Serviço Geológico do Brasil - CPRM

Economic Viability and Global Market Competitiveness of Specific Minerals

Lithium Geoeconomic Profile

Gilberto Dias Calaes, D.Sc. – Mineral Economist
Department of Geology and Mineral Resources – Advisor

Roberto Loreti Junior - Geologist
Geology and Mineral Resources Supervisor (SP)

Paulo Cesar Barbosa Junior - Geoscience Technician
Department of Geology and Mineral Resources – Assistant

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Lithium

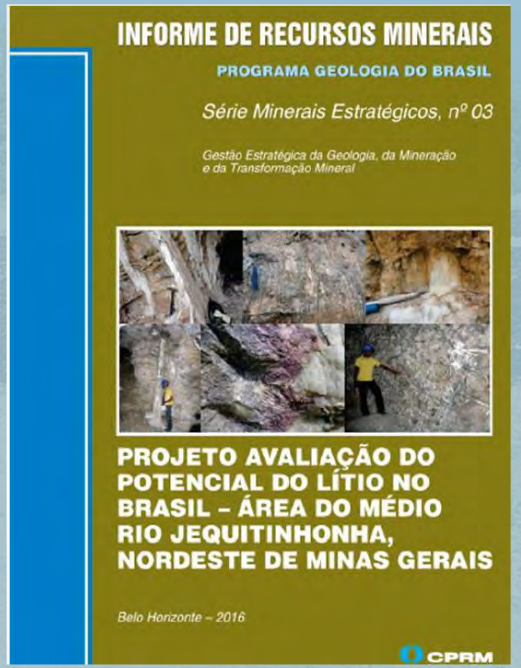
The Brazilian Geological Survey has done an study called "**Evaluation of the lithium potential in Brazil**". Its main focus is the midstream area of the Jequitinhonha River, northeastern Minas Gerais, where there are some mining companies that produce or will produce lithium. Other regions with occurrence of lithium have also been studied such as the **Borborema Province** and **Solenopoles Subprovince** located in northeast region of Brazil.

- Ore minerals: spodumene, petalite and lepidolite.
- Geological setting: widespread in LCT type pegmatites.
- **Conclusions:** The result demonstrated the potential in the mid-Jequitinhonha River area for a considerable expansion of its lithium reserves and other associated elements/minerals in lithineferous pegmatites.

Lithium

SGB/ CPRM Project:
Lithium Potential Assessment in Brazil

- Publication (2016)
- Lithium deposit geological modeling improvement
- Identification of new potential areas
- Lithineferous pegmatites exploratory model proposition



1st Step: Jequitinhonha Valley

2nd Step : Borborema

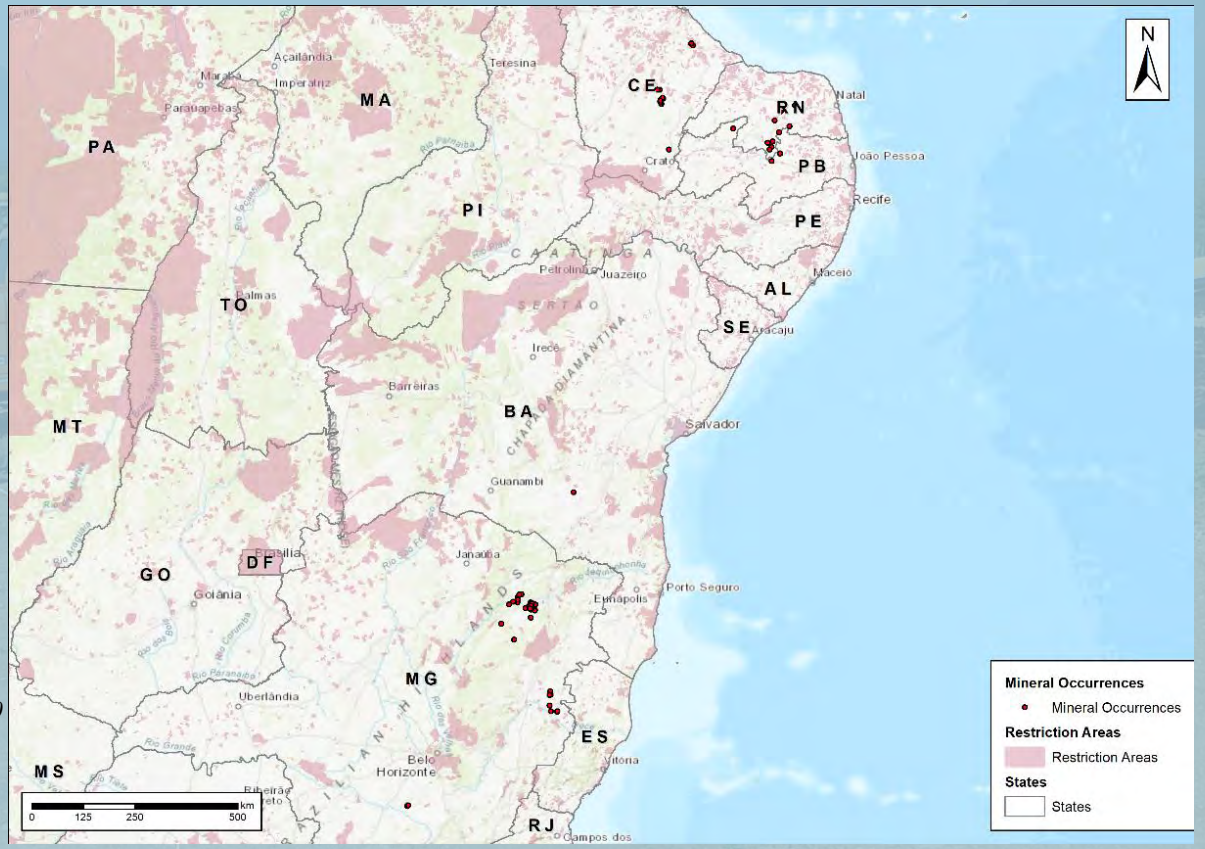
Other Areas:

