CLAIMS

1. An integrated process for carbon dioxide capture, sequestration and utilisation, which comprises:

a) providing an aqueous slurry comprising an aqueous liquid and a particulate solid comprising an activated magnesium silicate mineral;

b) in a dissolution stage, contacting a CO_2-containing gas stream with the aqueous slurry to dissolve magnesium from the mineral to provide a slurry comprising a magnesium ion enriched carbonated aqueous liquid and a magnesium depleted solid residue;

c) subjecting at least part of the magnesium depleted solid residue from step b) to a particle size classification process that separates the magnesium depleted solid residue into a fine particle size fraction and a coarse particle size fraction;

d) subjecting at least part of the coarse particle size fraction from step c) to a particle size reduction process to provide a particle size reduced fraction;

e) providing an aqueous slurry comprising particle size reduced fraction from step d) and repeating step b), wherein this step e) does not include using fine particle size fraction from step c); and

f) in a precipitation stage, precipitating magnesium carbonate from magnesium ions dissolved in b) and e).

2. The integrated process according to claim 1, wherein the magnesium ion enriched carbonated aqueous liquid is produced by dissolving the activated magnesium silicate mineral in one or more reactors fed by an input CO_2-containing gas stream near, at or above atmospheric pressure and thereafter, in a separate precipitation stage, inducing a pH shift in the liquid by the removal of dissolved CO_2 through the application of a partial

vacuum or sub-atmospheric pressure to the liquid thereby precipitating the magnesium carbonate.

3. The integrated process according to claim 1 or 2, wherein the CO_2-containing gas stream comprises a flue gas from a hydrocarbon combustion process, a calcining process or a chemical process.

4. The integrated process according to any one of claims 1 to 3 further comprising step e') in which at least part of the fine particle size fraction from step c) in the form of an aqueous slurry is used in a dissolution stage which comprises contacting a CO_2-containing gas stream with the aqueous slurry to dissolve magnesium from the fine particle size fraction to provide a slurry comprising a magnesium ion enriched carbonated aqueous liquid and a magnesium depleted solid residue, wherein the CO_2-containing gas stream used in this step has a higher CO_2 concentration than the CO_2-containing gas stream used in step b).

5. The integrated process according to claim 4, wherein step f) comprises precipitating magnesium carbonate from magnesium ions dissolved in steps b), e) and e').

6. The integrated process according to any one of claim 1 to 5, wherein the size classification process comprises a process that uses gravity or centrifugal forces to separate particles into the different particle size fractions.

7. The integrated process according to any one of claim 1 to 6, wherein the precipitation stage comprises a process where magnesium ions in aqueous liquid are precipitated out of solution as solid magnesium carbonate or hydrated forms of magnesium carbonate.

8. The integrated process according to any one of claim 1 to 7, wherein the magnesium depleted solid residue from any dissolution stage is subjected to a wet magnetic separation process to extract an iron-rich portion therefrom before any subsequent processing.

9. The integrated process according to any one of claims 1 to 8, wherein the pressure in each dissolution stage is in the range 100-20000 kPa and the temperatures is in the range 20 ºC-185 ºC.

10. The integrated process according to any one of claims 1 to 9, wherein step b) is conducted in two or more dissolution reactors.

11. A reactor system adapted to perform the processes of claim 1, the reactor system comprising one or more dissolution reactors, one or more precipitation reactors, one or more particle size classifiers and one or more particle size reduction devices.

12. The reactor system according to claim 11 adapted such that slurry exiting the one or more dissolution reactors is subjected to a separation process in a separator that substantially separates solids from liquids thereby separating the slurry into a stream comprising the magnesium ion enriched aqueous liquid and a stream comprising the magnesium depleted solid residue.

13. The reactor system according to claim 11 or 12 which comprises a particle size classifier that comprises one or more hydrocyclones.

14. The reactor system according to any one of claims 11 to 13, wherein particle size classifier yields a coarse particle size fraction comprising particles whereby the mass median diameter is in the range 10-250 microns and a fine particle size fraction comprising particles whereby the mass median diameter is in the range 1-50 microns, with the mass median diameter of the coarse fraction always greater than that of the fine fraction by at least 5 microns.