UO_2 interactions inside canister conditions

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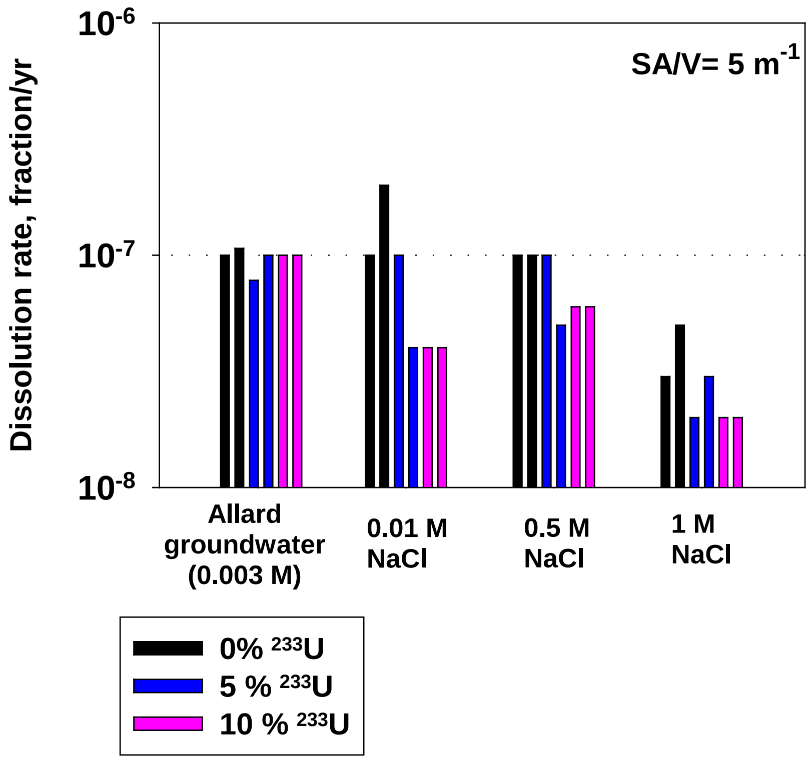
Previous studies (IN-CAN processes, NF-PRO) **:**

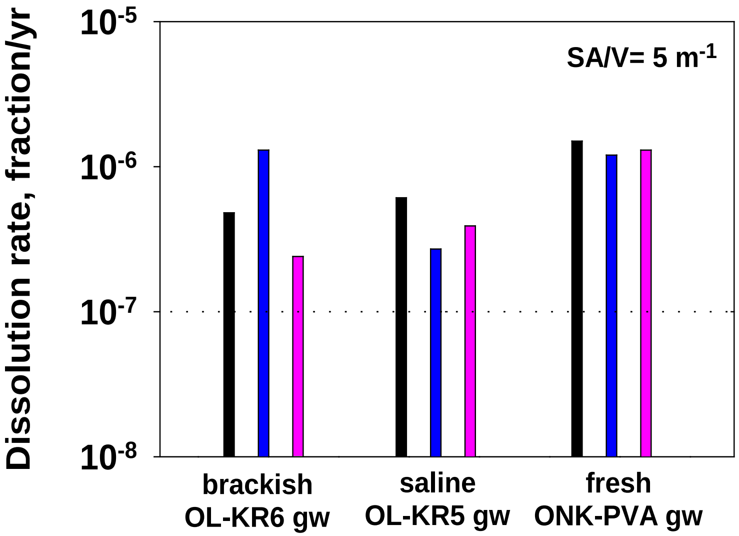
Dissolution rates of U from 0, 5, 10% ^{233}U-doped UO_2 samples in synthetic groundwaters (fraction/yr)