- São João del Rey Pegmatite Province
- Solonopoles Subprovince – CE
- Eastern Region of Minas Gerais
- South/ southeastern Region of Tocantins

Source: Paes, V. J. *Avaliação do Potencial do Lítio no Brasil*: Ações, Principais Resultados, Perspectivas Atuais e Futuras. SGB/ CPRM. III Simpósio Lítio Brasil. PPT presentation. 23p. 2018

Lithium

Mineral Occurrences and Restricion Areas



Sources: Mineral Ocurrences: SGB GEOSGB – Jun, 2020
Restriction Areas: MMA, INCRA, ICMBio, FUNAI, CSN and CDN – 2021
Data processed by the Platform P3M

Lithium

Mineral Rights

Mineral Rights								
States	Available		Exploitation		Exploration		Total	
	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)
Amapá					3	4,320	3	4,320
Bahia					46	53,300	46	53,300
Ceará	1	1,791			21	30,325	22	32,115
Minas Gerais	10	13,660	27	11.752	176	199,504	213	224,917
Pará					3	9,188	3	9,188
Paraíba	1	1,951			8	9,019	9	10,970
Pernambuco					25	21,560	25	21,560
Rio Grande do Norte	1	254	1	49	7	8,697	9	9,000
Roraima					7	33,697	7	33,697
Total	**13**	**17,655**	**28**	**11,801**	**274**	**369,610**	**315**	**399,066**

Source: ANM Open Data – 2019; Processed by Plataforma P3M

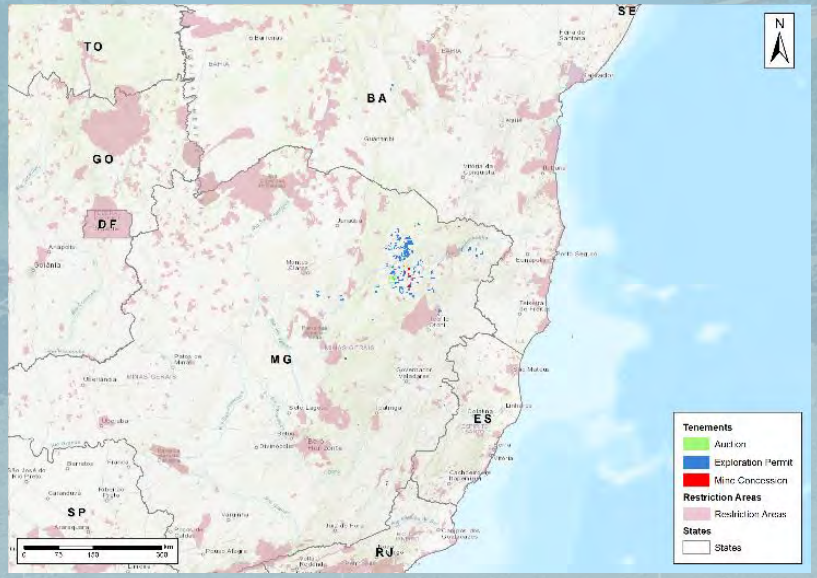
Occurrences, Deposits and Mineral Production Units	
States	O, D, MPU
Bahia	1
Ceará	23
Minas Gerais	54
Paraíba	5
Rio Grande do Norte	9
Total	**92**

