by R. Keith Evans,
January, 2009

A conference entitled “Lithium Supply and Markets” organised by Industrial Minerals mgazine was held in Santiago, Chile, in January this year. It was attended by 150 geologists, mining engineers, chemical engineers, producers, would be producers, battery experts and consumers.

I had the pleasure of making the first presentation concerning reserves and resources estimating in situ tonnages of 30.0 million tonnes Li - about 160.0 million tonnes of carbonate-the principal feed chemical for the chemicals used in lithium-ion batteries. My estimate was an update of a National Research Council report produced in the mid 1970’s and revised to include more recent discoveries using the tonnages estimated by the companies responsible for evaluating the targets.

As with the NRC report a fairly wide definition of reserves and resources was adopted along the lines of the statement made by Donella Meadows in 1972 -- “Reserve is a concept related to the amount of material that has been discovered or inferred to exist and that can be used given reasonable assumptions about technology and price”.

Definitions used by the USGS are tighter than this, hence lower tonnage estimates from that source. When the NRC team was chosen they were asked to produce a report on resources which in the opinion of the team stood a reasonable chance of being developed should a major demand develop. At the time the concern was in respect of lithium availability for fusion reactors. The tonnage estimated by the panel which included one current and one former USGS employee, was considerably higher than the 'official' estimate at that time.

Other estimates quoted in Santiago were, from Chemetall and FMC for 28.0 million tonnes Li and 35.7 million tonnes Li from SQM. In my address I also quoted an estimate by Laksic and Tilton (University of Chile and Colorado School of Mines respectively) of 35.0 million tonnes.

In a summary of the conference proceedings by the Chairman, Gerry Clark, he wrote “What speakers in the Santiago event demonstrated beyond any reasonable doubt is that lithium resources are large enough to cover any rationally conceivable demand”.

Before leaving the subject of resources and reserves I would like to make the comment that moving from one category to the other is an expensive exercise. As an example, the hectorite deposit on the Nevada/Oregon border comprises 5 lenses. When drilled years ago Chevron, the former owners, came up with a tentative estimate of 2.3 million tonnes Li.

As part of its Feasibility study, Western Mining has redrilled one of the lenses in a tight pattern to indicate a lithium tonnage of 162,000 tonnes - within 10% of the Chevron figure for that lens.

Do they feel any compulsion to undertake detailed drilling at the other lenses? As they are a relatively small company I doubt they can justify the expense so the other 2.0 million tonnes will remain a resource. The drilled lens contains 800,000 tonnes of carbonate – more than sufficient for a lengthy period.

In Santiago the issue of current chemical production capacity was discussed which is estimated at 115,000 tpa of lithium carbonate equivalents compared with current demand of approximately 95,000 tpa.

Of greatest interest were projections of future demand where the numbers vary greatly because of the varying assumptions regarding total vehicle numbers, the percentage penetration of the total market, the percentage that are lithium-ion powered and the vehicle type.

All three producers used the same figure of 0.6 kg carbonate per 1kWh of battery capacity with the type, battery capacity and carbonate demand tabulated below.

| Vehicle Type | Battery Capacity | LCE Demand |
|---|---|---|
| Mild HEV | 2 kWh | 1.2 kg |
| PHEV | 12 | 7.2 |
| EV | 25 | 15 |

SQM in its estimate for 2020 looked at two scenarios assuming 9% and 20% electric vehicles in the fleet with 60% and 80% being powered with Li-ion. The annual carbonate demand ranged from 20,000 to 30,000 tonnes in the conservative case 55,000 to 65,000 tonnes in the optimistic case.

Unlike others making estimates, SQM also looked at 2030 with 15% and 25% electric vehicles in the fleet and 75% and 90% being Li-ion powered resulting in a demand of 65,000 to 75,000 in the conservative case and 135,000 to 145,000 in the optimistic case.

Chemetall also tabulated a range of scenarios with 2020 demand for vehicles from a low 5,000 to 60,500 tonnes of carbonate demand.

FMC estimated the market penetration of HEV’s at 20-30%, PHEV’s at 2-5% and EV’s at 1-3% in 2020 resulting in a carbonate demand of 70,000 tpa.

