Pollution Remediation in Mining Processes

FEBRUARY 15, 2024

Clean Rivers Foundation | Grafinos Corporation

Executive Summary

Introduction

Lithium mining poses significant environmental dangers, including extensive water usage and pollution, soil degradation, and air contamination. The extraction process, particularly from brine, consumes vast amounts of water, leading to water scarcity in arid regions and contamination of local water sources with toxic chemicals like sulfuric acid and sodium hydroxide, which harm ecosystems and local communities. Additionally, the mining process disrupts wildlife habitats, causes soil erosion, and emits substantial greenhouse gases, contributing to climate change. These environmental impacts are exacerbated by the displacement of indigenous communities and the lack of sustainable mining practices, highlighting the need for more responsible and eco-friendly extraction.

Moreover, the environmental monitoring of lithium mining operations has often been inadequate, failing to account for the long-term impacts on the water cycle and local ecosystems. The lack of comprehensive environmental life-cycle analyses means that the full extent of water pollution and its effects on biodiversity and human health are not well-documented. In Chile, for example, the privatization of water and mineral rights has allowed mining companies to exploit these resources with minimal oversight, leading to significant ecological damage and social unrest among indigenous communities. The pollution of water sources not only threatens local wildlife, but also disrupts the lives of local residents, who are often left without access to clean water. These issues highlight the urgent need for more sustainable and responsible mining practices to mitigate the environmental and social impacts of lithium extraction.

> ***"We must begin thinking like a river if we are to leave a legacy of beauty and life for future generations." – David Brower***

Environmental Impacts of Lithium:

1. Water Usage and Pollution:
- High Water Consumption - Lithium extraction, particularly from brine, is water-intensive. It requires approximately 500,000 liters of water to produce one ton of lithium, which can lead to water scarcity.
- Water Pollution - The process can contaminate local water sources with chemicals such as hydrochloric acid and sodium hydroxide, affecting both human health and local ecosystems.

2. Soil and Land Degradation:
- Soil Degradation - Lithium mining can lead to significant soil erosion and degradation, impacting agricultural productivity and local vegetation.
- Land Disruption - Open-pit mining methods disrupt large areas of land, leading to habitat destruction and loss of biodiversity.

3. Air Pollution and Carbon Emissions:
- Air Pollution - Mining operations release dust and particulate matter, contributing to respiratory issues for nearby communities.
- Carbon Emissions - The extraction and processing of lithium are energy-intensive, leading to substantial greenhouse gas emissions. Each ton of mined lithium can emit up to 15 tons of CO_2.

4. Impact on Local Communities:
- Displacement and Health Issues - Mining activities can displace local communities and lead to health problems due to pollution and water scarcity.
- Indigenous Rights - Indigenous communities often face significant disruptions to their traditional ways of life and lack a voice in mining operations, leading to social conflicts.

5. Biodiversity Loss:
- Habitat Destruction - The extraction process can destroy habitats, threatening local wildlife, including endangered species.
- Aquatic Life - Water pollution from mining chemicals can harm aquatic ecosystems, affecting biodiversity in rivers and lakes

Clean Waterways

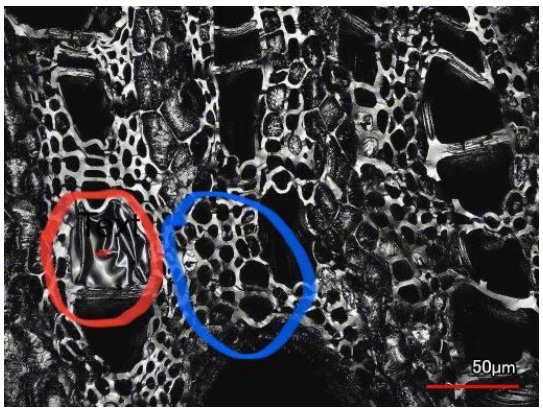
Project Background

Grafinos has developed a patented process to produce 3D Graphene (Grafinos) for >10x cheaper than current market methods. Grafinos' unique properties are derived from its structure.

Red circle: diamond lattice

Blue circle: unique Grafinos lattice

These 3-dimensional graphene lattices are what allow Grafinos to syphon the hydrogen found in methane (CH4)

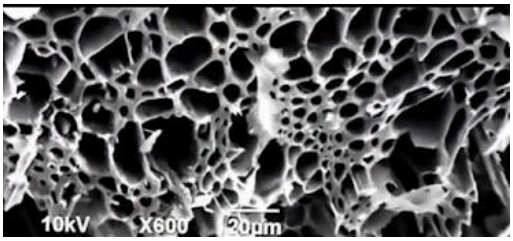


Advantages:

- No special equipment required
- Rare 3D graphene, readily usable in additives
- Producing >1 metric ton per week of product already
- Ability to match entire global Graphene production within 3 years
- Minimal energy input – comparable to that of igniting a matchstick
- Recycles biomass waste product and creates by-products that fix methane from the air
- Grafinos Cost: $0.05 per gram
- Current market price for graphene: $100-400 per gram

Removing Pollutants:

Grafino's AquaChar™ is currently sold as an end consumer product where it is used in commercial aquariums to sanitize water in lieu of using conventional chemical additives.



