A newly developed Ra selective resin based on molecular recognition technology for environmental applications

KHALFALLAH Soumaya, XU Fengqi; NIVESSE Anne-Laure; DEROO Lucie ; ASFARI Zouhair , HAPPEL Steffen and MONTAVON Gilles

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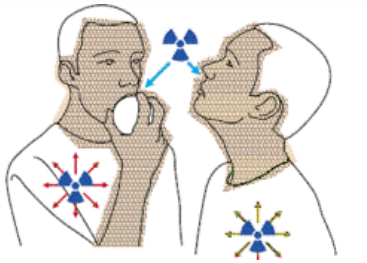
General context

Ra

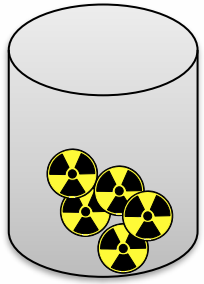


Similarity with Ca

Medical advantages

^{223}Ra ($T_{1/2} \approx 11,3d$) Therapy of Bone Metastases (cancer treatment)

How? What materials? Which characteristics?



Environmental issues

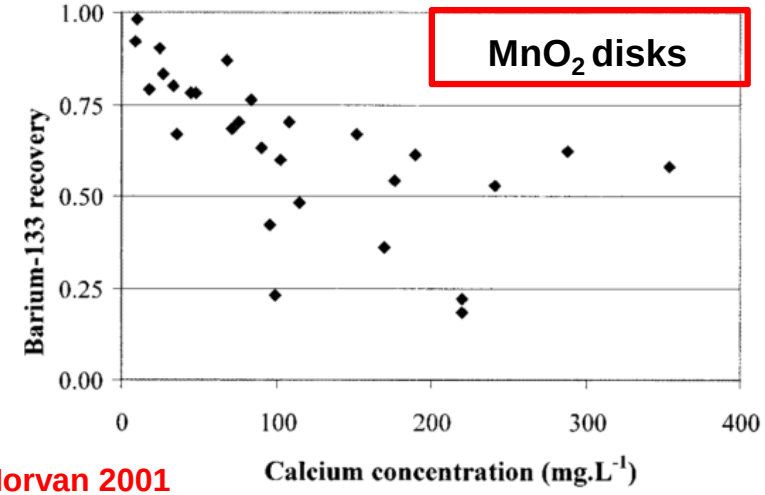
Ra accumulates in the body skeleton

Rn, Ra's daughter causes lung cancer

Selective recognition for decontamination / environmental monitoring / labeling

Background: Ra separation techniques

- **Fractional precipitation $RaCl_2$**
- **Ion exchange columns**: ammonium citrate/EDTA
- **Co-precipitation**: $BaSO_4/BaCO_3$
- **Synthetic clay**: Na-4-mica ($Na_4Al_4Si_4Mg_6O_{20}F_4 \cdot xH_2O$)
- **MnO_2 (resin, disks, fibers)**: Most common used procedure



Morvan 2001

Limited applicability

Alternative approach

MRT: Molecular Recognition Technology

Non-ion exchange process, using specially designed organic chelating agents.

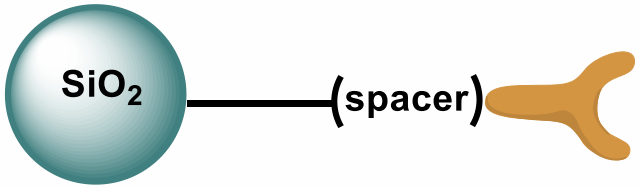
Our developed Ra resins

Chelating agent choice

- **Ra ion radius ≈ 1.7 Å**: adapted cavity
- **Ra hard Lewis acid**: Oxygen donor
- **Ra coordination sphere :** 8-12 (solid phase)

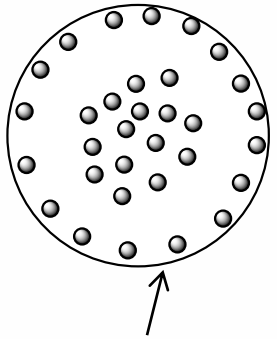
→Chelating agent: Ether crown derivative

