

# The Role of Lithium

Minerals For A Green Society

MMSA Symposium

February 4, 2010

WESTERN <sup>WLC</sup>  
LITHIUM

# What is Lithium



**Periodic Table of Elements**

	IA																0	
1	H																	He
2	Li	Be										B	C	N	O	F		Ne
3	Na	Mg	III B	IV B	V B	VI B	VII B	VII			IB	IB	Al	Si	P	S	Cl	Ar
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6	Cs	Ba	*La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7	Fr	Ra	+Ac	Rf	Ha	106	107	108	109	110								

* Lanthanide Series	58	59	60	61	62	63	64	65	66	67	68	69	70	71
	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
+ Actinide Series	90	91	92	93	94	95	96	97	98	99	100	101	102	103
	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

**Legend - click to find out more...**

<span style="color: blue;">H - gas</span>	<span style="color: red;">Li - solid</span>	<span style="color: red;">Br - liquid</span>	<span style="color: blue;">Tc - synthetic</span>
<span style="background-color: lightgreen; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span> Non-Metals	<span style="background-color: lightblue; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span> Transition Metals	<span style="background-color: yellow; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span> Rare Earth Metals	<span style="background-color: orange; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span> Halogens
<span style="background-color: yellow; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span> Alkali Metals	<span style="background-color: cyan; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span> Alkali Earth Metals	<span style="background-color: purple; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span> Other Metals	<span style="background-color: orange; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span> Inert Elements

# Lithium Market Is Relatively Small

## End Uses:

Glass and Ceramics

Lubricants

Refrigeration (coolants)

Pharmaceuticals

Polymers

Aluminum Production

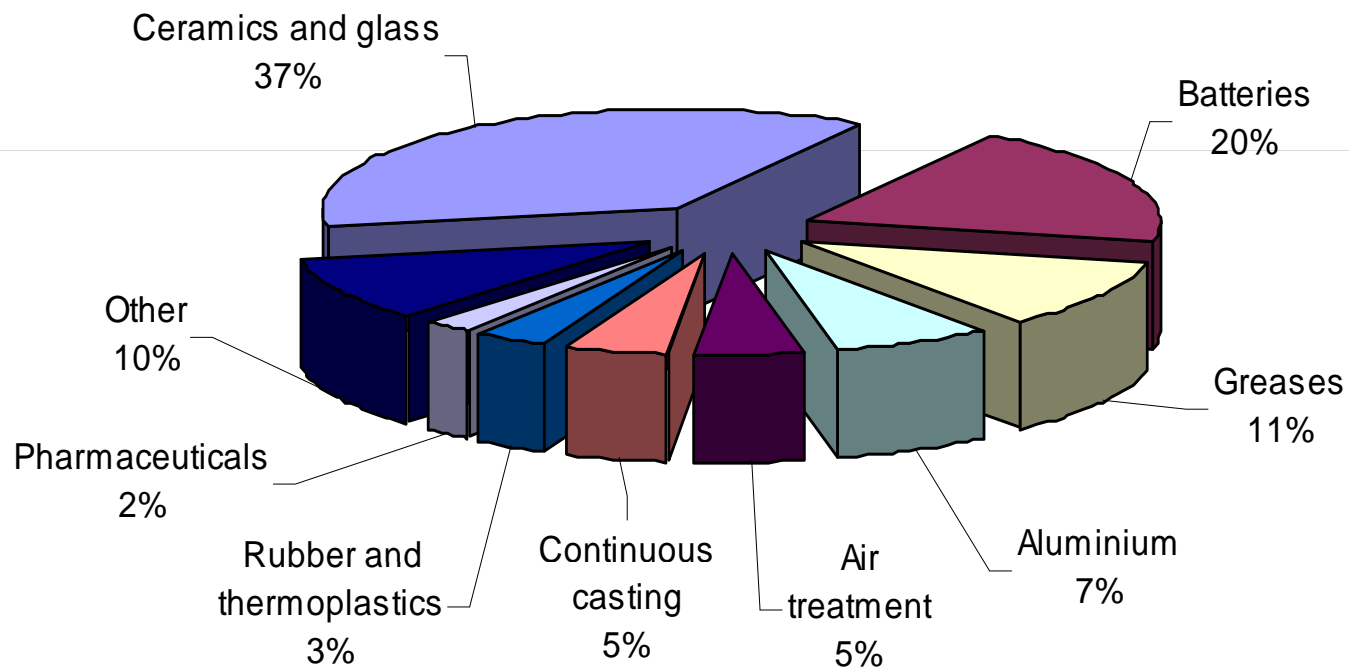


# Significant Growth in Portable Lithium-Ion Batteries

→ Mobile Electronics



# Lithium Consumption by end use



Source: Roskill

# Significant New Lithium Demand Growth

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Major car makers are advancing electric cars