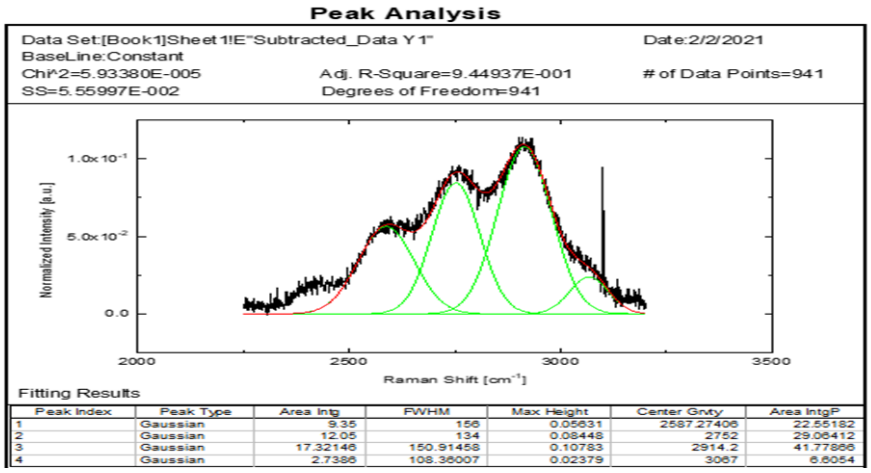
Grafinos has demonstrated abilities to filter a wide range of pollutants from water including pharmaceuticals and petroleum by-products such as sulfur, and heavy metals including lead and mercury.

Grafino's AquaChar™ was formerly studied by University of Miami to filter Mercury from water to undetectable levels within just 10 minutes.
Grafinos is a composite that contains

41% Graphite
29% Graphene
Graphene Oxides, useful for:
Sensors
Filtration
Graphene Nanoplatelets (GNPs), useful for:
Composites
Coatings
Energy storage
Metals & minerals

Verified independently through Raman Spectroscopy by Iowa State University

Peak Position	Species	Percent Population
2430	X	6.36
2587	G*	18.5
2752	Graphene G'	30.0
2914	Graphite D+D' (D+G)	37.4
3067	2D' (G+D')	7.72



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Preliminary Analyses for Mercury

Date: 8 May 2023

From: Vincent J. Zollo Jr., Ph.D.

To: Richard F. Ricardo

Re: AquaChar™

To start, 5 g of AquaChar™ was ground into a fine powder by sterilized mortar and pestle. 20 mg of finely ground AquaChar™ was dispersed via sonication into 18 mL of nanopure water (18.6 MΩ cm) after which time 2 mL of 100 ppm solution[1] of $Hg(OAc)_2$ was added for a final concentration of 10 ppm $Hg(CH_3COO)_2$. A 1 mL aliquot (**t0**) was removed, and the solution was sonicated for 10 minutes. After 10 minutes, another 1 mL aliquot (**t10**) was removed, and the solution placed back on the sonicator for an additional 20 minutes, after which time the last 1 mL aliquot (**t30**) was removed. Aliquots of the sample collected by syringe were filtered through 0.45 μm cellulose acetate filter to ensure no insoluble solid passed through the filter. The 1 mL aliquots were collected into Eppendorf tubes for analysis.

Positive Control

A 20 mL solution containing 10 ppm $Hg(CH_3COO)_2$ (6.26 μmol) was mixed with excess Na_2S (125.2 μmol). The solution rapidly changed color and produced an insoluble dark precipitate, namely HgS.

$$Hg(CH_3COO)_2\ (aq) + Na_2S\ (aq) \rightarrow 2\ NaCH_3COO\ (aq) + HgS\ (s) \downarrow$$

Negative Control

A 20 mL solution containing 10 ppm $Pd(CH_3COO)_2$ (4.46 μmol) was mixed with excess Na_2S (89.2 μmol). The solution did **not** produce a precipitate.

Aliquot Results

t0	dark solid precipitate formed; turbid tan solution	∴	Hg^{2+} detected
t10	no precipitate formed; clear non-colored solution	∴	Hg^{2+} **NOT** detected
t30	no precipitate formed; clear non-colored solution	∴	Hg^{2+} **NOT** detected

1. 4.6 mg (0.144 mmol) of mercury (II) acetate, $Hg(CH_3COO)_2$ was added to 46 mL of water for a final concentration of 100 ppm (0.313 mM).

