Geology of Economic Natural Lithium Deposits

Camilo de los Hoyos
PhD in Geology, Principal Geochemist
SRK Consulting (Argentina) S.A.

Lithium facts

Selected properties of lithium

Symbol	**Li**	**Unit**
Atomic number	3	
Atomic weight	6.94	g/mol
Density in solid form at 20°C	0.534	g/cm^3
Electrical resistivity	9.5	mΩ cm*

* 1 mΩ cm = 1.00 x 10^6 µS/cm

Source	**Content (ppm)**
Average earth's crust	17-20
Upper continental crust	24-46
Igneous rocks	28-30
Sedimentary rocks	53-60
Sea water	0.1-0.2

Sources: BGS, 2016 (www.MineralsUK.com). Kunasz, 2006 (Lithium Resources: 599-613). Evans, 2014 (Critical Metals Handbook, Chapter 10)

Highly-reactive grey alkali metal. It dos not occur in elemental form in nature.

The lightest and less dense non-gas element.

Very soft, with a hardness of 1 (Mohs scale).

Inflammable in oxygen and may ignite in moist air, although its compounds are note flammable.

Gives high mechanical strength and termal shock resistance to ceramic and glass.

Thickener for lubricants. Provides structure to hold the oil in place and acts as a sponge by releasing small amounts of oil during use.

High electrical conductivity and the most electronegative metal, which makes lithium ideal for its use in batteries.

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Lithium reporting may look confuse

To convert from:	Formula	To convert to:		
		Lithium (metal)	Lithium oxide content	Lithium carbonate equivalent
		Multiply by:		
Lithium	Li	1	2.153	5.323
Lithium oxide	Li_2O	0.464	1	2.473
Lithium carbonate	Li_2CO_3	0.188	0.404	1
Lithium chloride	LiCl	0.163	0.362	0.871

Most common lithium compounds used for public disclosure and reporting

Source: BGS, 2016 (www.MineralsUK.com)