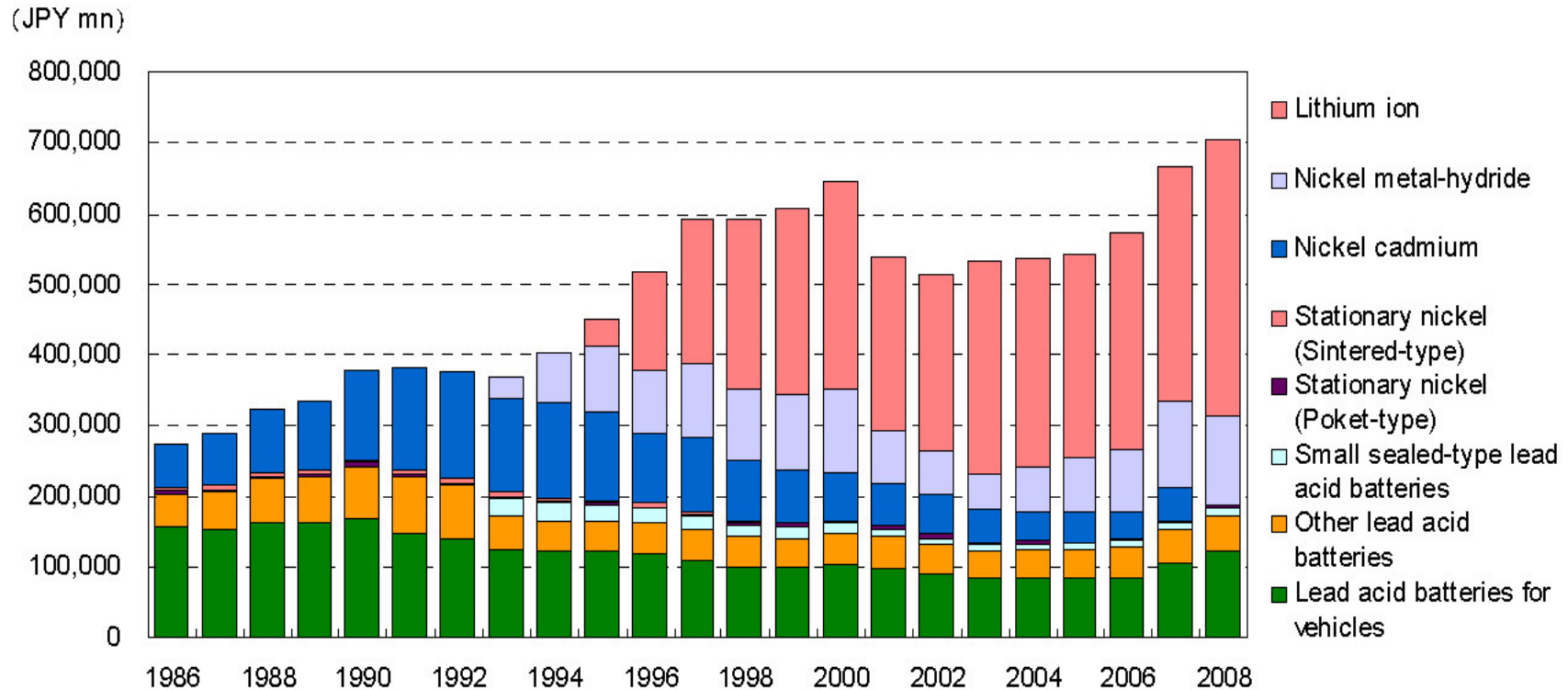
Get Plugged In.

