NICKEL PHYTOMINING
A Green Metal Extraction Technology
What is Phytomining?

- The use of specially developed agricultural plants called hyperaccumulators to extract metals from the ground and concentrate the metals in leaves and stems.

- This hay-like crop, once harvested, baled, dried, and ashed, produces a commercially valuable metal rich concentrate suitable as a high grade feed to existing smelters/refineries or for direct marketing.
Planting Methods
Nickel Phytomining Crop
Harvesting
Ashing & Purifying
Smelting Viridian’s Ash
Nickel Finished Product
Phytomining’s Potential

- Renders abundant non-viable and undeveloped resources into attainable (levels as low as < 0.05-1.0% nickel) reserves
- 1,000 hectares (2,500 acres, 4 sq miles, 10 sq kilometers) would support the production of 15,000 to 25,000 metric tons (MT) per year of biomass, which at ~2% nickel would capture 250 to 550 MT of nickel with approximate market value of $3-$7 million @ $6.00/annual-lb of production
- Combustion of biomass generates heat (6,500 Btu/lb) – 25,000 MT could produce approximately 15,000 MWh of electricity, with a value $1.2 million at $80/MWh
- A 450 MT (1 million lb) per year nickel project with nickel at $6.00/lb, would produce a net revenue of $5 million, $4 million from the sale refined nickel, $1 million from power credits
- This is applicable to both green field sites, and as a supplement to existing operations
Nickel laterites, the most appropriate resource base, are widely distributed; areas of particular interest are the Caribbean (Guatemala, Colombia, Dominican Republic, Cuba), Brazil, the Mediterranean (Albania, Greece, Turkey) and South East Asia/Pacific (Philippines, Indonesia, New Guinea, New Caledonia, Australia)
Advantages of Phytomining vs. Traditional Mining Processes

- Short lead time to production with harvest in under 24 months from decision to proceed as opposed to 7-12 years
- Enhance the cost effectiveness of existing mining operations
- Bypasses primary metal leach systems
- Substantially lower capital costs of ~$2.00/annual-lb of nickel production vs. $20-50/annual-lb with an associated power plant cost at $3.00/annual-lb of nickel production
- Lower operating costs of ~$2.00/annual-lb of nickel production (including refining) vs. $2.50-$6.00/annual-lb of nickel production
- Potential for $1.00/annual-lb in revenue from by-product heat/electric power vs. massive energy consumption and costs (Mining is very energy intensive – just one mining company (Vale) depletes 4% of Brazilian energy annually)
- Does not require skilled labor or specialized equipment
- Productive where mineral deposits are at levels that are as low as 1/20th the metal concentration required for conventional processes
- Has remedial, not destructive, effect on the environment
Viridian’s Technology Enables Low Cost Production

Nickel Industry Cash Cost Curve 2015 (net of byproducts)
**Nickel Prices are Historically Volatile**

The current low price of ~$5.00/lb is threatening low grade/high cost producers (see process flow sheets in the appendix), providing a unique opportunity for phytomining to provide a source of low cost supplemental feed.
Steps to Implementation

- Identify appropriate metal rich sites globally including nickel laterites and other metal rich substrates such as tailings from existing operations
- Conduct soil chemistry tests to determine optimal agronomic methods regarding fertilization, irrigation, and cultivation
- Prepare land for phytomining; plant seeds of metal hyperaccumulating species
- Harvest and bale hay* – one crop per year in temperate zones and two crops per year in the tropics
- Incinerate hay to recover or generate metal rich ash
- Provide metal rich ash to refineries/smelters to produce purified metal
Viridian’s Patented, Proprietary and Innovative Technology is Years Ahead of Any Potential Competitors

- Viridian spent four years in collaboration with USDA scientists identifying, collecting, and assessing over 300 hyperaccumulating species from around the globe.
- Viridian and its collaborators have invested over $5 Million developing its proprietary technology.
- Multi-year selective breeding program and agronomic research program has generated improved non-GMO cultivars and growing techniques.
- Improved cultivars and growing techniques result in phytomining improvements greater than 250% over unimproved varieties.*
- Viridian has generated commercial quantities of enhanced seeds.
- Viridian is poised to exploit commercial operations.

