



# Pre-concentration and selective separation of $Ra^{2+}$ from natural waters using a newly developed resin

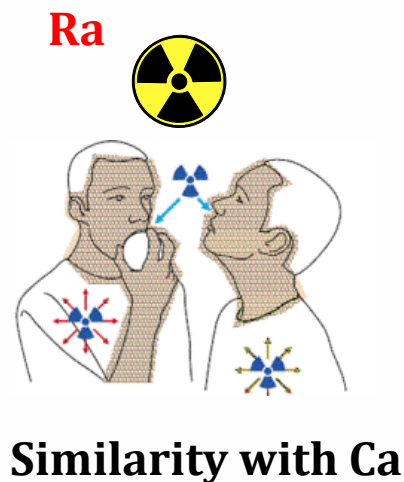
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**UGM TRISKEM international**

**21<sup>st</sup> of June 2022**





**Medical advantages**

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

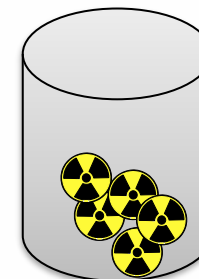
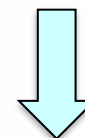
**Environmental issues**

Ra accumulates in the body skeleton

Rn, Ra's daughter causes lung cancer

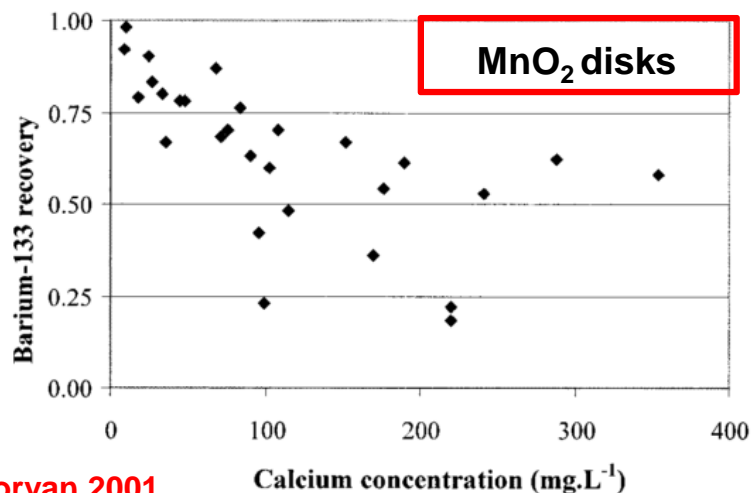
**Selective recognition for decontamination / environmental monitoring / labeling**

**How? What materials?  
Which characteristics?**



# Background: Ra separation techniques

- **Fractional precipitation**  $\text{RaCl}_2$
- **Ion exchange columns:** ammonium citrate/EDTA
- **Co-precipitation:**  $\text{BaSO}_4/\text{BaCO}_3$
- **Synthetic clay:** Na-4-mica ( $\text{Na}_4\text{Al}_4\text{Si}_4\text{Mg}_6\text{O}_{20}\text{F}_4 \cdot x\text{H}_2\text{O}$ )
- **$\text{MnO}_2$  (resin, disks, fibers):** Most common used procedure



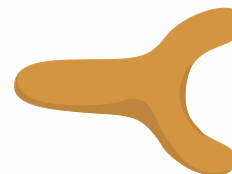
Morvan 2001

Limited applicability

Alternative approach

## MRT: Molecular Recognition Technology

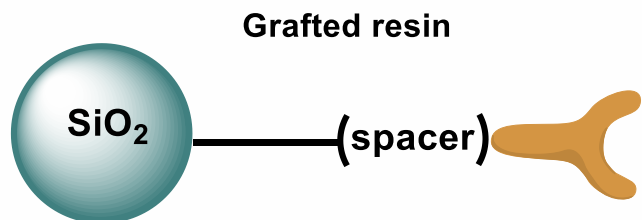
Non-ion exchange process, using specially designed organic chelating agents.