Grafted resin



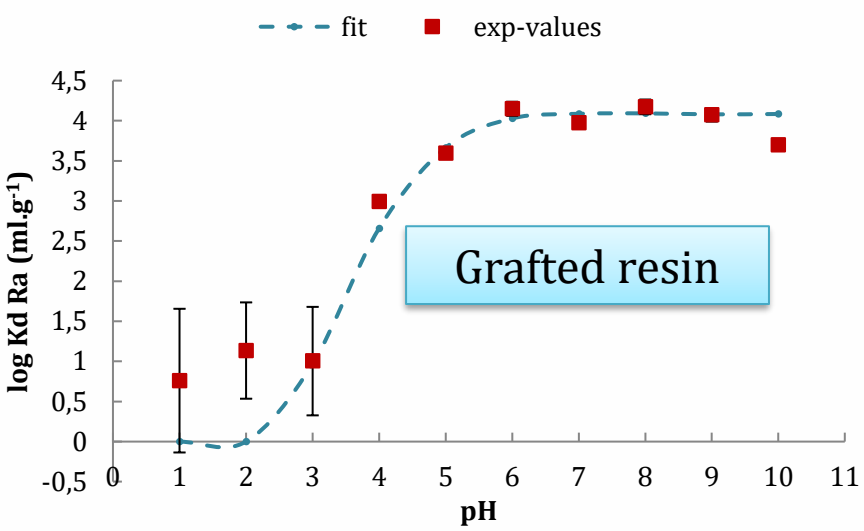
- **Solid Support:** SiO_2 100 mesh.
- **Spacer:** short alkyl chain.

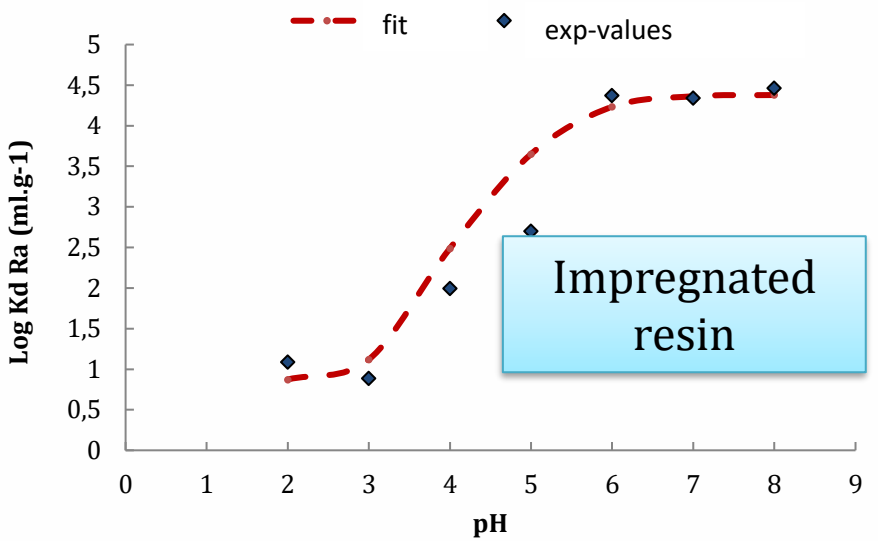
Impregnated resin



- **Solid Support:** aliphatic polymer (acrylic ester)
- **Solvent:** Fluorinated alcohol

