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Calcareous electrochemical precipitation, a new method to trap dissolved metallic contaminants in seawater

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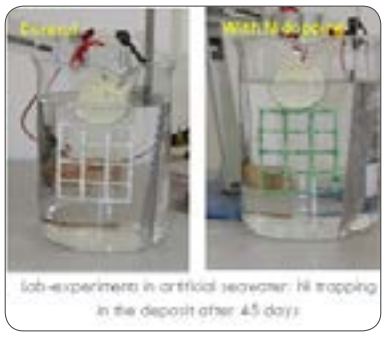
The contamination of coastal waters by trace metals is an important worldwide concern since they may significantly affect marine ecosystems. A novel use of the calcareous deposit formed on a metallic structure is proposed to trap metallic contaminants in seawater. It is the same deposit that builds up in many tea kettles or water pipes in areas where calcium-rich water is the norm. Whereas the calcareous deposition is a common problem for many people, we transformed this problem into a solution to trap metals. The calcareous deposit is formed in seawater by imposing a current on a galvanized steel electrode. The working electrode's potential reaches potential in the water reduction range. This reaction causes pH increase at the seawater/metal interface, inducing calcium and magnesium precipitation. A voluminous calcareous deposit composed of $CaCO_3$ and $Mg(OH)_2$ grows with polarization time. Experiments conducted *in situ* revealed that many metals can also be trapped. In order to better control and understand the mechanisms, lab-experiments were performed in artificial seawater. We first decided to study nickel trapping since nickel mining activities in New Caledonia are causing the subsequent pollution of local coastal waters. Artificial seawater was doped with $NiCl_{2(s)}$ and analysis revealed that Ni is trapped mainly as β-$Ni(OH)_2$. Ni content increases with the initial Ni concentration in the electrolyte. Up to 24% in weight of Ni is trapped in the deposit after seven days of polarization. The calcareous deposit appears like a simple implementation with just a metallic structure immerged in seawater and connected to an electrical circuit which can be charged by renewable energy. This electrochemical method is thus a promising and cheap clean-up device for remediation of contaminated seawater.



Lab-experiment in artificial seawater: Ni trapping in the deposit after 45 days

Recent Publications:

1. Carre´ C, Gunkel Grillon P, Serres A, Jeannin M, Sabot R and Quiniou T (2017) Calcareous electrochemical precipitation, a new method to trap nickel in seawater. Environmental Chemistry Letters 15(1):151-156.
2. Pasquet C, Le Monier P, Monna F, Durlet C, Brigaud B, Losno R, Chateau C, Laporte Magoni C and Gunkel Grillon P (2016) Impact of nickel mining in New Caledonia assessed by compositional data analysis of lichens. SpringerPlus 5(1):2022.
3. Pasquet C, Gunkel Grillon P, Laporte Magoni C, Serres A, Quiniou T, Rocca F, Monna F, Losno R, van Oort F and Chateau C (2016) Alternative dry separation of PM10 from soils for characterization by kinetic extraction: example of New Caledonian mining soils. Environmental Science and Pollution Research 23(24):25105-25113.
4. Gunkel Grillon P, Roth E, Laporte Magoni C and Le Mestre M (2015) Effects of long term raw pig slurry inputs on nutrient and metal contamination of tropical volcanogenic soils, Uvéa Island (South Pacific). Science of the Total Environment 533:339-346.
5. Gunkel Grillon P, Laporte Magoni C, Lemestre M and Bazire N (2014) Toxic chromium release from nickel mining sediments in surface waters, New Caledonia. Environmental Chemistry Letters 12(4):511-516.

Biography

Peggy Gunkel Grillon is an Environmental Chemist having expertise in heavy metals and their contamination, bioavailability and mobility in the environment. She is an Assistant Professor since 2008 and Deputy Director of ISEA laboratory (Institut des Sciences Exactes et Appliquées) at the University of New Caledonia. She has a keen interest in understanding heavy metals behavior in the environment for a modern society concerned with sustainable development. Recently, her activities also include the development of remediation techniques. With her colleagues she's been working for 4 years on the electrochemical precipitation of heavy metals in seawater to trap dissolved metallic contaminants

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