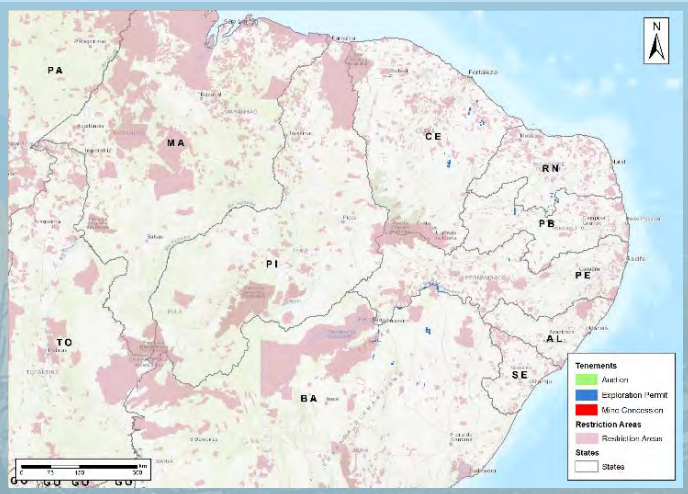
Source: SGB GEOSGB – Jun/2020

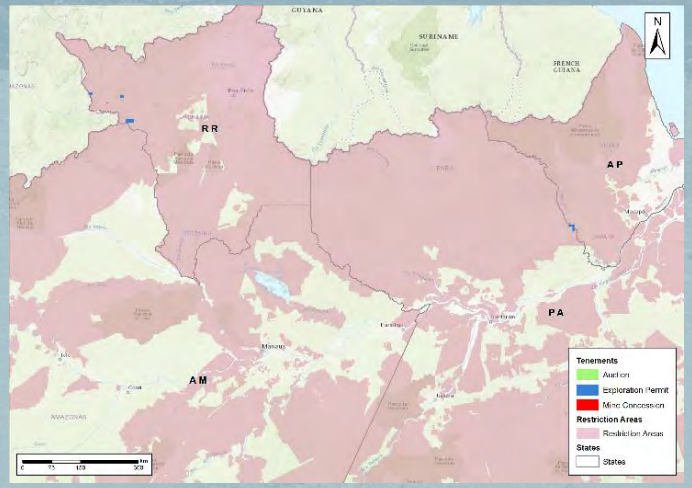
Processed by Plataforma P3M

Lithium

Mineral Rights and Restriction Areas







Sources: ANM Open Data – Oct, 2021.

Restriction Areas: MMA, INCRA, ICMBio, FUNAI, CSN and CDN – 2021

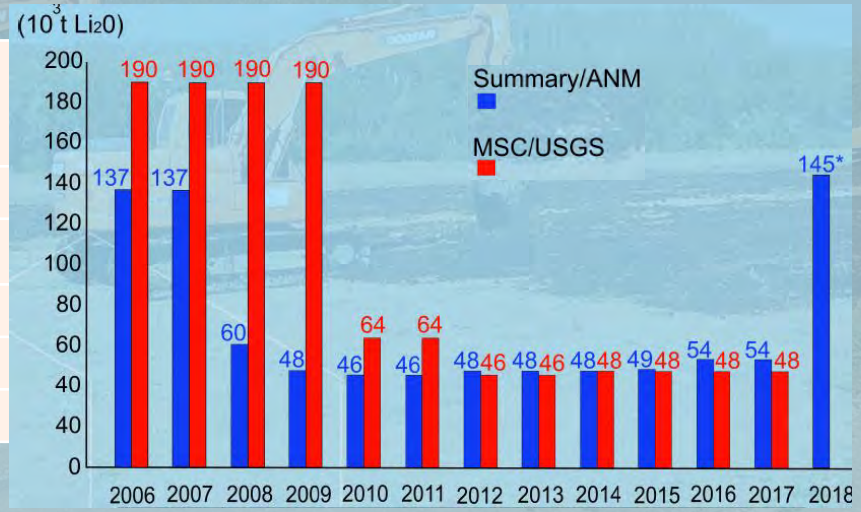
Data processed by the Platform P3M

Lithium

Brazilian Reserves (2020)

Municipality	State	Reserves (in thousand tons) Measured Ore	Measured Li_2O	Indicated Ore	Indicated Li_2O	Inferred Ore	Inferred Li_2O
Araçuaí	MG	639	9	1,277	23	1,343	17
Divisópolis	MG	-	-	-	-	-	-
Itinga	MG	8,177	129	6,675	98	5,130	77
São Tiago	MG	9,632	88	-	-	4,650	47
Total		**18,448**	**226**	**7,951**	**121**	**11,123**	**141**

Source: ANM Open Data – 2020; Processed by Plataforma P3M



Sources: ANM – Mineral Brazilian Summary

USGS – Mineral CXommodity Summaries

Lithium

World Reserves

Source: Garcia, I.G. *Recursos e Reservas de Lítio (Nacional e Internacional)*; ANM. III Simpósio Lítio Brasil; PPT presentation. 15p. 2018

Lithium

Brazilian Production (2019)

Municipality	State	Tons*	R$ thousand
Araçuaí	MG	11,145	13,390
São Tiago	MG	27,934	55.242
Total	-	**39,079**	**68.632**

**Spodumenium concentrated*

CFEM (2020)

Municipalities	R$ thousand
Araçuaí	158
Itinga	158
Nazareno	1,172
Total	**1,488**

Source: ANM Open Data – 2019;
Data processed by the Platform P3M

Araçuaí

Nazareno

Itinga

São Tiago

Source:Data processed by the Platform P3M

Lithium

Brazilian Production and Apparent Consumption

Discriminação		Unidade	2014(r)	2015(r)	2016(p)
Produção	Concentrado(1)/ Contido(2)	(t)	8.519 / 452	5.781 / 308	8.804 / 440
	Compostos Químicos(3)	(t)	619 (569)	529 (489)	725 (674)
Importação	Concentrado	(t)	-	-	-
		(US$-FOB)	-	-	-
	Compostos Químicos	(kg)	695	1.210	1.616
		(US$-FOB)	28.570	103.391	461.334
Exportação	Concentrado	(t)	-	-	21
		(US$-FOB)	-	-	Nd(8)
	Compostos Químicos	(kg)	5	251	-
		(US$-FOB)	1.620	1.576	-
Consumo Aparente(4)(7)	Concentrado	(t)	8.519	5.781	8.784
		(t)	619,7	529,9	726,6
Preços Médios(6)(7)	Espodumênio – importação	(US$/Kg)	-	-	-
	Espodumênio – exportação	(US$/Kg)	-	-	-
	Compostos – importação	(US$/Kg)	41	85	285
	Compostos – exportação	(US$/Kg)	324	6	-

Fonte: ANM/SRD, MDIC/SECEX, CBL. (1) inclui espodumênio, petalita e lepidolita, transferidos para industrialização de sais de lítio (carbonato e hidróxido) ou vendidos moídos; (2) contido em óxido de lítio; (3) produção total de sais de lítio, e em LCE (entre parênteses); (4) produção + importação – exportação; (5) consumo de sais de lítio no mercado interno; (6) preço médio exp. ou imp.; (7) a partir do Sumário 2016, dados para os três anos mostrados têm como base o Sistema Comex Stat do SECEX/MDIC, sem o arredondamento que antes era realizado no sistema COMEX/ANM; (8) Exportação de petalita com valor não disponível no sistema Comex Stat por razoes estatísticas; (-) dado nulo; (r) revisado; (p) preliminar.