*Source USDA
Management Team

- **Jay Nelkin, J.D., M.Sc., Founder & CEO**
  - Over 15 years phytomining experience
  - Extensive leadership experience overseeing phytomining development

- **David A Huggins, Ph.D., P. Eng, President and COO**
  - Over 40 years in Nickel Industry with INCO, BHP and Skye Resources
  - Broad experience covering process design and development, engineering, construction, operations and general management; of which 15 years specifically related to the evaluation and design of plants for the processing of nickel laterites in Guatemala, Indonesia and New Caledonia

- **David Bardin, Partner, Director Strategic Relationships**
  - Worked in sales and trading at Bear Stearns, and Oscar Gruss Inc.
  - Lived and worked in the Middle East for eight years; travelled extensively throughout Eastern and Central Europe developing a business network across various industries.
  - Most recently based in Paraguay, where he maintains contacts in the government and business communities
## Investment Highlights

### Market
- Multi-billion dollar opportunity to mine nickel using new, innovative technology

### Technology
- Validation through numerous field tests globally

### Reserve Base
- Very large, low grade deposits located globally that cannot be developed by conventional techniques

### Economics
- Very high returns even at low nickel prices. 50% plus IRR at $5-6 per lb nickel
- Low cost of production and capital intensity
- Multiple products from one process: metals and energy
- Rapid start up and production. 24 months vs. 7 years for conventional mining

### Team
- Experienced personnel on board

### Barriers to Entry By Competitors
- Patented and proprietary technologies
- Significant R&D lead – developed improved phytomining plant varieties and growing techniques
Thank you

For More information please contact David Bardin

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Appendix
Viridian Milestones

- Phytomining patents filed by the U.S. Department of Agriculture (USDA), University of Maryland and the University of Sheffield and patents issued and granted in the U.S. and other countries that licensed to Viridian

- Viridian enters into a Cooperative R&D Agreement (CRADA) with the USDA and multiple universities to successfully develop commercially feasible phytomining technology and crops

- Successful field trials conducted at sites in the United States, Canada and Indonesia. Viridian receives over $1,500,000 for its phytomining services
$20+ billion Global Annual Nickel Market.

- Nickel is the key ingredient in the manufacture of stainless steel and has over 300,000 industrial applications including in the manufacture of cars, aircraft, mobile phones and computers.
- In recent years over 50% of world demand has come from China, most recently satisfied by the direct shipment of ores from the Philippines and Indonesia.
- The new Indonesian Mining Law forbids the export of raw ore, requiring in-country processing; this provides a particular opportunity for Phytomining.
Advantages of Phytomining vs. Traditional Processes

Established Extraction Processes - All multiple Stage and Complex - High Capital and Operating Costs

**Nickel Laterites**
- Many forms and many processes - all targeted at extracting the nickel and rejecting the other rock components
- 1% - 1.5% Nickel
- 40%-50% Iron
- Capital (Ambatovy $50/an lb Ni; operating cost $2.50 to $4.00/lb depending on ore grade

**Limonites**
- 1% - 1.5% Nickel
- 40%-50% Iron
- Capital (estimated) $30-$40/an lb Ni; operating cost $2.50-$4.00/lb depending on ore grade

**Mixed Ores**
- 1% - 1.5% Nickel
- 20%-40% Iron
- Capital (estimated) $30-$40/an lb Ni; operating cost $2.50-$4.00/lb depending on ore grade

**Saprolites**
- 1.2%-2.5% Nickel
- <20% Iron
- Capital (Koniombo) $45/an lb Ni, operating cost $2.50 - $6.00/lb depending on grade

Phytomining - Simple Farming - Low Tech - Low Capital and Operating Costs

By selectively extracting the nickel, the plant eliminates the needs for mining, crushing, grinding and processes to reject the other rock components

**All Lateritic Ores**
- >0.1%Nickel
- <20% - 50% Iron
- Capital <$2.00/an lb Ni, operating cost (including refining) ~$2.00/lb independent of ore grade

Note - the ash is of similar nickel grade to the intermediate products from the laterite hydrometallurgical processes