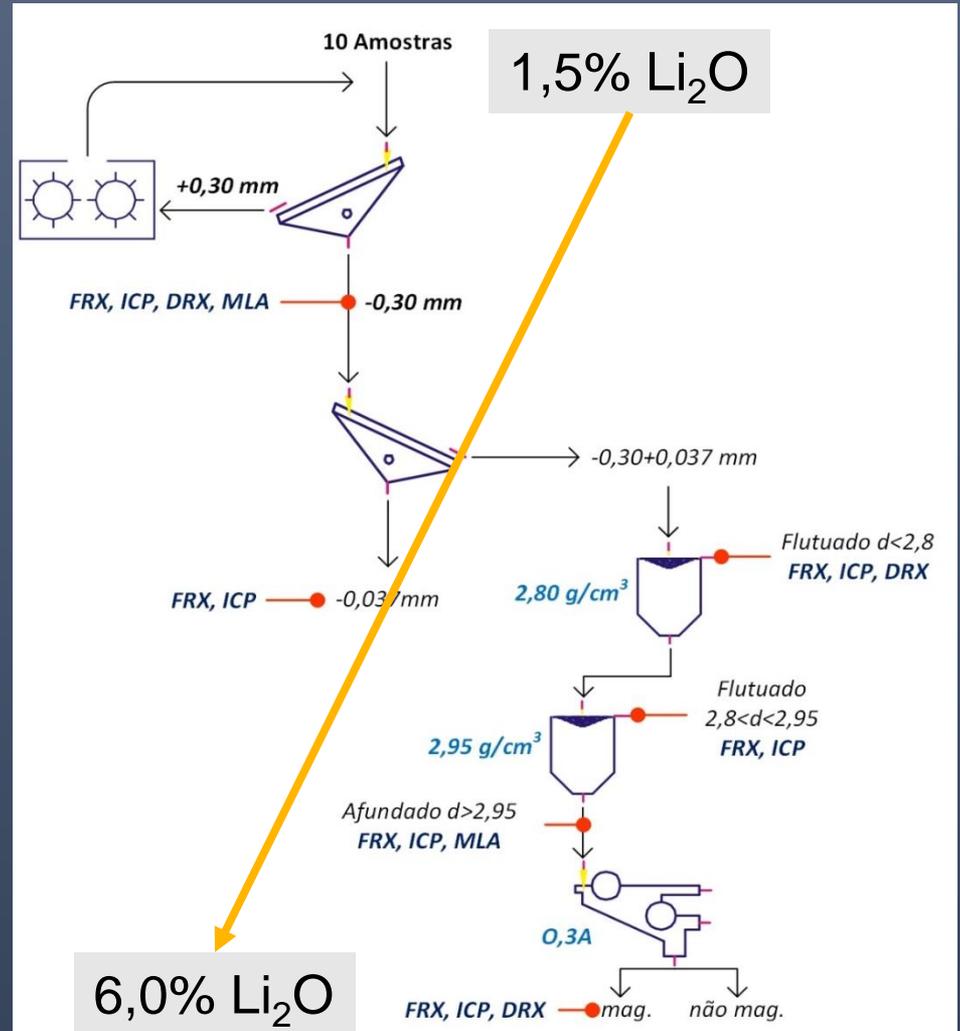


Caracterização Tecnológica de um minério de Lítio de Minas Gerais, Brasil



MARCO TIMICH

marco.timich@usp.br

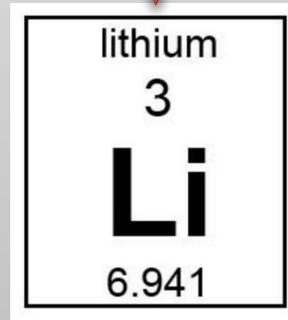
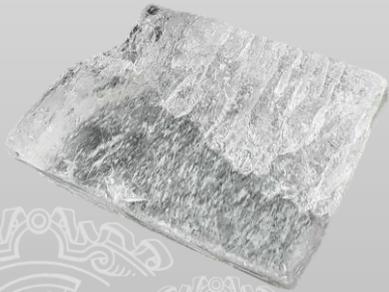
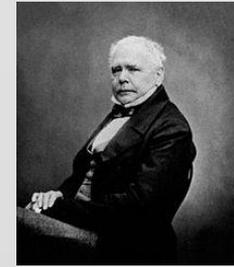


LÍTIO: WHITE GOLD

MARCO TIMICH



LÍTIO



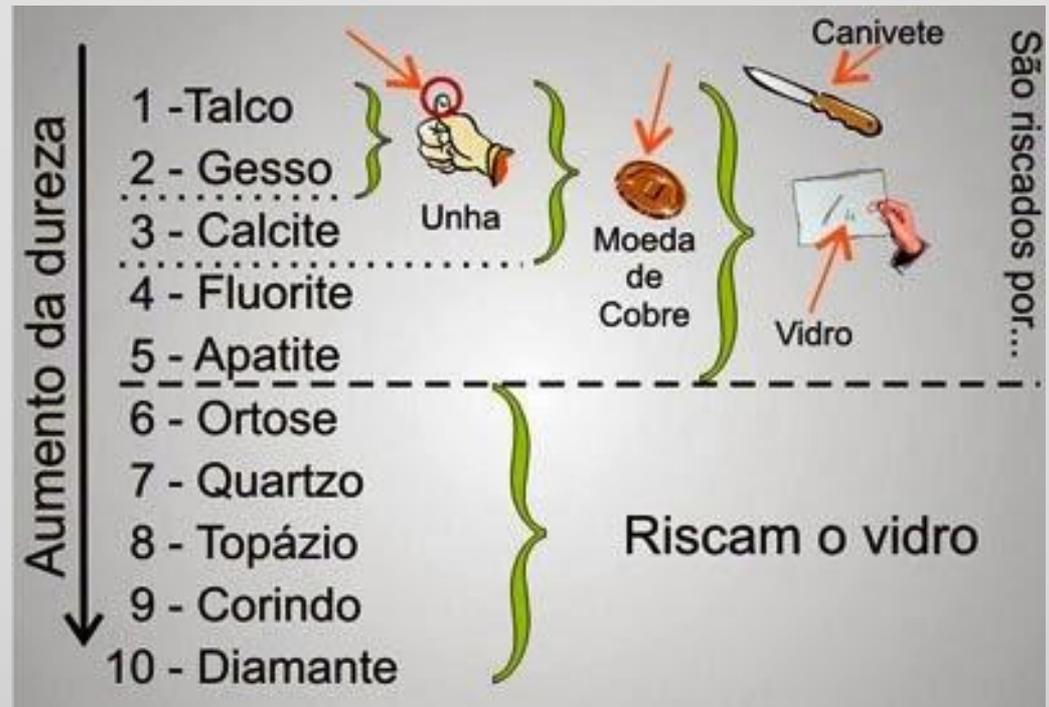
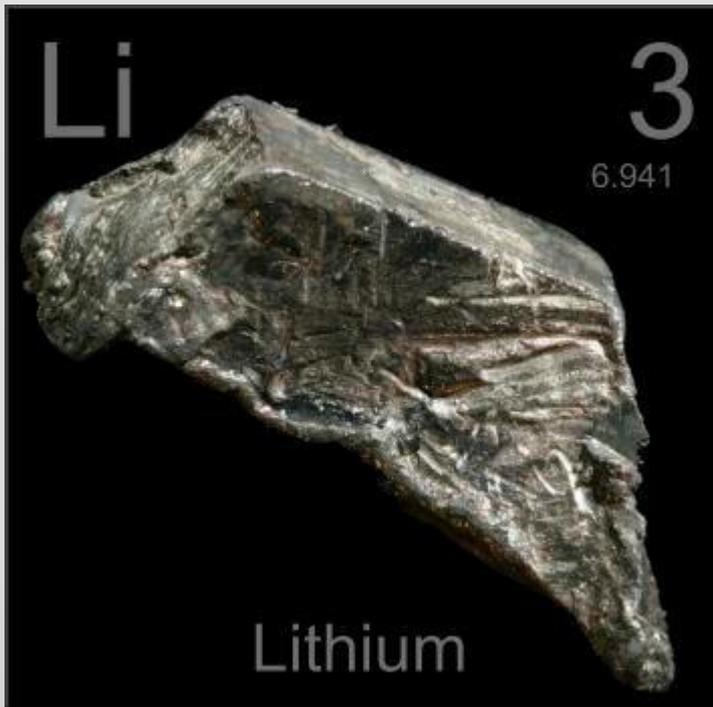
✓ José Bonifácio (1800)