Source: ANM - Sumário Mineral 2017

Lithium

Brazilian Mining Companies

CBL – Cia. Brasileira de Lítio

- The CBL is a 100% brazilian company, pioneer in the underground mining of lithiniferous pegmatite and in the processing of spodumenium.
- CBL produces lithium carbonate and hydroxide.
- Its products meet several applications, such as greases, lithium-Ion batteries, fluxing powders, heat treatment salts, pharmaceuticals, ceramics, and glass, among others.
- For a long time, CBL has been the only Li producer in Brazil.
- Currently it produces around 12,000 tons/ year of lithium concentrate.

Lithium

Brazilian Mining Companies

CBL - Cia. Brasileira de Lítio

The lithium concentrate produced by CBL is transfered to its installation located in Divisa Alegre – MG, where it is transformed in lithium carbonate and lithium hydroxide.

The lithium concentrate with 5,4% Li_2O is obtained through a heat treatment (decrepitation).

In Brazil, the lithiuim carbonate is used in the glass industry, the ceramic industry and in the prymary aluminum industry.

The lithium hidroxide is obtained from lithium carbonate or directly from mineral concentrates.

The lithium hidroxide is used in the special lubrificating greases. In the anhydrous form it is an ideal absorbent for carbon dioxide.

Lithium

Brazilian Mining Companies

SIGMA Lithium

- The Company, through its indirectly wholly-owned subsidiary Sigma Mineração S.A. (“SMSA”), is developing the largest hard rock lithium deposits, located in its wholly-owned Grota do Cirilo Project in Brazil with the goal of participating in the rapidly expanding global supply chain of electric vehicles (“EVs”).
- Based on the Feasibility Study Report, the Company plans to produce 220,000 tons annually of battery grade lithium concentrate lithium (33,000 tons of lithium carbonate equivalent (LCE) in Production Phase 1 and expects to be amongst the world’s lowest-cost producers. In Production Phase 2, production would be increased to 440,000 tons (65,000 tons of LCE) annually.

Source: SIGMA. *Sigma Lithium Resorces Inc.* III Simpósio Lítio Brasil. PPT Presentaion. 22p. 2018

Lithium

Brazilian Mining Companies

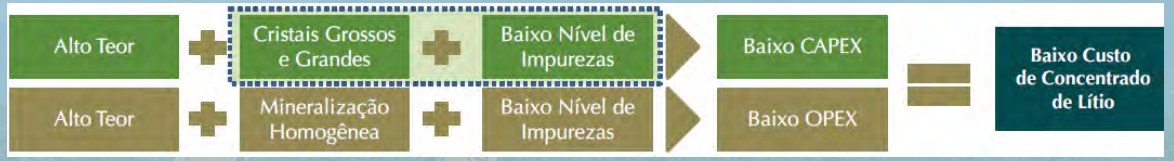
SIGMA Lithium

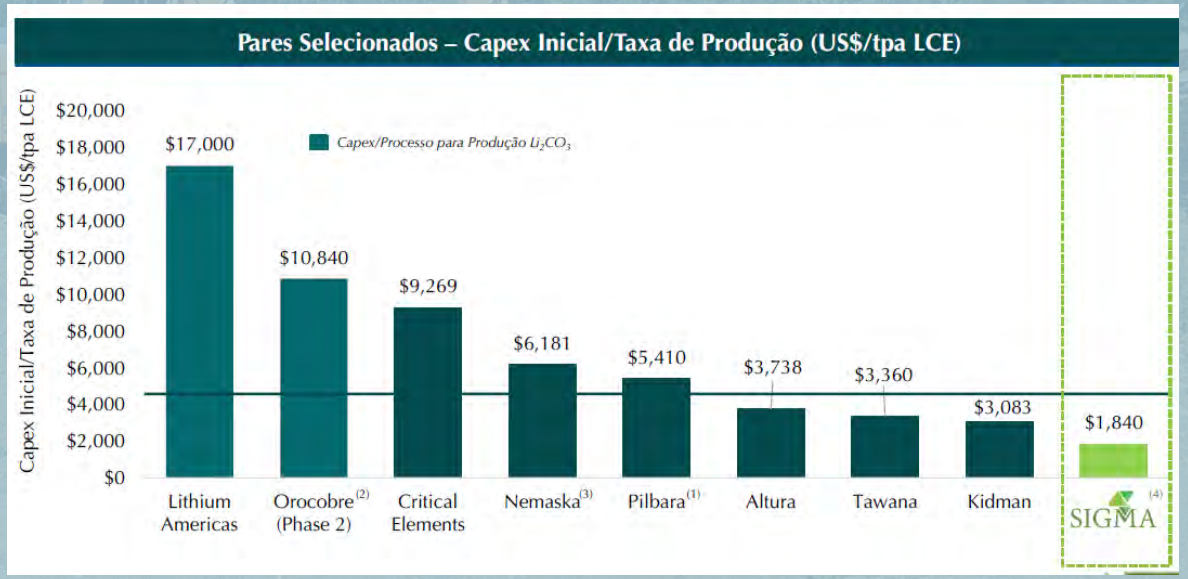
- The company holds mineral rights in an area of 18 thousand ha, located in the municipalities of Araçuaí and Itinga, in the Jequitinhonha Valley, northeastern region of Minas Gerais.
- In the company's mineral properties there are 9 disabled small mines and 11 exploration targets.
- The proven and probable reserves amount to 13,8 million tons with grade of 1,46% Li_2O.
- Xuxa deposit feasibility study (one of the 9 deposits in the company properties) demonstrated a NPV of US$ 249 million and OPEX (cash costs) of US$ 238/ tonne of concentrate with 6% Li_2O grade.
- The FS considers an open pit mining and a plant with processing capacity for 1,5 million tons/year, with production and sales of 220.000 tons/year of concentrated (1st stage) and 440.000 tons/year in the 2nd stage.
- The producing system will be supplied by renewable energy (hydroeletric), will adopt a dry processing route (without dam) and will recycle 90% of the water. The project will generate 500 jobs.

