

# Retention of radionuclides in a fracture infill

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# Introduction

- Crystalline host rock forms the last barrier in the system of DGR.
- Fracture infill can intensively increase retention rate of radionuclides.
- Several types of fracture fillings in URF Bukov 550 m below the surface (**calcite, chlorite, clay minerals**).
- The retention rate is quantified by sorption coefficients, which are input parameters used in reactive transport modeling and are determined by sorption experiments.
- **Ni** represents a radionuclide with complex chemistry, being influenced especially by pH and solution composition.
- **Cs** represents a medium sorbing cation with simple chemistry, being often used for screening purposes.

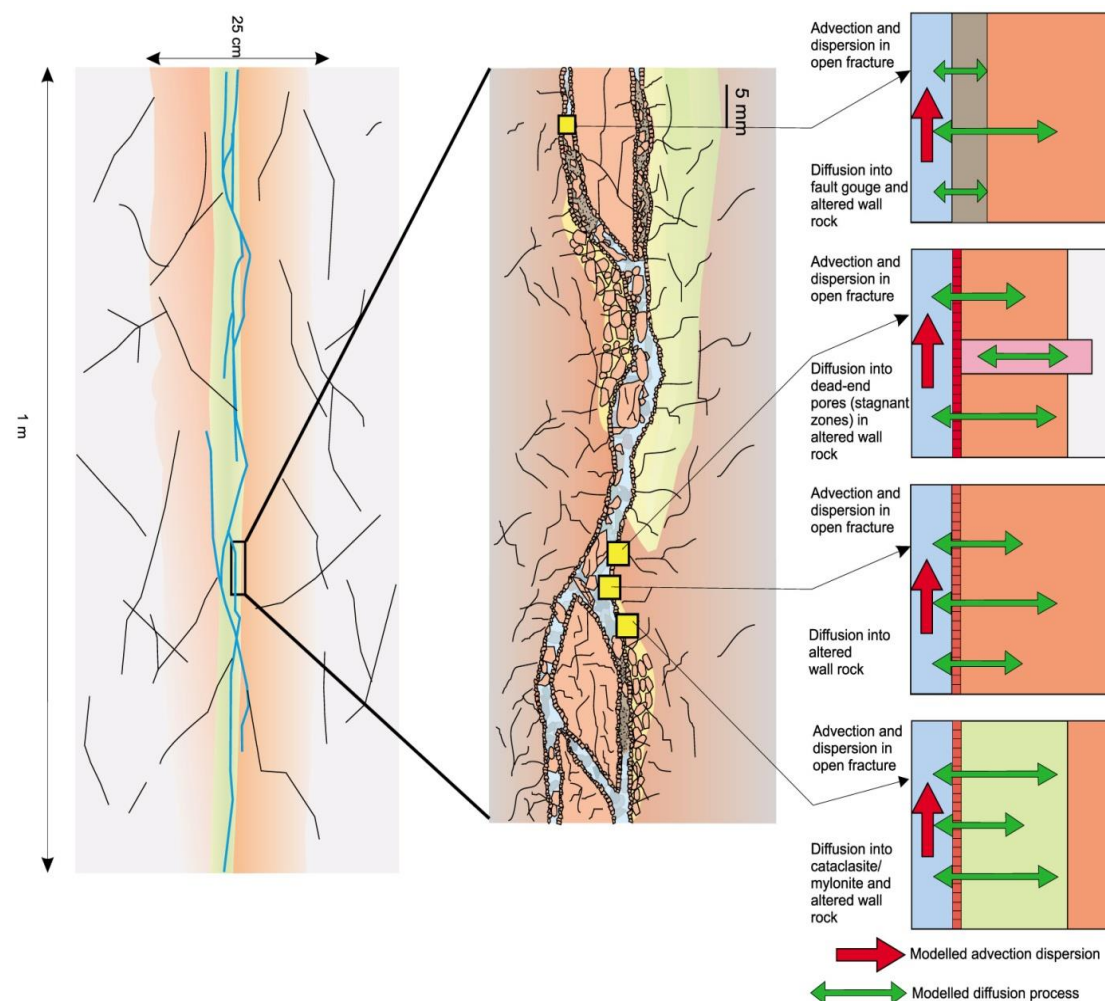


Fig.: Retention processes in the fracture (Poteri et al. 2010)