✓ Johan A. Arfwedson (1817)

✓ Brande & Davy (1818)

Em 1923 Lítio metálico começou a ser comercializado na Alemanha

LÍTIU – LITHOS - ROCHA



- Densidade 0,535 g/cm³
- Metal alcalino, macio
- Baixa densidade, pouco eletronegativo, altamente reativo
- Excelente condutividade elétrica
- Dureza abaixo do Talco

CONCENTRAÇÃO DE LÍTIO

Oceano: ~0,17 ppm

Crosta: ~20 ppm

Granito: ~30 ppm

Rochas sedimentares: ~60 ppm

Solo: 0-400 ppm



TIPOS DE DEPÓSITOS DE LÍTIO

Minerais



Fonte: Simmons, 2019

Íons



Fonte: Evans, 2014

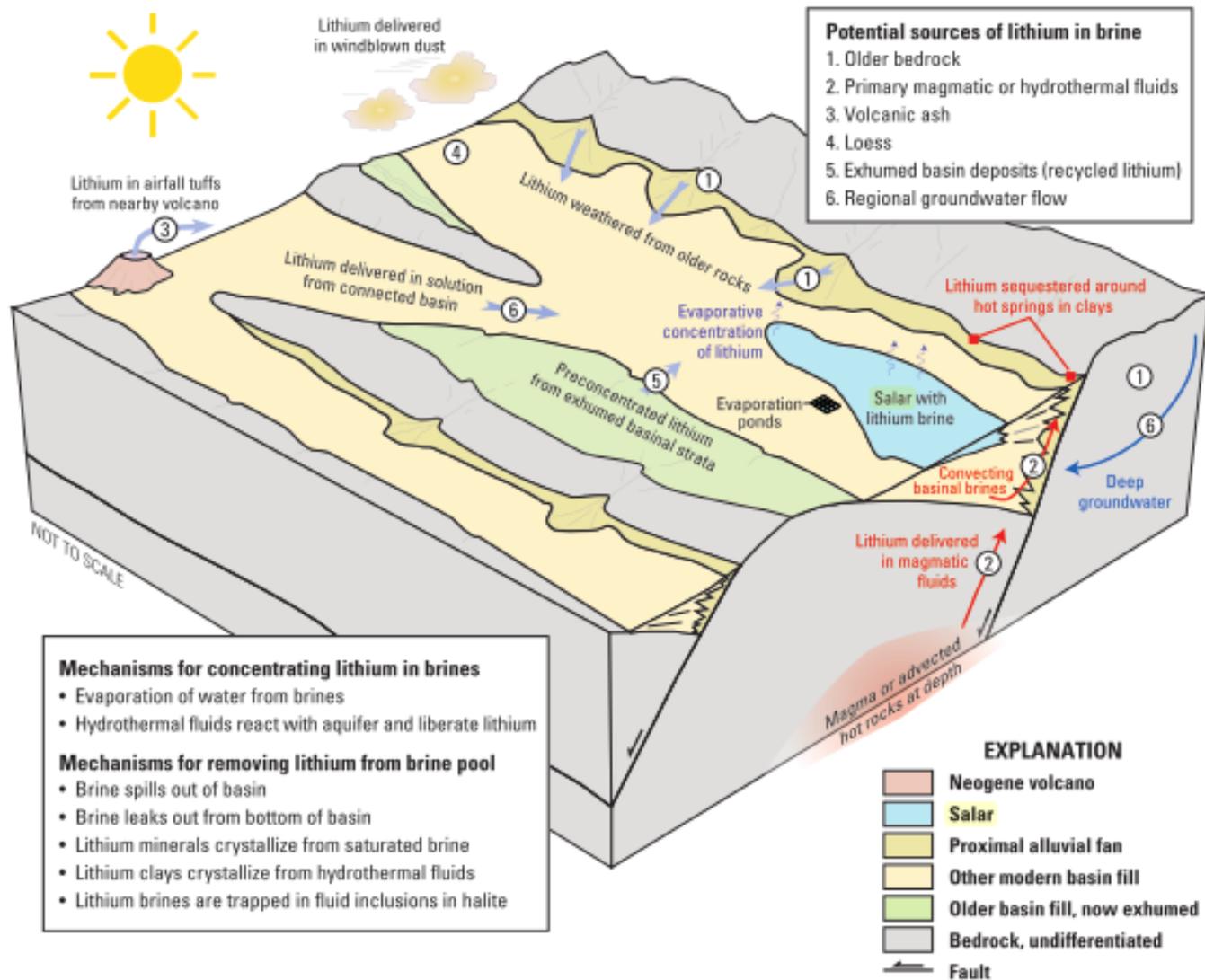
Salar (0,04-0,15 Li%)

TIPOS DE DEPÓSITOS

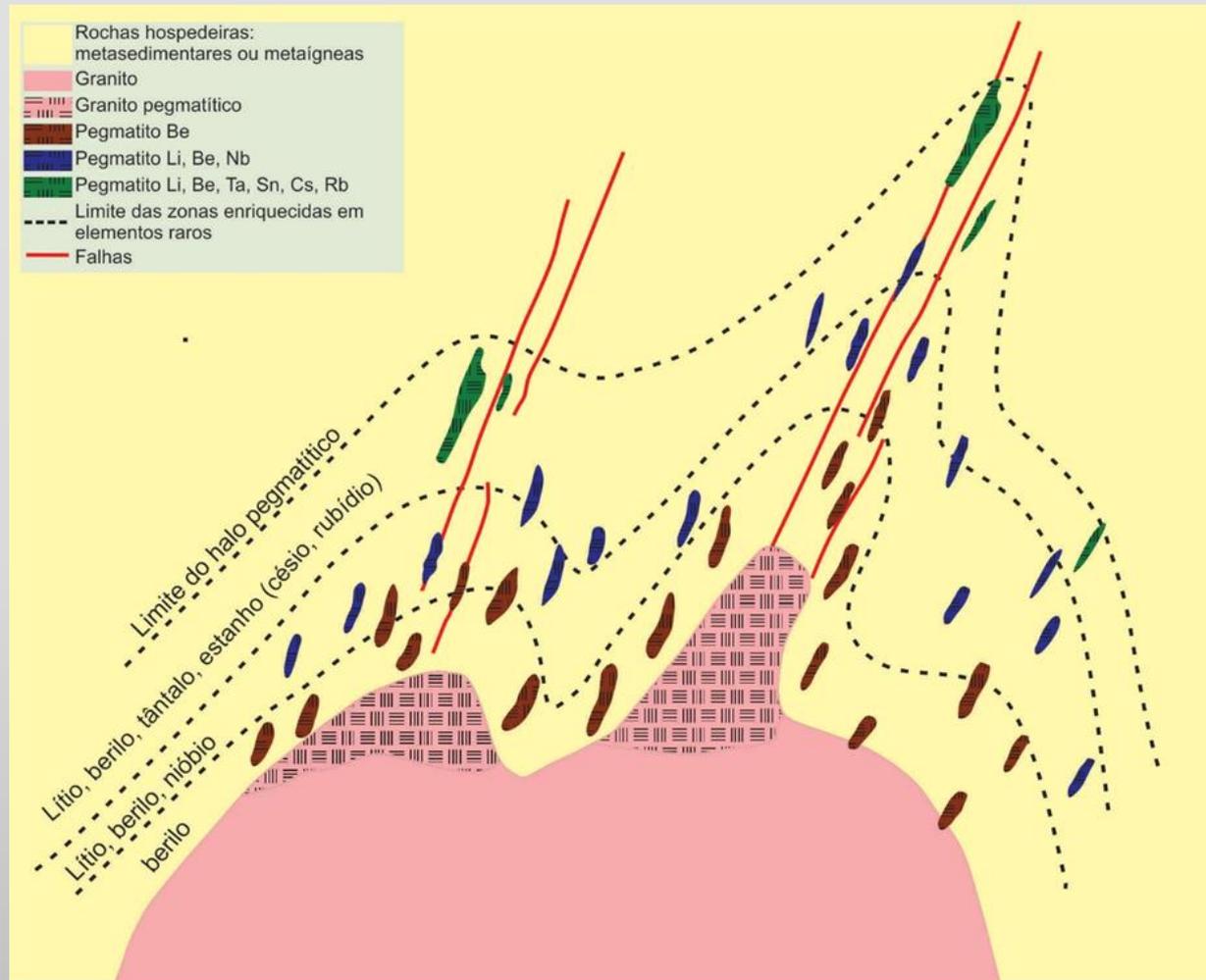
	Tipo de depósito	Teor típico	Exemplos
Minerais	Pegmatito	1,5-4% Li_2O	Greenbushes (Austrália)
	Hectorita	0,4% Li_2O	Kings Valley, Nevada (EUA)
	Jadarita	1,5% Li_2O	Jadar, Sérvia
salmouras	Continental	0,04-0,15% Li_2O	Salar do Atacama (Chile)
	Geotermal	0,01-0,035% Li_2O	Salton Sea Area, Califórnia (EUA)
	Campos de petróleo	0,01-0,05% Li_2O	Smackover Oilfield, Arkansas (EUA)



