP leader: Dr. Detlef Wegen (Joint Research Centre- Institute for Transuranium elements)



Experiments with new developed electrochemical cell for thin film applications (Photography from JRC-ITU)

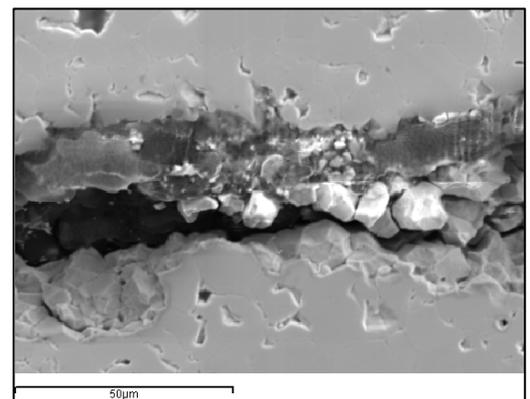
A specific session on the Use of Redox Processes in the Safety Case was organised during the last Annual Workshop

HARMONIZATION OF WORK PROGRAM AND IMPLICATIONS OF REDOX FOR THE SAFETY CASE (WP1)

The overall objectives of this workpackage were related to provide structures and regular up-dating of the overall project outcome. One of the objectives of this workpackage is the harmonization of the work program and to show the relevance of the redox processes in the Safety Case.

Due to the relevance that the redox processes have in the description of the Safety Case and to the attention that they received in the Performance Assessment Exercises, it was agreed that a paper will be prepared and submitted to a Scientific Journal at the end of the project showing the implications of the work within Recosy in the safety case.

WP leader: Dr. Lara Duro (Amphos 21)



Fe(III) precipitation in cracks. Cui et al. 2011, 3rd ReCosy Annual Workshop

KNOWLEDGE MANAGEMENT AND TRAINING (WP7)

The WP7 addresses the internal and external training as well as knowledge management for the RECOZY project.

A public web site was established within the project (www.recozy.eu). At this site, information about the project and the project activities are made available to the broad community. A project internal Intranet site were established where non-public documents and reports are kept.

The generic poster has been presented at different occasions, including Euradwaste'08 (Luxembourg), Migration'09 (Washington, USA), Migration 11 (Beijing, China), ICEM 2009 (Liverpool, UK), ICEM 2011 (Reims, France).

The Annual Project Workshops are important elements in the documentation and dissemination of the project outcome. The Annual Project Workshop Proceedings are comprehensive public reports with the key scientific-technical outcome. Proceedings with the scientific-technical outcome of the first project year are published as report FZKA 7466, the second annual proceedings as KIT-SR 7557 report, the third as KIT-SR 7603 and the final proceedings are currently in print as KIT-SR 7626.

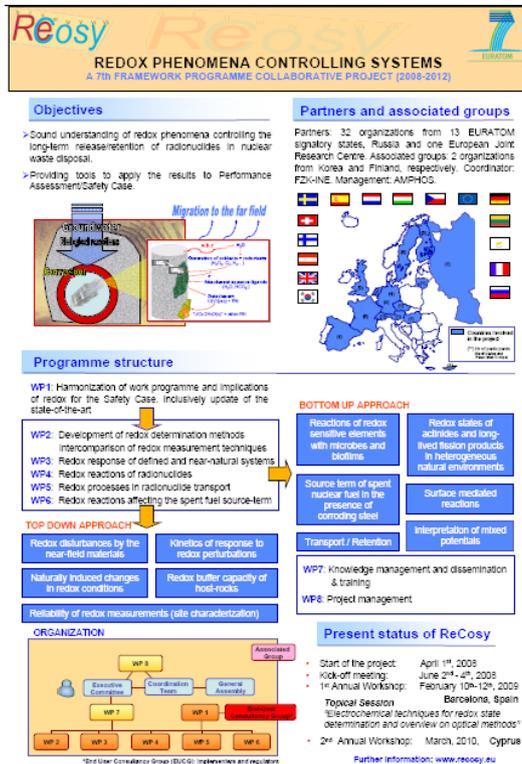
Dissemination of more detailed results are done through peer reviewed scientific journal papers, books, reports, proceedings of various conferences and workshops, PhD thesis, etc. Presentations at different occasions of detailed project work meetings and results or the overall project is also a key contributor to dissemination. The dissemination of the project is being very effective (i.e. 24 scientific journal papers, 8 technical reports or book chapters, oral presentations and posters at 35 international occasions in Europe, Japan, USA, Canada and Russia).

There are 28 PhD students and young researchers involved in the project, and 15 post-docs. TRAINING resources included in RECOZY are used for training-on-the-job of young researchers by project internal mobility measures. The measures are aiming for a maximum period of about three months where travel costs for the stay at another organization (or organizations) are covered. Partners or Associated groups applied through the Coordination Team for such training measures.

Six training mobility measures were agreed upon and were running until the end of experimental work and currently summarized.

Other network used as important training tool for the ReCoso partners is the project ACTINET I3 (www.actinet-i3.eu)

WP leader: Dr. Mireia Grivé (Amphos 21)



6 training mobility measures have been agreed upon and are presently under implementation



EVENTS

RECOSY 4th and Final Workshop (23rd-26th January 2012, Karlsruhe, Germany)

The 4th and Final Project Workshop was held in Karlsruhe (Germany) (23rd to 26th January 2012) hosted by KIT-INE. In association with this event, meetings of the different project consortium bodies (Executive Committee, General Assembly, End-User Consultancy Group) also took place.

There were 60 attendees at the workshop, representing Beneficiaries/Contractors, Associated Groups, the End-User Consultancy Group, and project external organizations. The workshop was organized in four days of oral presentations on results obtained within the project, two poster sessions, and a topical session on integration of redox processes in the Safety Case.

The main purpose of the Workshop was to communicate and discuss the scientific-technical outcome of the third project year in the form of oral presentations around the project, two poster sessions, and the topical session. A total of 31 presentations of the project and 20 posters were included in the programme.

During the workshop a specific Topical Session focused on "The integration of the Redox Processes in the Safety case", was organized by KIT-INE and AMPHOS where 4 presentations on this specific topic were given. The presentations described how Redox Processes have been considered in the French, Swedish and American Safety Cases, One additional presentation, on the geochemical implications of the Fukushima accident was given by T. Sasaki, from the Kyoto University. The scientific-technical outcome of the fourth project year is documented, reviewed by the EUCG and disseminated in the form of workshop proceedings (KIT report, KIT-SR 7626).



RECOSY 4th Annual Workshop (23rd to 26th January 2012), Akademie Hotel, hosted by KIT-INE

*Final workshop
proceedings are
available as KIT report*



RECOSY Final Workshop (23rd-26th January 2012), Karlsruhe (Germany)

RECOZY PARTICIPANTS