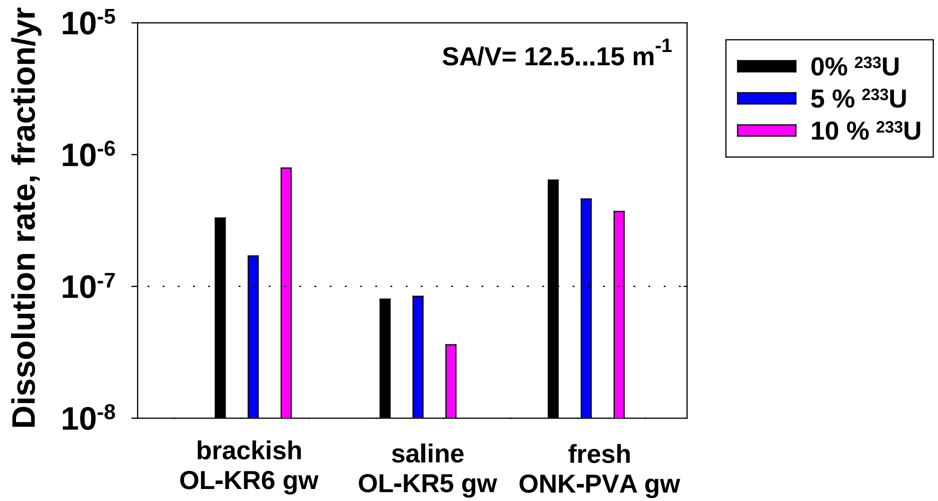
- Reducing conditions achieved by corroding iron in solution (Ar atmosphere)
- No indication of an effect of alpha radiolysis
- The rate decreased in 1M NaCl solution
- 2 x 10^{-8} to 1 x 10^{-7} fraction/yr
- U concentrations close to the detection limit of the analytical method (ICP-MS)

Previous studies (REDUPP):

Dissolution rates of U from 0, 5, 10% ^{233}U-doped UO_2 samples in natural groundwaters (fraction/yr)



