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Remediation of soils contaminated with metals

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Valgo is a company dedicated to soil remediation works and decontamination of mainly asbestos from building sites. Several years ago, in collaboration with ECOLAB (a laboratory, part of an institute for agronomy in Toulouse) a study began into the possibilities of removing pollutants from contaminated solid using hyper-accumulators. These are plants that are able to grow in soils with high metals content, and then to accumulate these metals in their roots, shoots or leaves. This process is reported to be very slow, reaching remediation goals in one or more centuries.

However, in collaboration with a group of students, experiments commenced in a greenhouse using Pelargonium, a well-known hyper-accumulator, to remove pollutants from contaminated soils. The belief was that the main obstacle for metal capture by the plant is the low bio-availability of the metals. This was because only a very small part of the metal is soluble, hence free for uptake by the plant.

To address this problem a chelator (EDTA) was introduced into the system, this being a chemical used in agriculture and medicine to interact with metals and enable their solution in water in a stable form.

It was considered that the amount of metal that might be solubilised could be greater than the plant uptake and that it

would be necessary to collect the water draining from the system. This occurred in practice, and the first results showed that most of the metals were being flushed through the soil and discharged from the containers in the drainings.

Based on these initial findings work began on the DePLAssMetaux project (Demonstrator for the Assisted Phyto-Lixiviation of heavy Metals). This project is funded by the French Ministry of Industry, through Ademe, the French Agency for Environment. There are five partners:

- VALGO: lead organisation of the project that brings experience of remediation work.
- Ecolab: the agricultural specialist, with focus on Pelargonium.
- LCA: a laboratory with biomaterials specialisation, Pelargonium being a provider of essential oils.
- Egeh: a study office with the role of performing impact studies for the project and preparing the mandatory declaration for the method of future remediation.
- The City of Graulhet: the brownfield site under study is within the city and included two tanneries that ceased activities during the 1990s.


Panel 1:

Metal	Quantity Mg/Kg soil as dry weight	Recovery %
Arsenic	32	0.3
Cadmium	1,345	4.0
Chromium	84.5	
Copper	23	5.0
Mercury	0.075	
Lead	210	11.5
Nickle	14.5	
Zinc	124	2.5

The DePLAssMetaux project commenced using soils that contained lead, copper, zinc, arsenic and cadmium, and were based upon both laboratory and greenhouse studies. The laboratory work concerned the treatment of water draining from the system, with focus on how to separate any residual metals contained in these drainings, and the best way for reuse of these drainings for soil irrigation. This was because the solubilisation of the metals was greater than the rate of plant uptake.

Accordingly, a technique was created to precipitate these metals as a recoverable sludge, then regenerate the de-polluted drainings for further irrigation. The metals concentrated in the sludge were then combined with the metals concentrated in the plant ash at the end of the trials to provide a value for total recovery.

The greenhouse studies were performed with Pelargonium to compare the different species for development and growth under different conditions, and the effect of chelators. The first results were calculated after 33 weeks, and the findings are given in *Panel 1* and are especially promising for lead remediation.

These experiments have been translated in more industrial terms. The photograph in *Panel 2* shows details of the site before adding the soil for treatment, and *Panel 3* shows the same area two days after planting the geraniums.

Panel 2: Construction of the remediation site.


The details of this field-scale pilot plant include:

- A zone for the study of about 300 m² in size, including an area for Pelargonium culture of 100 m², a shelter for the treatment plant, a cabin to serve as office and minilab.
- The excavation of a basin lined with an impervious membrane to keep the system fully encapsulated. Oversize stones were set in the base for drainage, before filling the basin with 100 tonnes of contaminated soil.
- A thousand Pelargoniums planted in this soil, and then watered with the demineralising or chelator solution.
- The collection of the drainings from the system in a sump and pumped periodically for the precipitation and collection of the metals as a sludge, then preparation and reuse of the drainings in the irrigation loop.

At the end of further extensive investigations the Pelargonium culture will be harvested, and an essential oil extraction will be performed to ensure the absence of metals in the extracts. The remaining plant-parts will then be incinerated and the total removal of metals from the system determined. Finally, the ashes containing the concentrated metals will be sent to a landfill for toxic wastes. ☹

Panel 3: Site 48 hours after transplant of Pelargonium plants.