Natural lithium compounds

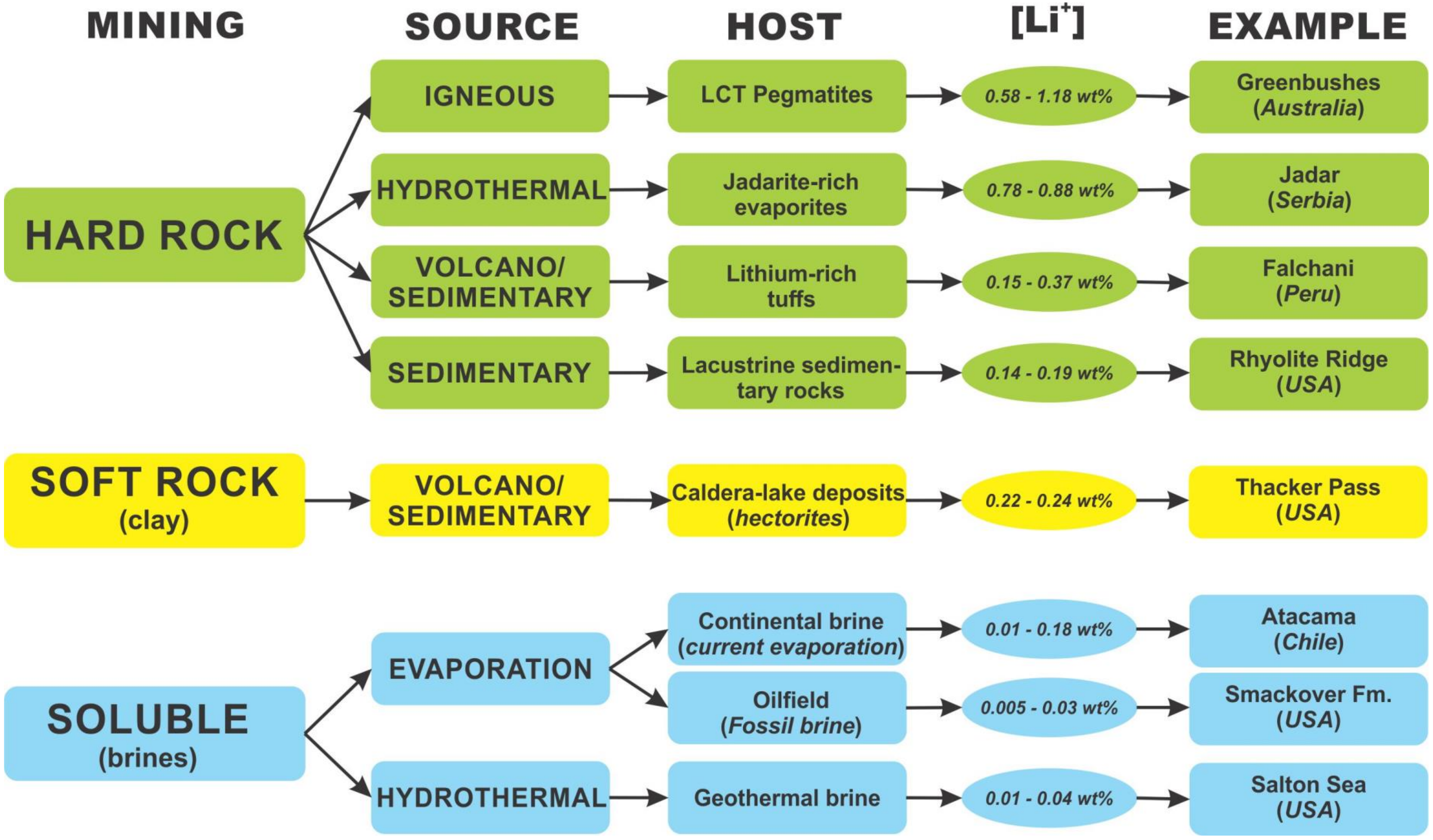
Most common lithium-bearing minerals

Mineral	Formula	Li2O (wt%)	Deposit type
Spodumene	$LiAlSi_2O_6$	6-9	Pegmatite (Hard Rock)
Petalite	$LiAlSi_4O_{10}$	4.73	Pegmatite (Hard Rock)
Lepidolite	$K(Li,Al)_3(Al,Si,Rb)_4O_{10}(F,OH)_2$	4.19	Pegmatite (Hard Rock)
Zinnwaldite	$KLiFeAl(AlSi_3)O_{10}(OH,F)_2$	2-5	Pegmatite (Hard Rock)
Amblygonite	$LiAl(F,OH)PO_4$	7.4	Pegmatite (Hard Rock)
Eucryptite	$LiAlSiO_4$	9.7	Pegmatite (Hard Rock)
Triphylite	$Li(Fe,Mn)PO_4$	9.47	Pegmatite (Hard Rock)
Jadarite	$LiNaSiB_3O_7(OH)$	7.3	Hydrothermal/sedimentary (Hard Rock)
Hectorite	$Na_{0.3}(Mg,Li)_3(Si_4O_{10})(F,OH)_2$	<1-3	Hydrothermal/sedimentary (Soft Rock)