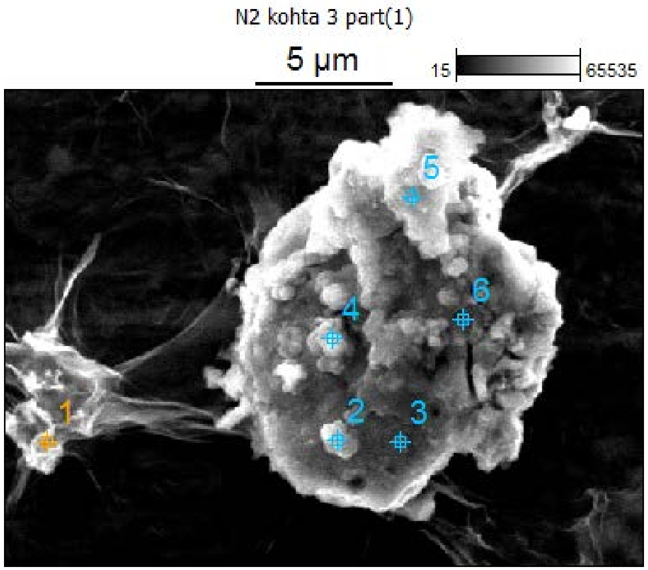
Mean results from parallel tests

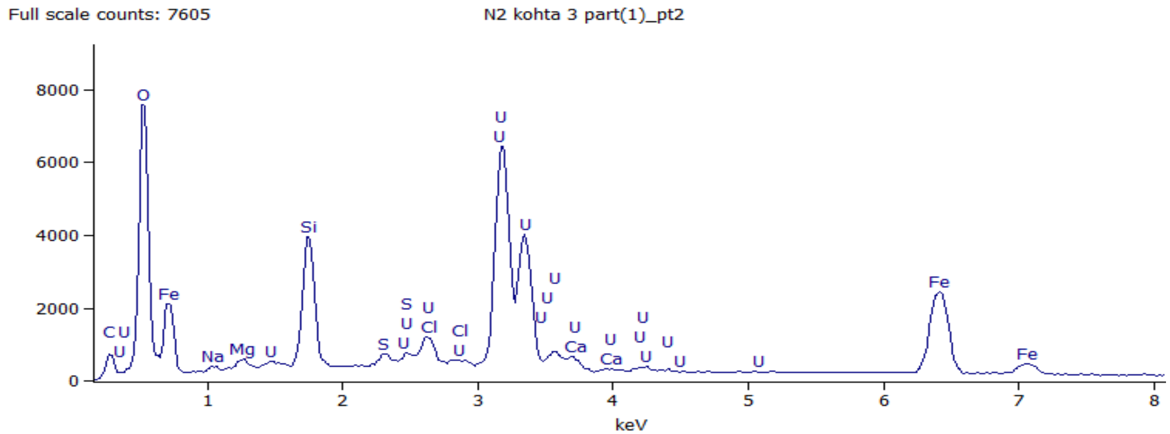


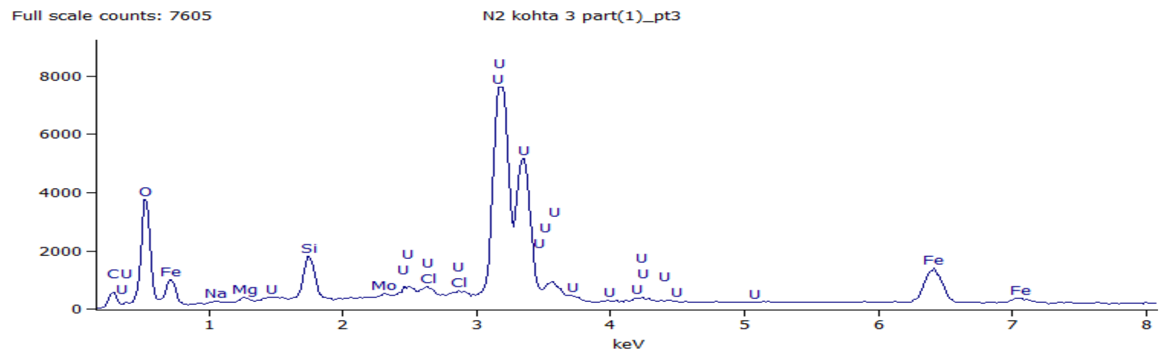
Results from single tests

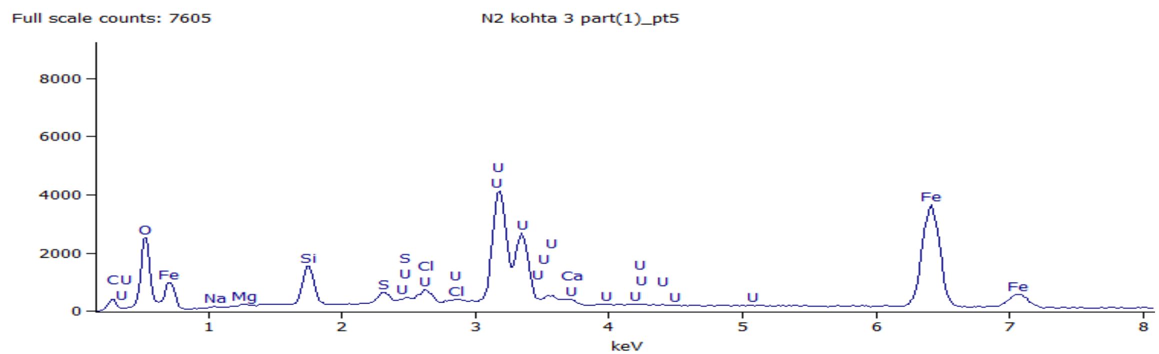
- Dissolution rates generally higher than in synthetic groundwaters, > 10^{-7} fraction/yr
- Lowest dissolution rates in saline OL-KR5 groundwater at higher SA/V
- The rate for the 10% ^{233}U-doped UO_2 higher than the rate for 5% ^{233}U-doped UO_2 at higher SA/V in brackish groundwater, suggesting the effect of alpha radiolysis
- High Resolution ICP-MS