LÍTIO NOS SALARES



GÊNESE DE PEGMATITOS



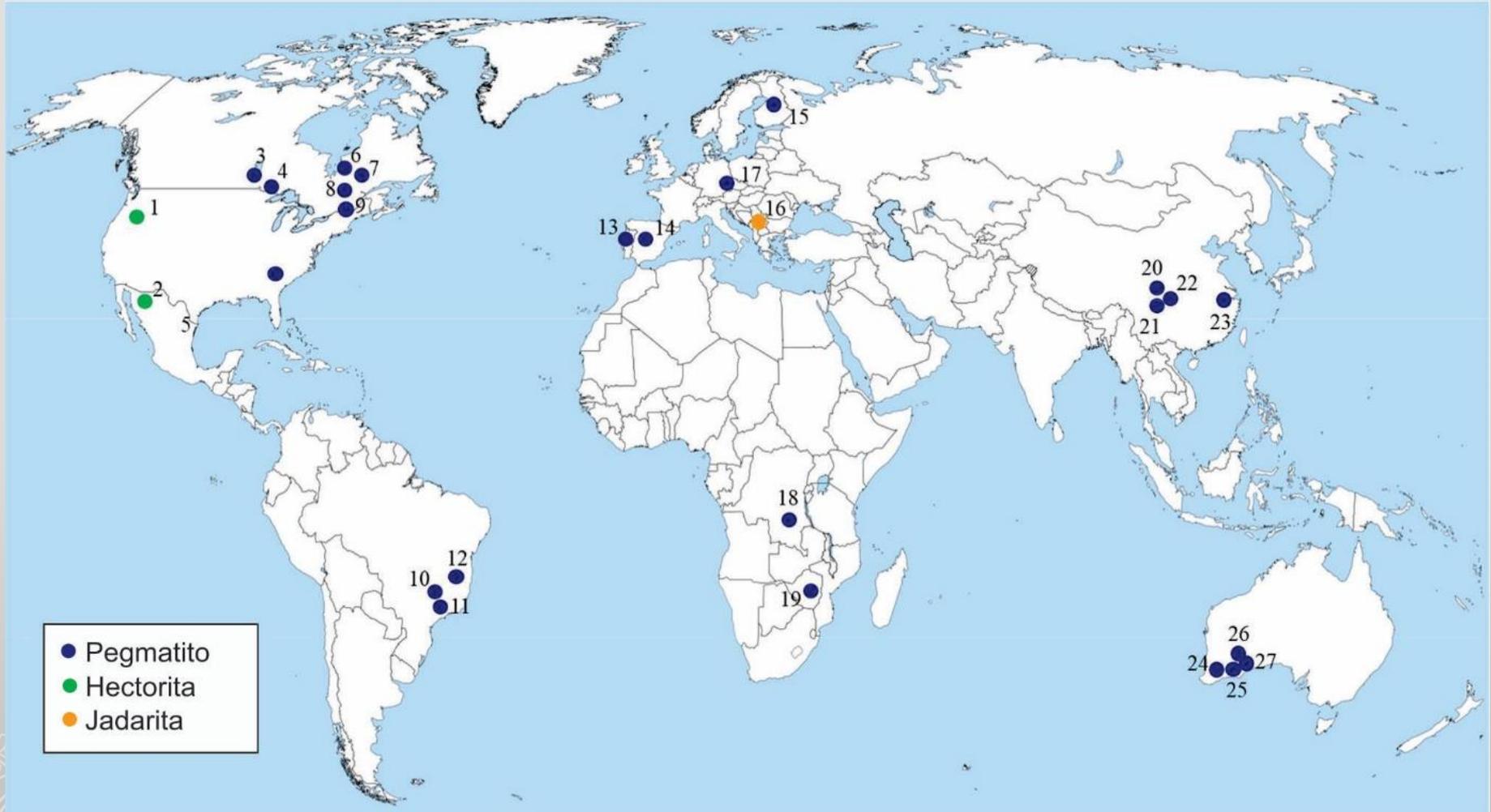
MINERAIS DE LÍTIO



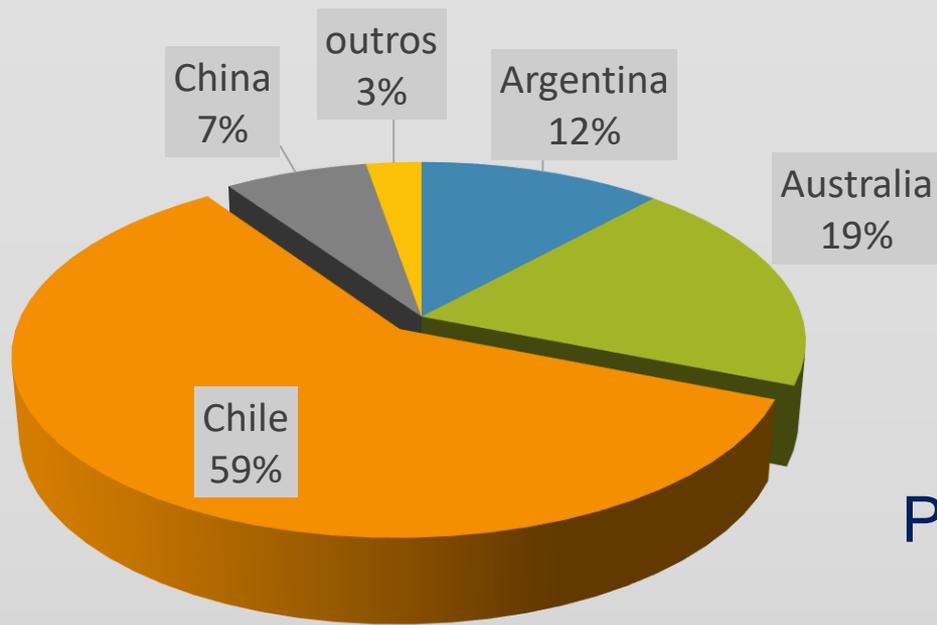
Mineral	Fórmula	Conteúdo %Li ₂ O		densidade	dureza
		teorico	real		
Espodumênio	LiAl[SiO ₃] ₂	8,1	4,5-8,0	3,1-3,2	6,5-7
Petalita	LiAlSi ₄ O ₁₀	4,89	2-4	2,4-2,5	6-6,5
Lepidolita	KLiAl ₂ Si ₃ O ₁₀ (OH,F) ₃	5,9	1,2-5,9	2,8-2,9	2-3
Ambligonita	LiAl[PO ₄][F,OH]	10,1	4,5-10	3,0-3,2	5,5-6
Zinwaldita	K[Li,Al,Fe] ₃ [Al,Si] ₄ O ₁₀ [F,OH] ₂	4,13	3,3-7,7	2,9-3,2	2-3
Eucryptita	LiAlSiO ₄	11,9	11,9	2,67	6,5