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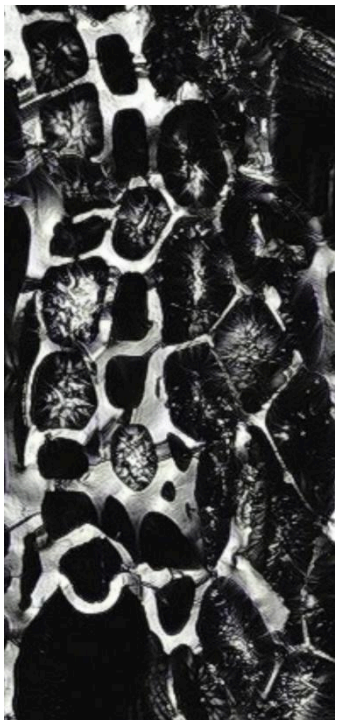
Conclusion of Preliminary Findings

Hg^{2+} was **not** detected in solution after 10 minutes of sonication with AquaChar™ and was **not** detected after 30 minutes of sonication. The AquaChar™ was observed to remove Hg^{2+} ions in aqueous solution.

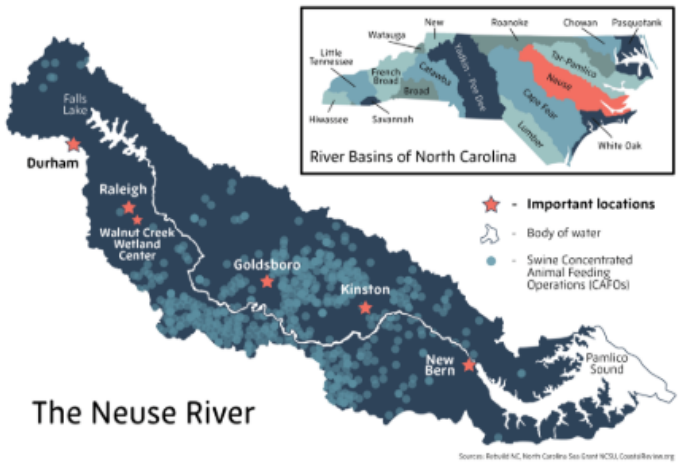


With its unique structure, the AquaChar™ is what makes the difference. Flash Petrification of Wood in a patented process allows for the cellulose and lignin found in wood fibers to be replaced by essential minerals at a molecular level. This “flash petrification” transforms the wood into a Crystalline Lattice with Diamond-like Properties of Functionalized Graphene with Spiraled Lattices of Metal Hydroxide, which is, per testing 29.1% graphene. This structure allows the material to operate as a nano scale filter. These unique properties allow it to pull, per the above test, to completely remove mercury from water.

PROJECTS AND CASES STUDY

The Neuse River

Grafinos with Dr Moeller and NOAA https://www.noaa.gov/, have been working since 2019 in a purification solution for the Neuse River Bacin in North Carolina
which was approved for cleaning up Chesapeake Bay, USA.
https://mediahub.unc.edu/challenges-to-the-clean-water-act-could-endanger-the-neuse-river/,
Due to Covid in 2020, this project was halted, however, our team is ready to commence operations in 2025.



Remediation Plan

Grafinos Proprietary Remediation Technologies:

Water Soluble/Chemical Remediation

- Precipitation and flocculation additives
- Oxidative reactions by supplementation of nanobubbles or aerated natural compounds

• Adsorption/Absorption of water-soluble chemicals by biological digestion/ingestion
• Chemical Resin Adsorption for final processing
• Top-Skimming, Straining, De-watering, solids and particulates from organic solution.
• De-watering and solids separation utilizing aeration/fractionation separation
• Organic solids/sludge concentration and digestion including bacterial and algae

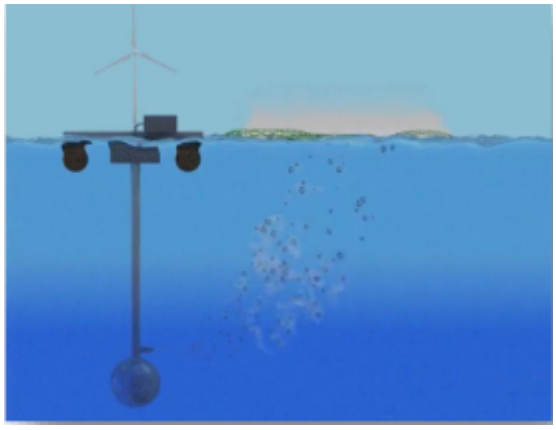
Bacterial Remediation

• Natural bacterial inoculation and mineral supplementation
• Supplementation of natural additives
• Precipitation and flocculation additives to improve water clarity
• Increased oxygenation to promote an aerobic bacterial biome
• Mechanical Aeration Foam Fractionation (dewatering) to remove water-borne bacterial organics, oils, and sludge
• Bacterial organic digestion/purification