Lithium

Brazilian Mining Companies

SIGMA Lithium





Source: SIGMA. *Sigma Lithium Resorces Inc.* III Simpósio Lítio Brasil. PPT presentation. 22p. 2018

Lithium

Brazilian Mining Companies

AMG

- With approximately 3,000 employees, AMG operates globally with production facilities in Germany, the United Kingdom, France, the United States, China, Mexico, Brazil, India, Sri Lanka, and Mozambique, and has sales and customer service offices in Russia and Japan.

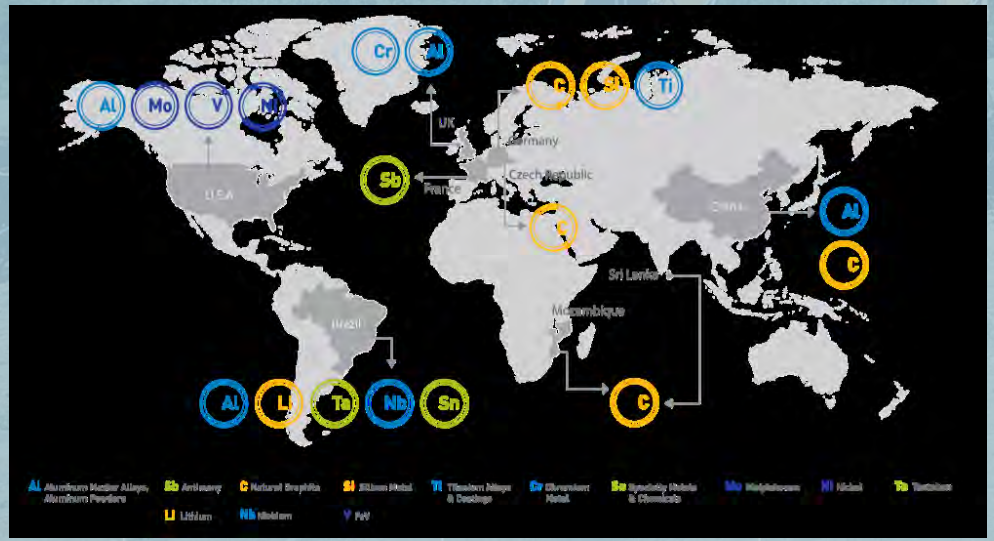
- Through a contract that anticipated the sale of 200,000 tons of lithium concentrate for the following five years, AMG financed the expansion of the Volta Grande mine, between the municipalities of Nazareno and São Tiago, in the Central region of Minas Gerais. The deal was closed by the brazilian subsidiary of the Amsterdam-based group, AMG Brasil, based on a **production of 40,000 tons/year**.

Source: www.DeepL.com/Translator (free version)

