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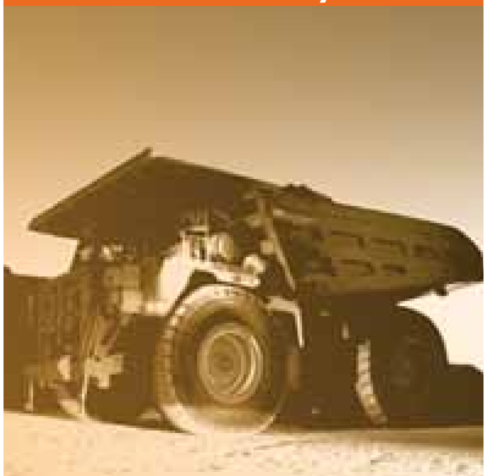

MINING INTELLIGENCE SERIES

# The future of lithium

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Business News Americas
Today's insight, tomorrow's opportunities

# Introduction

Lithium is in style. The promise of millions of cars powered by electric batteries has drawn the attention of every variety of investor. So much so, that lithium prices have tripled since the beginning of this decade, with prices now around US$6,000 per ton.

However, over the last few months, the promise that lithium holds was put in doubt by several reports claiming that there are not enough lithium reserves to meet the demand that the mass production of electric cars is expected to generate by the end of the decade. These arguments have been emphatically answered by many different industry experts from Keith Evans, a geologist and one of the most renowned lithium experts in the world, to large lithium producers like Chilean company SQM. Despite this, lithium mining still has some major obstacles ahead.

South America is at the epicenter of the metal's future. The largest salt-brine lithium reserves, which out of all the naturally occurring reserves, is where lithium can most easily be acquired, are found in salt flats in Chile, southwestern Bolivia and northwestern Argentina. Currently, Chile is the world's largest lithium producer and the Atacama salt flat is by far the most competitive in the world. Argentina is also producing and has attracted a variety of junior miners that are carrying out studies to begin developing new areas. Bolivia has one of the largest lithium deposits in the world and promises to be one of the main players in securing a future lithium supply.

In this report we will take a look at the future of lithium mining in South America, the difficulties that may arise and the outlook for lithium in the medium and long term.

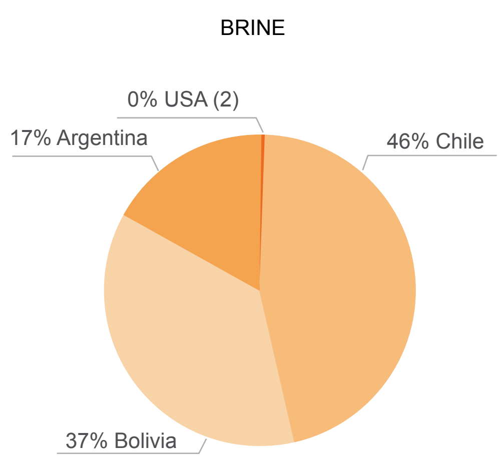



Figure 1
**World lithium reserves**

*Tons of lithium*

| Country | Minerals (1) | Brine | Total |
|---|---|---|---|
| USA (2) | 2,830,000 | 40,000 | 6,620,000 |
| Chile | | 6,900,000 | 6,900,000 |
| Bolivia | | 5,500,000 | 5,500,000 |
| China | 750,000 | | 3,390,000 |
| Argentina | | 2,550,000 | 2,550,000 |
| D.R. of Congo | 2,300,000 | | 2,300,000 |
| Russia | 1,000,000 | | 1,000,000 |
| Serbia | 850,000 | | 850,000 |
| Australia | 262,800 | | 262,800 |
| Canada | 255,600 | | 255,600 |
| Austria | 100,000 | | 100,000 |
| Brasil | 85,000 | | 85,000 |
| Zimbabwe | 56,700 | | 56,700 |
| Finland | 14,000 | | 14,000 |

(1) Pegmatite and Jadarite
(2) Total US reserves also include geothermal brines, oil wells and clays

