Using Hyperaccumulator Plants to Phytoextract Soil Ni and Cd

Rufus L. Chaney[a,*], J. Scott Angle[b,h], Marla S. McIntosh[b,h], Roger D. Reeves[c,h], Yin-Ming Li[d], Eric P. Brewer[d], Kuang-Yu Chen[b], Richard J. Roseberg[e], Henrike Perner[f], Eva Claire Synkowski[b], C. Leigh Broadhurst[b], S. Wang[b], and Alan J. M. Baker[g,h]

[a] USDA-Agricultural Research Service, Animal Manure and By-Products Lab, Beltsville, Maryland, USA, 20705. E-mail: chaneyr@ba.ars.usda.gov
[b] University of Maryland, College Park, MD, USA
[c] Institute of Fundamental Science-Chemistry, Massey University, Palmerston North, NZ, USA
[d] Viridian LLC, Houston, TX, USA
[e] Oregon State University, Central Point, OR, USA
[f] Institute for Plant Nutrition, Hohenheim University, Germany
[g] University of Melbourne, Melbourne, Australia
[h] Phytoextraction Associates LLC, Baltimore, MD, USA

* Author for correspondence and reprint requests

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Two strategies of phytoextraction have been shown to have promise for practical soil remediation: domestication of natural hyperaccumulators and bioengineering plants with the genes that allow natural hyperaccumulators to achieve useful phytoextraction. Because different elements have different value, some can be phytomined for profit and others can be phytoremediated at lower cost than soil removal and replacement. Ni phytoextraction from contaminated or mineralized soils offers economic return greater than producing most crops, especially when considering the low fertility or phytotoxicity of Ni rich soils. Only soils that require remediation based on risk assessment will comprise the market for phytoremediation.

Improved risk assessment has indicated that most Zn + Cd contaminated soils will not require Cd phytoextraction because the Zn limits practical risk from soil Cd. But rice and tobacco, and foods grown on soils with Cd contamination without corresponding 100-fold greater Zn contamination, allow Cd to readily enter food plants and diets. Clear evidence of human renal tubular dysfunction from soil Cd has only been obtained for subsistence rice farm families in Asia. Because of historic metal mining and smelting, Zn + Cd contaminated rice soils have been found in Japan, China, Korea, Vietnam and Thailand. Phytoextraction using southern France populations of *Thlaspi caerulescens* appears to be the only practical method to alleviate Cd risk without soil removal and replacement. The southern France plants accumulate 10–20-fold higher Cd in shoots than most *T. caerulescens* populations such as those from Belgium and the UK. Addition of fertilizers to maximize yield does not reduce Cd concentration in shoots; and soil management promotes annual Cd removal. The value of Cd in the plants is low, so the remediation service must pay the costs of Cd phytoextraction plus profits to the parties who conduct phytoextraction. Some other plants have been studied for Cd phytoextraction, but annual removals are much lower than the best *T. caerulescens.* Improved cultivars with higher yields and retaining this remarkable Cd phytoextraction potential are being bred using normal plant breeding techniques.

Key words: Zinc, *Thlaspi caerulescens*, *Alyssum murale*