GeoVoltaic System

Self-Deconstructing Galvanic Marine Battery

PATENT PENDING

Inventor: Sigurd Erik Demos Oesterud · June 2026

Technical Disclosure Summary · Non-Confidential

THE PROBLEM

Ocean-bottom seismic and monitoring surveys deploy thousands of autonomous, battery-powered sensor nodes annually at water depths up to about 4,000 m. Recovery typically relies on remotely operated vehicle (ROV) intervention or acoustic-release mechanisms, both of which can fail so that a fraction of nodes are not recovered and remain on the seabed.

- Recovery failure rates on the order of 1–5% per major survey can result in loss of hundreds of instruments over the lifetime of a node fleet.
- Lost equipment constitutes toxic marine waste; lithium cells and synthetic housings do not biodegrade and leach toxins for decades.
- Battery life of existing node deployments is inherently limited by fixed-capacity lithium packs, constraining mission duration and forcing tightly scheduled recording windows; premature depletion can result in loss of late-stage data and increased operational pressure for vessel support and instrument swap-out.
- Limited battery endurance also aggravates timing-synchronization-risk, because internal clocks drift cumulatively during long autonomous deployments and battery limits reduce the ability to recover, recalibrate, or re-synchronize nodes before timing accuracy degrades.
- Conventional onboard battery packs also occupy a significant fraction of internal node volume and mass, making battery space a major engineering and cost driver in node size, weight, packaging, and handling logistics.
- No prior art eliminates recovery at the battery system design level while also **offering a path to drastically reduce internal onboard battery space requirements**.

THE INVENTION

The GeoVoltaic system is a self-deconstructing galvanic marine battery whose structural housing is the cathode. Three interlocking design paradigms eliminate all non-biodegradable hardware:

- **Cathode as Structure —** conductive CNF-concrete matrix serves simultaneously as mooring anchor and 3D current-collecting cathode
- **Multi-Chamber Monolith —** 3D-printed PHA bioplastic framework divides cells into isolated quadrants, enabling single-pour manufacturing
- **Triggered Disintegration —** iron-pin disconnect plug initiates seawater short-circuit; Mg anodes convert to Mg(OH)2; expansion pressure fractures housing into non-toxic sediment

KEY SPECIFICATIONS

Configuration	4-cell series stack, monolithic cast block
Anode	Pure Mg / Mg alloy, star-shaped cross-section
Cathode matrix	Portland cement + 2% MWCNTs + 8% graphite
Framework	PHA bioplastic (PHB, PLA, starch also claimed)
Output	~3.3–3.6 V | 95–140 mA | Active phase
EOL trigger	Mechanical iron-pin plug disconnect — no electronics
Disintegration	Cascading fracture over days–weeks; final state: sand + carbon flakes + Mg(OH)2 sediment
Depth range	Shallow coastal (<50 m) to deep-ocean (>4,000 m)
Recovery	None required — zero hardware on ocean floor

CORE APPARATUS CLAIMS (independent + key dependents)

Independent claim 1 — The complete system comprising:

sacrificial metal anode core · un-galvanized metal mesh cathode contact · cementitious CNF-concrete structural housing mass functioning as mooring anchor AND active 3D cathode matrix · biodegradable polymer isolation framework permitting electrolyte ingress

- **Claims 2 / 15a —** Anode metal group: Mg, Mg alloys, Zn, Zn alloys, Al, Al alloys — any metal whose solid oxidation product has greater molar volume than the parent metal
- **Claims 4 / 5a —** Carbon additive group: MWCNTs, SWCNTs, graphene nanoplatelets, carbon black, graphite, carbon fiber, or combinations — any formulation reaching electrical percolation threshold
- **Claim 6 —** Polymer group: PHA, PHB, PLA, thermoplastic starch, bacterial cellulose, blends and copolymers thereof
- **Claim 6a —** Functional polymer definition: any marine-biodegradable polymer degrading within 24 months in ambient seawater — captures future materials not yet developed
- **Claim 15b —** Depth-agnostic apparatus: shallow coastal to deep-ocean — mix design adapted to deployment depth

EOL DISINTEGRATION METHOD (5-claim independent sequence)

Independent claim 16 — deploy-and-terminate sequence:

- **Deploy:** Series-stack battery system with removable disconnect plug deployed in marine environment
- **Activate EOL:** Mechanical plug removed — bare terminals exposed to open seawater
- **Short-circuit:** Seawater floods junction zone; zero-resistance loop across all cells
- **Expand:** Anode cores convert to solid metal hydroxide; molar volume exceeds parent metal
- **Disintegrate:** Internal pressure exceeds concrete tensile limit; cascading fracture along fault lines; non-toxic sediment — no recovery required

Claims 17–22 extend coverage to: Mg/Zn/Al chemistry, cascading multi-fragment fracture, single-pour manufacturing, any hydrostatic-pressure-tolerant galvanic system, full depth range, and any conductive carbon formulation.

COMPETITIVE POSITION & LICENSING INTEREST

- No prior art combines conductive cementitious cathode, biodegradable polymer isolation, and mechanically triggered disintegration in a single system
- Addresses ESG / environmental liability requirements now mandatory for offshore survey operators in the EU and increasingly required in US Gulf of Mexico permits
- Drop-in replacement for existing OBN/OBS battery form factors — no change to survey vessel operations
- Licensing targets: OBN/OBS manufacturers, seismic survey contractors, subsea instrumentation suppliers, offshore wind & environmental monitoring

Patent Pending — US Provisional Application filed. This document is a non-confidential technical summary prepared for disclosure to potential licensing partners and investors. Full patent application text is not disclosed herein. GeoVoltaic is the commercial name of the invention; trademark registration is pending. © 2026 Sigurd Erik Demos Oesterud. All rights reserved.