DEVELOPMENT OF C-STEEL CANISTER AND COMPACTED CA-MG BENTONITE BOUNDARY BASED ON EXPERIMENTAL APPROACH

NUCLEAR RESEARCH INSTITUTE

SÚRAO SPRÁVA ÚLOŽIŠŤ RADIOAKTIVNÍCH ODPADŮ

eurad European Joint Programme on Radioactive Waste Management

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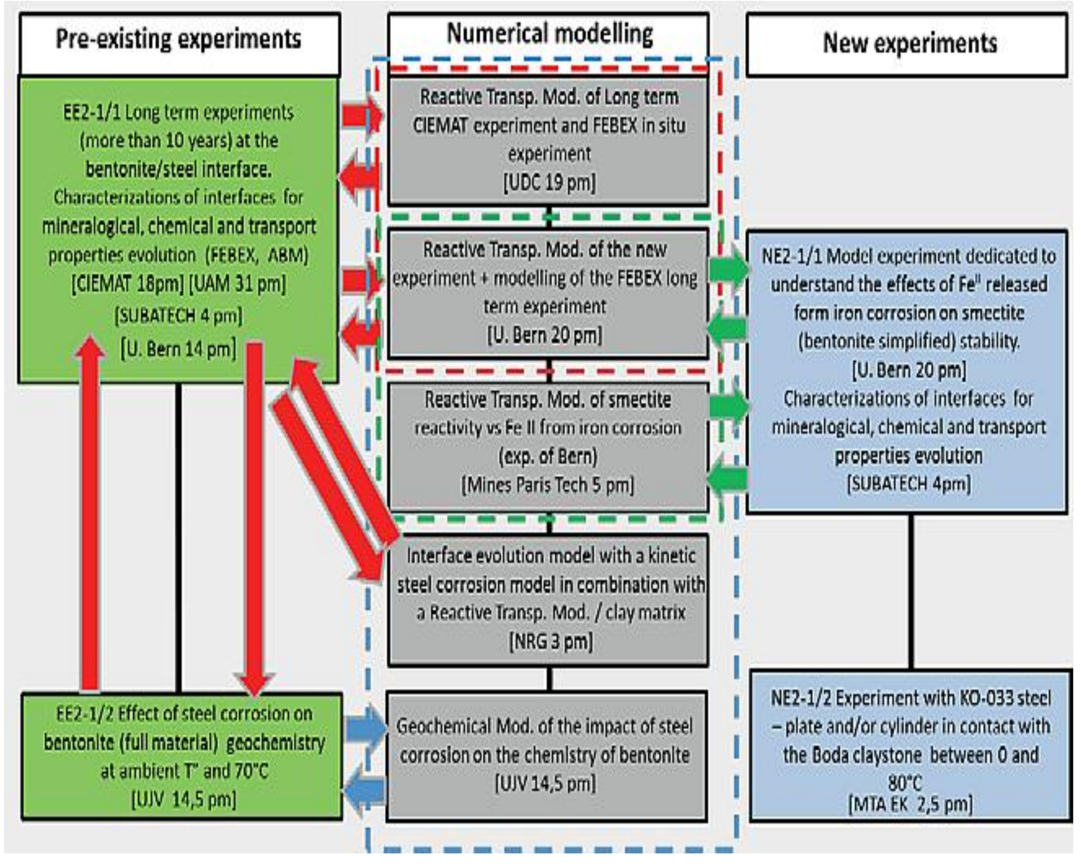
Introduction

The main objective of the ACED WP (Assessment of the Chemical Evolution of ILW and HLW Disposal Cells) of the EURAD EJP project (2019 - 2024) is to perfect the methodologies employed for obtaining a multidimensional quantitative representation of chemical interactions at the disposal system scale based on existing and new experimental data and to improve the description of the most important processes that describe the interaction between the waste disposal package (WDP) materials and the engineered barriers.