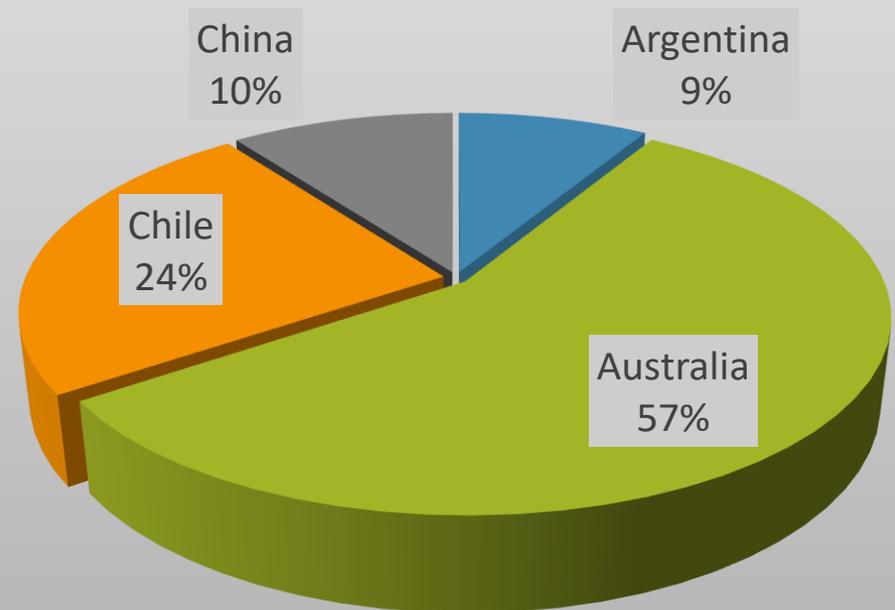
MINAS DE LÍTIO EM ROCHA



RESERVAS DE LÌTIO

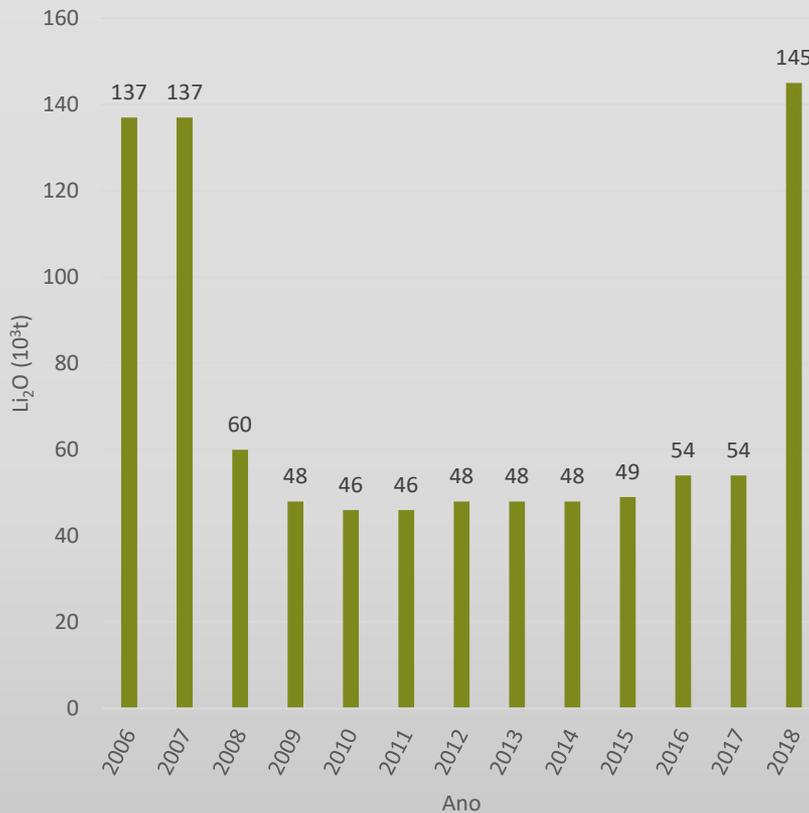


PRODUTORES DE LÌTIO

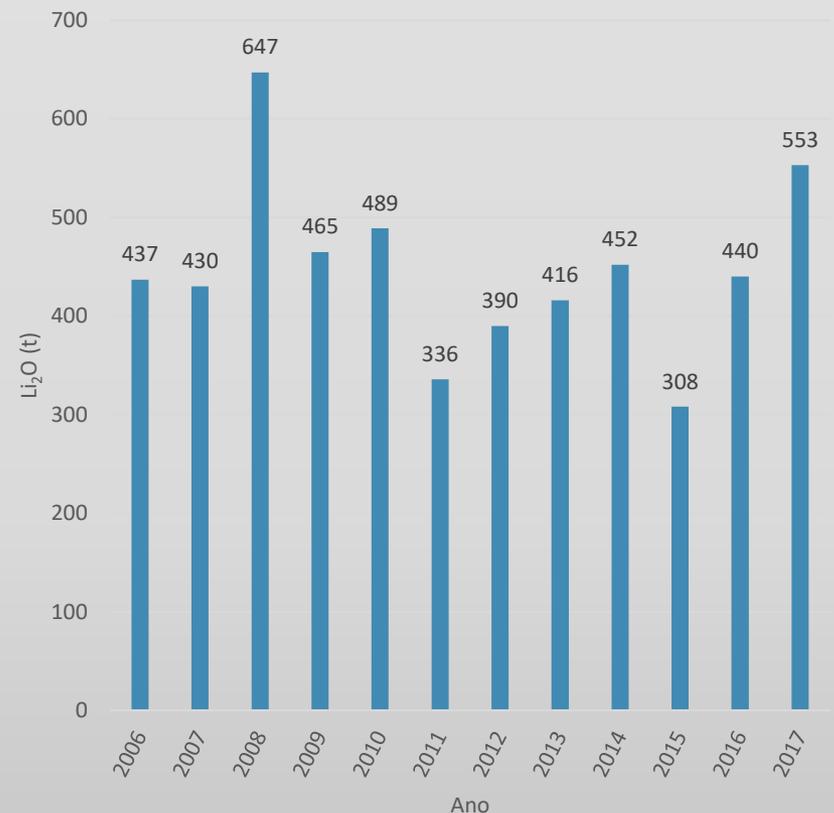


LÍTIO NO BRASIL

Reservas de Li - Brasil



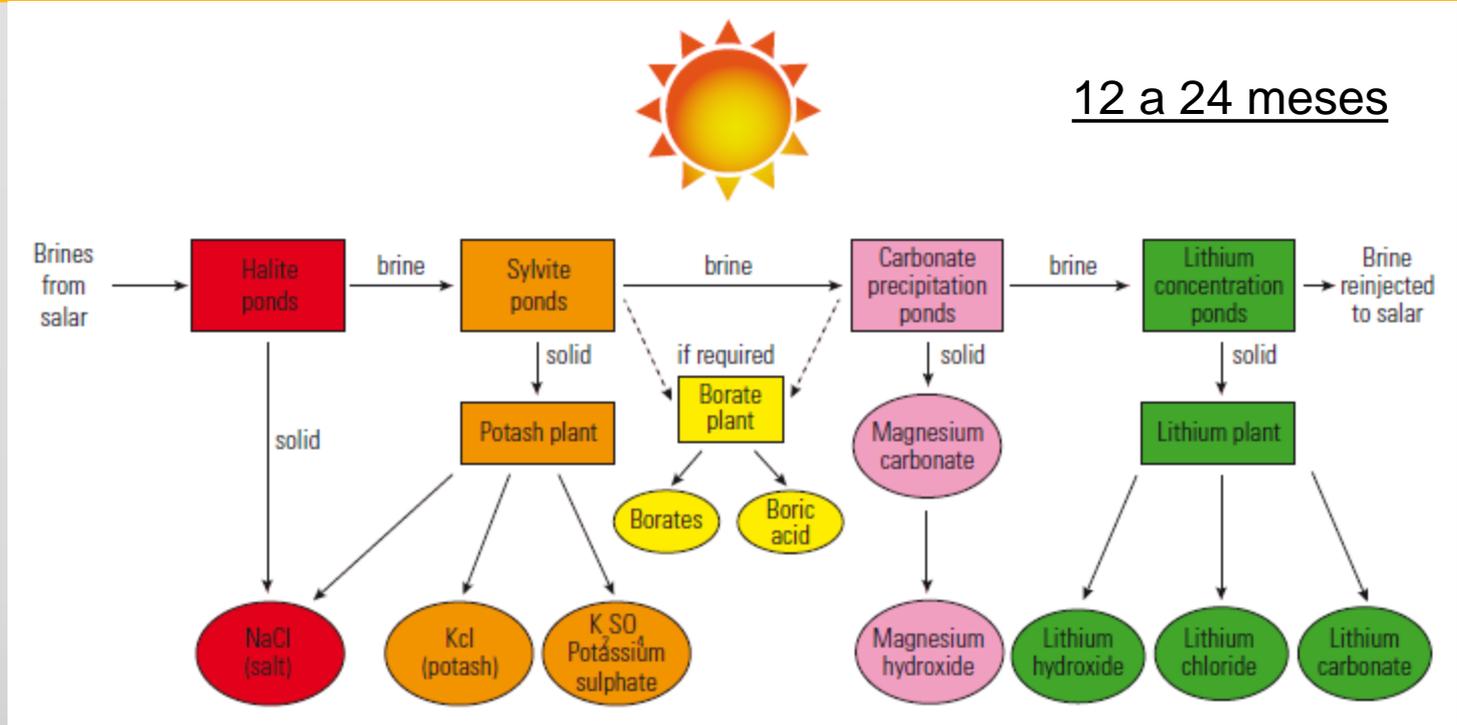
Produção - Brasil



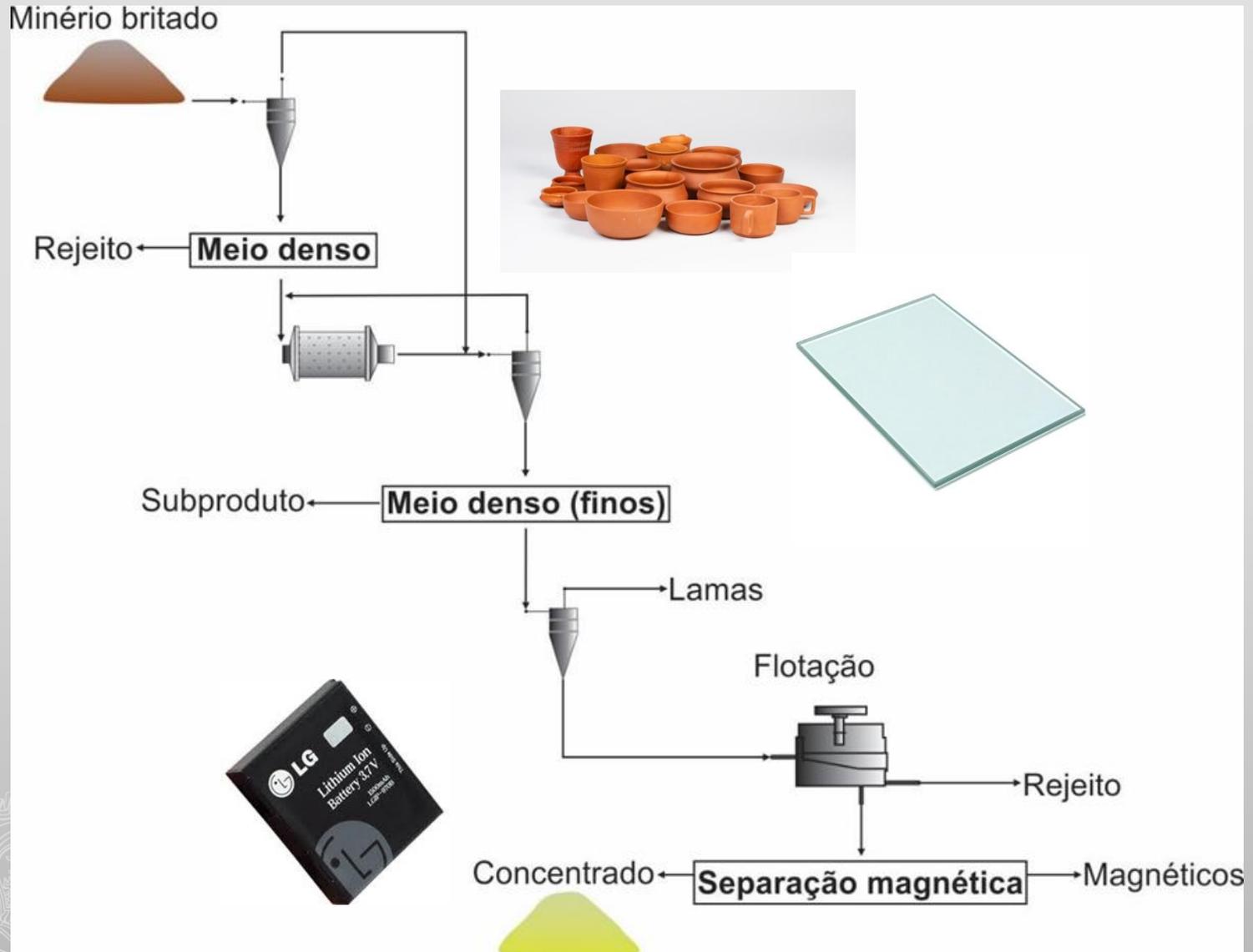
Fonte: III Seminário sobre Lítio, Garcia, 2018

Devido a sua utilização na área nuclear, as atividades de industrialização, importação e exportação de minérios e minerais de lítio, produtos químicos orgânicos e inorgânicos, lítio metálico e ligas de lítio estão sujeitas, no Brasil, a um regime de anuência prévia, supervisionado pela Comissão Nacional de Energia Nuclear (CNEN), conforme Decreto nº 2.413, de 04/12/97.

