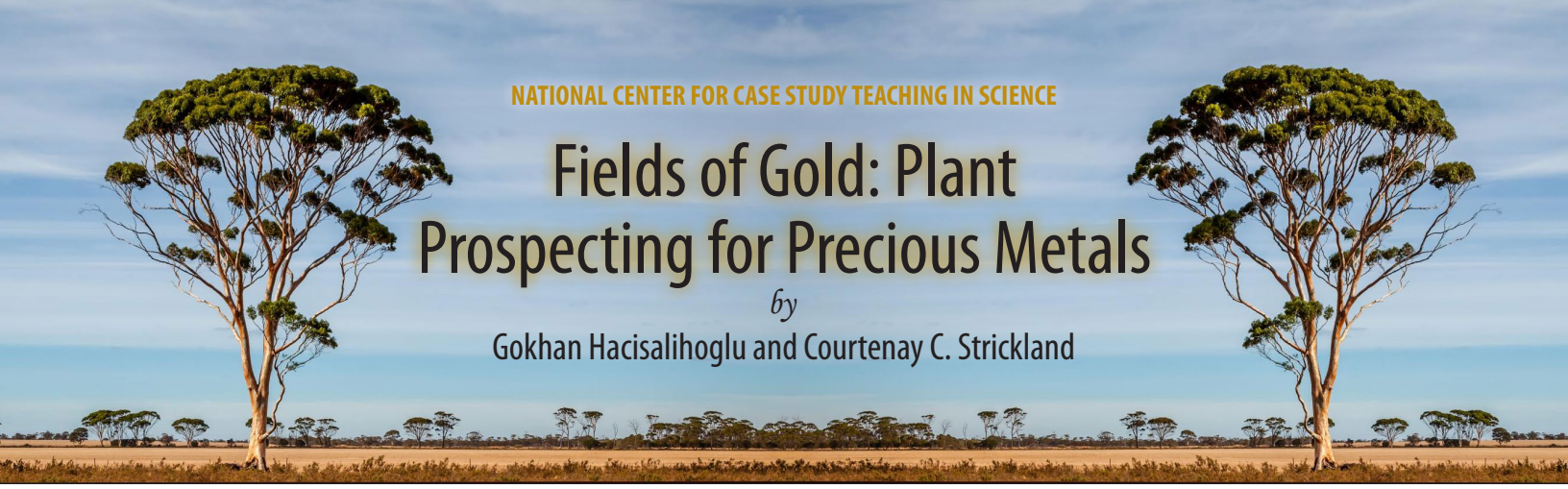

NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

Fields of Gold: Plant Prospecting for Precious Metals

by
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Part I – A New Technique for Gold Exploration

Greater Heights, Inc. (GH)—a global leader in green technology (greentech)—specializes in phytoremediation techniques that use living plants in the cleanup, removal, breakdown, or containment of soil that has been contaminated by pollutants. Specifically, GH uses hyperaccumulator plants to remove metals from soil. These hyperaccumulator species tolerate extreme levels of contamination, absorbing as much as four percent (4%) of their dry weight in metals. Though the full physiological mechanisms for this are not yet well understood, scientists know the phenomenon derives from millions of years of evolution, through which these species developed the capacity to survive in metal-rich soils. GH uses root uptake, xylem tissue translocation, and leaf harvest technologies to solve various metal removal problems around the world.

GH has just hired you as an agricultural engineer for phytomining. Your initial on-the-job assignment is to find and identify tree species capable of locating Western Australia's buried gold ores in eco-friendly ways.

You have just received an email stating that a staff meeting will be held on Monday morning. Since this is your first meeting, you have been asked to prepare a PowerPoint presentation to share your vision of gold phytomining with the rest of the staff. You are aware that your presentation needs to impress the VP of Research, who was skeptical about your hiring and who questions the validity and efficacy of phytomining. In addition to the PowerPoint presentation, you also need to prepare a handout outlining the key concepts and facts behind your ideas.

