Gold phytomining

Maria Letícia Neves Figueiredo
Definition: Bioharvesting of metals from high biomass crops grown in soil substrates, particularly those associated with sub-economic mineralization.
Why gold phytomining?

- Economic value: Valuable metal and high metal concentration in hyperaccumulator biomass.

<table>
<thead>
<tr>
<th>Metals</th>
<th>Biomass (kg/ha)</th>
<th>Metal concentration (mg/kg)</th>
<th>Metal concentration (kg/ha)</th>
<th>Current metal price in $ per hectare (May 2008)</th>
<th>Current metal price in $ per hectare (January 2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thallium</td>
<td>8000</td>
<td>4055</td>
<td>32.5</td>
<td>151,125</td>
<td>157,625</td>
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<td>Gold</td>
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<td>0.2</td>
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<td>6489</td>
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<td>Manganese</td>
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<td>55,000</td>
<td>1650</td>
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<td>Cobalt</td>
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<td>10,200</td>
<td>40.8</td>
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<td>Nickel</td>
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<td>17,000</td>
<td>306</td>
<td>6946</td>
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<td>Lead</td>
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<td>66</td>
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</table>

(Sheoran V., 2009)
Advantages of gold phytomining

- Possibility of exploiting metals from low-grade ores, overburdens, mill tailings or mineralized soil that is uneconomic by conventional mining methods.

- Formation of gold nanoparticles within plant cells
Plants do not normally accumulate gold; the metal must be made soluble before uptake can occur.

Gold hyperaccumulation: a concentration above 1 mg/kg in the dry weight of plant tissues.
Gold phyto-reclamation

- Many reports of gold accumulation by plants, in particular trees.
- Induced hyperaccumulation of gold has been achieved with Indian mustard (*Brassica juncea*), corn (*Zea mays*), *Berkheya coddii*, *Impatiens* sp. (touch-me-nots) and Chicory (*Cichorium intybus*).
Question 1

- List 3 advantages of gold phytomining (or phyto-reclamation)
Research target: To harvest a crop with a dry biomass of 10t from 1ha of land, and to induce gold concentration in the dry biomass of 100mg/kg
Field test carried out in 2003, at Fazenda Brasileiro mine, north of the city of Salvador in Bahia, Brazil, with collaboration with Companhia Vale do Rio Doce.
A mini ore pad 15mx15mx0.5m deep was constructed on top of a waste-rock dump at the farm’s site.

The phyto-reclamation trial plot 6 weeks after seeding.
The 6-week growing cycle used in the trial was insufficient for the two species to attain maximum biomass.

Phyto-toxicity of the Ca\(^+\) plot, due to high pH of the ore amended.

Accumulated metal concentrations were higher in Indian mustard.
Trial for gold phyto-reclamation

- Highest gold recovery: 18%
- Plants accumulate gold in proportion to the concentration of metal in the substrate.
- A gold concentration of 2mg/kg is required in the substrate to yield a crop with a gold concentration of 100mg/kg.
Conclusions

- Feasible technology
- Good for reinstitute vegetation and recover residual gold.
- Results consistent with those obtained in laboratory greenhouse conditions.
Question 2

- Name one change to the site or the methods you should do to improve the gold phyto-reclamation


Answers to questions:

1) Valuable metal that can generate income with a low cost extraction. Technique that doesn’t damage the environment. Technique that can extract the metal from sites that regular mining can’t. Production of gold nanoparticles within the plant.

2) Do not use Ca+ to increase the pH as an amendment. Inhibit the plant’s copper uptake, because it is highly toxic to the plant. Do more than one cycle of plant harvesting. Genetically modify the plants to increase it’s gold uptake and it’s resistance to copper.