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Facilitated transport of zinc by bacterial colloids

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1 INTRODUCTION

From the 1980's, field observations have shown the main role played by colloidal particles which facilitate pollutants transport through soils (McCarthy and Zacchara, 1989). Nevertheless, until now, most of tranfer models don't take into account colloidal transport.

In this study, the starting point is a balanced state : a medium colonized by a biofilm, and the experiments consist in debalancing this state, inducing colloidal transport, which then may facilitate zinc migration. Colloidal particles are actually fragments of biofilm : bacterial cells mixed with extracellular polymeric susbtances.

2 METHODS

Loire sand was the porous media used as packed columns. Colloidal particles were *Pseudomonas putida* bacterial biofilm fragments. They were generated by biofilm destabilisation which was caused by variations in inlet solution composition.

First, the sand was colonized during one week by free cells solution injection then growth medium circulation. Once the biofilm was developped, the destabilisation scenario was as follows : injection of zinc and calcium during 3 pore volumes, then injection of 3 more pore volumes with highly concentrated sodium, then distilled water

till the end of experiment. The variation of the chemical composition of the entering solution could represent scenarios accuring in urban areas were runoff waters can be chemically very different and can bring heavy metals into soils.

In the effluent pH and conductivity were monitored. Protein content was evaluated by Lowry method and cations concentration were quantified by atomic absorption spectroscopy and ionic chromatography. Electronic microscopy was used to observe biofilm fragments.

IMPACT code was used to simulate transport of soluble species, thanks to cation exchange model (more details in Vulava *et al.*, 2002). Reactions taken into account are exchange between species fixed to surfaces (Na_f, Ca_f and Zn_f) and soluble species, this model only takes into account the transfer of soluble zinc, calcium and sodium.

$2\ Na_f + Ca^{2+} \Leftrightarrow Ca_f + 2\ Na^{+}$; $pK_{Na/Ca}$=0.05

$Ca_f + Zn^{2+} \Leftrightarrow Ca^{2+} + Zn_f$; $pK_{Zn/Ca} = 1$

3 RESULTS and discussion

The biofilm that has developped in the sand in a good cation exchanger, and the destabilisation of the biofilm was occuring after the introduction of pure distilled water in the column. The main difference between experimental data and modelled curve for zinc may be explained by colloidal transport phenomenon. Indeed, a small quantity of zinc eluted with the destabilisation of the biofilm can not be explained by cation exchange reactions between the bacteria and zinc. Transmission electronic microscopy and analyses of zinc and proteins contents in the porous media before and after experiments led to same conclusions : a part of eluted zinc is associated to destabilised bacterial colloids.

4 CONCLUSIONS

Facilitated transport of zinc by bacterial colloids has been outlined. Importance of destabilisation process through the definition of a specific scenario involving sodium/cation exchange, has been stressed. This study also confirms the necessity to study colloidal transport. Its originality is to use living colloids, and to start with colloids initially fixed in the medium as a biofilm.

Further research is needed in particular on mobilisation and redeposition processes.

Other destabilisation parameters have to be investigated also : hydraulic parameters, pH variations.

5 REFERENCES

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