ÚJV involvement (Task 2.2)

- ❑ Summarisation and processing of the information available on corrosion experiments performed to date
- ❑ The application of a reactive transport model to corrosion experiments, studying development of the carbon steel - Ca-Mg bentonite systems at various temperatures

Laboratory corrosion testing of WDP materials (the ÚOS experiment)

- ❑ Laboratory experiments
- ❑ Anaerobic conditions in a glove box (Ar atmosphere)
- ❑ Surface temperature of samples of 70°C
- ❑ BAM bentonite (Ca-Mg bentonite)
- ❑ Manganese steel 422707
- ❑ Other potential WDP materials
  Ti alloy, copper, stainless steel

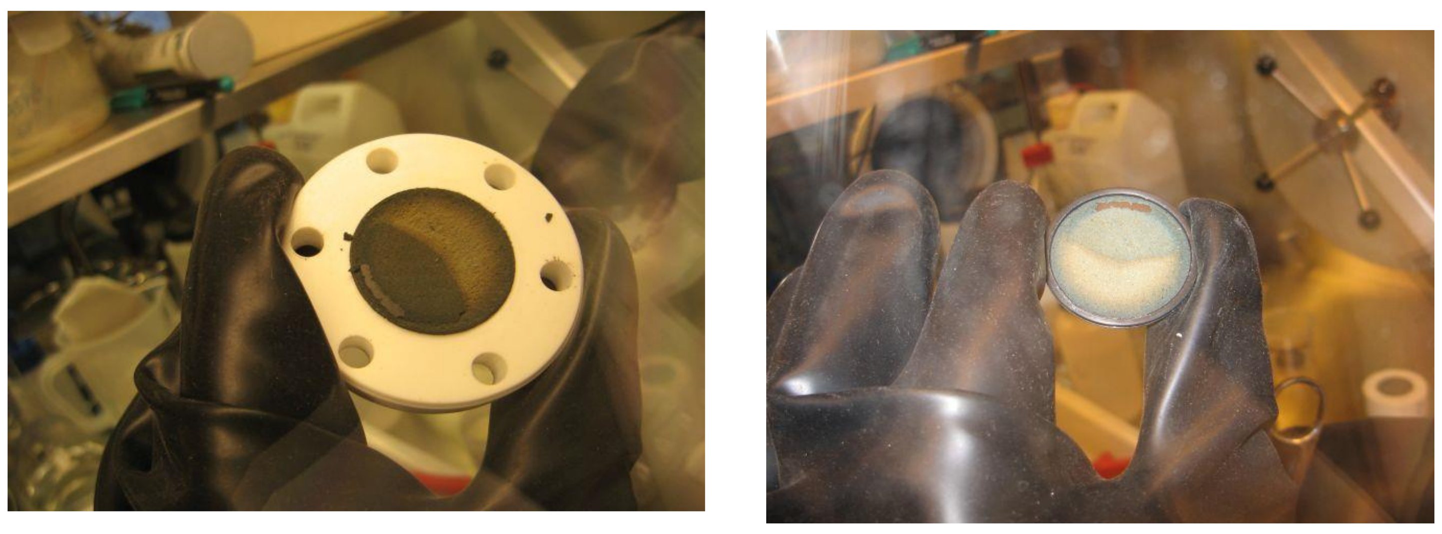


Fig. 1 *Bentonite (contact with a metal sample; left) and a metal sample with bentonite residues in an anaerobic box (Dobrev et al. (2017); ÚOS experiment*

Laboratory accelerated test (CoPr)

- ❑ Laboratory accelerated corrosion experiment with Fe powder and steel
- ❑ Anaerobic conditions in a glove box (Ar atmosphere)
- ❑ Laboratory temperature, 40°C and 70°C
- ❑ BAM bentonite
- ❑ Fe powder; carbon steel 12050

In-situ heated corrosion experiment (MaCoTe)