# Power Grid Storage & Automobile



# Lithium-ion is Battery of Choice

## Displacing other battery chemistries

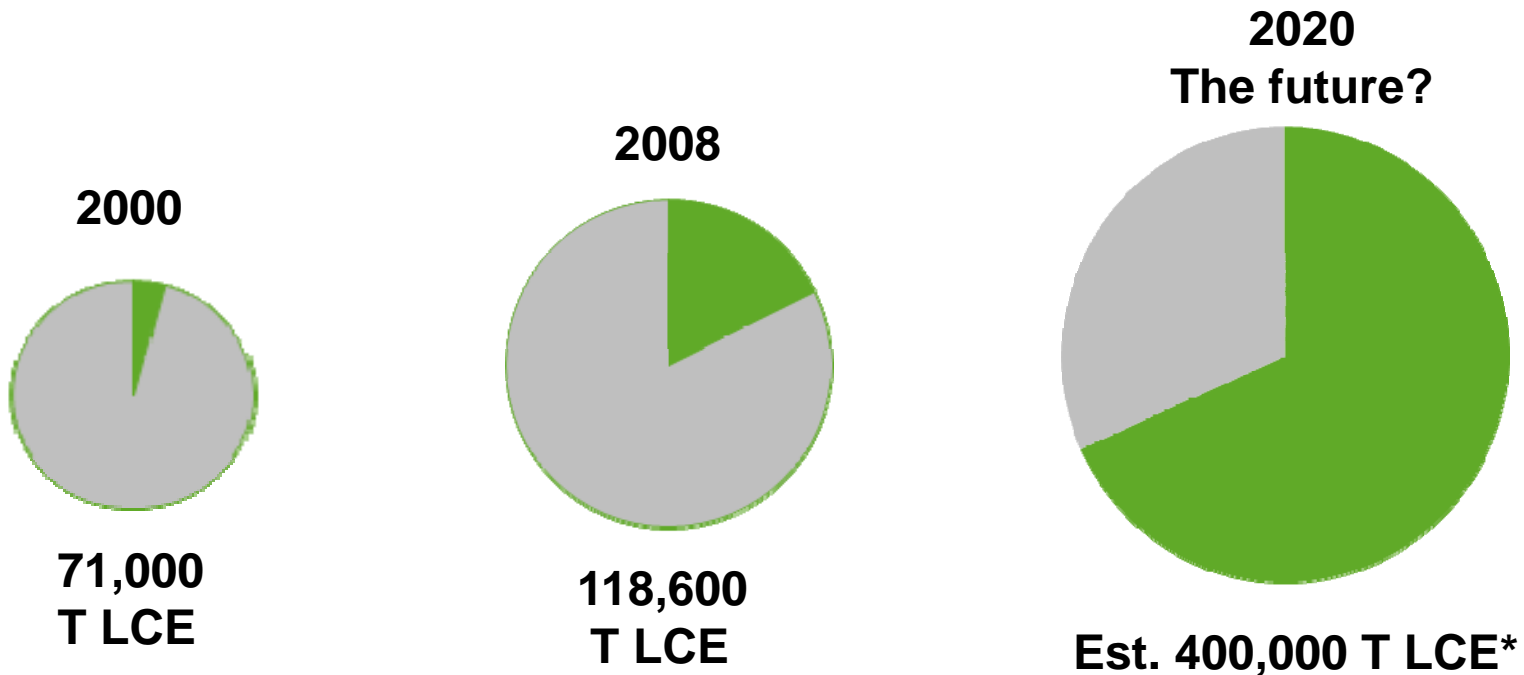


Source: Battery Association of Japan, Barclays Capital



# Lithium – Near Term Growth Potential

-  Demand from Batteries
-  Other Demand Sources



$\text{Li}_2\text{CO}_3 = \text{LCE}$  (Lithium Carbonate Equivalent, 5.323 x Li)

\*Estimate based on 5% market growth and 10% EV adoption rate over 10 years.



# Washington Support for Lithium-ion

## \$2.4 Billion Stimulus Funding for Lithium Batteries

“New plug-in hybrids roll off our assembly lines, but they will run on batteries made in Korea. Well I do not accept a future where the jobs and industries of tomorrow take root beyond our borders – and I know you don’t either. It is time for America to lead again,”



President Obama.

