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 ~~ions~~ metal cations capable of forming ~~an~~ insoluble metal cation carbonate ~~and/or hydroxide~~ salts; and

contacting the aqueous solution comprising the metal cations~~-~~ with an electrode ~~that~~ to electrolytically induce~~s~~ alkalinization, thereby ~~inducing the precipitation of~~precipitating ~~a~~the insoluble metal cation carbonate~~-~~ ~~and/or hydroxide solid~~salt~~(s)~~s from the solution.

~~2. The method of claim 1, wherein the fluid is a gaseous fluid.~~

~~3~~2. The method of claim 1~~ or 2~~, wherein the gaseous fluid comprises between 0.04 to 100 vol. % $CO_2$.

~~4~~3. The method of ~~any one of claims 1 to 3~~claim 1 or 2, wherein the gaseous fluid is atmospheric air.

~~5~~4. The method of any one of claims 1 to ~~4~~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.

~~6~~5. The method of any one of claims 1 to ~~5~~4, wherein the aqueous solution contains an amount of dissolved carbon dioxide that is in equilibrium with the gaseous fluid.

~~7~~6. The method of any one of claims 1 to ~~6~~5, wherein the aqueous solution is in thermal equilibrium with the gaseous fluid.

~~8~~7. The method of any one of claims 1 to ~~6~~5, wherein the aqueous solution is not in thermal equilibrium with the gaseous fluid.

~~9. The method of any one of claims 1 to 6, wherein the aqueous solution contains an amount of dissolved carbon dioxide that is not in equilibrium with the gaseous fluid.~~

~~10. The method of claim 1, wherein the fluid is a liquid fluid.~~

~~11~~8. The method of any one of claims 1 to ~~10~~7, wherein the metal cations ~~ions~~ capable of forming ~~an~~ the insoluble metal carbonate salts comprise ~~ions including one or more of:~~cations of Ca, Mg, Ba, Sr, Fe, Zn, Pb, Cd, Mn, Ni, Co, Cu, ~~and~~ 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.

~~12~~11. The method of any one of claims 1 to ~~11~~10, wherein the aqueous solution has a concentration of NaCl of ~~about~~ 1,000 ppm or more.

~~13~~12. The method of any one of claims 1 to ~~12~~11, wherein the aqueous solution has a concentration of NaCl of ~~about~~ 30,000 ppm or more.

~~14~~13. The method of any one of claims 1 to ~~13~~12, wherein the aqueous solution comprises seawater.

~~15~~14. The method of any one of claims 1 to ~~14~~13, wherein the electrode comprises a metallic, a non-metallic, or a carbon--based mesh.

~~16~~15. The method of any one of claims 1 to ~~15~~14, wherein the method utilizes an ~~end-to-end~~ energy intensity of ~~about~~ 2.5 MWh or less per ton of carbon dioxide mineralized.

~~17~~16. The method of any one of claims 1 to ~~16~~15, wherein the aqueous solution ~~contains an amount of dissolved carbon dioxide that is buffered to atmospheric abundance~~is bubbled with atmospheric air.

~~18~~17. The method of any one of claims 1 to ~~17~~16, wherein the electrode produces an increased alkaline condition, *in situ*, in the aqueous solution within ~~about~~ 2 to 20000 µm of the electrode.

~~19~~18. The method of claim ~~18~~17, wherein the alkalinized condition is a pH of 9~~8~~ or greater.

~~20~~19. The method of any one of claims 1 to ~~19~~18, wherein the electrode comprises a metallic, a non-metallic, or a carbon-based material.

~~21~~20. The method of claim ~~20~~19, wherein the electrode contains stainless steel, titanium oxide, carbon nanotubes, polymers, graphite, or any combination thereof.

~~22~~21. The method of any one of claims 1 to ~~21~~20, wherein the electrode comprises pores having a diameter in the range of ~~about~~ 0.1 µm to ~~about~~ 10000 µm.

~~23~~22. The method of any one of claims 1 to ~~22~~21, wherein the electrode comprises an electroactive mesh, and inducing the precipitation of the metal carbonate ~~and/or hydroxide solid(s)~~salts includes rotating a cylinder ~~consisting~~ comprising~~of~~ the electroactive mesh in the solution, while applying suction to draw the solution onto the outer surface of the mesh.

~~24~~23. The method of any one of claims 1 to ~~23~~22, wherein the solution is a brine solution.

~~25~~24. The method of any one of claims 1 to ~~24~~23, wherein the solution is an alkaline metal-containing solution.

~~26~~25. The method of any one of claims 1 to ~~25~~24, wherein inducing precipitation of the metal carbonate ~~and/or hydroxide solid(s)~~salts includes inducing precipitation of at least one carbonate ~~or hydroxide~~ of Ca, Mg, Ba, Sr, Fe, Zn, Pb, Cd, Mn, Ni, Co, Cu, or Al.

~~27. A flow-through electrolytic reactor comprising an intake device in fluid connection with a rotating cylinder comprising an electrode, and a scraping device and/or liquid-spray based device for separating a solid from a surface or solution.~~

~~28. The flow-through electrolytic reactor of claim 27, further comprising an aqueous solution comprising carbon dioxide, Ca ions, and Mg ions.~~

~~29. The flow-through electrolytic reactor of claim 27 or 28, wherein the electrode is capable of inducing removal of dissolved inorganic carbon by precipitation of a carbonate and/or hydroxide solid from an aqueous solution comprising carbon dioxide and ions capable of forming an insoluble carbonate and/or hydroxide salt.~~

~~30. The flow-through electrolytic reactor of any one of claims 27 to 29, wherein the electrode contains a metallic or carbon-based mesh.~~

~~31. The flow-through electrolytic reactor of claim 30, wherein the electrode contains stainless steel, titanium oxide, carbon nanotubes, polymers, graphite, or any combination thereof.~~

~~32. The flow-through electrolytic reactor of any one of claims 27 to 31, wherein the reactor comprises a plurality of electrodes.~~

~~33. The flow-through electrolytic reactor of claim 32, wherein the plurality of electrodes are arranged in a series of planar cells in parallel or cylindrical cells in parallel.~~

~~34. The flow-through electrolytic reactor of any one of claims 17 to 33, wherein the reactor is in fluid communication with a desalination device.~~

~~35. The method of claim 10, wherein the liquid fluid is an aqueous fluid.~~

~~36. The method of claim 35, wherein a gaseous stream is bubbled through the liquid fluid before the liquid fluid is contacted with the aqueous solution.~~