- ❑ Grimsel underground laboratory (CH)
- ❑ Anaerobic conditions that simulate the GTS conditions (emplacement in boreholes)
- ❑ Surface temperature of samples of 70°C
- ❑ Three types of sample modules
  - ❑ Czech BAM bentonite and carbon steel 12022
  - ❑ MX80 bentonite and carbon steel
  - ❑ MX80 bentonite and a copper coating material

Fig. 2 *Emplacement of samples in five boreholes at GTS (MaCoTe)*

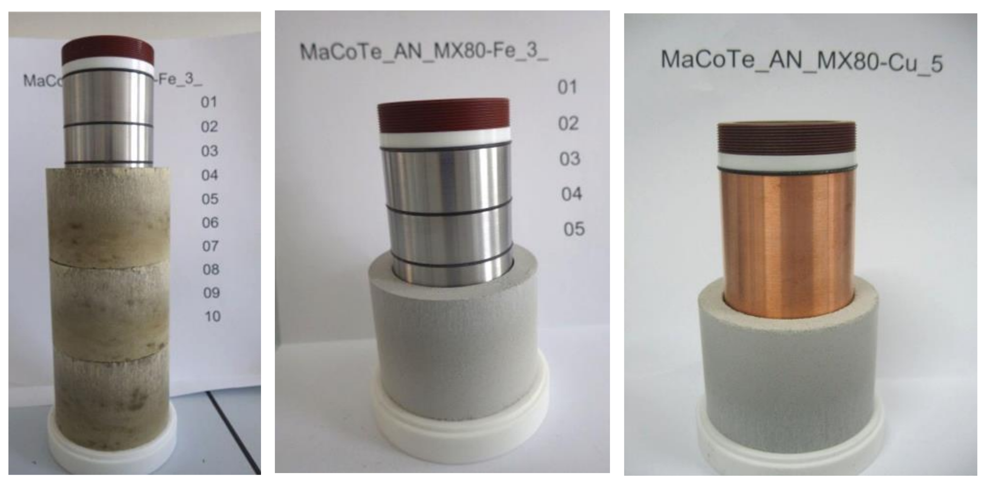


Fig. 3 *Metallis samples and bentonites (MaCoTe)*

Fig. 4 *Compacted bentonite with a layer of a mixture of Fe powder and corrosion products; lab temperature, 189 days; CoPr experiment.*

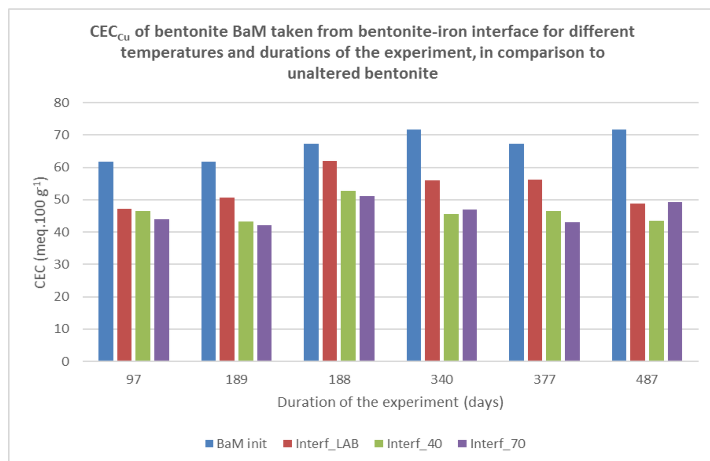


Fig. 5 *Changes in bentonite CEC values at the bentonite - Fe interface depending on the temperature and duration of the experiment.*

Geochemical modelling (PHREQC)

- ❑ Equilibrium model (Fe – bentonite boundary); including bentonite pore water modelling
- ❑ Kinetic model (the influence of kinetics; time course)
- ❑ 1D reactive transport model, incl. kinetics;
  time and spatial development in an Fe/steel – bentonite – H_2O system (Gondolli et al. 2018)