# Potential Growth in U.S. Domestic Market

**By 2013 demand capacity for battery grade lithium in the U.S. is forecast to rise to 30,000 tonnes LCE per annum.**

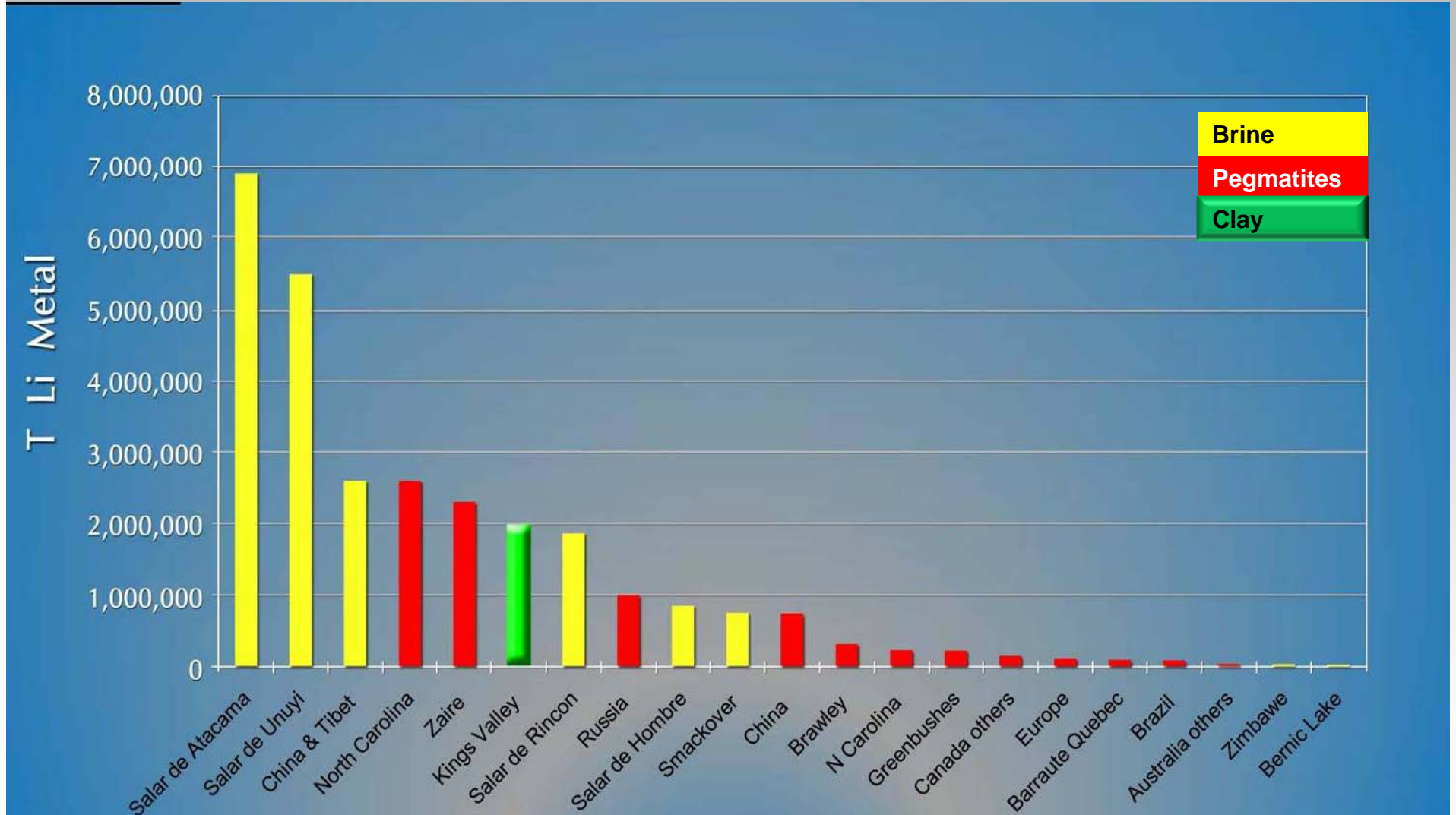
Company	Millions of Stimulus Funding Awarded
JCI & SAFT	\$394 (2 plants)
A123	\$249
Dow Kokam	\$161
Compact	\$151
Enerdel	\$118



**Stimulus funded U.S. battery plants requiring 20,000 – 30,000 tonnes of LCE in total annually under construction *now***

\*Source: DOE for funding and Western Lithium estimates for LCE requirements.