Resin applicability conditions: effective pH range



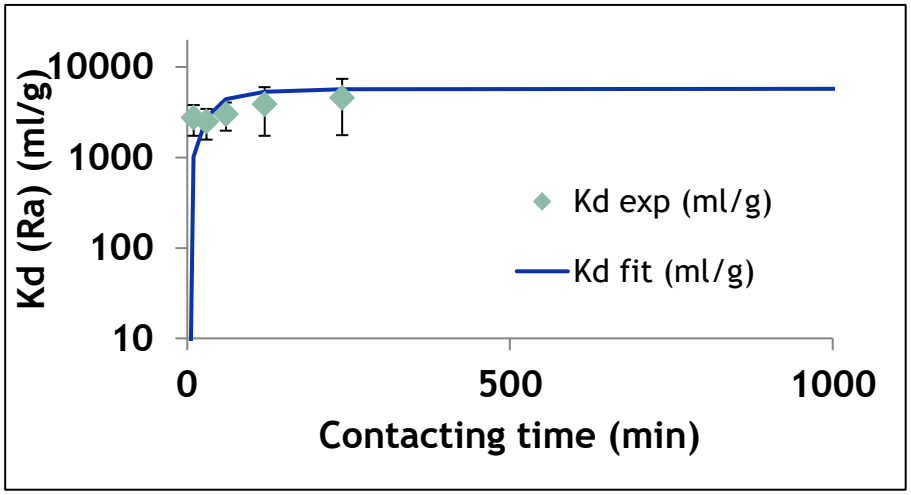


- No sorption was detected for pH ≤3 (Grafted resin), pH ≤4 (Impregnated resin),
- Maximum adsorption is reached over pH 5 (grafted resin) and over pH 6 (impregnated resin)

- In acidic conditions the extractive molecule is protonated and no neutral complexes can be formed in the presence of Ra^{2+}
- With the organic solvent, the deprotonation is delayed.

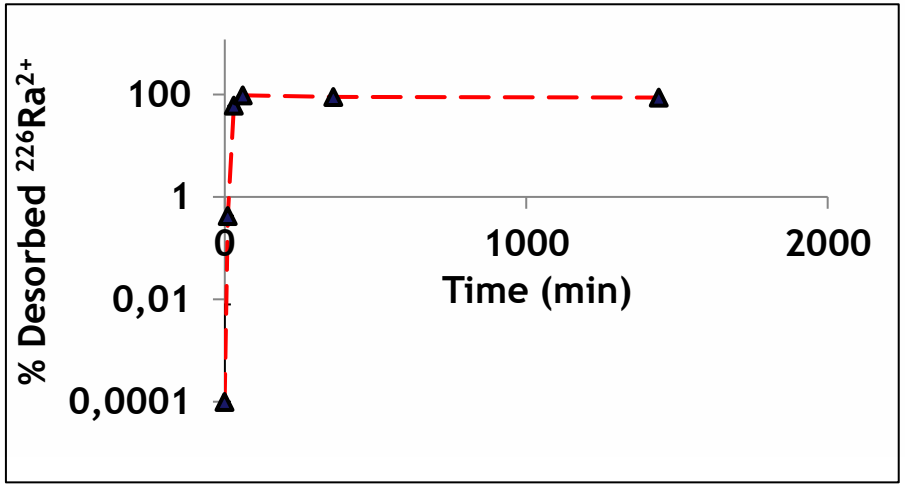
Grafted Ra-Resin: kinetics behavior investigations

Ra uptake (pH=7)