BENEFICIAMENTO EM SALARES



BENEFICIAMENTO DO ESPODUMÊNIO

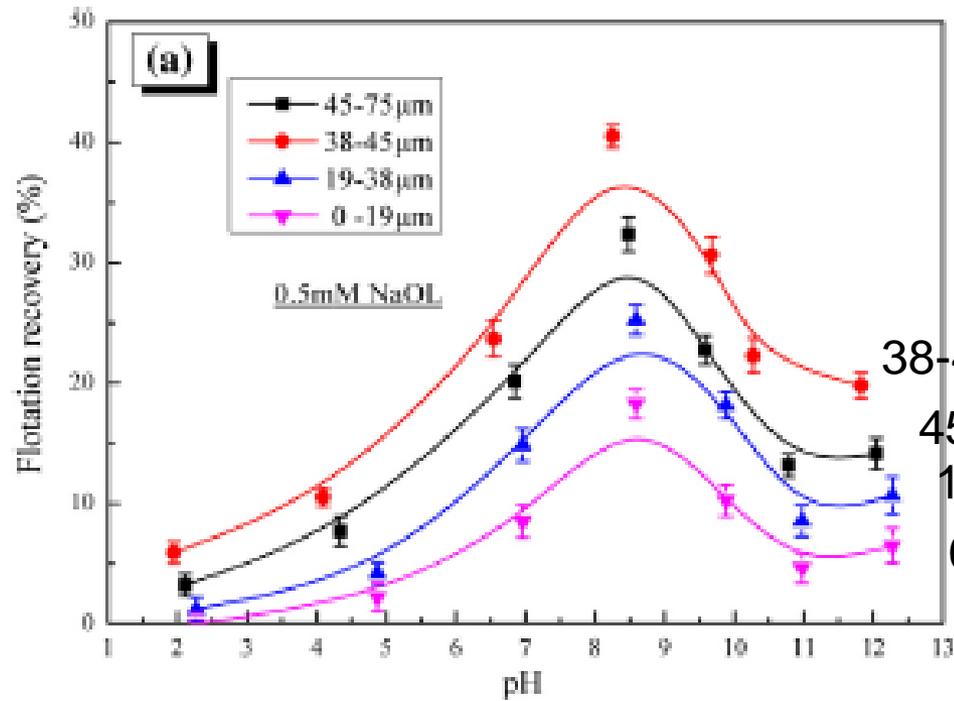


FLOTAÇÃO DO ESPODUMÊNIO

Collector type	Mineral(s) floated	Dosage (g/t)	Pulp pH
Armac T	Feldspar, quartz and mica	180–315	
Tallow amine acetate	Mica, feldspar	113–180	3.0–3.5
Sodium resinate	Iron-bearing minerals	900	
Stearyl trimethyl ammonium chloride	Lepidolite	50–200	2–9
Aeromine 3000C	Lepidolite	350	3
Armeen 12D	Lepidolite	500	3
Tall oil fatty acid	Spodumene	680	7
Oleic acid + naphthenic acid	Spodumene	500 + 200	8.5–9.5
Sodium oleate	Spodumene	Variable	8
Oleic acid	Spodumene	1400	7.5–9.8
Sodium oleate + dodecyl trimethyl ammonium chloride	Spodumene	9:1 M ratio	8–9