Lithium

Brazilian Mining Companies

AMG

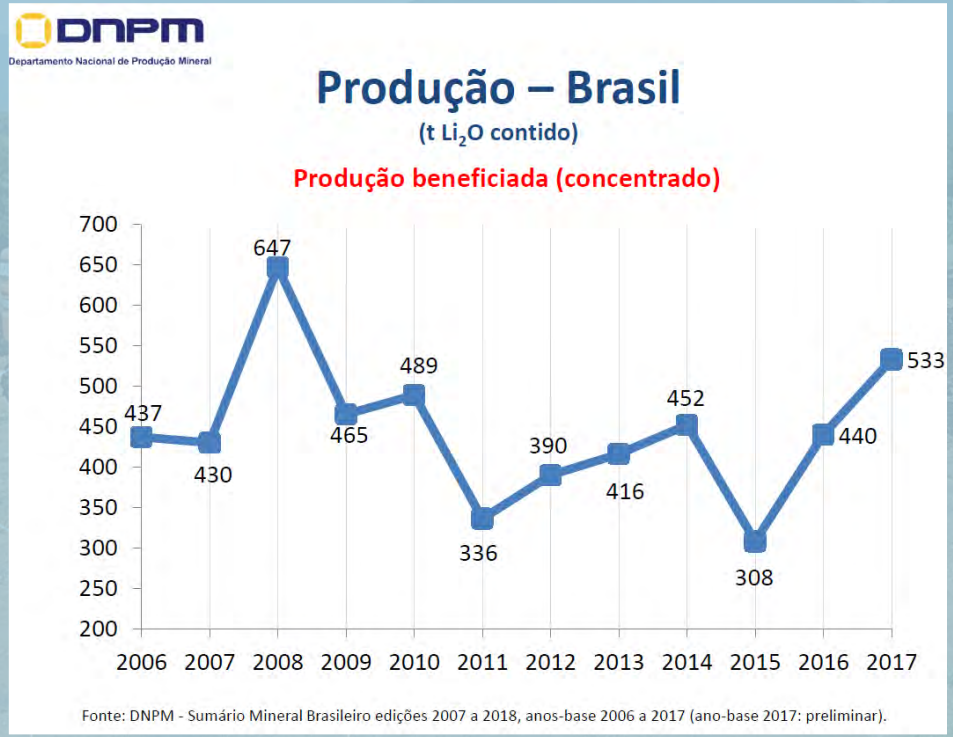


Source: AMG presentation. III Simpósio Lítio Brasil. PPT presentation. 22p. 2018

Source: AMG Annual Report, 2020

Lithium

Brazilian Production



Source: Garcia, I.G. *Recursos e Reservas de Lítio (Nacional e Internacional)*; ANM III Simpósio Lítio Brasil; PPT presentation. 15p. 2018

Lithium

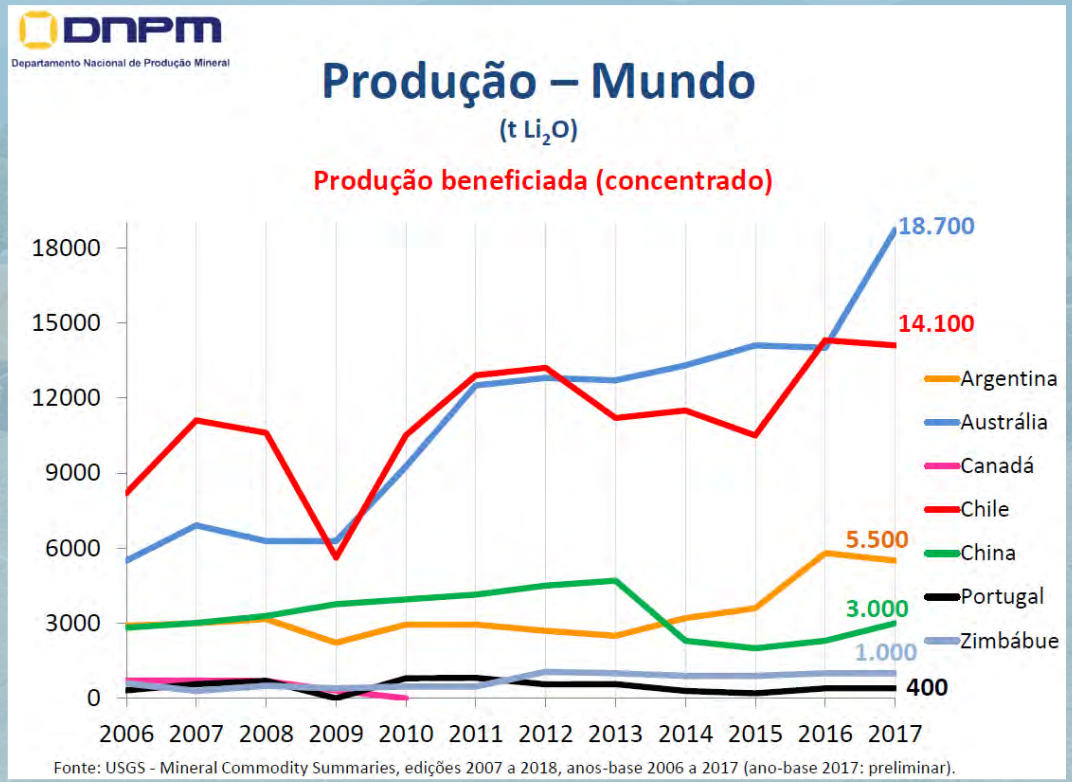
Brazilian manufacturing initiatives

- The first lithium-sulfur battery cell factory in the world is being installed in Juiz de Fora (Zona da Mata) by Oxis Brasil. The initiative is led by the Minas Gerais Development Company (CODEMGE) and British company Oxis Energy. With investments of approximately R$ 245 million, operations should start in 2023.

- A group of eight Silicon Valley companies will install at the industrial airport of Confins, in the Metropolitan Region of Belo Horizonte (RMBH), the Colossus Cluster Minas Gerais, focused on the production of lithium batteries, components and electric vehicles, through investments of US$ 3.5 billion in the next few years. Operations are expected to start in 2022.

Lithium

World Production



Source: Garcia, I.G. *Recursos e Reservas de Lítio (Nacional e Internacional)*; ANM. III Simpósio Lítio Brasil; PPT presentation, 15p. 2018

Lithium

Current and Future Brazilian Demand

Lithium Carbonate

Aluminum: 65%
Pharmaceutical: 6%
Glasses: 6%
Paints and Varnishes: 3%
Others: 20%