# World Lithium Resources - by type



# Pegmatite

Spodumene



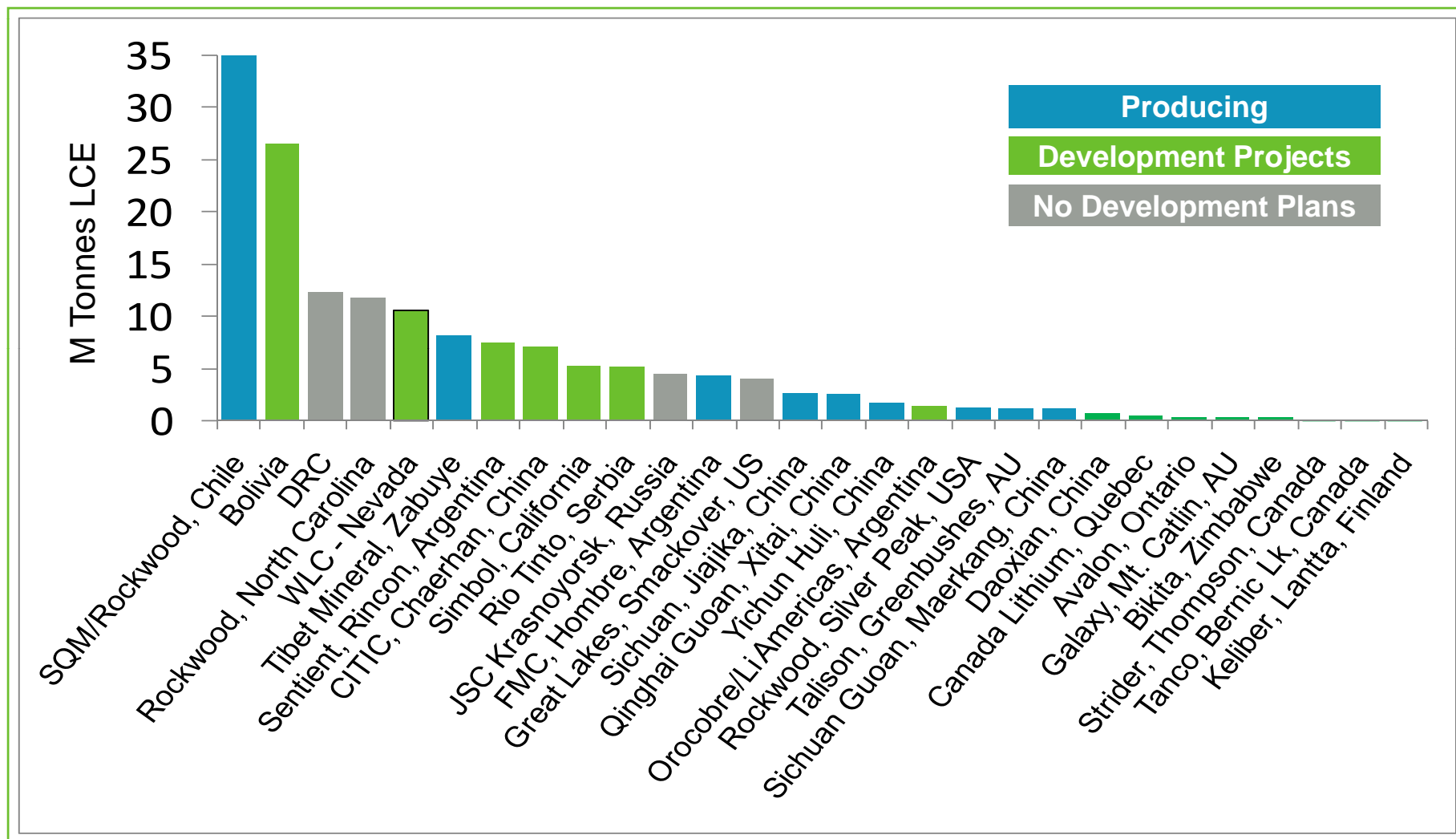
# Brines



# Hectorite Clay



# World Lithium Resources – by development plans



Source: Roskill Information Services Ltd., R. Keith Evans, National Research Council and Western Lithium estimates. Estimates are not NI 43-101 compliant.