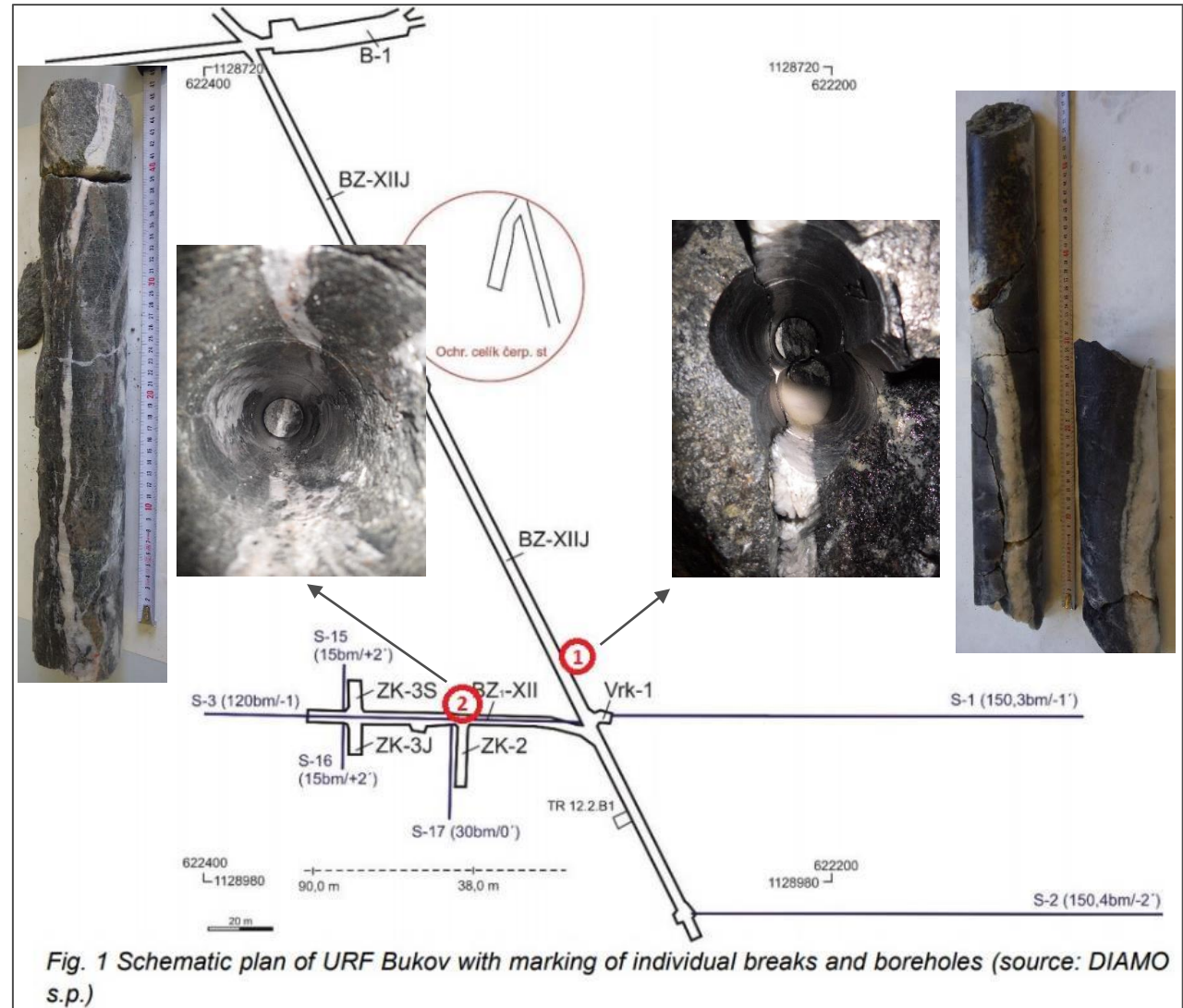
# Sampling of calcite fracture filling (URF Bukov)



