CLAIMS

1. A process for recovering lithium from a lithium-containing silicate mineral, the process comprising:

mixing the silicate mineral with nitric acid;

subjecting the mixture to a leaching process having conditions such that lithium values in the silicate mineral are leached into an aqueous phase as lithium nitrate;

separating the lithium nitrate from the aqueous phase;

subjecting the separated lithium nitrate to thermal treatment, at a temperature that causes decomposition of the lithium nitrate into solid lithium oxide, and such that a gaseous stream that comprises oxides of nitrogen is produced;

passing the gaseous stream comprising oxides of nitrogen to a nitric acid production stage in which nitric acid is produced for reuse in the leaching process.

2. A process according to claim 1, wherein the leaching process conditions comprise increasing temperature and/or pressure of the leaching process so as to accelerate leaching of lithium values into the aqueous phase as lithium nitrates.

3. A process according to claim 1 , wherein the leaching process conditions further comprise reacting the silicate mineral in a stoichiometric excess of nitric acid, for a controlled period of time, with the controlled period of time being terminated by:

(i) neutralising residual free nitric acid; or

(ii) heating the product of leaching so as to distil excess nitric acid along with water as vapour.

4. A process according to claim 3, wherein in (i) the residual free nitric acid is neutralised by recycling a proportion of alkaline lithium compounds produced as part of the process for recovering lithium, with the alkaline lithium compounds that are recycled including one or more of: Li_2O, LiOH and Li_2CO_3.

5. A process according to claim 3, wherein in (i), a leached product mass resulting from the leaching process is first passed to a solid-liquid separation stage in which solids in the leached product mass are separated from a solution comprising lithium nitrate, with the solution then being passed to the neutralisation stage (i), and with the solids being separated from the process as tailings.

6. A process according to claim 3, wherein in (ii) the excess nitric acid and water vapour are distilled off as vapours in a drying stage, with a heating medium for the drying

stage optionally comprising molten lithium nitrate produced in a subsequent process stage, and wherein the distilled nitric acid and water vapour are collected for use in regenerating nitric acid.

7. A process according to claim 6, wherein, in a crystallisation stage, the solution of lithium nitrate from leaching is concentrated and crystallised to form crystalline $LiNO_3$.

8. A process according to claim 7, wherein, prior to crystallising the $LiNO_3$, the leached lithium nitrate solution is separated from a residue of insoluble solids of the silicate mineral.

9. A process according to claim 8, wherein in (ii) dried solids that are produced by distilling the excess of nitric acid and water are re-slurried using solution that is separated from the crystalline $LiNO_3$ produced in the crystallisation stage, and additional process water.

10. A process according to claim 7, wherein the crystallised $LiNO_3$ is separated from solution, and wherein the solution separated from the crystalline $LiNO_3$ is passed to a vessel to be mixed with the dried solids that are produced by the distilling off of the excess of nitric acid.

11. A process according to claim 6, wherein a resulting $LiNO_3$ intermediate product is melted, optionally with a proportion of the molten $LiNO_3$ being passed for use as the heating medium in the drying stage in (ii).

12. A process according to claim 11, wherein the molten $LiNO_3$ intermediate product is subjected to said thermal treatment.

13. A process according to claim 12, wherein the thermal treatment comprises burning ammonia in an excess of air and in the presence of a suitable catalyst, with the resultant gaseous stream that includes oxides of nitrogen being passed to the nitric acid production stage to produce the nitric acid for reuse in the leaching process.

14. A process according to claim 12, wherein, in a slaking stage, a controlled amount of pure (distilled) water is added to the Li_2O produced in said thermal treatment, the amount being sufficient to convert the Li_2O to LiOH and to cause all of the LiOH to dissolve into solution.

15. A process according to claim 14, wherein, in a further crystallisation stage, the solution of lithium hydroxide is concentrated and crystallised to form pure crystalline lithium hydroxide monohydrate $LiOH{\cdot}H_2O$, and with the crystallised $LiOH{\cdot}H_2O$ being separated from solution.

16. A process according to claim 15, wherein the crystallised $LiOH{\cdot}H_2O$ is further

processed by (a) drying the crystals, and (b) further heating the dried crystals under reduced pressure conditions to a temperature of at least 180°C to drive off the water of crystallization to create an anhydrous lithium hydrate product, and collecting and condensing the water vapour distilled off to produce additional pure process water.

17. A process according to claim 15, wherein the lithium hydroxide solution that is separated from the crystalline lithium hydroxide monohydrate is divided such that:

a first proportion of the solution is recycled to the leaching process for use in terminating the reaction of the silicate mineral with the nitric acid, the lithium hydroxide solution neutralising residual or remaining free nitric acid; and

a second proportion of the solution is used in the scrubbing of carbon dioxide from process off-gases.

18. A process according to claim 17, wherein the second proportion of the solution is used to scrub carbon dioxide from:

a flue gas that is produced during pre-treatment of the lithium-containing silicate mineral, prior to mixing the mineral with the nitric acid solution; and/or

a flue gas that may be produced during thermal treatment of a lithium nitrate intermediate product of the process; and

wherein the scrubbing of carbon dioxide from the flue gas using the lithium hydroxide solution produces a lithium carbonate stream, with a proportion being lithium carbonate in solid form that is able to be separated from the stream as a lithium carbonate product of the process.

19. A system for recovering lithium from a lithium-containing silicate mineral, the system comprising:

a leaching reactor in which a mixture of the silicate mineral and nitric acid is subjected to conditions such that lithium values in the silicate mineral are leached into an aqueous phase as lithium nitrates;

a separation stage in which the lithium nitrate is separated from the aqueous phase;

a thermal treatment stage in which the separated lithium nitrate is subjected to thermal treatment at a temperature that causes decomposition of the lithium nitrate into solid lithium oxide, and that produces a gaseous stream that comprises oxides of nitrogen;

a nitric acid production stage to which the gaseous stream comprising oxides of nitrogen is passed and in which nitric acid is produced for reuse in the leaching reactor.