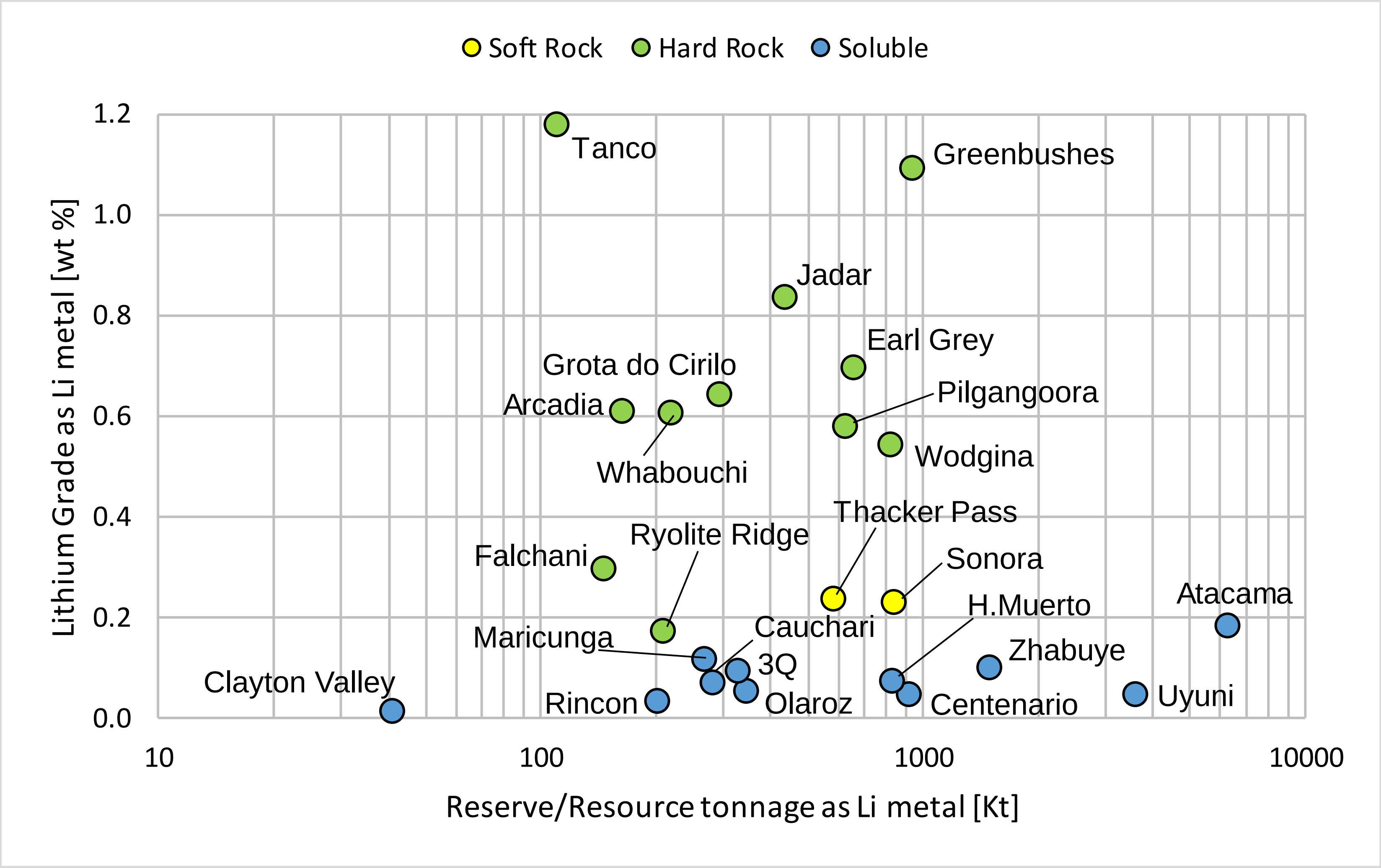
No economic lithium mineral in evaporite-type deposits

Sources: BGS, 2016 (www.MineralsUK.com). Bowell et al., 2020 (Elements 16: 259-264)

