

Micro-distribution of major to trace elements across the root-sediment interface in salt marshes

Rita M. Godinho^{1,2}, C. Vale¹, M. Caetano¹, L. C. Alves^{2,3}, T. Pinheiro^{2,3}

¹IPMA Instituto Português do Mar e da Atmosfera, Lisboa, 1449-006, Portugal.

Phone: +351-213027000

²CFNUL Centro de Física Nuclear da Universidade de Lisboa, 2686-953, Portugal.

E-mail: rgodinho@ipma.pt

³IST/ITN Instituto Superior Técnico, Universidade Técnica de Lisboa, 2686-953, Portugal.

Introduction: The biogeochemical processes induced by plant activities are a key aspect for the self-remediation capacity of wetlands [1]. A striking feature of salt marshes is the presence of iron plaques or iron-rich rhizoconcretions on the plant roots [2]. The root-system microenvironments may play a significant role on the elemental cycling and pollutant detoxification or sequestration in upper sediments [3]. Small scale distributions of minor and trace elements are poorly documented and, most importantly, how root-sediment interactions affect the larger scale remediation process of salt marsh [4]. This study reports the major- to trace-element distribution, at a micrometer scale, across the interfaces sediment-rhizoconcretion-root in a contaminated salt marsh. Concentration gradients point to the uniqueness of these systems and lighten how salt marshes may act as a filter to contamination.

Methods: A sediment volume of 20 cm³ was collected from a *Halimione portulacoides* pure stand in the Rosário salt marsh, located in the southwestern part of the Tagus estuary. Slices of sediment containing tubular rhizoconcretions [2] attached to host sediments and roots were obtained and cross sections were analyzed at the proton microprobe set up of ITN/IST [5]. Particle induced X-ray emission (PIXE) and Rutherford backscattering spectrometry (RBS) were used simultaneously to obtain morphological and quantitative elemental distribution data.

Results: Spatial distribution maps and concentration profiles of P, Cl, K, Ca, Mn, Fe, Cu, Zn and As from sediment, rhizoconcretion and the root interior were obtained. Figure 1 exemplifies the Fe case. Noteworthy, content varied within a broad interval in one millimeter: reached 55% Fe near the concretion-root interface, decreased to 10% in the first 200 μm , and was <5% in the host sediment. Maximum concentrations of P (3%), As (1200 $\mu\text{g g}^{-1}$), and Zn (3000 $\mu\text{g g}^{-1}$) were found in concretions, being one order of magnitude above the values registered in the host sediment. Roots presented enhanced concentrations of Mn, Cu and Zn in contrast with the Fe and As distribution. Among the analyzed cortex, medulla and epidermis, this tissue retained the higher Cu and Zn concentrations.

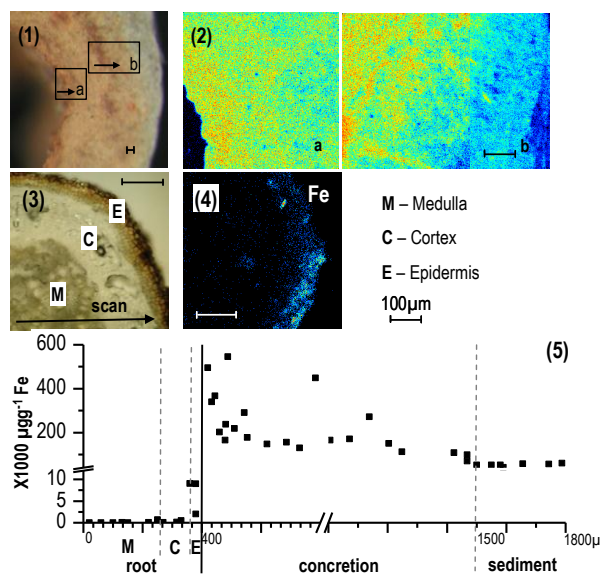


Fig. 1: (1,3) Optical microscopy photographs of *H. Portulacoides* rhizoconcretion and root cross section; (2,4) PIXE map of spatial distribution of Fe; (5) Fe concentrations along the transept root to sediment.

Discussion: By examining the micro-scale distribution of trace elements at sediment-rhizoconcretion-root interfaces this work points to: (i) strong concentration gradients of several elements in the inner part of concretions adjacent to the root wall; (ii) additional concentrations peaks within concretions reflecting the enrichment of interstices with Fe precipitates; (iii) selective barrier of the root epidermis to the trace elements crossing the concretions; (iv) internal partitioning of Cu, Zn and Mn among the root tissues.

H. portulacoides induces changes on rhizosphere, leading to the sequestration of several elements near the root wall. This retention may affect the metal cycling in salt marsh ecosystems. In the present work, it was found that Fe, P and As were immobilized in rhizoconcretions while Cu, Zn, and Mn crossed the root wall and were taken by the plant.

References: [1] Weis and Weis (2004) *Environ Int* **30**:685-700; [2] Vale et al. (1990) *Sci Total Environ* **97**:617-626; [3] Xu et al. (2009) *Water Air Soil Pollut* **200**:79-87; [4] Vesik et al. (1999) *Plant Cell Environ* **22**:149-158; [5] Verissimo et al. (2007) *Microsc Res Tech*.**70**:302-309.