*Supplementary Materials*

# Investigation of Enhanced Leaching of Lithium from $\alpha$-Spodumene Using Hydrofluoric and Sulfuric Acid

**Hui Guo, Ge Kuang, Haidong Wang, Haizhao Yu and Xiaokang Zhao**

**Table S1.** XRF analyzed results of ore sample.

| Elements | wt % |
|---|---|
| O | 41.043 |
| F | 0.129 |
| Na | 0.351 |
| Mg | 0.088 |
| Al | 11.430 |
| Si | 32.626 |
| P | 0.260 |
| K | 0.680 |
| Ca | 0.446 |
| Ti | 0.053 |
| Mn | 0.060 |
| Fe | 0.537 |
| Zn | 0.006 |
| Ga | 0.013 |
| As | 0.011 |
| Rb | 0.172 |
| Sr | 0.002 |
| Zr | 0.009 |
| Nb | 0.002 |
| Ag | 0.001 |
| Cs | 0.016 |
| Tl | 0.001 |
| Total* | 87.9% |

*The total mass fraction <100% can be distributed to low X-ray yields for the light elements like H, C that they were difficult to quantify limited by instrumental conditions.

**Table S2.** AAS analyses of lithium concentration in lixivium under different HF/ore.

| Lixivium | Ore/HF, g/mL | | | | |
|---|---|---|---|---|---|
| | **1.5:1** | **2:1** | **2.5:1** | **3:1** | **3.5:1** |
| c(Li), g/L | 0.90 | 1.05 | 1.23 | 1.43 | 1.37 |
| V, mL | 157 | 173 | 168 | 158 | 163 |
| L%, % | 55.19 | 70.54 | 80.40 | 88.28 | 87.50 |

**Table S3.** AAS analyses of lithium concentration in lixivium under different temperature.

| Lixivium | Temperature, °C | | | |
|---|---|---|---|---|
| | **50** | **75** | **100** | **125** |
| c(Li), g/L | 1.04 | 1.35 | 1.50 | 1.48 |
| V, mL | 170 | 168 | 159 | 165 |
| L%, % | 69.44 | 88.28 | 93.52 | 95.86 |

**Table S4.** AAS analyses of lithium concentration in lixivium under different $H_2SO_4$/ore*.

| Lixivium | Ore/$H_2SO_4$, g/mL | | | | |
|---|---|---|---|---|---|
| | **1:1** | **1:1.5** | **1:2** | **1:2.5** | **1:3** |
| c(Li), g/L | 0.76 | 0.78 | 0.77 | 0.78 | 0.79 |
| V, mL | 180 | 175 | 178 | 180 | 176 |
| L%, % | 53.06 | 53.05 | 53.99 | 55.19 | 54.57 |

*dissolution with HF/ore 1.5:1.

**Table S5.** AAS analyses of lithium concentration in lixivium under different $H_2SO_4$/ore*.

| Lixivium | Ore/$H_2SO_4$, g/mL | | | | |
|---|---|---|---|---|---|
| | **1:1** | **1:1.5** | **1:2** | **1:2.5** | **1:3** |
| c(Li), g/L | 1.41 | 1.49 | 1.45 | 1.33 | 1.34 |
| V, mL | 163 | 160 | 170 | 179 | 183 |
| L%, % | 53.06 | 53.05 | 53.99 | 55.19 | 54.57 |

*dissolution with HF/ore 3:1.

**Table S6.** AAS analyses of lithium concentration in lixivium under different time.

| Lixivium | Time, h | | |
|---|---|---|---|
| | **2** | **3** | **4** |
| c(Li), g/L | 0.71 | 0.88 | 0.72 |
| V, mL | 173 | 160 | 179 |
| L%, % | 47.97 | 55.19 | 50.48 |

**Table S7.** AAS analyses of lithium concentration in lixivium for the dissolution kinetics investigations.

| Time, min | c(Li), g/L | V, mL | L% |
|---|---|---|---|
| 15 | 1.16 | 168 | 76.24 |
| 20 | 1.29 | 159 | 80.21 |
| 30 | 1.28 | 173 | 86.59 |
| 60 | 1.35 | 172 | 90.55 |
| 90 | 1.45 | 163 | 92.68 |
| 120 | 1.48 | 165 | 95.66 |
| 150 | 1.45 | 170 | 96.18 |
| 180 | 1.51 | 164 | 96.74 |

**Table S8.** XRF analyses of insoluble residues under optimal conditions.

| Elements | wt % |
|---|---|
| O | 23.820 |
| F | 19.127 |
| Na | 0.120 |
| Mg | 0.130 |
| Al | 15.394 |
| Si | 20.318 |
| S | 0.822 |
| K | 0.359 |
| Ca | 0.191 |
| Ti | 0.018 |
| Mn | 0.028 |
| Fe | 0.541 |
| Zn | 0.014 |
| Ga | 0.003 |
| As | 0.008 |
| Rb | 0.612 |
| Zr | 0.050 |
| Ag | 0.001 |
| Sn | 0.009 |
| Cs | 0.046 |
| Total∗ | 81.6% |

∗The total mass fraction <100% can be distributed to low X-ray yields for the light elements like H, C that they were difficult to quantify limited by instrumental conditions.