Drilling location: BZ-XIIJ\_219,4 m



Drilling location: BZ-XII\_38,8 m



# Sample preparation and characterization



**Materials** (grain size: 0.63 - 0.125 mm, pre-washed with SGW2)



natural calcite with host rock admixture



natural calcite



migmatite host rock

## Characterization (XRD / SSA-BET)

**Natural calcite** – SSA (Kr) 0.0956 m<sup>2</sup>/g

mineral	calcite	quartz
%	89.5	10.5

**Natural calcite with rock admixture** – SSA (Kr) 0.1318 m<sup>2</sup>/g

mineral	calcite	quartz	chlorite	plagioclase	K-feldspar	dolomite
%	74.5	20.5	1.5	2	1	0.5

**Migmatite host rock** – SSA (Kr) – 0.2878 m<sup>2</sup>/g

mineral	calcite	quartz	chlorite	plagioclase	amphibole	biotite
%	4.5	15.5	3	53	13	11

# Experimental conditions



## Experiments - Batch sorption methods

Variable  $m/V$  ratio method – linear sorption isotherm

$m/V$ ratio	$m$ (g)	$V$ (ml)
0.1	0.5	5
0.125	0.625	5
0.167	0.833	5
0.2	1	5
0.25	1.25	5
0.334	1.67	5

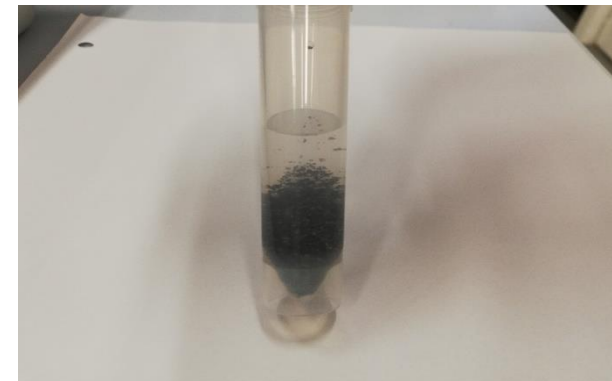
$m/V$  ratio for batch sorption experiment on calcite

- Aerobic condition
- Material fractions – 0.63 - 0.125 mm
- Ni, Cs nonradioactive carrier –  $1 \cdot 10^{-5}$  mol/l  $\text{NiCl}_2$ ,  $\text{CsCl}$
- Samples continuously shaken – orbital shaker (120rpm)
- Duration – 14 days
- Concentration changes in supernatant – radioactivity measurements of tracers  $^{63}\text{Ni}$  and  $^{134}\text{Cs}$

## Solution

SGW2- synthetic groundwater, Ca- $\text{HCO}_3$  type (IS 0.005 mol/l)

Species	$\text{Na}^+$	$\text{K}^+$	$\text{Ca}^{2+}$	$\text{Mg}^{2+}$	$\text{Cl}^-$	$\text{SO}_4^{2-}$	$\text{HCO}_3^-$	pH
c (mg/l)	16,5	2,14	37,3	8,32	3,49	21,9	168,7	8,2



Mixed batch reactor with migmatite host rock

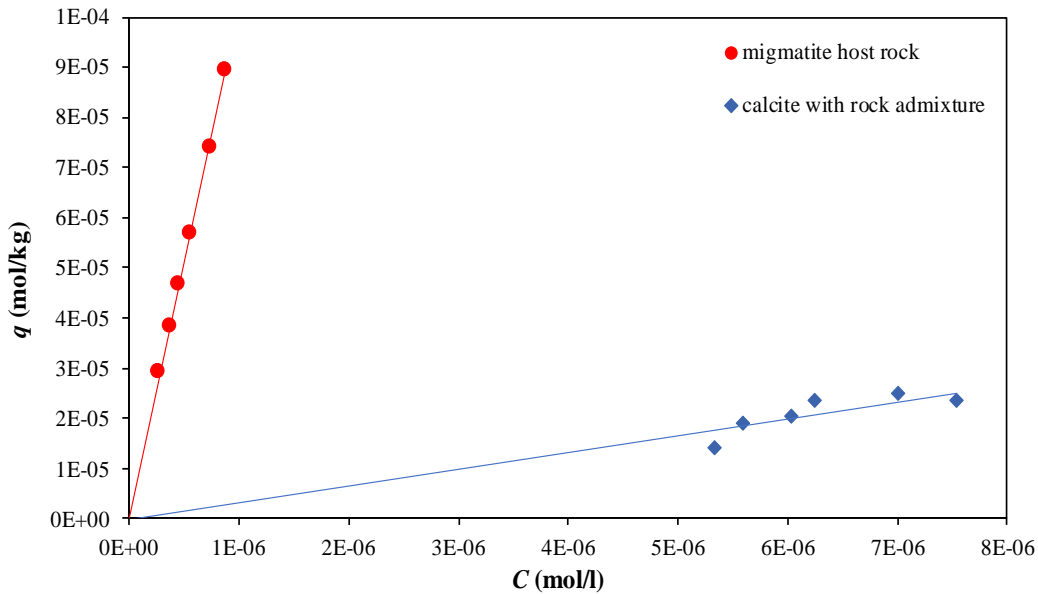
# Results of batch sorption exp.