Natural lithium deposits



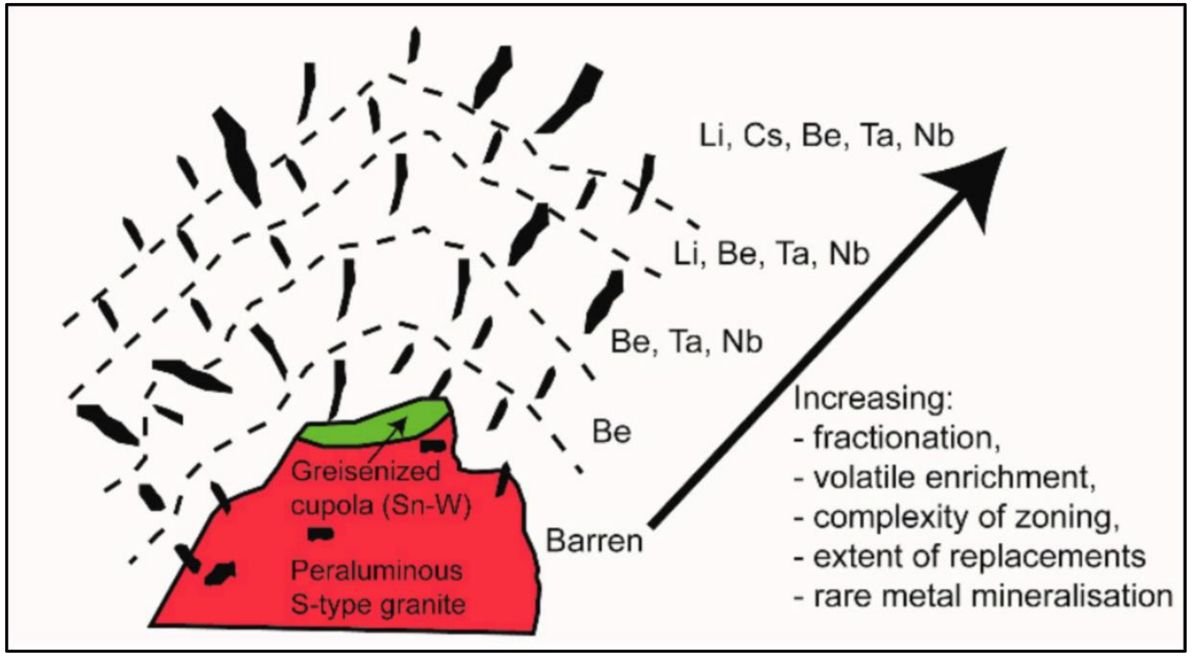
Natural lithium deposits: Resources



Source: Modified from Bowell et al., 2020 (Elements 16: 259-264)

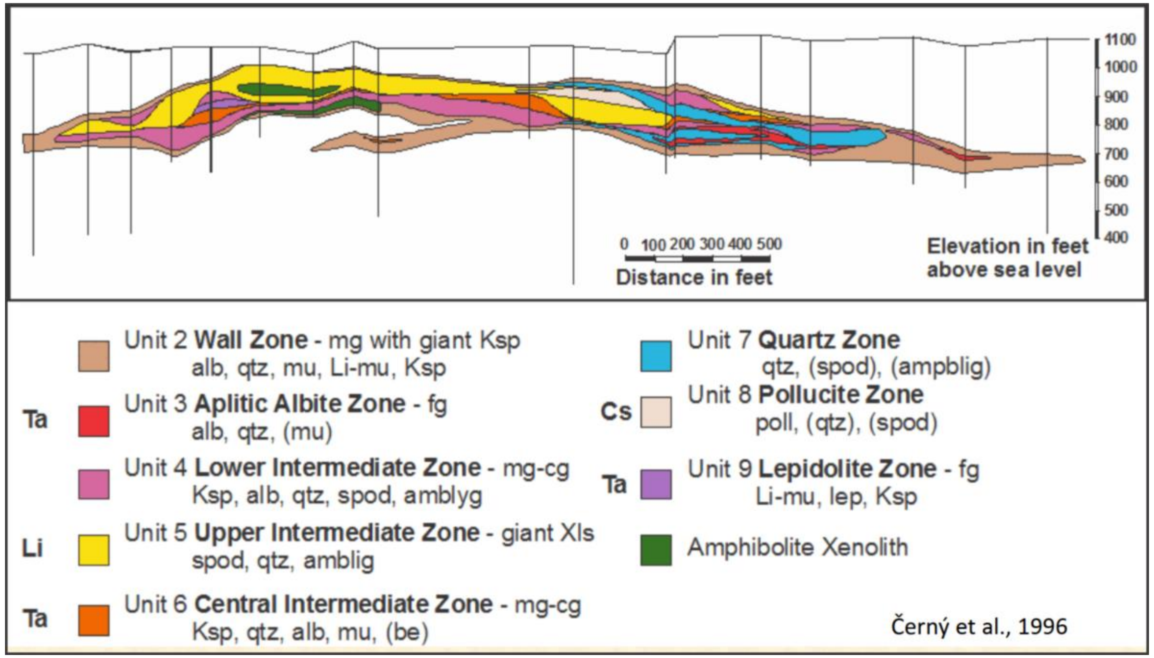
LCT Pegmatites

Simplified scheme for LCT pegmatites emplacement and chemical zonning



Source: Steiner, B.M., 2019; Minerals 9(8): 499-522)