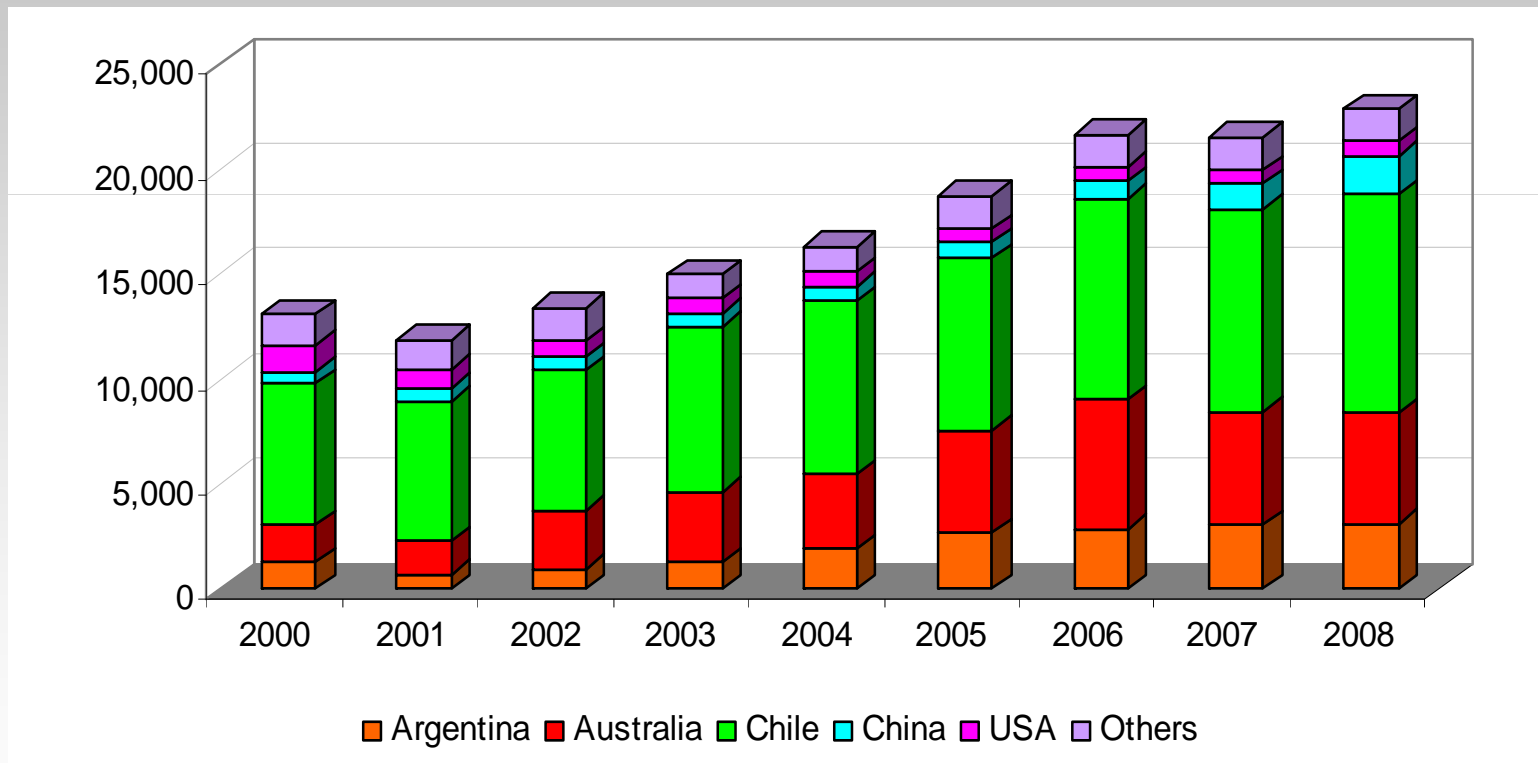
# Lithium Supply – Top Producers

Producer	Location	2008 Production (tonnes LCE)
SQM	Chile	32,600
Talison	Australia	28,200
Rockwood	Chile	22,500
FMC	Argentina	16,600
Various	China (Total)	9,900
Rockwood	USA	3,700
Others		5,100
<b>Total</b>		<b>118,600</b>



Source: Roskill 2009  
Lithium Carbonate Equivalent (LCE)

# Lithium Production by Country



Source: Roskill

FUEL SUPPLY



Bikes ready for harvest in a lithium pond in the heart of the Salar de Atacama in Chile.