SEM/EDS of Fe surface (a test with 5 % ^{233}U-doped UO_2, SA/V= 15 m^{-1})









- **black coloured precipitates** on the surface of iron strips, especially in the tests with higher SA/V in natural groundwaters

- SEM/EDS analyses ⇒ U, Si
- The amounts of precipitates too small for XRD

WG4 – Spent fuel dissolution & chemistry in container: UO_2 interactions inside canister conditions

- To gain improved understanding of the chemical and corrosion processes and their effects on UO_2 dissolution mechanisms and rates under in-canister conditions after water intrusion
- The role of iron and other metal surfaces (secondary phases) and of groundwater composition (e.g. Si and sulphide)

- Dissolution experiments with Gd-doped and alpha-doped UO_2 in simulated canister conditions
  - magnetite, cast iron, copper, H_2
  - batch experiments in Ar atmosphere
  - an autoclave system to maintain gas phase composition (H_2)
  - tracer methods
- Natural groundwaters
- Natural groundwater with elevated Si content

Solid UO_2 samples

UO_2 phase	[^{233}U] (%)	[^{235}U] (%)	[^{238}U] (%)	$^{235}U/^{238}U$	Samples (g)
Un-doped	0	2.82	97.18	0.029	1, 1, 3 g
5% ^{233}U-doped **15.7 MBq/g**	5.0	4.5	90.5	0.050	1, 1, 3 g
10% ^{233}U-doped **31.4 MBq/g**	10.0	4.5	85.5	0.053	1, 1, 2.5 g

UO_2 (10 % ^{233}U) ↔ alpha activity of spent fuel 3000 years after disposal
UO_2 (5 % ^{233}U) ↔ alpha activity of spent fuel 10 000 years after disposal

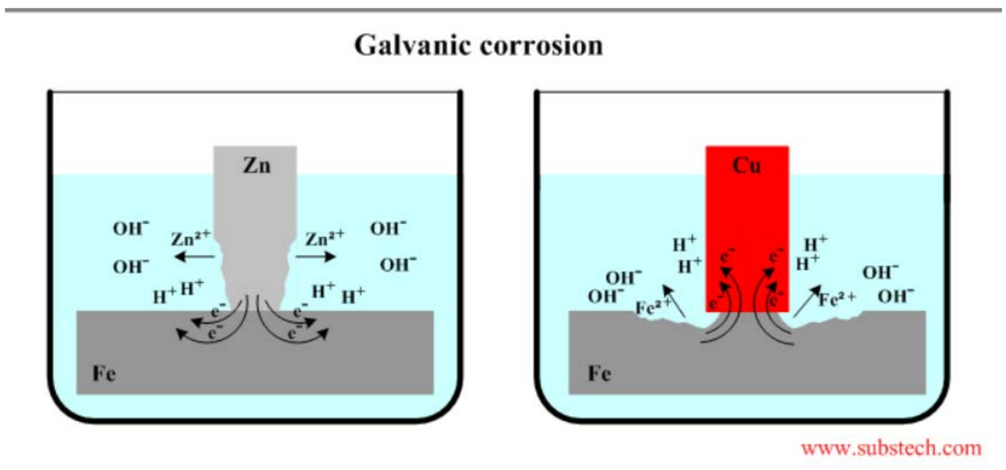
Gd-doped UO_2, 6% Gd_2O_3 (0.71% U-235)

The availability of alpha- and Cr_2O_3/Al_2O_3 - doped UO_2 is investigated

Effect of galvanic corrosion

Leena Carpen, VTT

- In the case of water intrusion to the inside of canister the possible galvanic corrosion may have an effect to the dissolution of UO_2
- **Galvanic corrosion** is an electrochemical process in which one metal corrodes preferentially to another when both metals are in electrical contact, in the presence of an electrolyte
- Galvanic corrosion can accelerate the corrosion of less nobel metal parts and thus change the chemistry of the ground water
- Besides copper and cast iron also materials in fuel assembly will produce galvanic contacts with several different metal types (zircalloy, stainless steels, inconel)