→ > 80% of $^{226}Ra^{2+}$ adsorbed after 10 min of contact.: **Rapid kinetics**

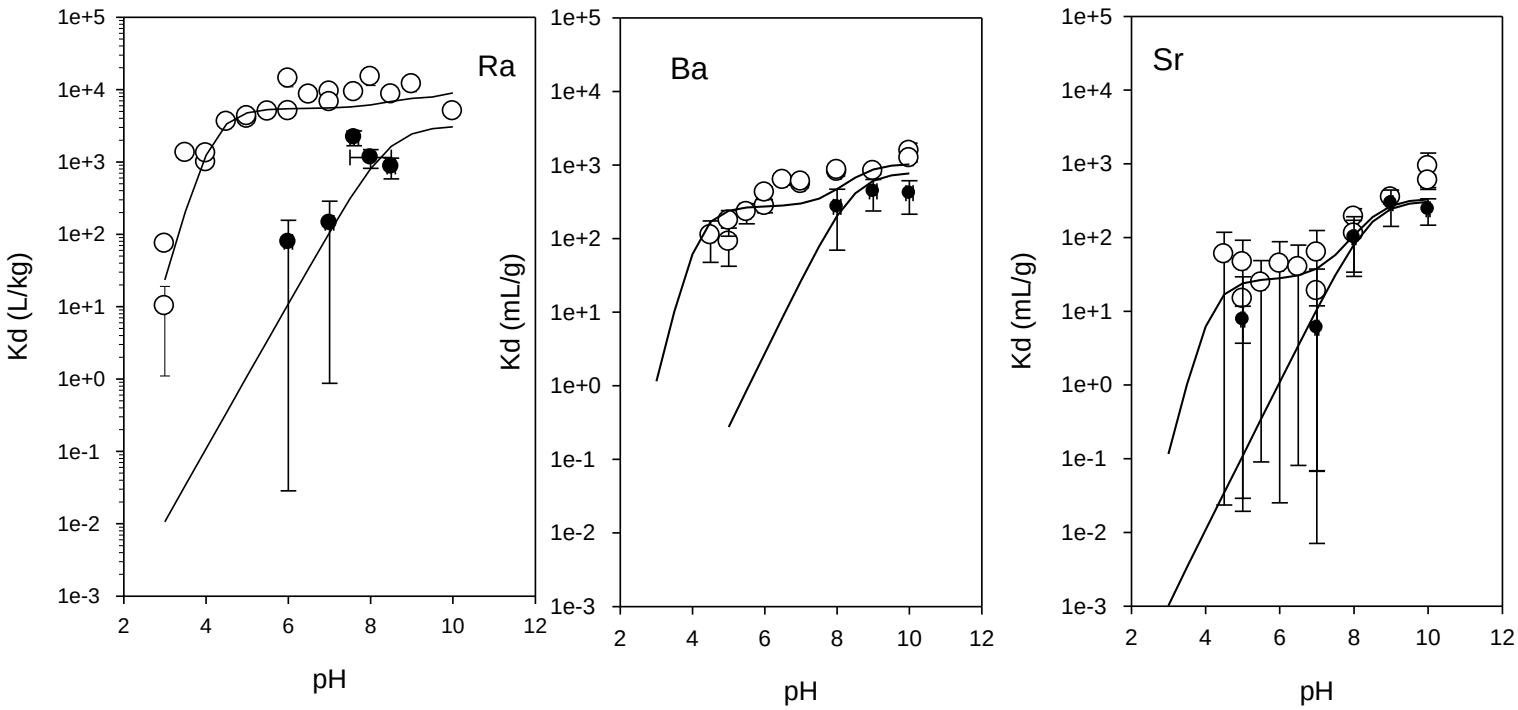
Ra desorption (pH<0)



→ **Rapid** desorption and reversible process:

Starting material **Regeneration**

Selectivity tests



Adsorption of Ra^{2+}, Ba^{2+} and Sr^{2+} ions with grafted (black symbols) or ungrafted (white symbols) silica as a function of pH. The m/V ratio is fixed at 2.5 g.L