## Cesium

Material	$K_d$ (ml/g)
natural calcite	$R_d$ values of individual V/m ratio for Cs were lower than quantification
calcite with rock admixture	$3.3 \pm 0.2$
migmatite host rock	$101.9 \pm 0.6$

$K_d$  (Cs)

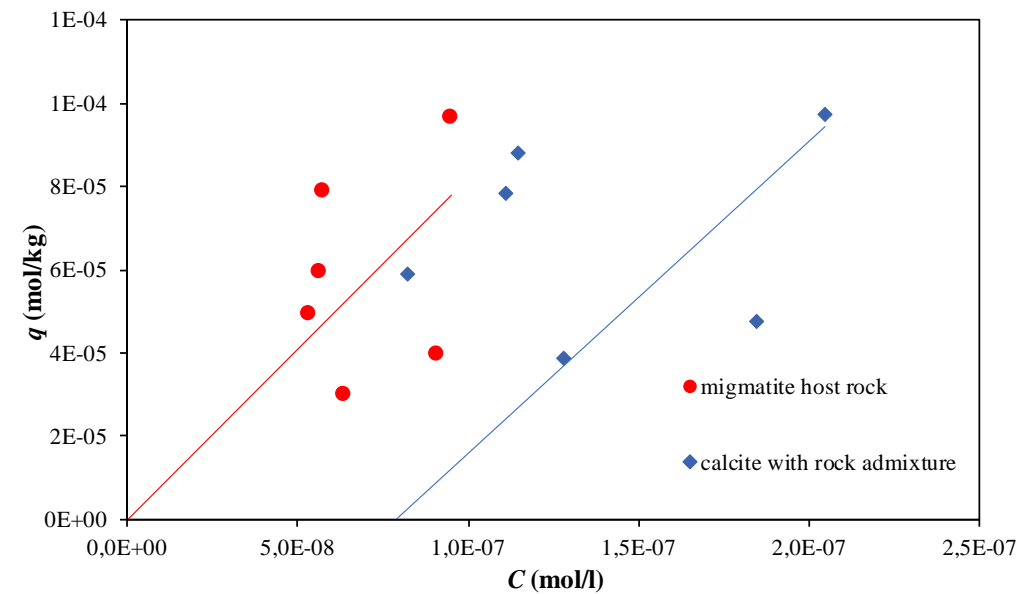


Linear sorption isotherms for Cs

## Nickel

Material	$K_d$ (ml/g)
natural calcite	$39 \pm 12$
calcite with rock admixture	$460 \pm 83$
migmatite host rock	$821 \pm 147$

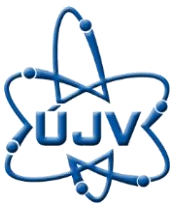
$K_d$  (Ni)



Linear sorption isotherms for Ni

# Summary

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- Sorption data for metamorphic host rock and fracture infill has been determined.
- Ni sorption on natural calcite was lower level than that Ni sorption on the surrounding host rock (migmatite).
- No sorption of Cs on natural calcite was observed
- Data set with parameter range, that can be used for performance assessment, has been complemented.

# Outlook

- Sorption analyses on more heterogenous infill material - samples with clay minerals

Sample No.	Calcite	Chlorite	Kaolinite	Quartz	Plagioclase	Mica	Smectite
1	33	4	10	25	10	5	13

Tab.: XRD analyses in wt. % (the sample contains ca. 0,5 wt.% of hematite)





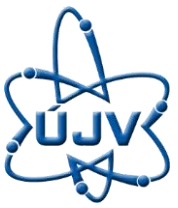
# Acknowledgement

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# Thank you for your attention

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