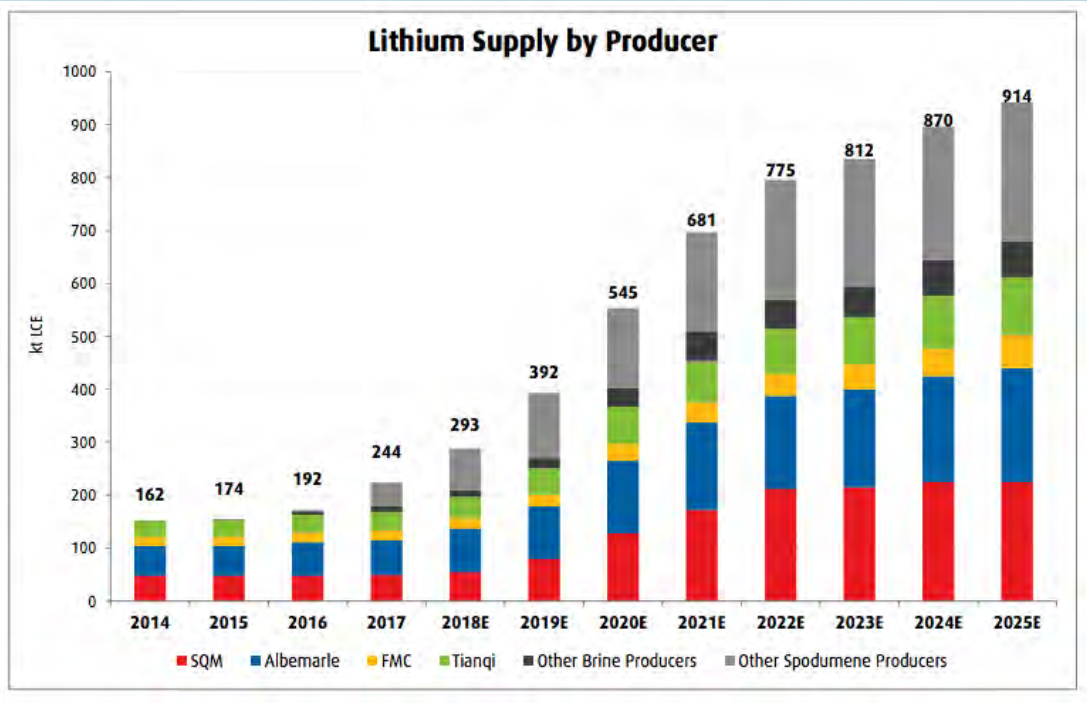
Lithium Hydroxide

Oils and greases: 94%
Dyes and pigments: 3%
Catalysts: 1%
Others: 2%

Applications	Companies and Entities
Batteries	Eletrocell; IPEN; Itaipu; Moura
Traction system	WEG, Eletra
Vehicles	CPFL, EDRA, ELETRA, FIAT, ITAIPU, IVECO, VOLVO COPPE/ UFRJ, EMTU-SP

Lithium

Market



Source: CODEMGE. *Investimentos para integração da cadeia de lítio no Brasil: da mina à mobilidade elétrica,* Simpósio Lítio Brasil; PPT presentation. 19p. 2018

Lithium

Market

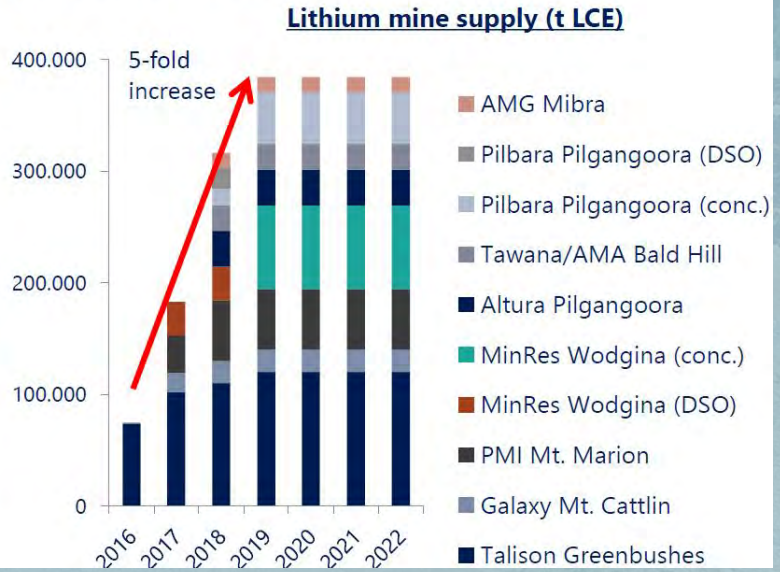
More spodumene hits the market in 2018 as new Australian/Brazilian supply starts; if all goes to plan…

PILBARA MINERALS

TAWANA

ALTURA Mining Limited

AMG



Source: Lazen, J. et al. *Lithium, Batteries and xEVs – Roskill's view of international markets and prices.* Simpósio Lítio Brasil; PPT presention. 19p. 2018

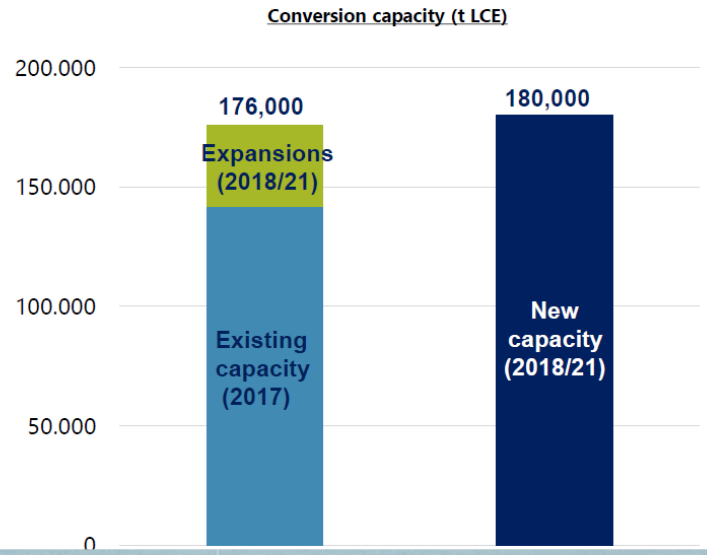
Lithium

Market

Existing and potential new spodumene converters with Australian feedstock are doubling their nameplate capacity