Source: Cochilco/Evans

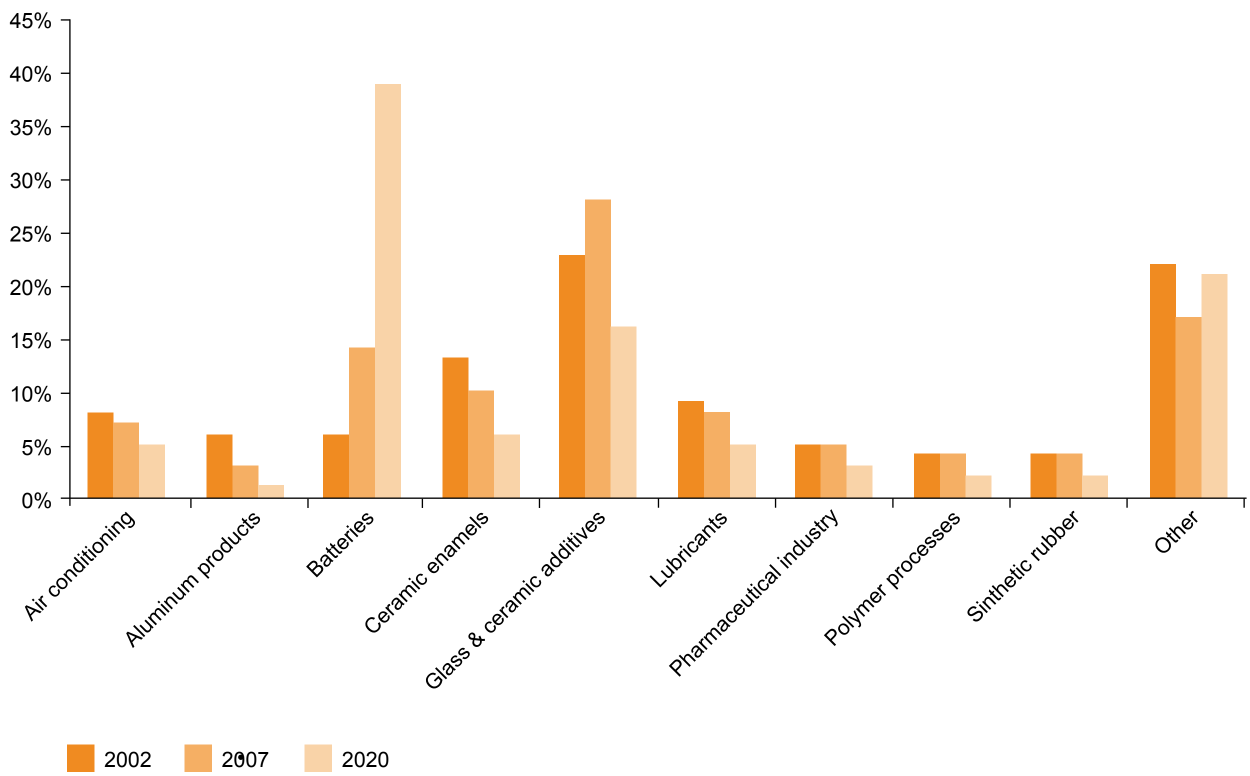
# Lithium fever

Lithium is the lightest known metal and traditionally has been used in the ceramics, glass, aluminum, and lubrication industries, to make glass frits, and in pharmaceuticals. That being said, its journey as the "metal of the future" truly began in the late 90's when it became popular in portable electronic devices. Cell phones, notebooks, netbooks, digital cameras and other electronic devices needed a way to solve the problem of providing energy for systems that continually put more and more demands on increasingly small and higher storage capacity energy units found the solution they were looking for in rechargeable lithium-ion batteries. The numbers speak for themselves: lithium battery demand increased by 27% per year between 2002 and 2007.

This leap in demand caused prices to shoot from US$1,760 per ton in 1999 to almost US$6,000 per ton in 2008, according to data published by the Chilean Copper Commission (Cochilco). Between 2003 and 2007 lithium consumption grew by 8% annually, although growth fell by 4% in 2008 and dropped around 12% in 2009 as a result of the worldwide recession.