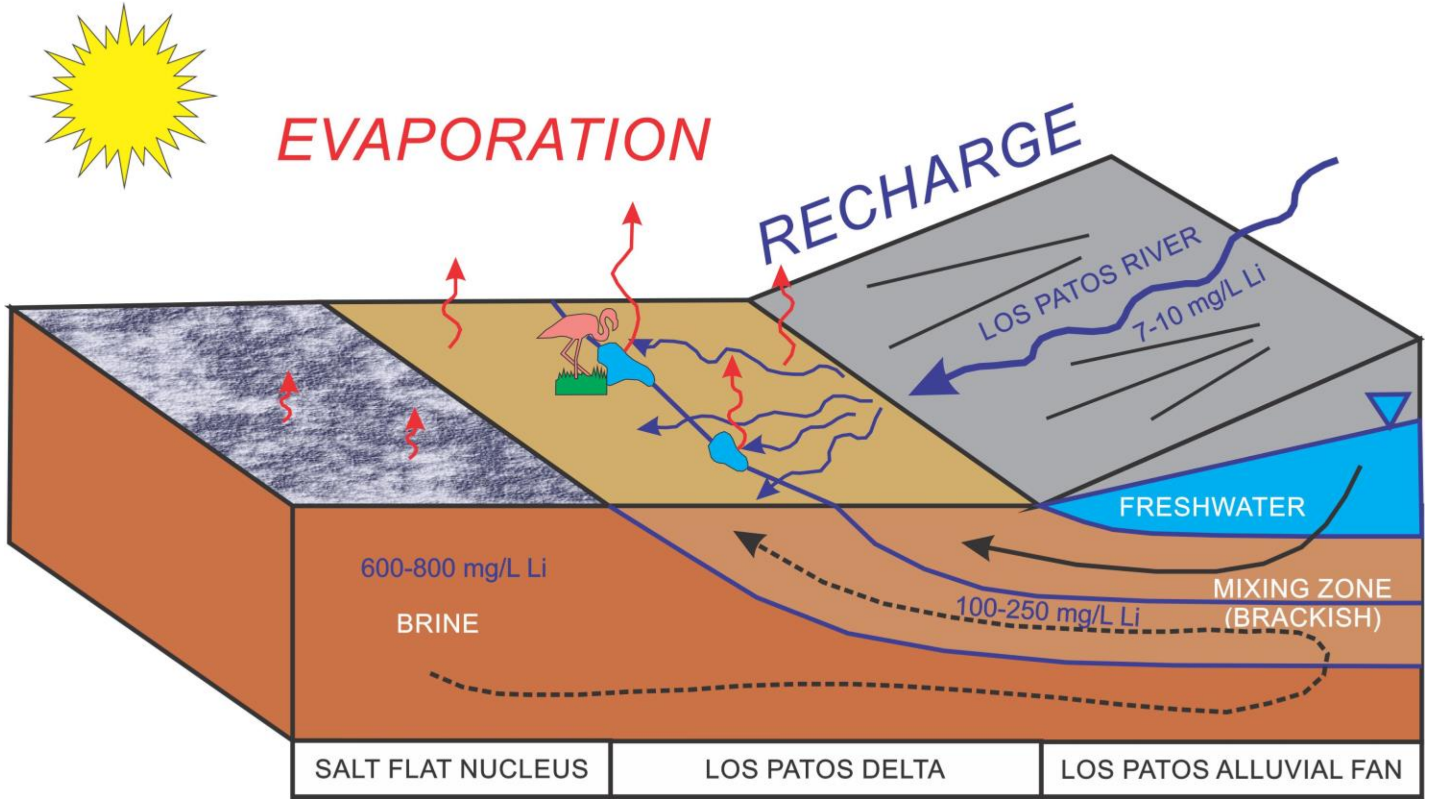
The Tanco LCT pegmatite (Manitoba, Canada)



Source: Černý et al., 1998; 17th International Mineralogical Association, Field Trip Guide Book B6

Continental lithium brines

Very simplified scheme for lithium recharge and concentration



Source: Modified from Marazuela et al., 2019. Science of the Total Environment 651(1): 668-683

Munk et al. (2016, Reviews in Economic Geology 18: 339-365):