Existing:

- Tianqi
- Albemarle
- Ganfeng
- General Lithium
- Ruifu
- Yahua
- Zhonghe
- RongJie (Youngy)



New processors:

- Hebei Tianyuan (Optimum)
- Jiangxi SE (JV Burwill)
- Sichuan Zhiyuan
- Jiangxi Dongpeng
- Fancy Resources
- NAL (CATL) (Canada)
- SQM/Kidman (Australia)
- POSCO (Korea)
- Nemaska (Canada)
- Albemarle (Australia)

Source: Lazen, J. et al. *Lithium, Batteries and xEVs – Roskill's view of international markets and prices.* Simpósio Lítio Brasil; PPT presentation. 19p. 2018

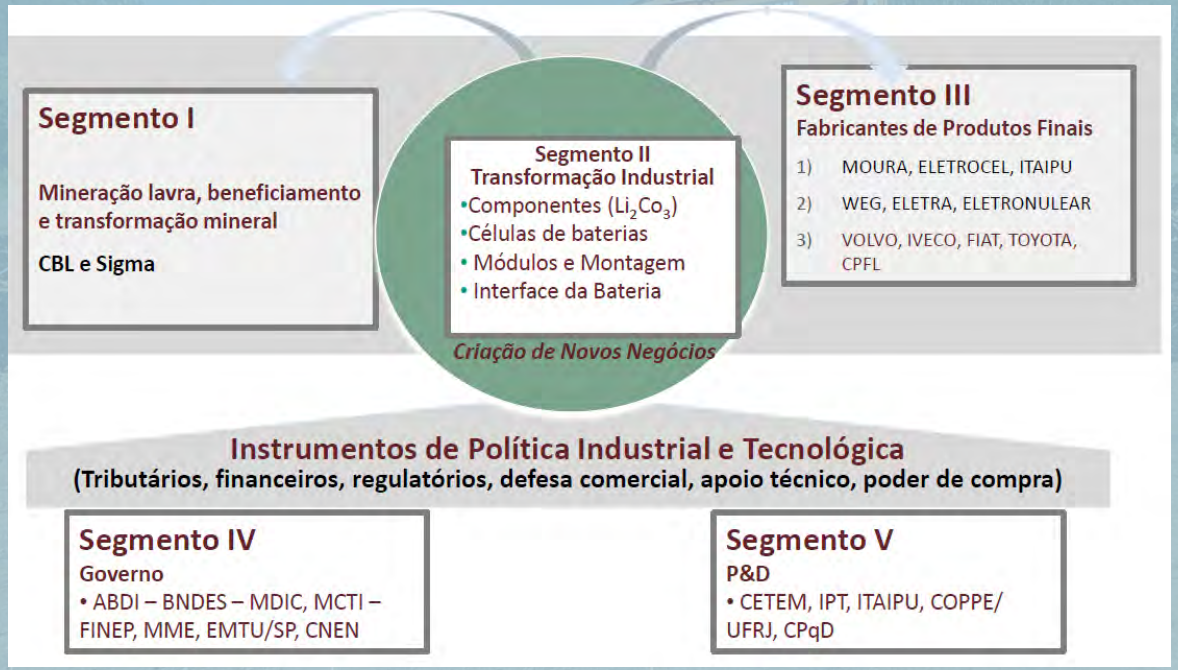
Lithium

Government Policies – Some examples

- Tax exemption on the disposal of shares of small and medium-sized companies (Law 13,043/ 2014)
- Decree 2.413/97: Regulates the industrialization, import and export activities of lithium minerals and ores, organic and inorganic chemical products, including their compositions, manufactured from lithium, metallic lithium and lithium alloys, and their derivatives of interest to nuclear energy
- Brazil/Germany agreement (2016): cooperation in the development of programs to stimulate the production of electric vehicles.
- CAMEX Resolution 97/ 2015: Reduced the import tax rate for vehicles equipped with electric motors from 35% to 0%.
- State incentives for the acquisition of electric vehicles: IPVA exemption or reduction; rotation of license plates.
- **Pro-Strategic Minerals:** Decree 10,657, of March 24th, 2021 - Institutes the Policy to Support the Environmental Licensing of Investment Projects for the Production of Strategic Minerals - Pro-Strategic Minerals, provides for its qualification under the Investment Partnership Program and creates the Interministerial Committee for the Analysis of Strategic Minerals Projects.

Lithium

Government Policies / A framework previously discussed



Source: CEDRAZ, M.A. *Desenvolvimento da Cadeia Produtiva do Lítio no Brasil: Possíveis Ações*. II Simpósio do Lítio, PPT presentation. 40p., 2016

SERVIÇO GEOLÓGICO DO BRASIL
CPRM

Gilberto Dias Calaes, D.Sc.
Assessor da DGM

Serviço Geológico do Brasil – CPRM
DGM – Diretoria de Geologia e Recursos Minerais
e-mail: gilberto.calaes@cprm.gov.br
Telefone: (21) 2549.2465; (21) 99855.4263
www.cprm.gov.br

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MINISTÉRIO DE MINAS E ENERGIA
PÁTRIA AMADA BRASIL GOVERNO FEDERAL