Figure 2

**Use of lithium batteries by segment (2002-2020E)**



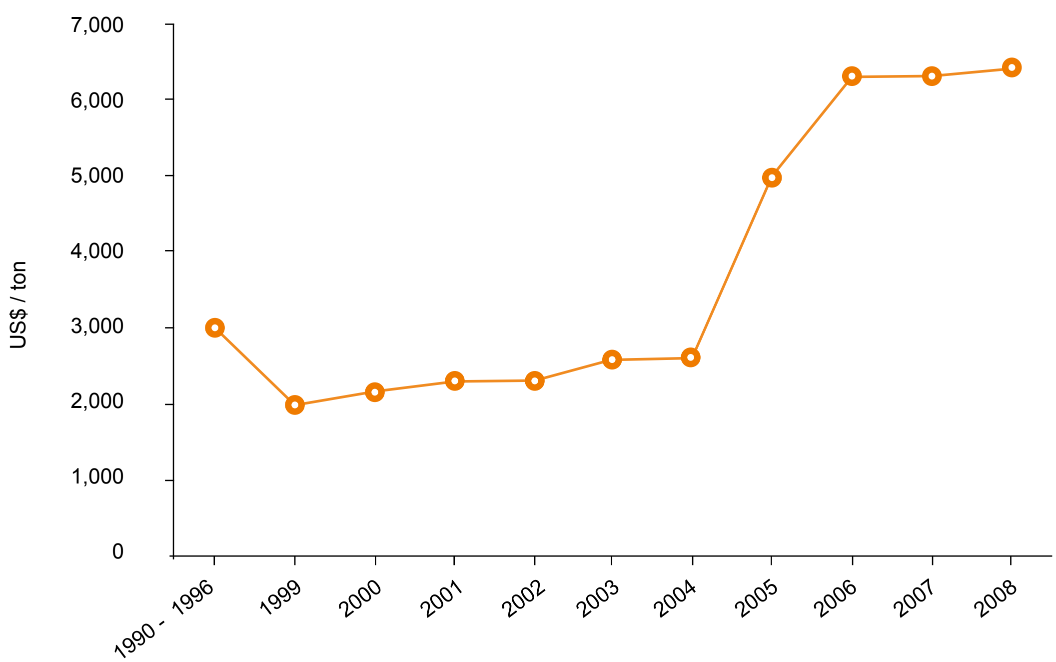

Source: TRU Group

Currently, lithium can be extracted from salt brine, or minerals, mainly spodumene, and is then processed to attain lithium carbonates which then undergoes a second transformation to reach lithium hydroxide and lithium chloride. Producing lithium by evaporating salt brine is much less expensive than directly extracting it from minerals.

Mineral extraction uses a great deal of energy since it involves a flotation stage that must be completed to produce concentrates, which are later calcified at more than 1,000 degrees Celsius, and then mixed with sulfuric acid and heated to 250 degrees, to obtain lithium sulfate. These are then mixed with water to dissolve the sulfate and only after being purified by filtration, treated with sodium carbonated, are lithium carbonates finally attained.

Figure 3

**Price trend for lithium carbonate (1996-2008)**



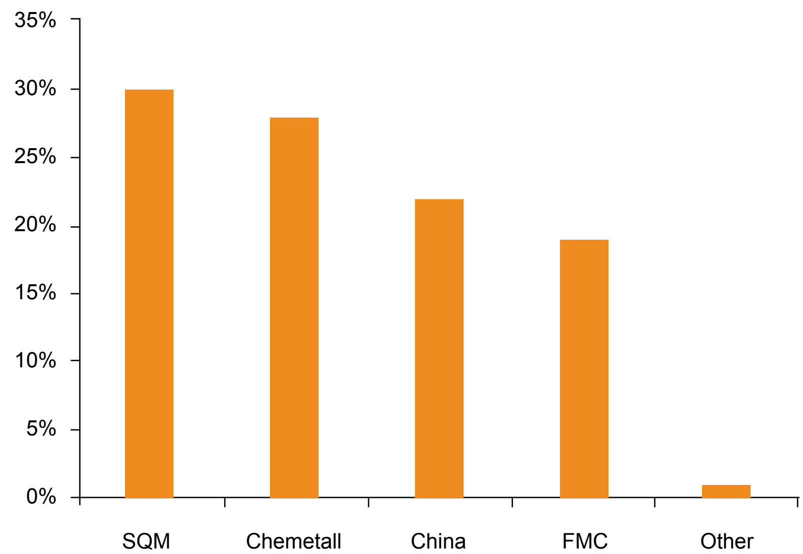

Source: Cochilco

The main salt brine production projects are found in Chile, in the Atacama salt flat where the Sociedad Chilena del Litio-Chemetall and SQM operate, and in Argentina, in the Hombre Muerto salt flat where FMC Lithium operates. There are also smaller scale operations in the US, in Silver Peak, Nevada, and in China, in Taijanair and Zhabuye.

