1. Introduction

Various anthropogenic sources contribute to enhance the levels of many radionuclides and metals in the marine environment. Quantitative information on the adsorption/desorption of radionuclides and metals by suspended loads is important in the study of their environmental behaviour.

In this work, laboratory experiments were directed at studying the kinetic transfer of Cd, Cr, Co, Pb and Ra in marine aqueous suspensions. The samples were collected from the Strait of Gibraltar (North of Morocco).

The quantification of these transfer processes is carried out by determining the distribution coefficients; Kr and the kinetic transfer coefficients, Kj. These are obtained by adopting the appropriate compartment model able to describe the observed behaviour (A. Laissauoi et al., 2008).

2. Objective

This work has several objectives:
- the study of uptake kinetic metals: Cd, Cr, Co, Pb.
- the study of effect of direct and indirect spiking on the adsorption (with Cd).
- the study of uptake kinetic of Ra (using an environmental analog 133Ba-133).

3. Material and Method

- The experimental procedure followed consists of adding a known amount of the tracer in dissolved form to water samples. Aliquots were extracted at controlled time intervals. Solids were removed by centrifugation and the aqueous phase was analyzed by appropriate equipments: Gamma spectrometer for Ba-133 and Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) for heavy metals (Pb).
- To highlight the effect of direct and indirect spiking on the adsorption, two experiments were carried out. In the first one (Experiment Cd1), the unfiltered seawater had direct spiking. While in the second one (experiment Cd2), the seawater followed all the preparation steps shown in the figure 2.
- In the case of Ba-133, two experiments were carried out. The experiment A was carried out only with natural seawater containing 7.8 ppm of suspended particle matter (SPM). The experiment B was performed by suspending (101.2 mg) of sediment in 1 L of seawater.

4. Results & Discussions

Experiments with Metals

Time evolutions of metal concentrations in the dissolved phases are shown in Figures 2 and 3. Adsorption of metals was described by a two consecutive and parallel reactions (CPR) having different characteristic times; a fast adsorption in the first moment followed by an extremely low reaction. By fitting the experimental data (points) to the theoretical function, kinetic transfer and distribution coefficients were obtained (Table 1).

![Fig. 3: Time evolutions of Cd and Pb concentrations in the dissolved phases. The lines are the best fits to the theoretical function.](image1)

![Fig. 4: Time evolutions of Cd1 and Cd2 concentrations in the dissolved phases.](image2)

Table 1. Values of transfer coefficients for the studied metals obtained by processing the time evolutions of concentrations in the dissolved phases.

<table>
<thead>
<tr>
<th>Metal</th>
<th>Cd1</th>
<th>Cd2</th>
<th>Cr</th>
<th>Co</th>
<th>Pb</th>
</tr>
</thead>
<tbody>
<tr>
<td>k01</td>
<td>0.0118</td>
<td>0.116</td>
<td>0.005</td>
<td>0.067</td>
<td>0.0242</td>
</tr>
<tr>
<td>k02</td>
<td>0.0015</td>
<td>0.081</td>
<td>0.005</td>
<td>0.047</td>
<td>0.0005</td>
</tr>
<tr>
<td>k10</td>
<td>2.56x10⁷</td>
<td>3.65x10⁷</td>
<td>1.87x10⁷</td>
<td>1.79x10⁷</td>
<td>2.79x10⁷</td>
</tr>
</tbody>
</table>

Effect of direct and indirect spiking

The adsorption of Cd by particulate matter is both rapid and significant in the case of experiment 2. This means that the Cd is relatively less available to the particles when complexed with ions from the seawater.

By fitting the experimental data (points) to the theoretical function, kinetic transfer and distribution coefficients were obtained (Table 1).

5. Conclusions

The experimental procedure followed to explain the environmental behaviour of Cd, Co, Cr, Pb and Ba 133 , has been successfully developed.

Two steps Model of consecutive and reversible reactions is appropriate to describe the experimental results for all the studied heavy metals, showing the presence of two active sites on the particles.

In the case of Ba-133, the uptake by the SPM doesn’t show any kinetic, while that by suspended sediments (101.2 mg) unambiguously shows three-step kinetics. This result underlines the important role of sediments in the dispersion process.

6. Acknowledgements

This work was supported by the Moroccan REMER (Réseau National des Sciences et Techniques de la Mer). Project Call 2010.

7. Reference