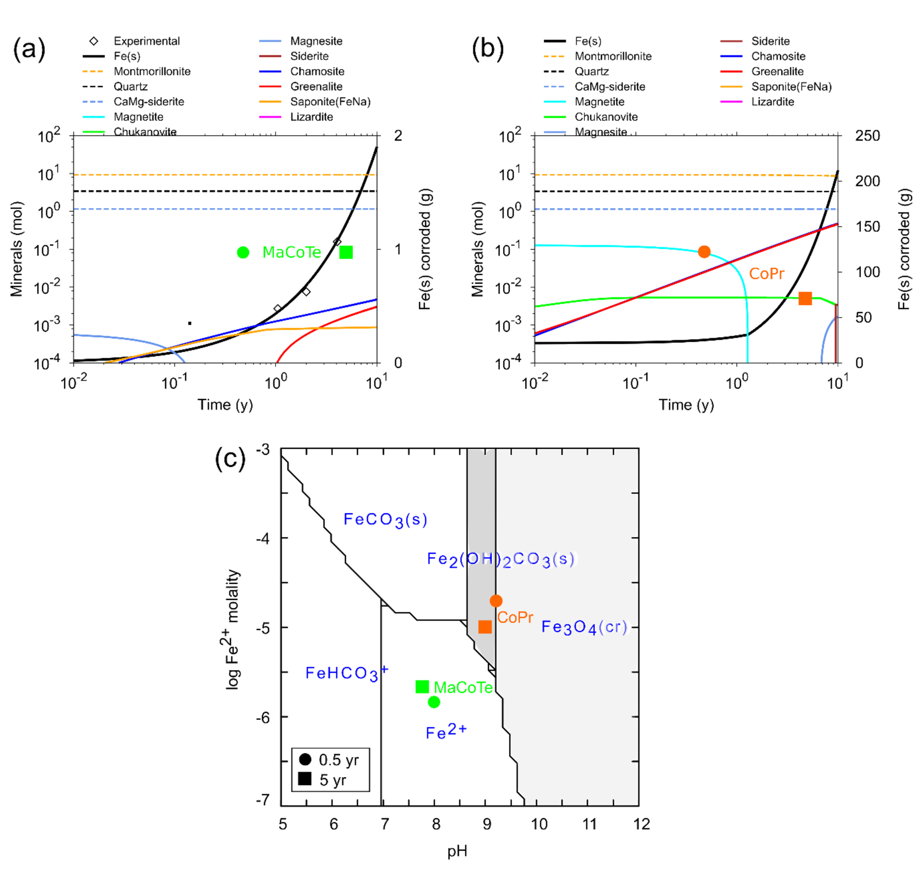


Fig. 6 ***Kinetic modelling of MACOTE and CoPr experiments***
Evolution of Fe(s) and the mineral phases for the iron–BaM–water systems considered in the (a) MaCoTe and (b) CoPr projects, both at 25 °C; and (c) molality versus pH diagram of Fe showing the most stable species and selected solid phases of Fe (namely, FeCO3 – siderite; $Fe_2(OH)_2CO_3$ – chukanovite; Fe_3O_4 – magnetite; Fe-bearing phyllosilicate minerals not considered) at 25 °C and different solution compositions.

Conclusions

- ▪ The geochemical reaction transport model that has been developed for the Fe/steel-bentonite-water system (Gondolli et al. 2018) will also be applied to the MACOTE and ÚOS experiments as part of the EURAD EJP ACED WP.
- ▪ MX 80 bentonite will be used as a reference material.

Acknowledgements
ÚJV's participation in all the projects was financed or co-financed by SURAO. ÚJV is participating in the MACOTE project as part of an international consortium of NAGRA (CH), RWM (UK), NWMO (CAN), NUMO (JAP) and SURAO. The geochemical reactive transport model for the UOS and MACOTE experiments will be developed using funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 847593, WP ACED and co-funding from SURAO. .

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