Application: results from French mineral waters

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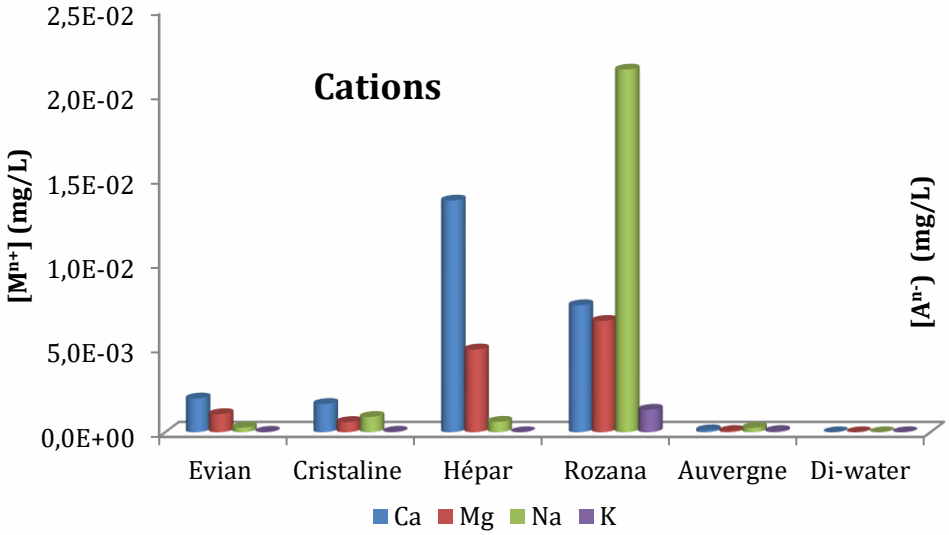
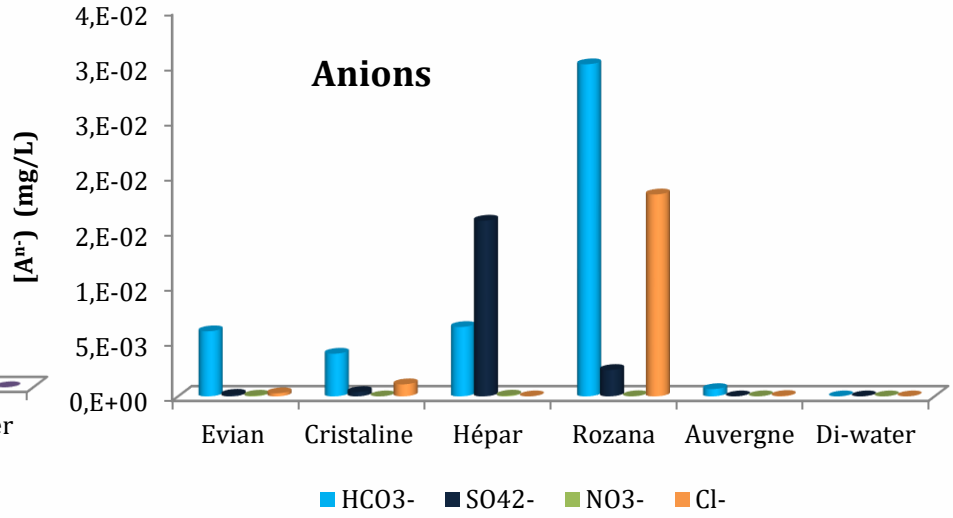
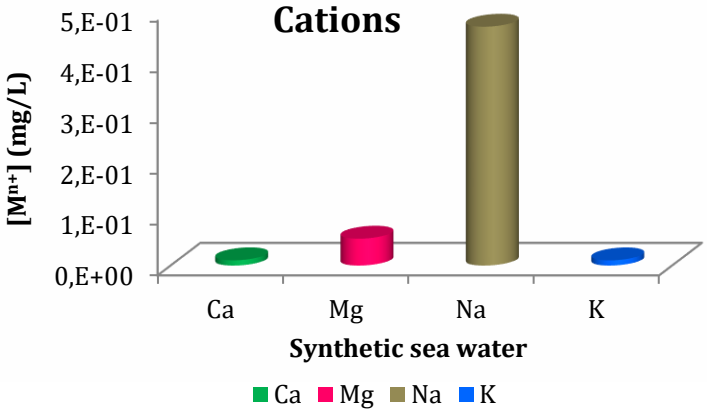
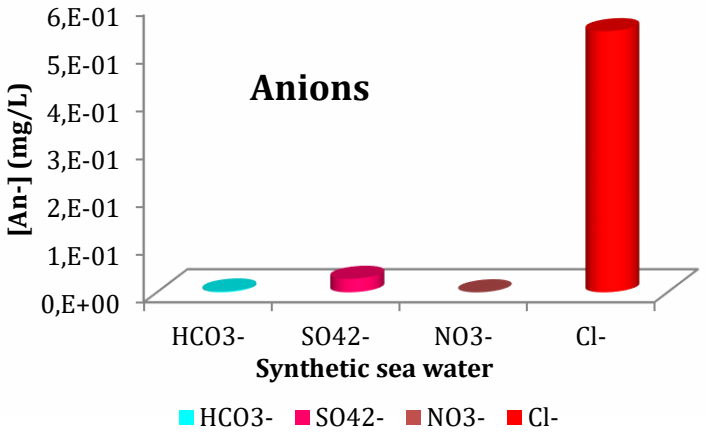
Chosen waters

