As-related bacterial activities in marine sediments

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Introduction: A recent evaluation of the potential impact of arsenic on human health revealed high concentrations of arsenic in marine sediments of the South Marseille littoral. The marine cycle of arsenic is well described in the water column, from dissolved species to phytoplankton, zooplankton and more complex organisms. In contrast, only scarce data are available on the phenomena controlling arsenic transport from sediment to water column. Moreover, the bacterial cycle of arsenic in marine sediments has not been studied yet. Here we compared AsIII-oxidizing and AsV-reducing activities in marine sediments containing high or low arsenic concentrations. We also looked for functional genes related to AsIII oxidation and dissimilatory AsV reduction in the two types of sediments.

Methods: Two port sites in SE France were selected for the first sampling campaign: L'Estaque and Saint-Mandrier. L'Estaque site has been polluted with arsenic by several industrial activities, and Saint-Mandrier was chosen as a reference for the low arsenic content of its sediments, according to previous investigations. Two types of samples were taken: surface sediments (0-10 cm) and lower-than-surface sediments (10-20 cm). The AsIII-oxidizing bacterial activities were determined by inoculating sediments in minimal mineral medium containing 100 $mg.l^{-1}$ AsIII. The AsV-reducing activities were evaluated by inoculating sediments in a buffered medium containing organic energetic substrates and 100 $mg.l^{-1}$ AsV. Molecular methods based on the functional genes *aoxB* (AsIII oxidation) and *arrA* (AsV respiration) were applied in order to evaluate their diversity in the port sediments. As we recently developed the DGGE fingerprinting technique on *aoxB* genes, the *aoxB*-carrying community was studied in more details.

Results: Chemical analyses confirmed that arsenic concentrations, as well as other metallic or organic pollutant concentrations, are significantly higher in L'Estaque than in Saint-Mandrier sediments (Table 1). AsIII-oxidizing bacteria are present at both sites but are more active in the polluted sediment than in the reference one (Figure 1). High AsV-reducing bacterial activities of similar levels were detected at both sites. *aoxB* and *arrA* genes were found in all sampled sediments. DGGE on *aoxB* genes revealed no seasonal nor depth impact on AsIII-oxidizing bacterial community structure, and only few bands were common to both sites. Gene sequence analyses revealed divergent *aoxB* and *arrA* gene from known sequences thus suggesting the presence of specific, probably halophilic As(III) oxidizers and As(V) respiratory reducers.

Site	L'Estaque		Saint-Mandrier	
	0-10 cm	10-20 cm	0-10 cm	10-20 cm
As*	141	232	17	17
Cu*	354	367	191	337
Pb*	360	412	96	108
Zn*	469	463	294	209
Org. C %	3.8	3.2	2.7	4.6
Tributyltin*	374	59	179	43
Dibutyltin*	224	63	142	ND**
Monobutyltin*	347	39	197	ND**
Total Hydrocarbons*	1141	1646	588	ND**

*mg/kg dry sediment **Not Detected

Tab. 1: Concentration in some main pollutants in L'Estaque and Saint-Mandrier sediments.

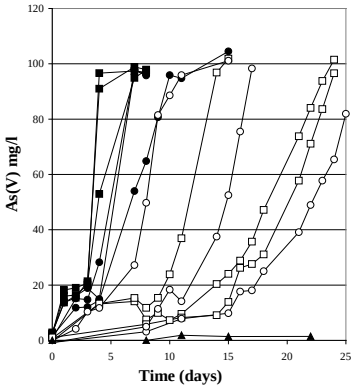

Fig. 1: Determination of AsIII-oxidizing activities. Closed symbols: L'Estaque site. Open symbols: Saint-Mandrier site. Squares: 0-10 cm. Circles: 10-20 cm. Triangles: not inoculated control..

Discussion: Altogether, our results showed a very active bacterial community against As in the marine sediments, where active AsIII oxidizers and AsV reducers co-exist at both locations. The next part of the work will explore the consequence of this activity on As release from the sediment to the water column.

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