German chemical company Chemetall, the same group that controls the Sociedad Chilena del Litio, runs the Silver Peak operations, which started up in 1996. Operations in China are a recent development and were made possible thanks to the development of new technology that allows salt brine with high magnesium content to be treated. This technological advance took place in 2004 and China now self-supplies its lithium needs.

The main spodumene production is concentrated in Australia, where Talison Lithium exploits the Greenbushes open pit mine, which has a capacity of producing 260,000 tons of lithium concentrates a year.

Figure 4
**Lithium producers: Market share (2008)**




Source: SQM

# The future on wheels

The boom in lithium use caused by the popularity of electronic devices that require powerful, long-lasting, rechargeable and light batteries is only the start of the very promising future that many are predicting for this metal. The idea of millions of cars powered by electric batteries is the fuel for the current enthusiasm over lithium. According to the TRU Group, which is one of the most important consultants in the lithium market, by 2020 38% of the lithium batteries used will be found in vehicles.

Figure 5
**Lithium battery use by type (2002-2020E)**

| Type of battery | 2002 | 2007 | 2020 |
|---|---|---|---|
| Disposable | 40 | 21 | 8 |
| Rechargeable | 60 | 79 | 54 |
| Vehicular | 0 | 0 | 38 |

Source: TRU Group

The weight of lithium-ion batteries gives them an important advantage over their competitors made out of nickel. A lithium ion battery stores two or three times as much energy per weight unit as a nickel battery.

Although the crisis caused a number of car manufactures to slow down their developments, hybrid autos are already on the production lines. In mid-2009 Mercedes Benz released its S400 hybrid model, which was the first car to use a lithium-ion battery. GM has placed its bet on electric vehicles as well, and is expecting to launch its first model at the end of 2010 when it releases the Chevrolet Volt (Opel Ampera in Europe), and around the same time Nissan will launch the Leaf, the first 100% electric car. Although Toyota, the maker of the Prius - the pioneer of hybrid vehicles- will continue to use nickel batteries in this model, the Japanese manufacturer will be using lithium-iron batteries in the plug-in version of this model it is working on. In fact through its affiliate Toyota Tsusho Corp, Toyota signed an agreement in late January to form a JV with Australian miner Orocobre to develop the Olaroz salt flat in Argentina and produce lithium and potassium.

Carlos Ghosn, the president of Nissan, has also said that by 2020 10% of the cars the company sells will be electric. This translates into some 6 million cars a year.

# Is there enough lithium?

These optimistic forecasts have lead many specialists to question if there will be enough lithium to meet demand. William Tahil, the research director at Meridian International Research, a research and technology consultancy, published a report in December 2006 that caused quite a stir by claiming that lithium reserves would not be enough to meet the forecasted demand.

Tahil's report uses reserve data calculated by the US geological survey (USGS) and includes data only for lithium-ion batteries made using lithium from salt flats. The report also warns of the geopolitical risks that having production concentrated in three countries in South America may implicate. The report concludes that the mass production of lithium-ion batteries for automobiles will quickly use up reserves, that the US will stop depending on the Middle East for oil and start depending on South America and that China will carry on as a practically self-supplying market, elevating US vulnerability to energy issues.

