Coastal Barrier
- Global Fix -

INNOVATION

Perhaps - All is not lost

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Due to "Ground Breaking" new research, it will now be possible to sink metal poles (anode and cathode) around the shore line and apply a low current of approximately 3 volts, that will solidify marine sand into cement-like rock.

The potential change to our environment is enormous.

Consider low impact Tidal Generators, able to provide a low voltage power source to coastal areas, creating hardened barriers against erosion.

The reverse is also true… by switching the polarity of the power, the sand is able to 'liquefy' again!

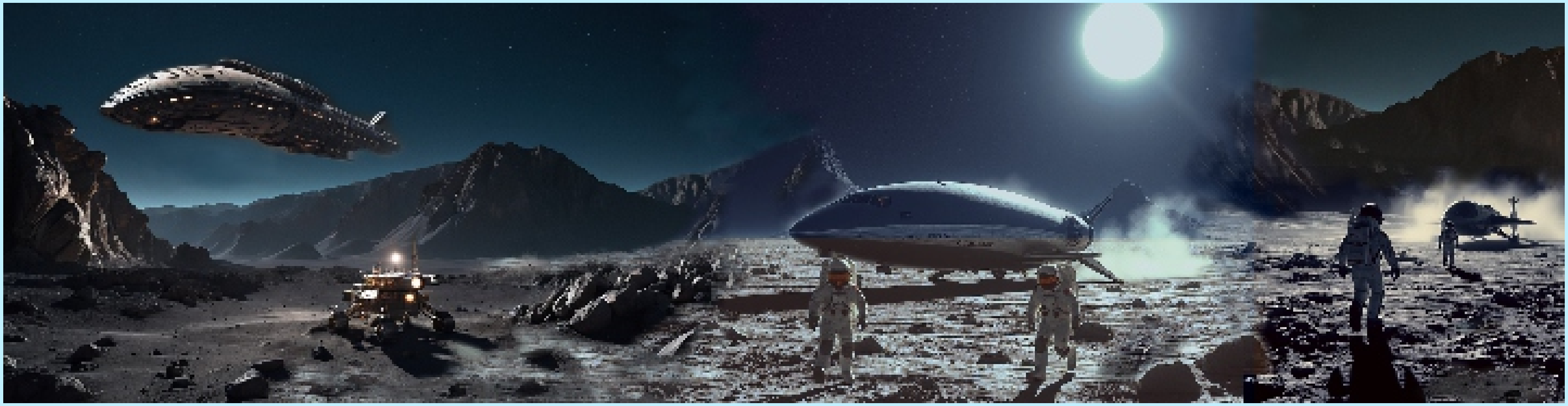
- It will be possible to create sea barriers offshore to mitigate heavy storms and even tsunamis.
- It will be possible to create hardened barriers on the shore line to protect properties and other natural resources.
- There is a potential to create more permanent shipping channels, especially in narrow water-ways.
- There is a potential to provide better foundations for bridges and other marine structures.
- There is a potential for building materials outside of the marine environment.

Coastal Barrier
- Interplanetary Concrete -

INNOVATION

Regolith on the Moon may react in similar ways to our coast and provide a means of creating buildings from 99% of Lunar Resources.

Similarly, Mars may be able to provide all the resources needed by dropping anodes and cathodes into the regolith with just the addition of water - which appears will be readily available.



Imagine - on Mars - paved roads, watercourses, tunnel walls, buildings... all providing shelter from harmful cosmic rays, dust storms and the ferocity of the environment - all with a few poles and a solar panel. There needs to be a huge amount of research done on this project - quickly.

COASTAL BARRIER

- SLURRY TREATMENT -

INNOVATION

Dredging Slurry is difficult to dispose of, even after it has drained and dried. Research needs to be done to determine whether it is effective to apply the Rotta Loria effect to provide a mateial that is suitable for road-base or other primary foundation materials.

Draining the swamp would never have been easier. It may be practical to apply voltage to a range of dredged materials and then excavate to create canals and faster flowing waterways to speed further drainage.

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Scientists Develop "Shockingly" Simple Solution To Combat Coastal Erosion

By Northwestern University August 30, 2024

A new method developed by Northwestern University uses electrical currents to solidify marine sand, creating durable, rock-like structures that could replace costly traditional coastal defenses like sea walls.

Researchers from Northwestern University have demonstrated that a zap of electricity can strengthen a marine coastline for generations, mitigating the rising threat of erosion in the face of rising sea levels and climate change.

In their study, recently published in Communications Earth and the Environment, the researchers took inspiration from clams, mussels, and other shell-dwelling sea life, which use dissolved minerals in seawater to build their shells. Similarly, the researchers leveraged the same naturally occurring, dissolved minerals to form a natural cement between sea-soaked grains of sand. But, instead of using metabolic energy like mollusks do, the researchers used electrical energy to spur the chemical reaction.