1) Hyper-arid climate

2) Closed (endorheic) basin

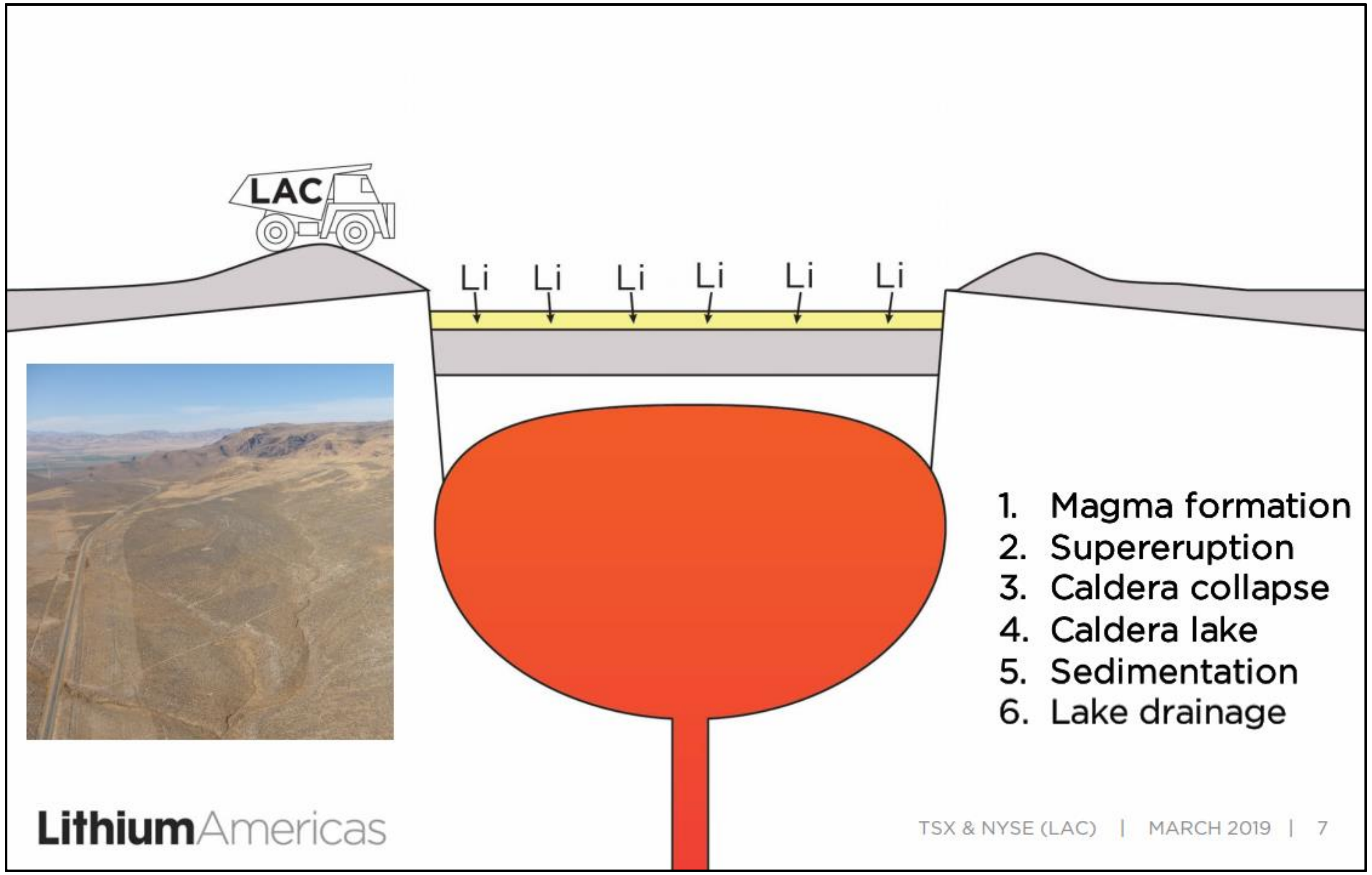
3) Associated hydrothermal activity

4) Tectonically driven subsidence

5) Suitable lithium sources

6) Sufficient time

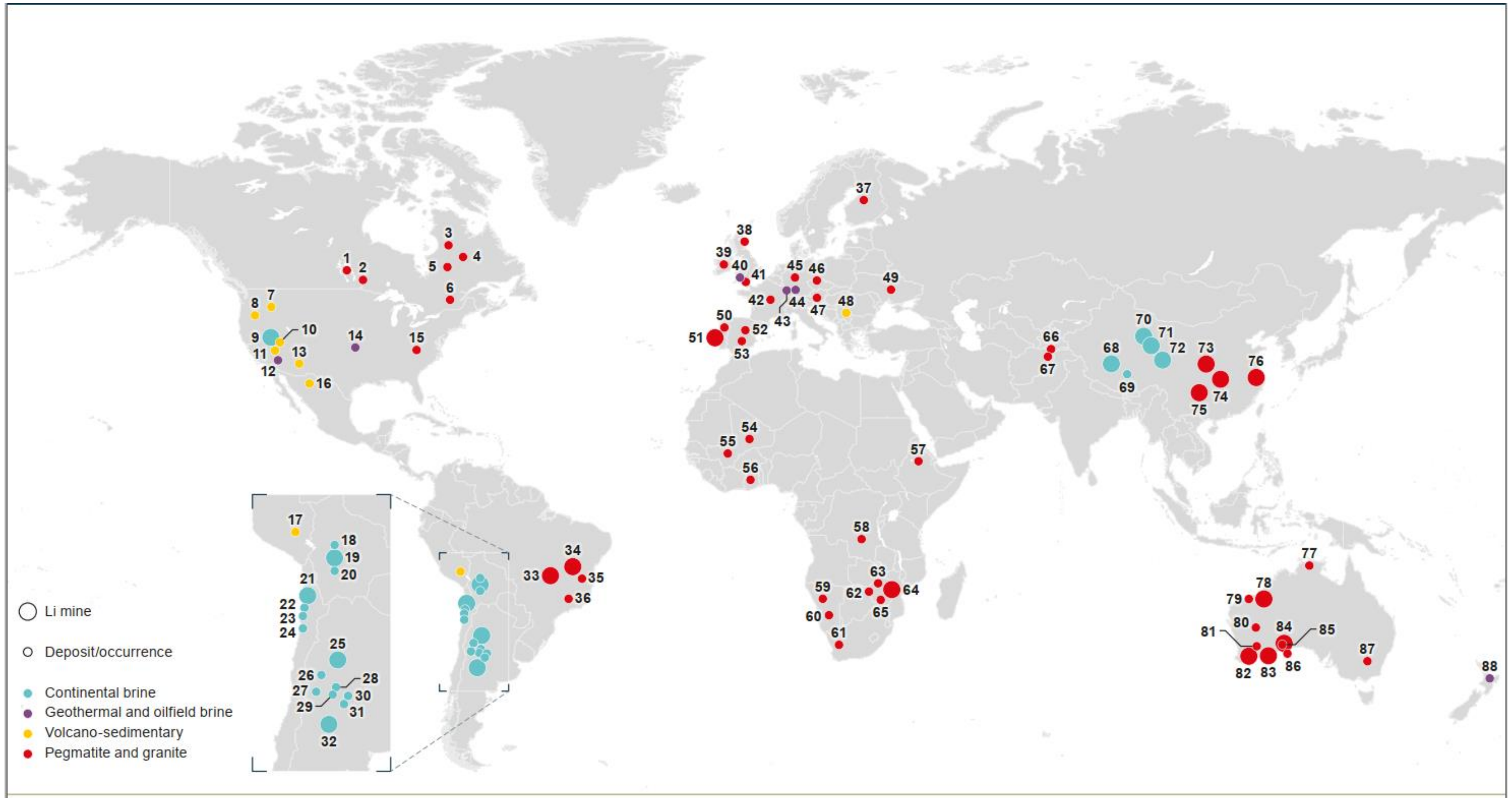
Volcano-sedimentary Li-clay deposits



Simplified conceptual scheme for lithium for the formation of the Thacker Pass Li-rich clay deposit by Lithium Americas Corporation

Source: https://www.lithiumamericas.com/_resources/presentations/PDAC-March-2019-v3.pdf

Global lithium deposits by type



Source: Shaw, R.A. (2021) Global lithium (Li) mines, deposits and occurrences (November 2021). British Geological Survey

Pegmatites
1) Tanco, Canada
5) Whabouchi, Canada
36) Volta Grande, Brazil
78) Pilgangoora, Australia
82) Greenbushes, Australia

Continental brine
9) Silver Peak, USA
19) Salar de Uyuni, Bolivia
21) Salar de Atacama, Chile
24) Salar de Maricunga, Chile
25) Salar de Olaroz, Argentina
32) Salar del Hombre Muerto, Argentina
68) Zhabuye, China

Li-clay deposits
8) Thacker Pass, USA
16) Sonora, Mexico

Geothermal and oilfield brine
12) Salton Sea
41) Saint Austell, United Kingdom

Other hard-rock deposits
17) Falchani, Peru
48) Jadar, Serbia

Gracias por su atención

Thanks for your attention