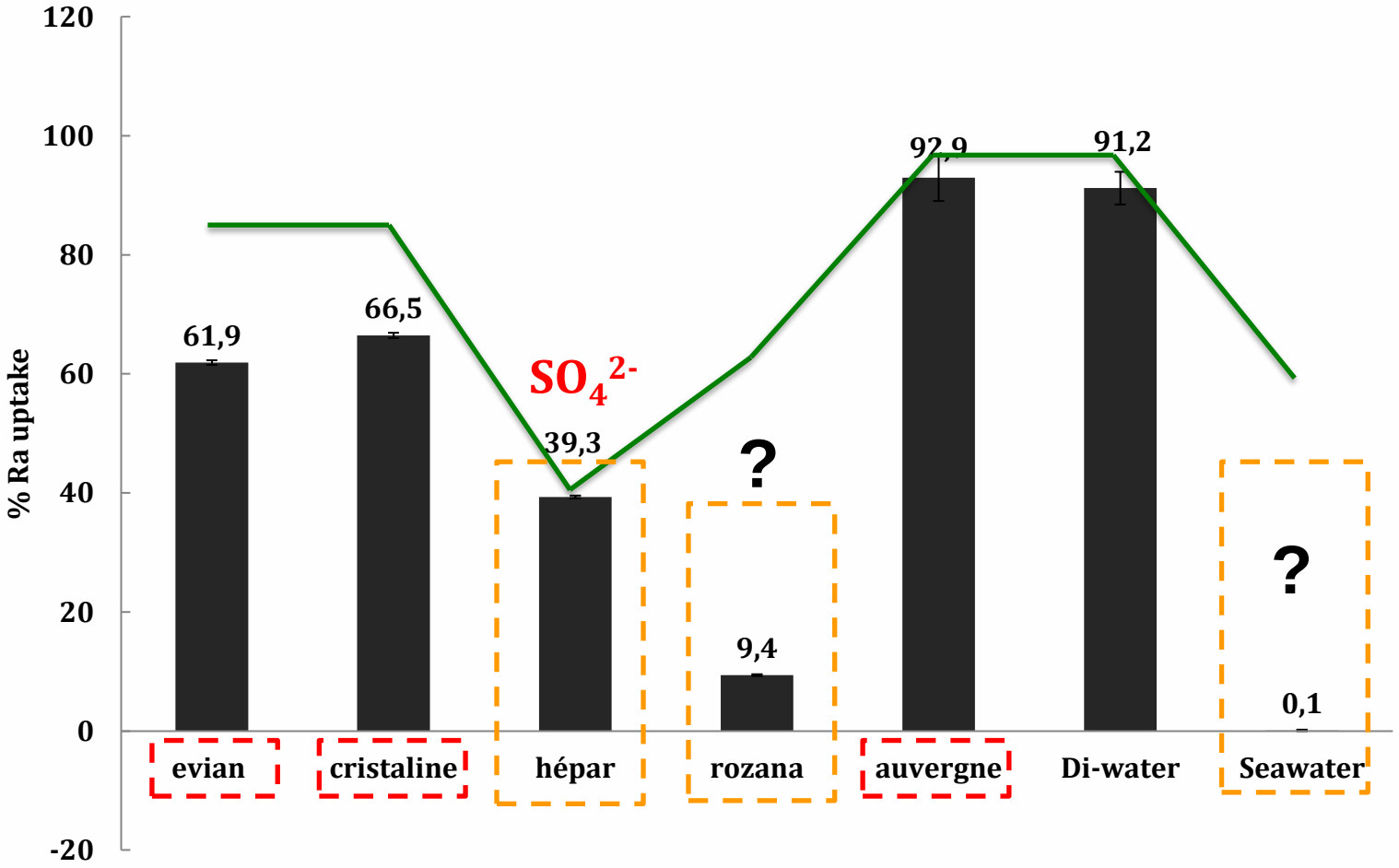






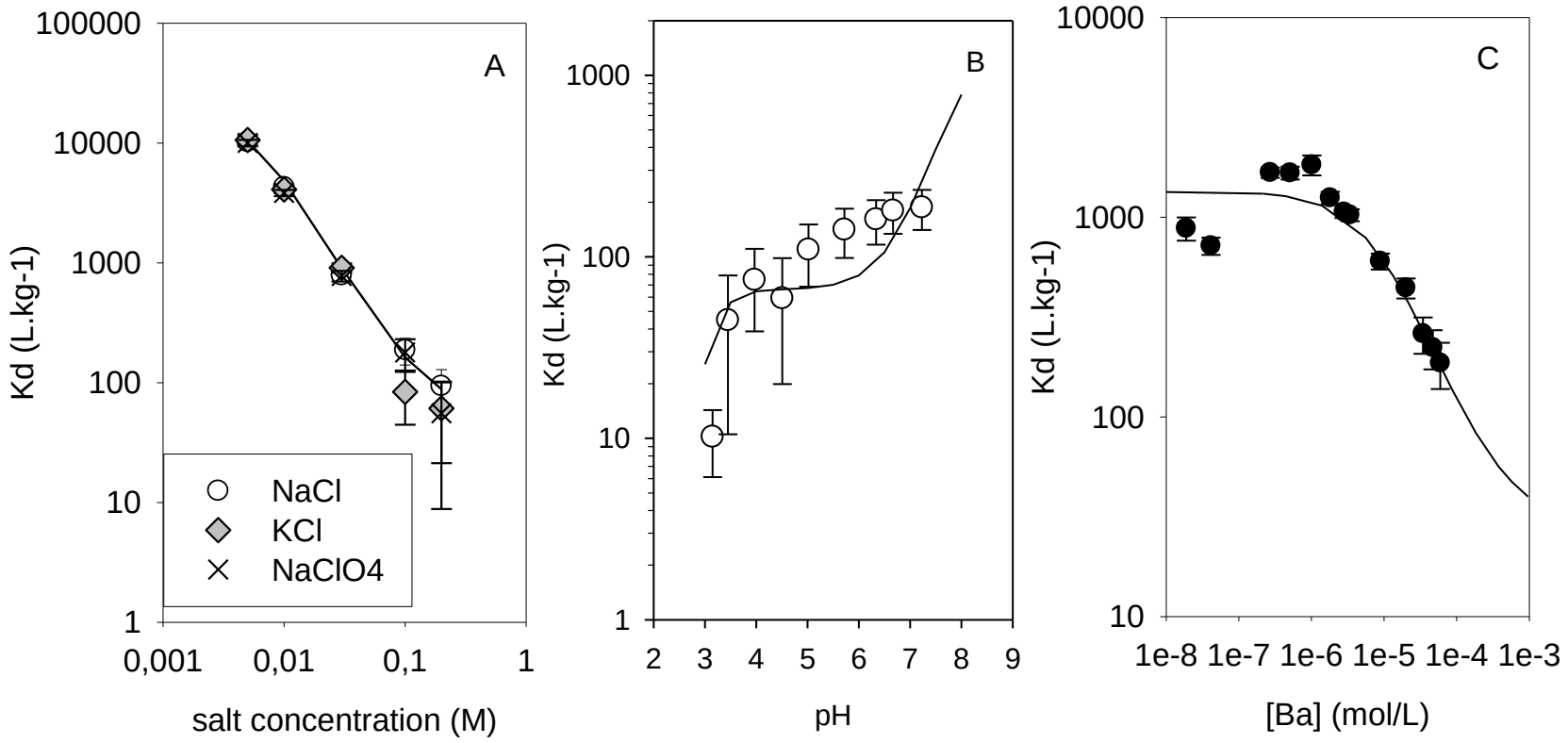


Ra uptake tests using different spiked chosen waters



Batch experiments; solid/liquid ratio =1g/L

Effect of salt on Ra adsorption on Grafted Ra resin (GR)



Sorption of Ra and Ba on GR in salty waters; m/V of 1 $g.L^{-1}$. (A) Effect of the type of salt and its concentration on Ra adsorption; pH=7.0 ± 0.1;. (B) Effect of the pH on Ra adsorption in 0.1M NaCl. (C) Sorption isotherm in concentration for Ba in the presence of 9.2 10^{-3} M of NaCl.

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