CLAIMS

1. A method of removing carbon dioxide from a gaseous fluid comprising carbon dioxide, the method comprising:

contacting the gaseous fluid comprising carbon dioxide with an aqueous solution comprising calcium and magnesium cations to form an aqueous solution comprising calcium cations, magnesium cations, and carbon dioxide; and

contacting the aqueous solution comprising calcium cations, magnesium cations, and carbon dioxide with an electroactive mesh to electrolytically induce alkalinization, thereby precipitating the calcium and magnesium carbonate salts from the aqueous solution.

2. The method of claim 1, wherein the gaseous fluid comprises from 0.04 to 100 vol. % CO_2.

3. The method of claim 1 or 2, wherein the gaseous fluid is atmospheric air.

4. The method of any one of claims 1 to 3, wherein the gaseous fluid is flue gas emitted from a natural gas-fired power plant, a coal-fired power plant, an iron mill, a steel mill, a cement plant, an ethanol plant, or a chemical manufacturing plant.

5. The method of any one of claims 1 to 4, wherein the aqueous solution comprises an amount of dissolved carbon dioxide that is at equilibrium with the gaseous fluid.

6. The method of any one of claims 1 to 5, wherein the aqueous solution is at thermal equilibrium with the gaseous fluid.

7. The method of any one of claims 1 to 5, wherein the aqueous solution is not at thermal equilibrium with the gaseous fluid.

8. The method of any one of claims 1 to 7, wherein the aqueous solution further comprises Ba, Sr, Fe, Zn, Pb, Cd, Mn, Ni, Co, Cu, Al, or any combination thereof.

9. The method of any one of claims 1 to 8, wherein the aqueous solution further comprises alkaline earth metal cations.

10. The method of claim 9, wherein the alkaline earth metal cations comprise Ca, Mg, or both.

11. The method of any one of claims 1 to 10, wherein the aqueous solution has a concentration of NaCl of 1,000 ppm or more.

12. The method of any one of claims 1 to 11, wherein the aqueous solution has a concentration of NaCl of 30,000 ppm or more.

13. The method of any one of claims 1 to 12, wherein the aqueous solution comprises seawater.

14. The method of any one of claims 1 to 13, wherein the electroactive mesh comprises a metallic mesh.

15. The method of any one of claims 1 to 13, wherein the electroactive mesh comprises a non-metallic mesh.

16. The method of any one of claims 1 to 13, wherein the electroactive mesh comprises a carbon-based mesh.

17. The method of any one of claims 1 to 16, wherein the method utilizes an energy intensity of 2.5 MWh or less per ton of carbon dioxide mineralized.

18. The method of any one of claims 1 to 17, wherein the aqueous solution is bubbled with atmospheric air.

19. The method of any one of claims 1 to 18, wherein the electroactive mesh produces an increased alkaline condition, *in situ,* in the aqueous solution within 2 to 20000 µm of the electroactive mesh.

20. The method of claim 19, wherein the alkaline condition is a pH of 9 or greater.

21. The method of any one of claims 1 to 20, wherein the electroactive mesh comprises a metallic material.

22. The method of any one of claims 1 to 20, wherein the electroactive mesh comprises a non-metallic material.

23. The method of any one of claims 1 to 20, wherein the electroactive mesh comprises a carbon-based material.

24. The method of any one of claims 1 to 19, wherein the electroactive mesh contains stainless steel, titanium oxide, carbon nanotubes, polymers, graphite, or any combination thereof.

25. The method of any one of claims 1 to 24, wherein the electroactive mesh comprises pores having a diameter in the range of 0.1 µm to 10000 µm.

26. The method of any one of claims 1 to 25, wherein inducing the precipitation of the calcium and magnesium carbonate salts includes rotating a cylinder comprising the electroactive mesh in the solution, while applying suction to draw the solution onto the outer surface of the mesh.

27. The method of any one of claims 1 to 26, wherein the solution is a brine solution.

28. The method of any one of claims 1 to 27, wherein the solution is an alkaline metal-containing solution.

29. The method of any one of claims 1 to 28, wherein inducing precipitation of the calcium and magnesium carbonate salts includes inducing precipitation of at least one carbonate of Ba, Sr, Fe, Zn, Pb, Cd, Mn, Ni, Co, Cu, or Al.