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 metal cations capable of forming insoluble metal cation carbonate salts; and

contacting the aqueous solution comprising the metal cations with an electrode to electrolytically induce alkalinization, thereby precipitating the insoluble metal cation carbonate salts from the solution.

2. The method of claim 1, wherein the gaseous fluid comprises between 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 contains an amount of dissolved carbon dioxide that is in equilibrium with the gaseous fluid.

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

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

8. The method of any one of claims 1 to 7, wherein the metal cations capable of forming the insoluble metal carbonate salts comprise cations of Ca, Mg, 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 metal cations comprise 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 electrode comprises a metallic, a non-metallic, or a carbon-based mesh.

15. The method of any one of claims 1 to 14, wherein the method utilizes an energy intensity of 2.5 MWh or less per ton of carbon dioxide mineralized.

16. The method of any one of claims 1 to 15, wherein the aqueous solution is bubbled with atmospheric air.

17. The method of any one of claims 1 to 16, wherein the electrode produces an increased alkaline condition, *in situ*, in the aqueous solution within 2 to 20000 μm of the electrode.

18. The method of claim 17, wherein the alkalinized condition is a pH of 9 or greater.

19. The method of any one of claims 1 to 18, wherein the electrode comprises a metallic, a non-metallic, or a carbon-based material.

20. The method of claim 19, wherein the electrode contains stainless steel, titanium oxide, carbon nanotubes, polymers, graphite, or any combination thereof.

21. The method of any one of claims 1 to 20, wherein the electrode comprises pores having a diameter in the range of 0.1 μm to 10000 μm.

22. The method of any one of claims 1 to 21, wherein the electrode comprises an electroactive mesh, and inducing the precipitation of the metal 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.

23. The method of any one of claims 1 to 22, wherein the solution is a brine solution.

24. The method of any one of claims 1 to 23, wherein the solution is an alkaline metal-containing solution.

25. The method of any one of claims 1 to 24, wherein inducing precipitation of the metal carbonate salts includes inducing precipitation of at least one carbonate of Ca, Mg, Ba, Sr, Fe, Zn, Pb, Cd, Mn, Ni, Co, Cu, or Al.