In laboratory experiments, a mild electrical current instantaneously changed the structure of marine sand, transforming it into a rock-like, immovable solid. The researchers are hopeful this strategy could offer a lasting, inexpensive, and sustainable solution for strengthening global coastlines.

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"Over 40% of the world's population lives in coastal areas. Because of climate change and sea-level rise, erosion is an enormous threat to these communities. Through the disintegration of infrastructure and loss of land, erosion causes billions of dollars in damage per year worldwide. Current approaches to mitigate erosion involve building protection structures or injecting external binders into the subsurface," said Alessandro Rotta Loria, Louis Berger Assistant Professor of Civil and Environmental Engineering at Northwestern's McCormick School of Engineering, who led the study.

"My aim was to develop an approach capable of changing the status quo in coastal protection — one that didn't require the construction of protection structures and could cement marine substrates without using actual cement. By applying a mild electric stimulation to marine soils, we systematically and mechanistically proved that it is possible to cement them by turning naturally dissolved minerals in seawater into solid mineral binders — a natural cement."

Challenges in Current Coastal Defense Strategies

From intensifying rainstorms to rising sea levels, climate change has created conditions that are gradually eroding coastlines. According to a 2020 study by the European Commission's Joint Research Centre, nearly 26% of the Earth's beaches will be washed away by the end of this century.

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To mitigate this issue, communities have implemented two main approaches: building protection structures and barriers, such as sea walls, or injecting cement into the ground to strengthen marine substrates, widely consisting of sand. However, multiple problems accompany these strategies. Not only are these conventional methods extremely expensive, but they also do not last.

“Sea walls, too, suffer from erosion,” Rotta Loria said. “So, over time, the sand beneath these walls erodes, and the walls can eventually collapse. Oftentimes, protection structures are made of big stones, which cost millions of dollars per mile. However, the sand beneath them can essentially liquify because of a number of environmental stressors, and these big rocks are swallowed by the ground beneath them.

“Injecting cement and other binders into the ground has a number of irreversible environmental drawbacks. It also typically requires high pressures and significant interconnected amounts of energy.”

Eco-Friendly Electrocementation Process

To bypass these issues, Rotta Loria and his team developed a simpler technique, inspired by coral and mollusks. Seawater naturally contains a myriad of ions and dissolved minerals. When a mild electrical current (2 to 3 volts) is applied to the water, it triggers chemical reactions. This converts some of these constituents into solid calcium carbonate — the same mineral mollusks use to build their shells. Likewise, with a slightly higher voltage (4 volts), these constituents can be predominantly converted into magnesium hydroxide and hydromagnesite, a ubiquitous mineral found in various stones.

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When these minerals coalesce in the presence of sand, they act like glue, binding the sand particles together. In the laboratory, the process also worked with all types of sands — from common silica and calcareous sands to iron sands, which are often found near volcanoes.

“After being treated, the sand looks like a rock,” Rotta Loria said. “It is still and solid, instead of granular and incohesive. The minerals themselves are much stronger than concrete, so the resulting sand could become as strong and solid as a sea wall.”

While the minerals form instantaneously after the current is applied, longer electric stimulations garner more substantial results. “We have noticed remarkable outcomes from just a few days of stimulations,” Rotta Loria said. “Then, the treated sand should stay in place, without needing further interventions.”

If communities decide they no longer want the solidified sand, Rotta Loria has a solution for that, too, as the process is completely reversible. When the battery’s anode and cathode electrodes are switched, the electricity dissolves the minerals — effectively undoing the process.

“The minerals form because we are locally raising the pH of the seawater around cathodic interfaces,” Rotta Loria said. “If you switch the anode with the cathode, then localized reductions in pH are involved, which dissolve the previously precipitated minerals.”

The process offers an inexpensive alternative to conventional methods. After crunching the numbers, Rotta Loria’s team estimates that his process costs just $3 to $6 per cubic meter of electrically cemented ground. More established, comparable methods, which use binders to adhere and strengthen sand, cost up to $70 for the same unit volume.

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Research in Rotta Loria's lab shows this approach can also heal cracked reinforced concrete structures. Much of the existing shoreside infrastructure is made of reinforced concrete, which disintegrates due to complex effects caused by sea-level rise, erosion, and extreme weather. If these structures crack, the new approach bypasses the need to rebuild the infrastructure fully. Instead, one pulse of electricity can heal potentially destructive cracks.

"The applications of this approach are countless," Rotta Loria said. "We can use it to strengthen the seabed beneath sea walls or stabilize sand dunes and retain unstable soil slopes. We could also use it to strengthen protection structures, marine foundations, and so many other things. There are many ways to apply this to protect coastal areas."