To develop a powerful presentation, you must uncover and explain the structure and mechanisms behind phytomining.

Questions

Use the word bank to match the appropriate letters to the descriptions below.

(a) Accumulation	(b) Gold exploration	(c) Gold mining	(d) Hyperaccumulator	(e) Phytoextraction
(f) Phytomining	(g) Phytoremediation	(h) Precious metals	(i) Refining	(j) Xylem

1. _____Exploring for gold deposits and nuggets.
2. _____A type of hyperaccumulation in which a plant absorbs and stores metals.
3. _____Plant-based exploration and extraction of precious metals.
4. _____Rare and high economic value metals such as gold, silver, and platinum.
5. _____A type of vascular tissue that transports water and minerals from soil to root, stem, and leaf.
6. _____Continuous increase by addition.
7. _____Cleaning the metal.
8. _____Using plants to remove contaminants in the soil or water.
9. _____A plant that can accumulate large quantities of metals.
10. _____Process of mining gold ores from underground.

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Part II – A Scientific Article

After a literature search, you have selected the *Nature Communication* research paper, "Natural gold particles in *Eucalyptus* leaves and their relevance to exploration for buried gold deposits" (Lintern *et al.*, 2013), for your upcoming meeting. The article is open access, and you find it at **https://www.nature.com/articles/ncomms3614**. At the meeting, you will need to lead attendees in a discussion. The questions below will help you prepare.

Questions

1. Why is *Eucalyptus* a good candidate for gold exploration and phytomining?

2. Fill in the table below to summarize the advantages and disadvantages of phytomining.

Advantages	*Disadvantages*

3. What are the main advantages of *Eucalyptus salmonophloia* for phytomining?

Part III – Show Me the Evidence

The following tables and figure are taken from the Lintern *et al.* (2013) study on *Eucalyptus* leaves. Discuss the results and answer the following questions.

Qusetions

1. Which plant organ is the most reliable in detecting gold? Describe the results depicted in Table 1.

Table 1. Gold concentrations in parts per billion (ppb) in various plant parts (leaves, bark, twigs), litter, and soil. *Source:* adapted from Lintern *et al.*, 2013, Supplementary Table S2,

FieldID	*Leaves*	*Litter*	*Bark*	*Twigs*	*Soil*
RD 71	2.2	6.8	1.4	0.7	9.4
RD 72	3.6	2.4	0.8	2.1	10.4
RD 73	1.8	10.9	0.6	1.1	12.8
RD 74	1.3	5.6	1.4	0.8	11.7
RD 75	2.3	5.2	1.6	1.8	12.8
RD 76	3.1	6.2	0.6	2.3	12.9
RD 77	4.9	3	0.8	1.9	16.1
RD 78	3.2	4	0.1	1.5	16
RD 79	1.6	7.8	0.6	1.1	17.6
RD 80	7.8	4.4	1	2.4	14.9
RD 51	47.6	4.8	0.6	26.2	31
RD 50	14.1	5.2	1.6	3.06	31.5
RD 60	1.7	7	0.8	0.9	21.4
RD 53	4	4.8	2.2	1	27.1
RD 54	2.9	6.4	1.8	1.4	26.5
RD 52	6.3	3.8	0.6	1.5	20.6
RD 55	20.3	5.6	0.6	6.2	24.1
RD 56	82.9	5.2	0.4	44.05	18.7
RD 59	9.8	7.9	3.8	2.4	25.9
RD 57	4.4	4.7	0.4	0.7	22.6
RD 58	18.8	13.1	0.4	3.1	21.5
RD 70	7.9	6.2	1.4	2.5	24.4
RD 69	3.5	4.4	2.2	1.1	15.4
RD 68	5.47	4.0	0.8	2.03	13
RD 67	2.5	5.0	2.8	1.5	11.9
RD 66	6.3	7.2	0.6	1.9	15.6
RD 65	2.2	3.4	1.2	1.1	11.5
RD 64	3.9	3.6	0.8	1.1	12.5
RD 63	3.5	6.1	1.2	0.8	11.4
RD 62	1.1	8.1	2.4	1.4	11.6
RD 61	10.4	6.4	1	1.3	11.1
Mean	**9.4**	**5.8**	**1.2**	**3.9**	**17.5**
Stand.	**16.0**	**2.2**	**0.8**	**8.6**	**6.3**