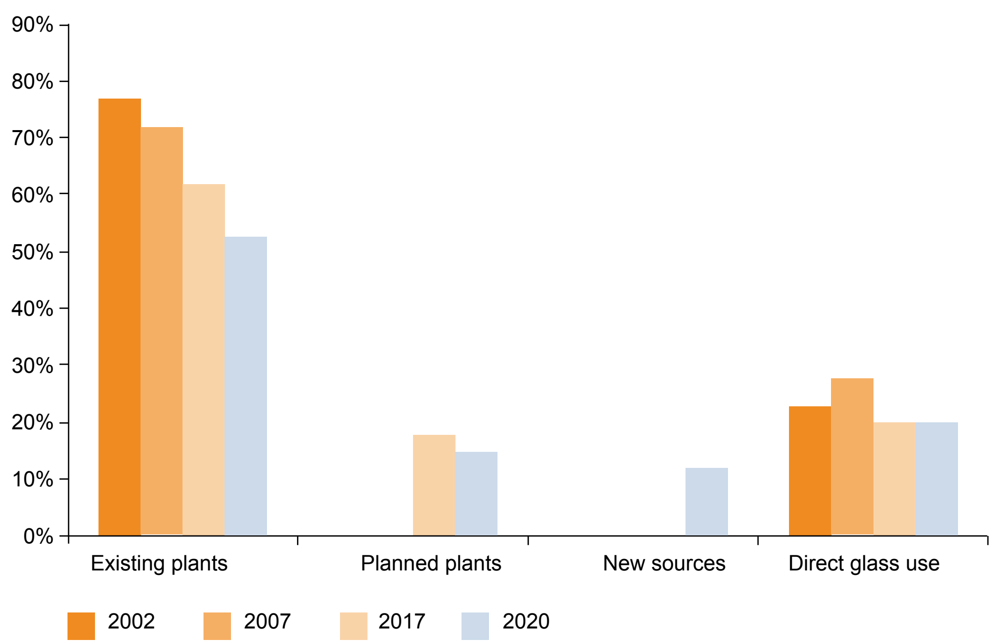
However, other experts have shot down Tahil's arguments. Keith Evans, a geologist with more than 40 years experience in lithium mining, has indicated that Tahil's reserve calculations are incorrect in many cases, contradictory and do not take into account the technological developments that growing lithium demand provides an incentive for, such as the aforementioned case in China where production in salt brines with high magnesium content was made possible thanks to new technology. Evans also emphasizes the potential for increasing spodumene based lithium production if lithium demand increases as much as current projections say it will. The technology that makes it possible to obtain lithium from spodumene at competitive costs is indeed available, he assures.

According to SQM, the world's known reserves exceed 100 million tons of lithium carbon equivalent, and this could increase significantly as more initiatives to increase production take off. In fact, the company said in an e-mail interview that global lithium resources total approximately 300 million tons of lithium carbonate equivalent. Even so, with only the known current reserves it would be possible to supply the total lithium demand forecasted for 2020 700 times over. In other words, more than 3,000 times the demand that electric powered vehicles are predicted to generate that year (2020). Looking at it another way, these reserves will provide the lithium needed to cover some 600 billion vehicles, which would be enough for 8,000 years of the world's current automobile production.

Edward Anderson, CEO of TRU, agrees with these estimates. "We don't expect any problems in the new 10 years," he says. "The big producers like SQM and Sociedad Chilena del Litio can expand production and although Chinese producers have had some problems, these are being resolved and they will also be able to increase output. In general, all producers will be able to do so."

According to Anderson there will actually be surplus production capacity until 2013 because of the capacity of current producers and because the Sentient Group will be starting operations at the Rincón salt flat in Argentina as well. After 2013 Anderson expects the market to remain stable until around 2018 or 2020 at which point a new operation to meet increased demand will be needed. Anderson is less optimistic than SQM about their capacity to continue increasing production indefinitely, but he does believe that the lithium market will develop in an orderly manner until the end of the decade.

Figure 6
**Lithium supply forecast (2002-2020E)**




Source: TRU Group

## Prices and juniors

Lithium's buoyancy suddenly fell last September when SQM announced unilateral 20% reduction in its prices. "This measure was based on supply and demand results," SQM told Business News Americas in an e-mail interview. "Clearly installed capacity exceeds demand as a result of increasing capacity and lowered demand from the international crisis," the company added.

With SQM's decision duly noted and the outlook for orderly growth until 2017 or 2018, lithium experts agree that prices won't likely increase. There is no reason for prices to go up on the horizon and experts agree that SQM's decision to lower prices before renewing its contracts was correct.