FLOTAÇÃO DO ESPODUMÊNIO



38-45 μm

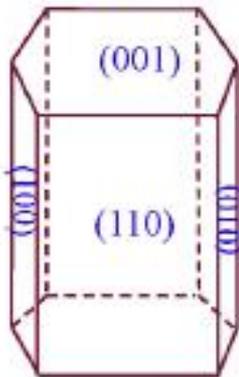
45-75 μm

19-38 μm

0-19 μm

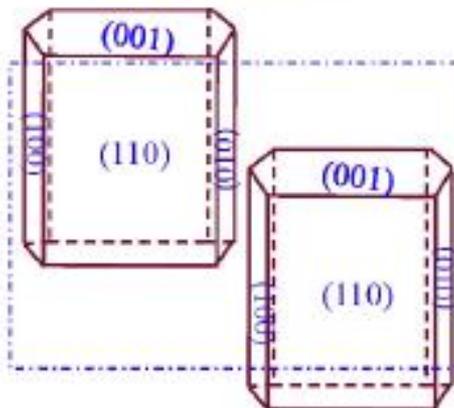
Xu et al. 2016b

Coarse particles



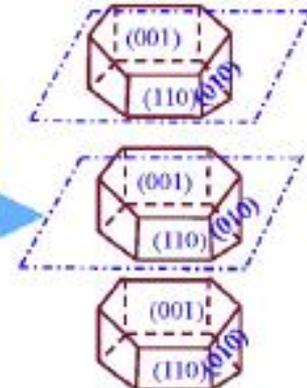
Crushing
or
Grinding

Medium particles



Crushing
or
Grinding

Fine particles



PRODUTOS E APLICAÇÕES

Key Products

Lithium Carbonate



Lithium Hydroxide



Lithium Metal



Organo-lithium



Special Metals



Key Applications



Li-Ion Batteries



Glass Ceramics



Cement



Aluminum



Li-Ion Batteries



Grease



CO₂ Absorption



Mining



Li Primary Batteries



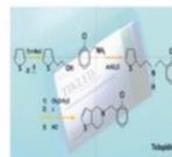
Pharmaceuticals



Al-Alloys



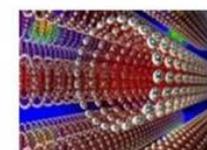
Elastomers



Pharmaceuticals



Agrochemicals