# Our developed Ra resins

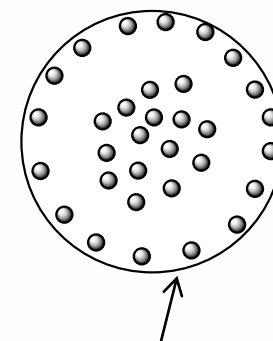
- Ra ion radius  $\approx 1.7 \text{ \AA}$ : adapted cavity
- Ra hard Lewis acid: Oxygen donor
- Ra coordination sphere : 8-12 (solid phase)

→ Chelating agent: Ether crown derivative



- Solid Support:  $\text{SiO}_2$  100 mesh.
- Spacer: short alkyl chain.

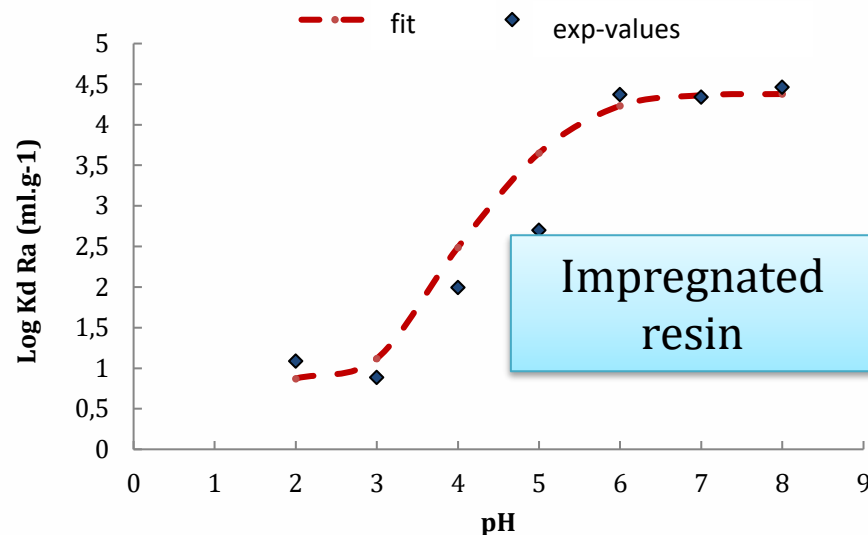
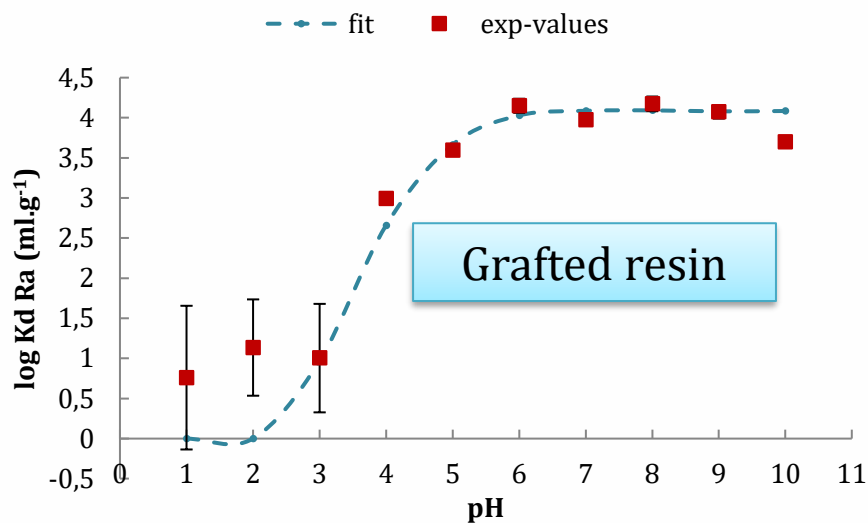
## Impregnated resin