In fact, a number of specialists in the field do not trust the projections that some junior miners are using to calculate profits and promote projects to investors. "It worries us that a lot of juniors are exaggerating lithium prices by 30% to 40%,"Anderson from TRU says. "I haven't seen a single junior that has a realistic price. These juniors, and a number of analysts, are developing projects and attracting investors based on completely unreal prices."

Currently there are around 20 companies trying to get lithium projects off the ground but Anderson believes that of all these, only around three have a chance of becoming a reality and actually making profits, although none of them could even get close to producing at the same costs as SQM. "There's just no way. It would be impossible for them to compete with the costs of current producers. But this doesn't mean they can't be profitable either," Anderson says, with the added warning that these projects require a lot of investment, especially in time. "It takes about 8 to 10 years to get a project like these into production," he says.

While there are technologies that help speed up this process, at least three or four years are needed to get industrial lithium production started. It is also important to remember that each salt flat is different. Both Uyuni and projects in Argentina need to bring in experts and figure out the techniques and processes that best suit the characteristics of each specific salt flat; and this of course, takes time.

Besides time and money, personnel and their expertise are key to the success of a lithium project. Lithium involves very complex chemistry and "the problem is that the companies behind these projects [in South America] are made up of geologists, and what these companies really need is to be led by chemical engineers," Anderson says. While geology is an important factor, chemistry is absolutely fundamental. "The other problem is that the geologists working here are conventional geologists, not salt flat geologists, who actually work with a completely different type of geology that is in fact more of a mix between geology and the oil industry. All I can say to investors now is that they need to be very careful."

Despite this, big industrial conglomerates are keeping a very close eye on these developments, as Toyota's involvement in the Olaroz salt flat in Argentina indicates. Mitsubishi is also following the Bolivian government's plans for the Uyuni salt flat very closely.

# Projects: Who's who

Although the main lithium reserves are found in Chile, Bolivia and Argentina, it's Argentina that has the largest number of juniors and projects at different stages of development. Below is a list of some of the most important lithium prospects in South America:

***Salar de Olaroz/Cauchari - Orocobre:*** This project is located in the Jujuy province, in northwestern Argentina, near the Chilean border. According to a recent report from Orocobre there are currently three evaporation wells running as a part of preliminary studies on the project. The deposit is excellently located: it's connected by highway with the Antofagasta port in Chile, only 70 kilometers from the railway that connects to both Antofagasta and the rest of Argentina and is 15 kilometers from a pipeline. According to the company, the deposit has low magnesium content and the potential to produce 15,000 tons of lithium carbonate per year and 36,000 tons of potash a year. Lithium content is around 670 parts per million, clearly below the 1,570 parts per million in Atacama but more than the 320ppm found in the Uyuni deposit in Bolivia. The project is relatively near FMC's operations in the Hombre Muerto salt flat and can use conventional lithium recovery technology. Besides Olaroz, Orocobre also has a dozen other salt flat related properties. Toyota Tsusho Corp's entrance as a partial owner of the project – an agreement that also brought in the financial support of Japan's export bank- gives the project a very interesting advantage. The company expects to make the decision to start development at Olaroz this year.

***Proyecto Mariana - TNR Gold/International Lithium:*** Located in the Llullaillaco salt flat, in Argentina's Salta province, this project is owned by TNR Gold, which announced its intention to spin out its lithium and rare earth assets via subsidiary company International Lithium in April 2009. The company expects to finish the spin-off process during the first quarter this year. The Mariana project covers 120 square kilometers in the salt flat and TNR gold is planning to carry out geophysical studies, hydrological tests and drilling at the project this year. Pre-feasibility studies will start once the International Lithium spin-off is completed.

***Salares 7 - Salares Lithium:*** This project is located in the Atacama region and consists of rights in seven salt flats (Salar Grande, Piedra Parada, La Isla, Agua Amarga, Las Parinas, Aguilar and Maricunga) in this area in Chile, five of which are grouped together in a 200 square kilometer area 235 kilometers away from the city of Copiapó. The company, Salares Lithium, announced the purchase of 572 square kilometers of new concessions located near the 394 square kilometers of potential concessions it already holds. The idea behind these purchases is to have enough space around and between the salt flats to eventually construct production and support infrastructure. The company is currently designing an exploration program.