2. Which part of the typical *Eucalyptus* leaf develops the highest concentration of gold (Au)? Use the data in Table 2 to support your answer.

Table 2. Gold concentrations in parts per billion (ppb) in various sections (left, middle, right) of individual leaves. *Source:* Lintern *et al.*, 2013, Supplementary Table S3, CC BY-NC-SA 3.0.

Lab ID	*left*	*middle*	*right*
RD56T-1	23	7	39
RD56T-2	5	6	9
RD56T-3	11	76	15
RD56T-4	20	9	72
RD56T-5	40	24	74
RD56T-6	96	18	36
RD56T-7	56	124	33
RD56T-8	41	5	15
RD56T-9	70	8	14
RD56T-10	6	13	30
RD56T-11	17	46	10
RD56T-12	51	33	141
RD56T-13	359	11	84
RD56T-14	37	72	48
RD56T-15	30	10	32
RD56T-16	19	41	16
RD56T-17	30	25	46
RD56T-18	10	19	264
RD56T-19	37	250	21
RD56T-20	10	6	7

3. Describe the results depicted in the graph in Figure 1. Which two elements have the strongest relationship?

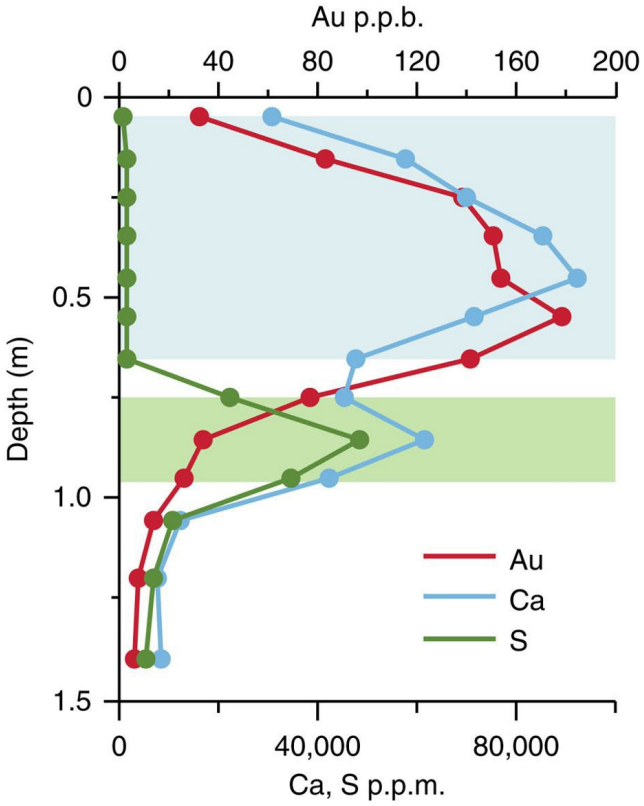

Figure 1. Relationship between different metals in the soil. Metal concentrations are shown in parts per billion (ppb). *Source:* Lintern *et al.*, 2013, Figure 5, CC BY-NC-SA 3.0.

4. What is the average concentration of gold (Au) that a single eucalyptus leaf contains based on the data from Table 2?

5. Besides gold, which other metals could *Eucalyptus* trees could be used to find?

6. What did this paper show? Is it realistic to use *Eucalyptus* trees for gold exploration? Why or why not?

7. Based on what you learned from the research paper, design a follow-up experiment with a new metal (other than gold) and a new plant (other than *Eucalyptus*).

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