Ligand + organic solvent

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

# Resin applicability conditions: effective pH range

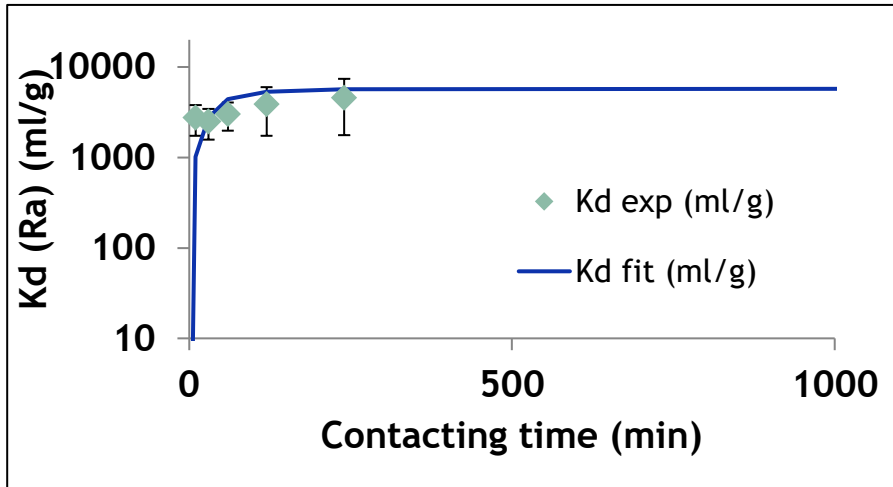


- No sorption was detected for pH ≤3 (Grafted resin), pH ≤4 (Impregnated resin),
- Maximum adsorption is reached over pH 5 (grafted resin) and over pH 6 (impregnated resin)

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

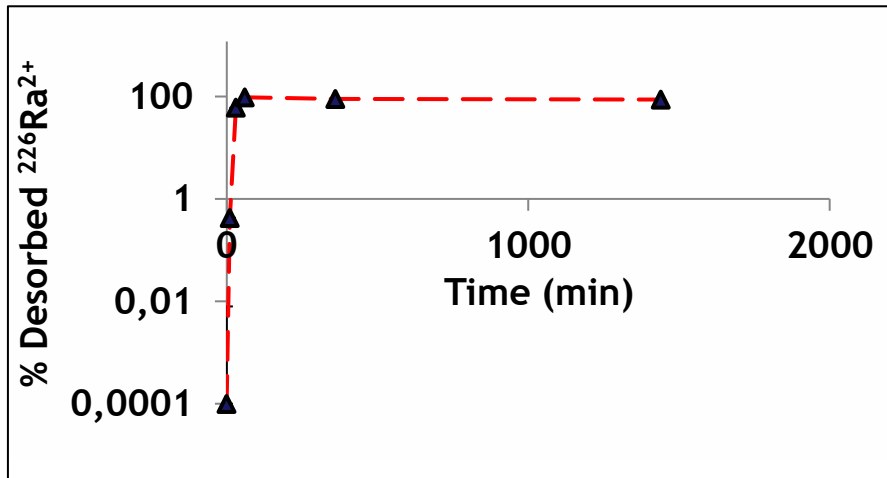
# Grafted Ra-Resin: kinetics behavior investigations