Electronics



Scintillation

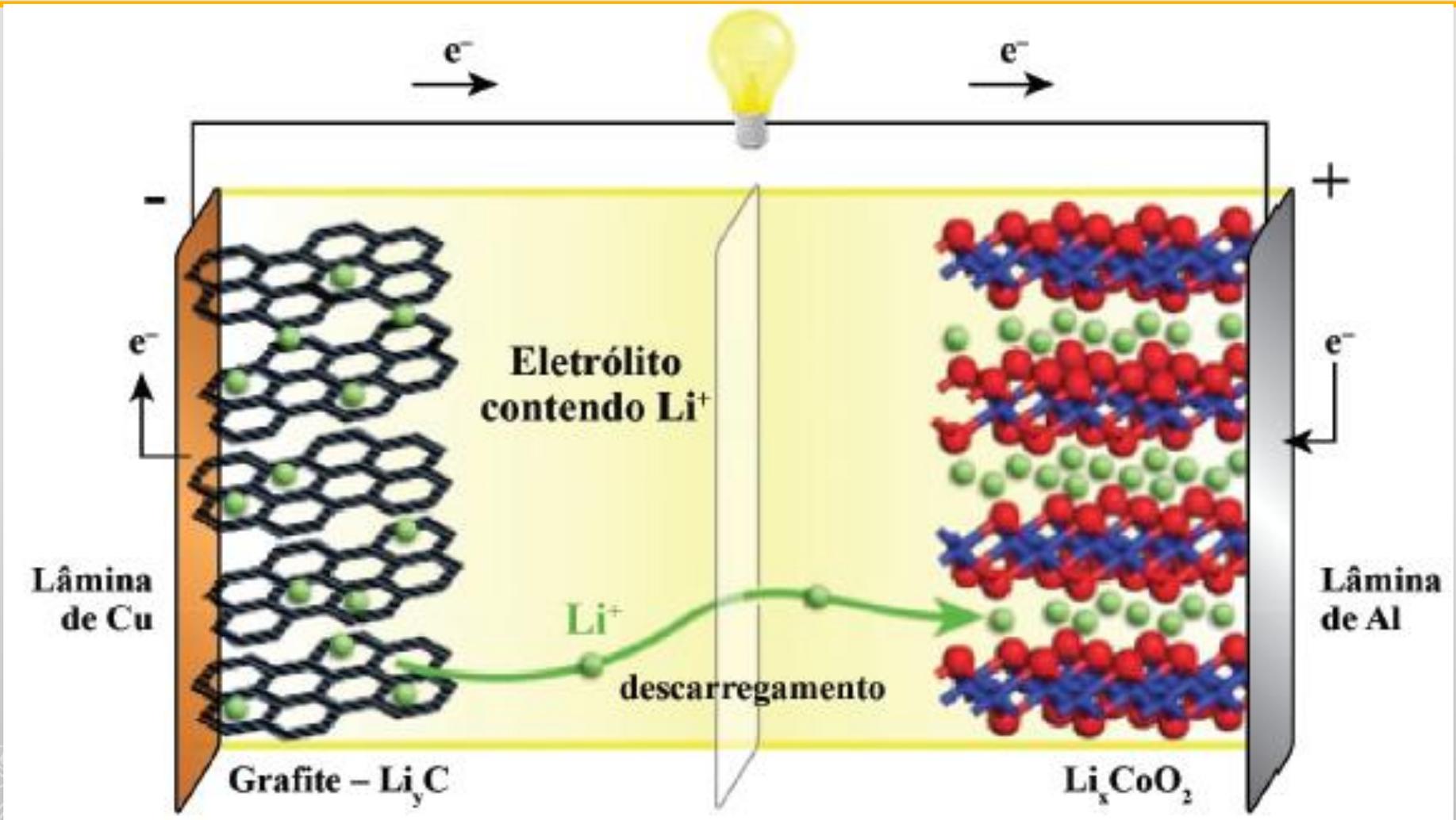


Industrial Catalysis



Airbag Ignition

BATERIAS ÍON-LÍTIO

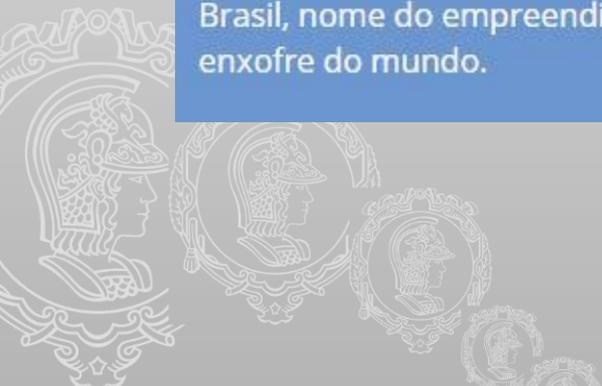


LÍTIO

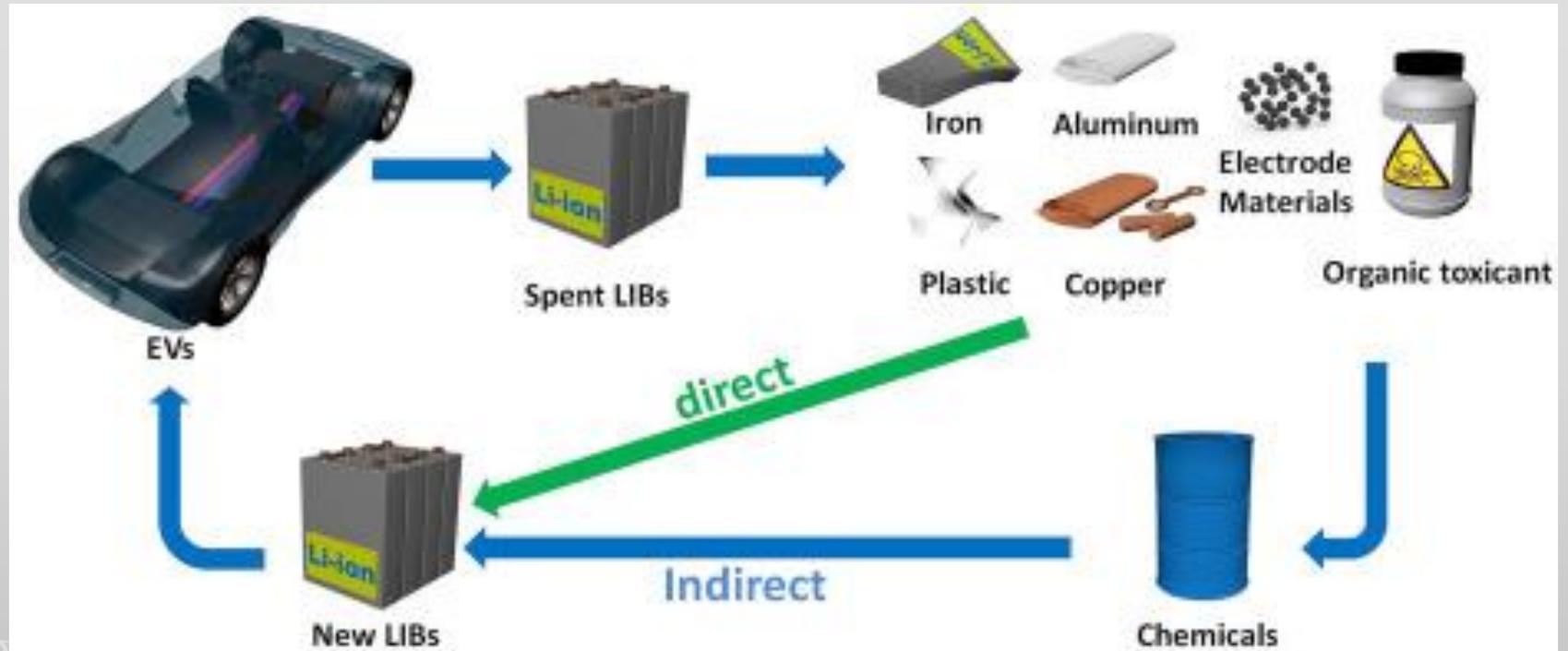


MG terá primeira fábrica de células de bateria de lítio-enxofre

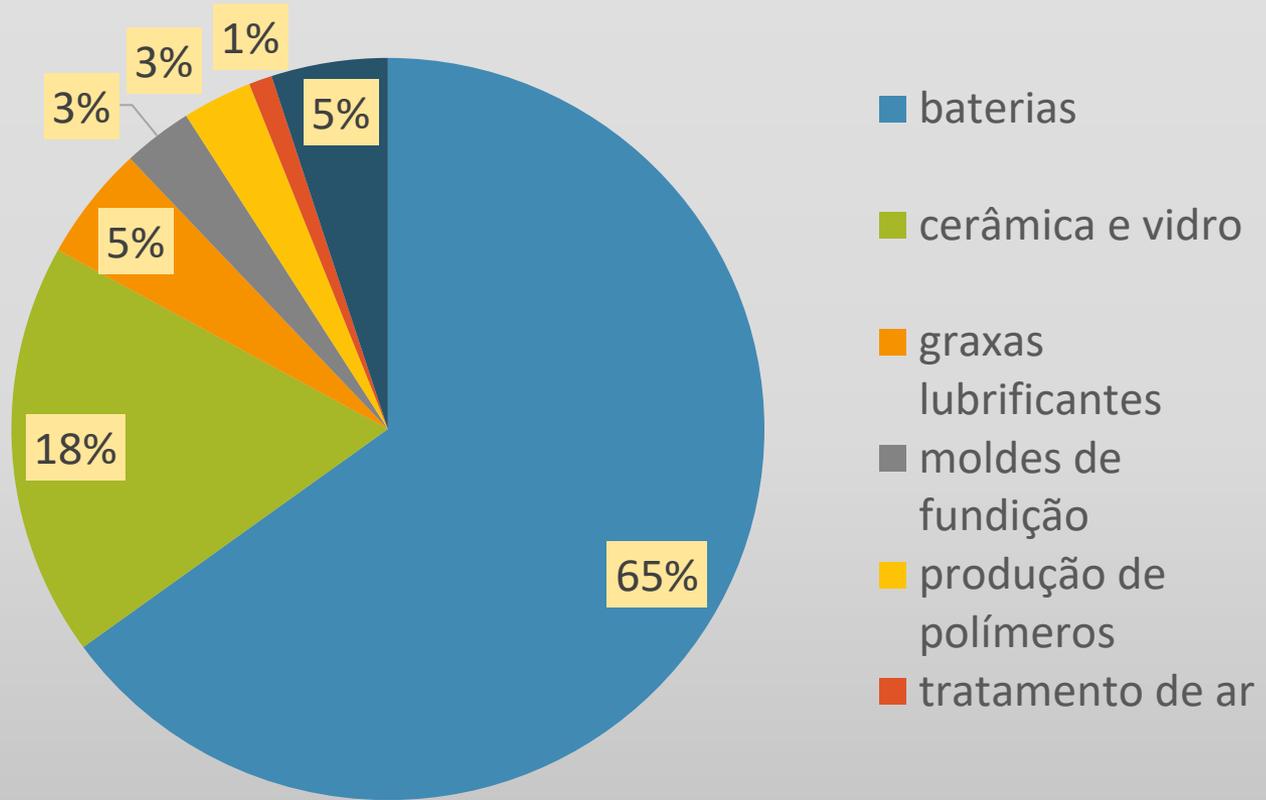
A Companhia de Desenvolvimento de Minas Gerais (Codemge) e a empresa britânica Oxis Energy assinaram um contrato de locação de 15 anos com a Mercedes Benz para instalação de uma fábrica no parque industrial da indústria de automóveis em Juiz de Fora (MG). Segundo o governo de Minas, a Oxis Brasil, nome do empreendimento fruto da parceria, será a primeira fábrica de células de baterias de lítio-enxofre do mundo.