Next, Rotta Loria's team plans to test the technique outside of the laboratory and on the beach.

Reference: "Electrodeposition of calcareous cement from seawater in marine silica sands" by Andony Landivar Macias, Steven D. Jacobsen and Alessandro F. Rotta Loria, 22 August 2024, Communications Earth & Environment.

DOI: 10.1038/s43247-024-01604-3

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Samples of seawater-soaked sand in Rotta Loria's laboratory.

The vertical, silver posts are electrodes.

Credit: Northwestern University

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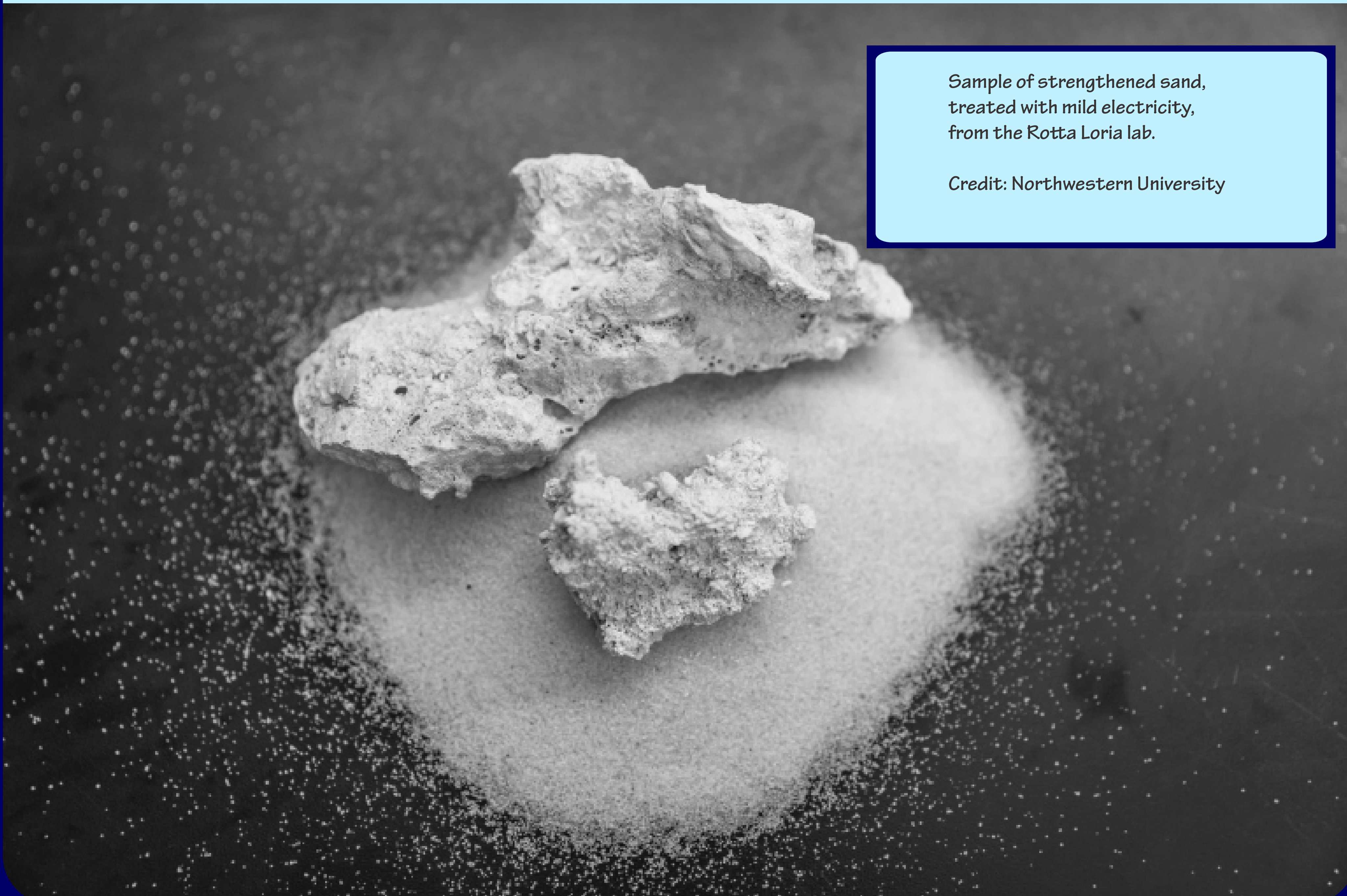

Sample of strengthened sand,
treated with mild electricity,
from the Rotta Loria lab.

Credit: Northwestern University