## Ra uptake (pH=7)



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

## Ra desorption (pH<0)

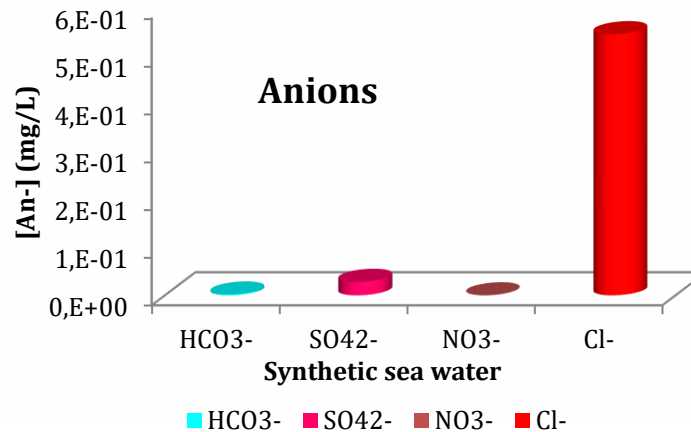
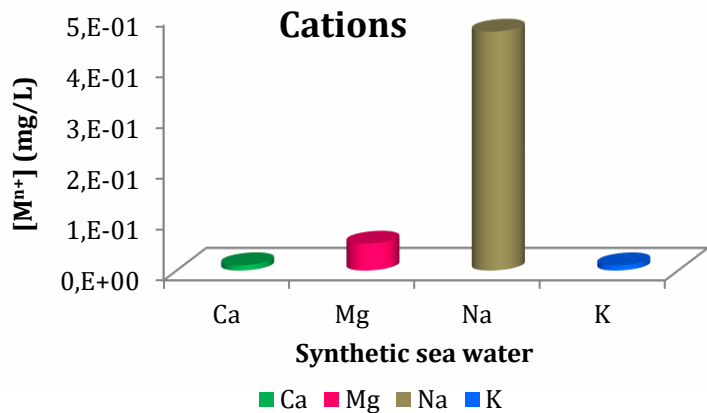
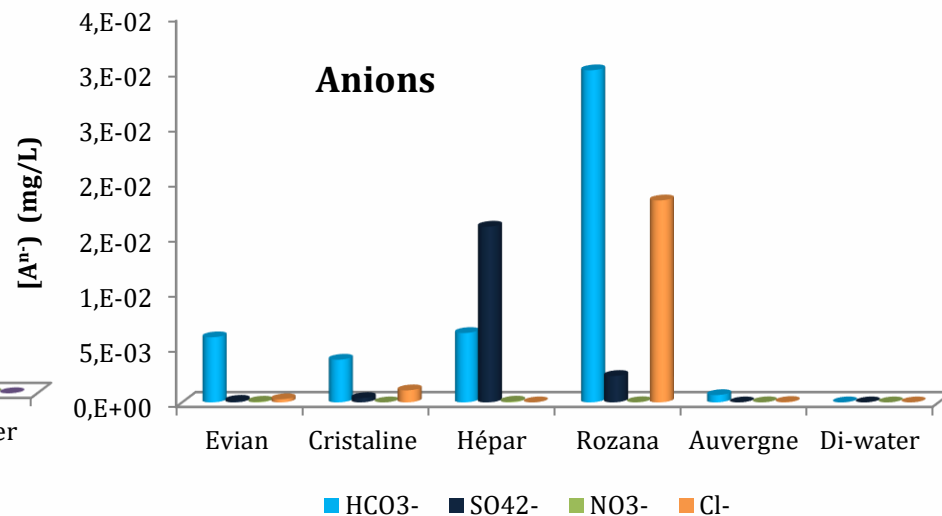
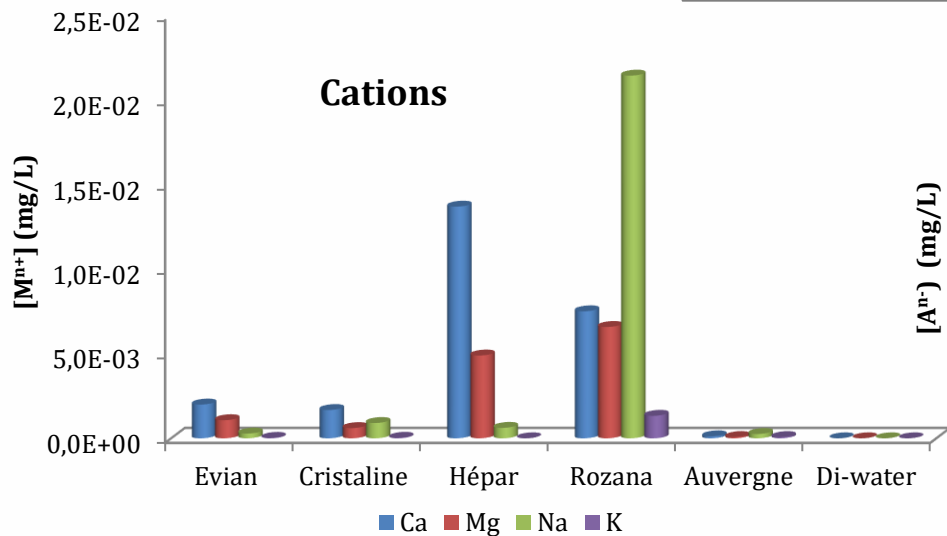


→ **Rapid** desorption and reversible process:

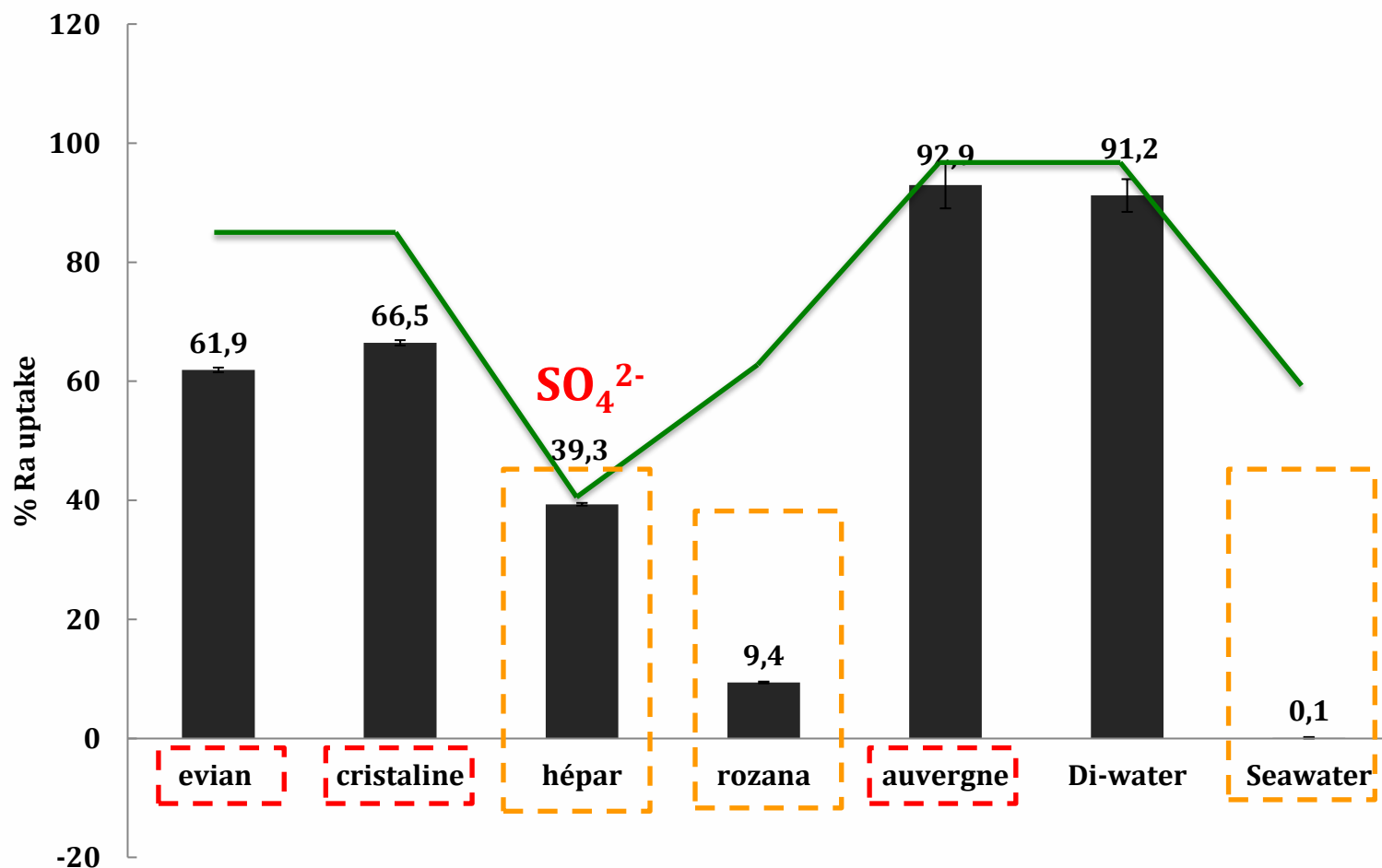
Starting material **Regeneration**

# Application: results from French mineral waters

## Chosen waters



# Ra uptake tests using different spiked chosen waters

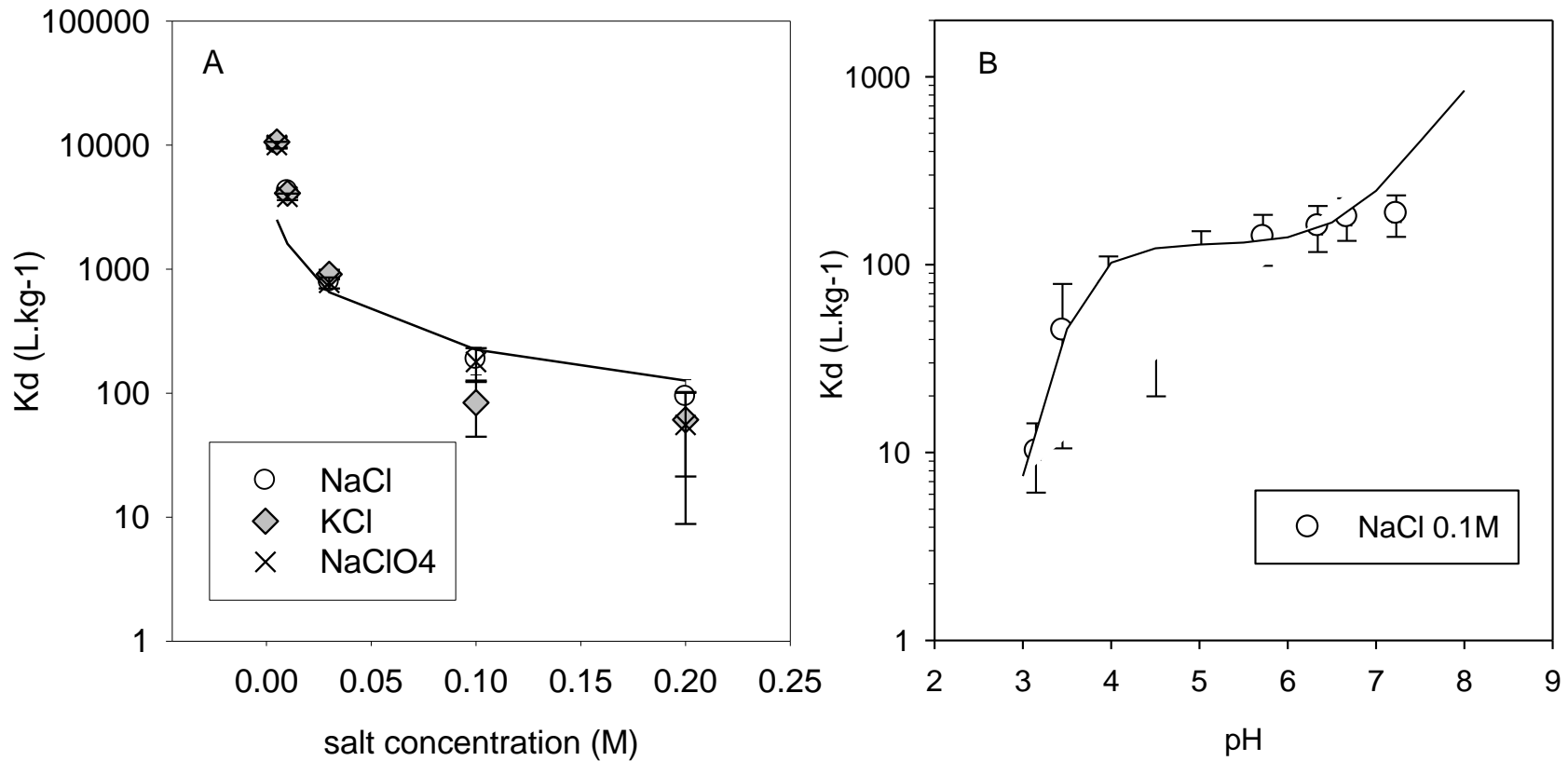


Batch experiments; solid/liquid ratio = 1g/L



# Ra uptake tests using different spiked chosen waters

- ❖ For “classical” waters brands (i.e. Evian, Crystalline and Auvergne), the retention is good showing no competition effects with major cations,
- ❖ For Hépar, a strong decrease is noticed which can be well reproduced by the modelling → high sulfate content
- ❖ As the Rozana water is the only carbonated water among those tested, the carbonate content of the water and the value of the constant between Ra and  $\text{HCO}_3^-$  in PHREEQC are two possible explanations to investigate
- ❖ Sea water → high concentration of Na ( Fengqi XU theses)



Sorption of Ra on grafted resin in salty waters. (A) Effect of the type of salt and its concentration;  $\text{pH}=7.0\pm 01$ ;  $\text{m/V}$  of  $1\text{g.L}^{-1}$ . (B) Effect of the pH;  $\text{m/V}$  of  $1\text{g.L}^{-1}$ .

- A new grafting resin specific for Ra is presented. It is very effective in the field of classical pH natural waters (~6-8),
- On the other hand, its application is limited to waters with a low salt content.
- The impregnated resin has a clear advantage: the synthesis method is very fast, the quantity of ligand introduced is greater
- The impregnated resin is still under process improvement in order to enlarge its pH field

**To be continued...**



**Thank you for your  
attention**