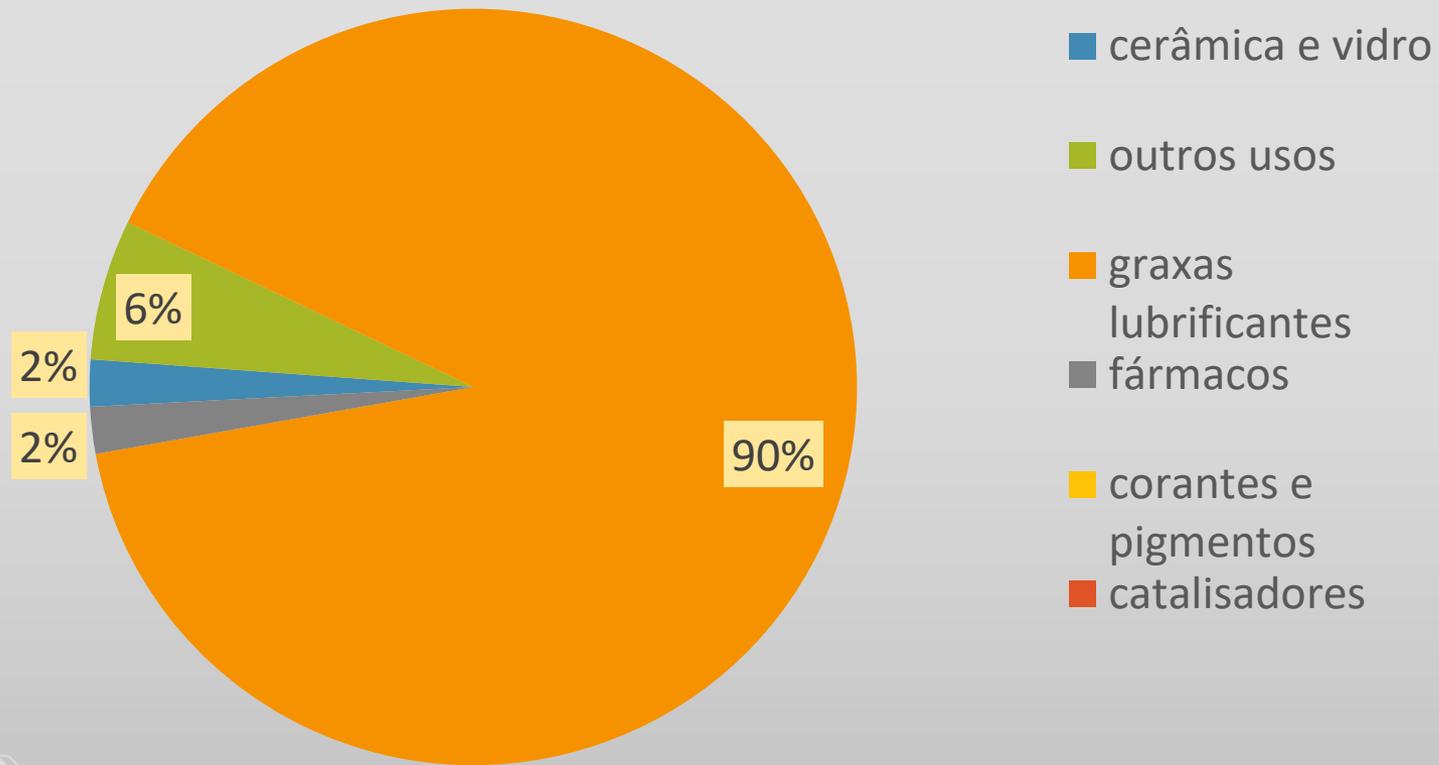
RECICLAGEM DE BATERIAS



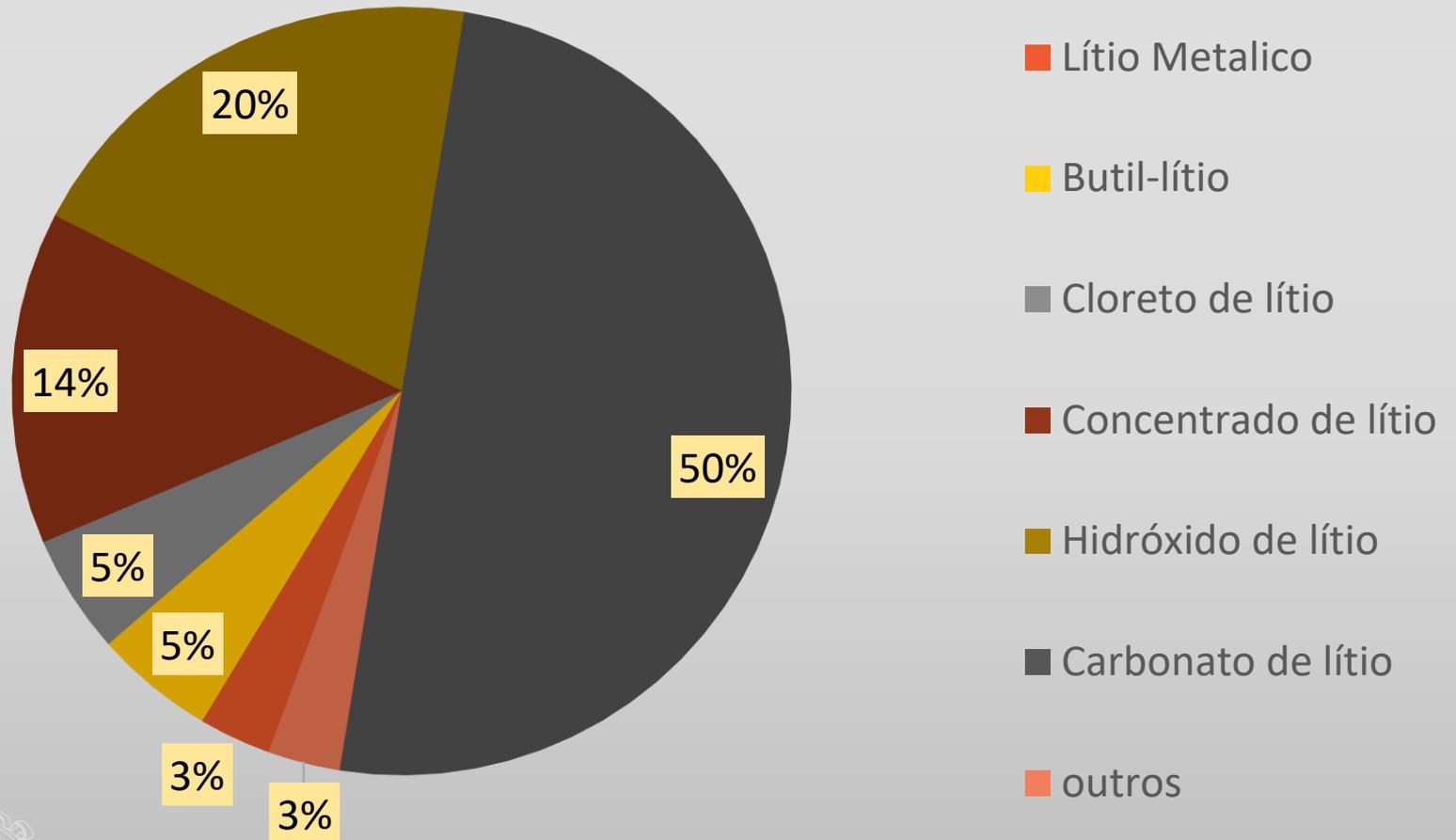
APLICAÇÕES NO MUNDO



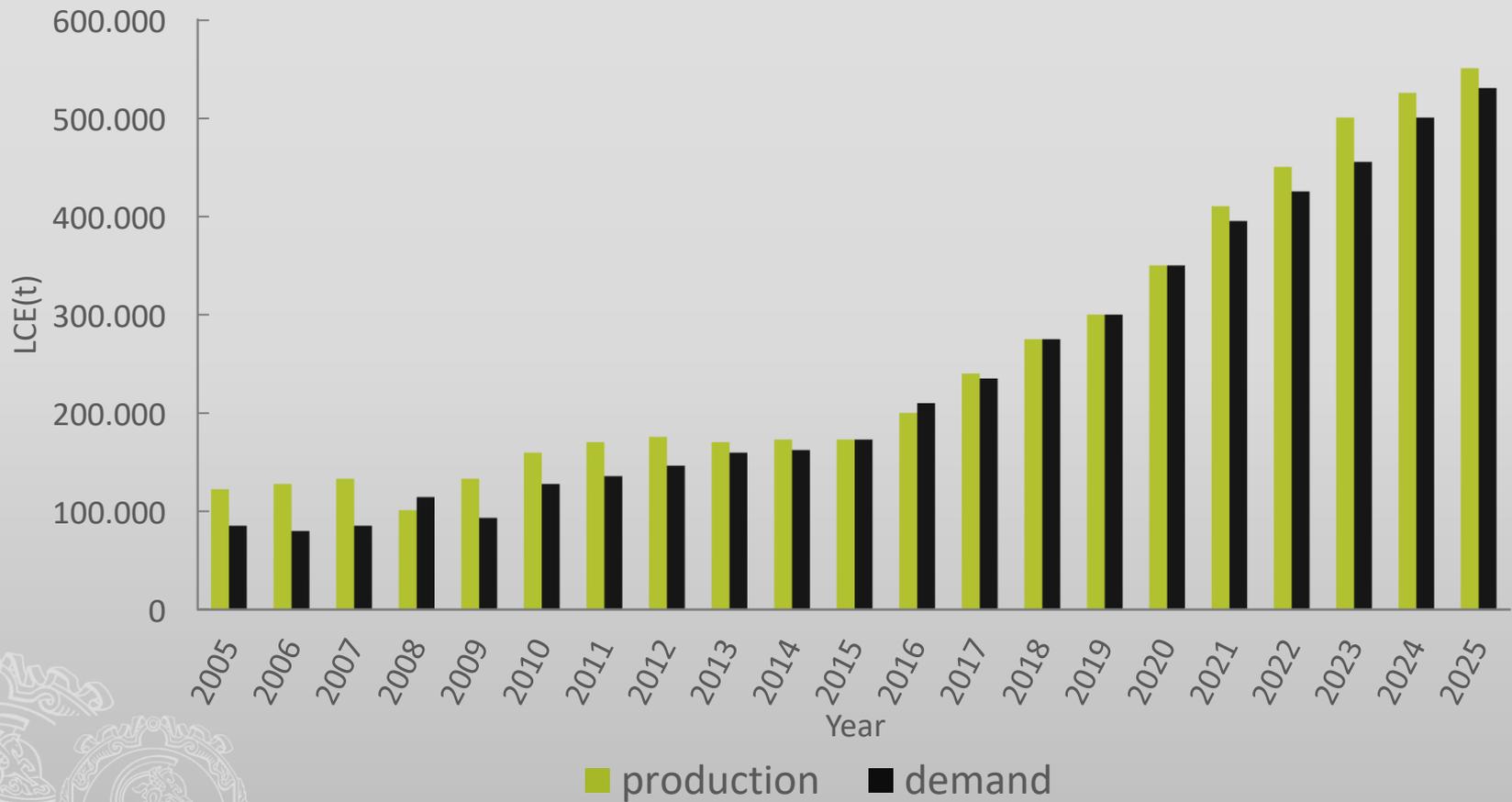
APLICAÇÕES NO BRASIL



COMPOSTOS DE LÍTIO



LÍTIO: WHITE DUST



Fonte: Mineral Commodity Summaries, 2019 e Tadesse et al., 2019

- TADESSE, Bogale et al. The beneficiation of lithium minerals from hard rock ores: A review. **Minerals Engineering**, v. 131, p. 170-184, 2019.
- EVANS, K. Critical Metals Handbook. In: **Critical Metals Handbook**. [s.l: s.n.]. p. 231–260.
- Garcia, I. J. III Seminário sobre Lítio –Brasil, CETEM/RJ, 2018
- XU, Longhua et al. Selective flotation separation of spodumene from feldspar using new mixed anionic/cationic collectors. **Minerals Engineering**, v. 89, p. 84-92, 2016c.
- XU, Longhua et al. Surface crystal chemistry of spodumene with different size fractions and implications for flotation. **Separation and purification technology**, v. 169, p. 33-42, 2016b
- HUANG, Bin et al. Recycling of lithium-ion batteries: Recent advances and perspectives. **Journal of Power Sources**, v. 399, p. 274-286, 2018.