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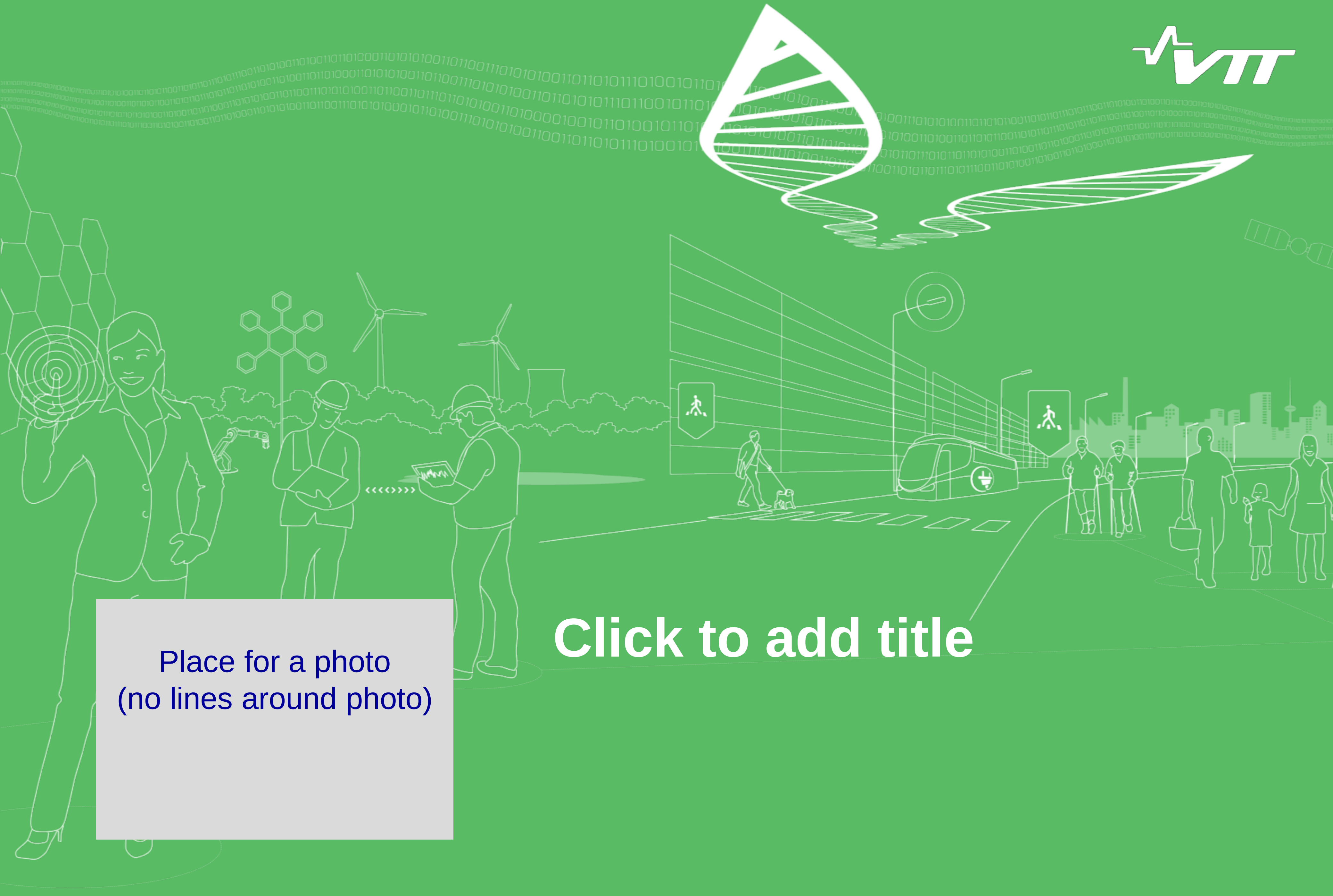

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