Algae Remediation

• Top-Skimming, Straining, De-watering, solids and particulates from organic solution.
• Excess nutrient removal and balance
• De-watering and solids separation utilizing aeration/fractionation separation
• Organic solids/sludge concentration and digestion
• Increased oxygenation to offset and degas co2 water holdup

Grafinos Autonomous Cleaning Vessel



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NOAA
U.S. DEPARTMENT OF COMMERCE

Pilot Program Proposal

A Groundbreaking Proposal

In an unprecedented effort to safeguard our most vital ecosystems, a groundbreaking initiative is being proposed to deploy cutting-edge technology for preservation of Minnesota's waterways while allowing for the mining of precious resources. The project aims to fund the development and operation of a water and chemical cleaning solution which leverage Grafinos Corporation's revolutionary AquaChar™ filtration technology. By harnessing the power of AquaChar™ and integrating it into a comprehensive a pollution mitigation solution, the project, a joint initiative between Clean Rivers Foundation, a registered 501c3 Non-Profit, and Grafinos Corporation, seeks to

revolutionize the way we approach water remediation in some of our nations's most precious ecosystems.

This ambitious initiative not only aims to combat the alarming levels of pollution generated by mining operations threatening delicate ecological balances but also serves as a beacon of hope for sustainable solutions that can be replicated in other vital waterways around the globe. With proper intervention efforts, there is no reason why vital resources cannot be exploited without irreparable harm being committed on the local environment. By joining forces with cutting-edge technology from Grafinos Corporation and the environmental stewardship of Clean Rivers Foundation, the project has the potential to leave a lasting legacy for generations to come.

Conclusion

The ambitious project, a joint initiative between the Clean Rivers Foundation and Grafinos Corporation, represents a bold and innovative approach to addressing the pressing potential issues of pollution caused by mining operation on waterways and environment. By harnessing the power of cutting-edge technology and a shared commitment to environmental stewardship, this project has the potential to leave a lasting legacy for generations to come.

The pilot phase, involving the development of the initial protocol and efficacy studies, will serve as a crucial stepping stone towards the ultimate goal of deploying a comprehensive pollution management solution. This initial phase will provide invaluable insights into the efficacy of Grafinos' AquaChar™ filtration system, the operational challenges, and the potential impact on water quality.

The data and lessons learned from the pilot phase will inform the development of a comprehensive plan to scale up the project, enabling the Clean Rivers Foundation and Grafinos Corporation to achieve their ambitious target of keeping our waters clean. This monumental undertaking will not only combat the alarming levels of pollution threatening the delicate ecosystem but also serve as a beacon of hope for sustainable solutions that can be replicated in other vital waterways around the globe.

The project represents a bold step towards a future where cutting-edge technology and environmental stewardship go hand in hand, paving the way for a cleaner, healthier, and more sustainable world. By joining forces and leveraging their respective strengths, the Clean Rivers Foundation and Grafinos Corporation are poised to make a lasting impact on one of the world's most precious ecosystems, setting an example for others to follow.

As the world grapples with the pressing challenges of environmental degradation, initiatives like this project serve as a beacon of hope, demonstrating that with innovation, collaboration, and a shared commitment to sustainability, even the most daunting challenges can be overcome. The success of this project will not only guard the vitality of America's waterways but also inspire others to embrace similar solutions, ultimately contributing to a more sustainable and prosperous future for all.

Teams Leaders:

Richard F. Richardo
Inventor of Grafinos production process, CEO of Grafinos

Author of patent:
System and method for filtering and decomposition of methane, CO2, and volatile organic compounds
Inventor of quantum encryption algorithm, previously worked as advisor on Drone and Nuclear Facility Security (hardware-to-hardware secured communications)

Scientific Advisors

Vincent J. Zollo Jr, PhD
linkedin.com/in/vincentjzollojr
Nanomaterials Researcher
10+ years in laboratory instrumentation and spectroscopy:
Nuclear Magnetic Resonance, Fourier Transform Infrared Spectroscopy, Thermographic Analysis

Ray Cruz Arias
linkedin.com/in/rcruzarias
Biopharmaceutical, Electrical, Automation Engineer
30 years of industry experience:
Johnson Controls, Schneider Electric, Walgreens Boots Alliance