***Salar de Olaroz/Cauchari - Lithium Americas:*** This project is the result of combining Lithium Americas' and Grupo Minero Los Boros' mining properties with those properties that were acquired in September with purchase of lithium production rights, and the salt brine from the Borax Argentina/Rio Tinto properties in Cauchari in 2009, and borders the

Orocobre project mentioned above. The company has already completed 20 kilometers of seismic studies to create 3D models of the deposits and started a reverse circulation-drilling program in September 2009 that will total 2,000 square meters when finished. In September 2009 the company had collected US$7.5 million for the project via a private placement that involved a strategic partner who also was given a spot on the company board as well. Three months later Lithium Americas brought and additional US$10.5million for the project with another private placement.

***Salar del Rincon/Sentient:*** Located in the Salta province, near the Chilean border, this project is the furthest along of all Argentine projects. Originally Australian miner Admiralty Resources was developing the project, but after facing a serious financial crisis in 2008 Admiralty sold the project to the private equity firm Sentient Group for US$27million in late 2008. In 2007 the company had built evaporation wells in the Rincón salt flat to feed the pilot plant, which produced12 tons of 97% pure lithium carbonate in 2008 and showed very high recovery levels. The project's estimated investment is around US$105 million, with a lithium carbonate production capacity of 17,000 tons per year.

***Salar de Salinas Grandes and others/Rodinia:*** In December 2009 Canadian miner Rodinia Minerals purchased 4,500 hectares in the Salinas Grandes salt flat, located in the Jujuy province in northwestern Argentina. Besides this the company also reached an agreement in January 2010 on the purchase of three more salt flats in the Salta province (the Diablillos, Centenario and Ratones salt flats.) Presently these four projects are in the exploration stage and Rodinia is reviewing the data from drilling and seismic studies carried out there. The company is being supported by the Forbes & Maniatan investment bank.

***Uyuni***

***Salar de Uyuni/Comibol:*** Bolivian state miner Comibol plans to start operations at a lithium carbonate, sulfate and potassium chloride pilot plant in the Uyuni salt flat, located in the Potosí department in southwestern Bolivia, in April 2010. Uyuni is considered one of the world's largest lithium reserves, even though further studies must be completed to verify this as well as its lithium, potassium and magnesium content. According to specialists, however, the suspicion that the flat may have very high magnesium content and the fact that it floods almost every year are working against the project. The Evo Morales government wants Uyuni development to be 100% state run, but Uyuni's development has a long and troubled history, both because of the opposition of communities that live off of it, and Bolivia's traditionally anti-foreign investment politics.

# Conclusions

Despite the lithium demand's stumble in 2009, the outlook for this metal for the rest of the decade is more than positive. South America has some important natural advantages that will help it take advantage of the growth in demand expected for this metal. That being said, considering the uncertainty that surrounds this metal - from the likelihood of actually getting lithium production started at a profit, to the risk of lithium technology being replaced by another- should result in caution. The examples of exaggerated expectations have been very damaging to the industry.

The current lithium situation has also brought up another important question: what type of public policies should governments establish to regulate the production of a metal than many consider a strategic asset?

The position of the Bolivian government, which wants to take advantage of the current lithium fever to encourage internal technological developments, might sound like a good answer to this question on paper, but could be a recipe for disaster if not handled properly. As the experts have said, producing lithium involves very complex chemistry and is best developed by a network of collaboration rather than having a go at it alone.
In Chile, where lithium production rights are overseen by a special organization, the Chilean copper commission has recommended that the government analyze the type of policies it enacts for lithium very carefully. Besides carefully studying the role of the state in future lithium developments in Chile, it is also important not to lose sight of the fact that it's a private company (SQM) that has developed the world-class know-how of lithium production there.

Unlike what's happened in Chile, and what is being planned in Bolivia, in Argentina lithium development is being carried out under very conventional regulations, which has facilitated the arrival of junior companies in the northwestern territory of that country.

Judging by the dynamism that these companies have seen over the last few months as far as mergers and acquisitions go, this framework seems to be suitable for developing lithium.

In any case, Chile and Argentina are very well positioned to dive right into the lithium boom. Bolivia, for its part, has all the potential in the world but needs to establish more realistic policies before it will be able to take advantage of the burgeoning market.

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