TRU Group presented a study made on behalf of Mitsubishi Corporation. They estimated the production of battery equipped cars at approximately 5 million/year by 2020. They also estimated that technical issues will be resolved for HEV’s by 2011, for PHEV’s by 2014 and for EV’s by 2016.

Future Production

Current capacity for chemical production approximates to 115,000 tpa lithium carbonate equivalents. At the conference Chemetall announced that it would stage expansions in response to market demand which could more than double capacity (to 50,000 and 15,000 tpa carbonate and hydroxide respectively) by 2020 and FMC stated that at current production rates

they had reserves to last for 70 years.

SQM pumps sufficient brine to recover approximately 800,000 tpa of potash (potassium chloride and potassium sulfate) together with a modest tonnage of boric acid. From this feed they have the lithium capacity to produce 40,000 tpa carbonate but the lithium in the brine greatly exceeds this and the excess is returned to the salar. The expansion potential is very large and the company claims that the returned brine contains in excess of 200,000 tpa carbonate.

The Chinese plan to expand brine based capacity to 85,000 tonnes by 2010 but it is known that they are having serious problems with the high magnesium/lithium ratios in two of their brine sources.

In addition to current operations there are several projects in the pipeline. Three pegmatite based operations are being evaluated, one each in Australia (Galaxy Resources), Canada (Canadian Lithium) and one in Finland (Keliber Resources) with combined in situ reserves of 124,000 tonnes Li.

In Argentina the Salar de Rincon project is targeted to produce 17,000 tpa carbonate and the Salar de Olaroz, further north, is being evaluated by Orocobre.

In Bolivia, the Salar de Uyuni, is receiving massive attention by the press with claims that “it is the Saudi Arabia of lithium” also “it has nearly 50% of the world’s reserves” and “it is the most beautiful resource on the planet”. It is undoubtedly large – Ballivian and Risacher estimated 5.5 million tonnes Li but are only one sixth of the world's resources. However, it has problems with a low lithium concentration and a high Mg/Li ratio which will complicate and increase the cost of processing. The richest part of the reserve is in an area where the aquifer is very thin and the whole salar floods seasonally – diluting grade and complicating the construction of the very large area of solar evaporation ponds that will be required.

Mention has been made previously of Western Lithium’s hectorite deposits in the western United States. The resource contains in excess of 2.0 million tonnes Li. Costs are not known yet and this also applies to Simbol Mining’s proposal to recover lithium from the rich geothermal brines in the Salton Sea area of Southern California.

RTZ’s jadarite deposit in Serbia appears to be extremely attractive. This unique mineral occurs in 3 stacked layers. Reserves were disclosed for one of them in Santiago – 0.95 million tonnes Li. If mined out over a period of 20 years it would produce 60,000 tpa carbonate with the co-production of 300,000 tpa boric acid. The geological evidence suggests that this deposit could contain double the currently stated reserves.

Cost Considerations

Claims have been made that if (ever) the cheap brine sources became exhausted or that demand grows to such an extent that the current producers cannot meet demand - citing pegmatite costs as an example, costs and prices would increase considerably.

In fact a high percentage of current Chinese production is from spodumene and two years ago

SQM estimated production costs at between $1.80 to $2.20/lb . A former North Carolina producer recently gave a ball-park estimate of $2.50-$3.00/lb for production from the former operations there.

In Santiago, Chemetall did the maths as far as batteries are concerned. Assuming a battery cost of 500 Euros per kW/h and a carbonate cost of 6 Euro/kilo the carbonate cost is less than 1% of the total. Clearly, higher costs are palatable in this application.

Finally, in situ resources total approximately 30.0 million tonnes and a recovery of 50% seems probable. As a result of an increase in exploration activity more resources will be discovered and partly explored pegmatites will be drilled at depth and along unexplored strike lengths. An example is the Tallison pegmatite in Western Australia where increased reserves were announced in Santiago – from 223,000 tonnes Li in my estimate to 1.5 million tonnes.

There are a large number of additional Salares in the Andean altiplano now receiving the attention of geologists and if recovery from hectorites proves to be viable there are numerous other occurrences reported upon by the USGS.

Returning to the demand side, each million tonnes of recovered elemental lithium or 5.32 billion kilos of carbonate will be sufficient for 532 million vehicles requiring a 10 kW/h battery. Most batteries will require much less.

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April, 24th 2009
Revised: May, 5th 2009