# THE SAUDI ARABIA OF LITHIUM

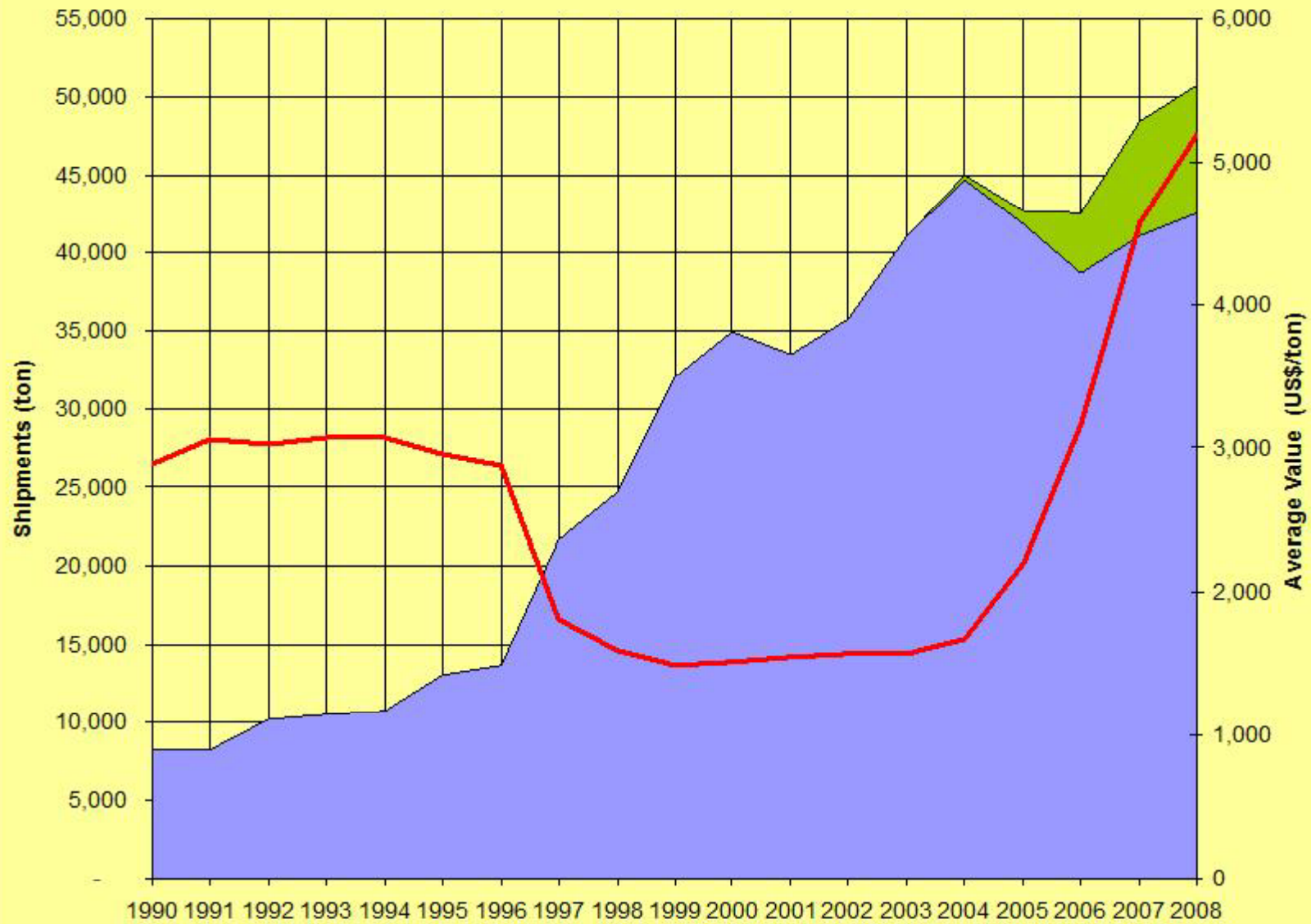
THE GAS ENGINE MADE PETROLEUM THE WORLD'S BIGGEST COMMODITY. THE ELECTRIC CAR COULD DO THE SAME FOR THE THIRD ELEMENT ON THE PERIODIC TABLE. BY BRENDAN I. KOERNER

**N**OTHING GROWS IN THE HEART OF THE SALAR DE ATACAMA. THIS ancient Chilean lake (60-90) miles north of Santiago may be the driest place on Earth, a wasteland strewn with salt-encrusted rocks that resemble cow pies. Annual rainfall on the salar (which in Spanish means "salt lake") rarely tops a few millimeters. The cloudless skies combine with the high altitude, 1.4 miles above sea level, to produce punishing solar radiation, capable of frying exposed flesh in minutes.

# Atacama Salar - Chile

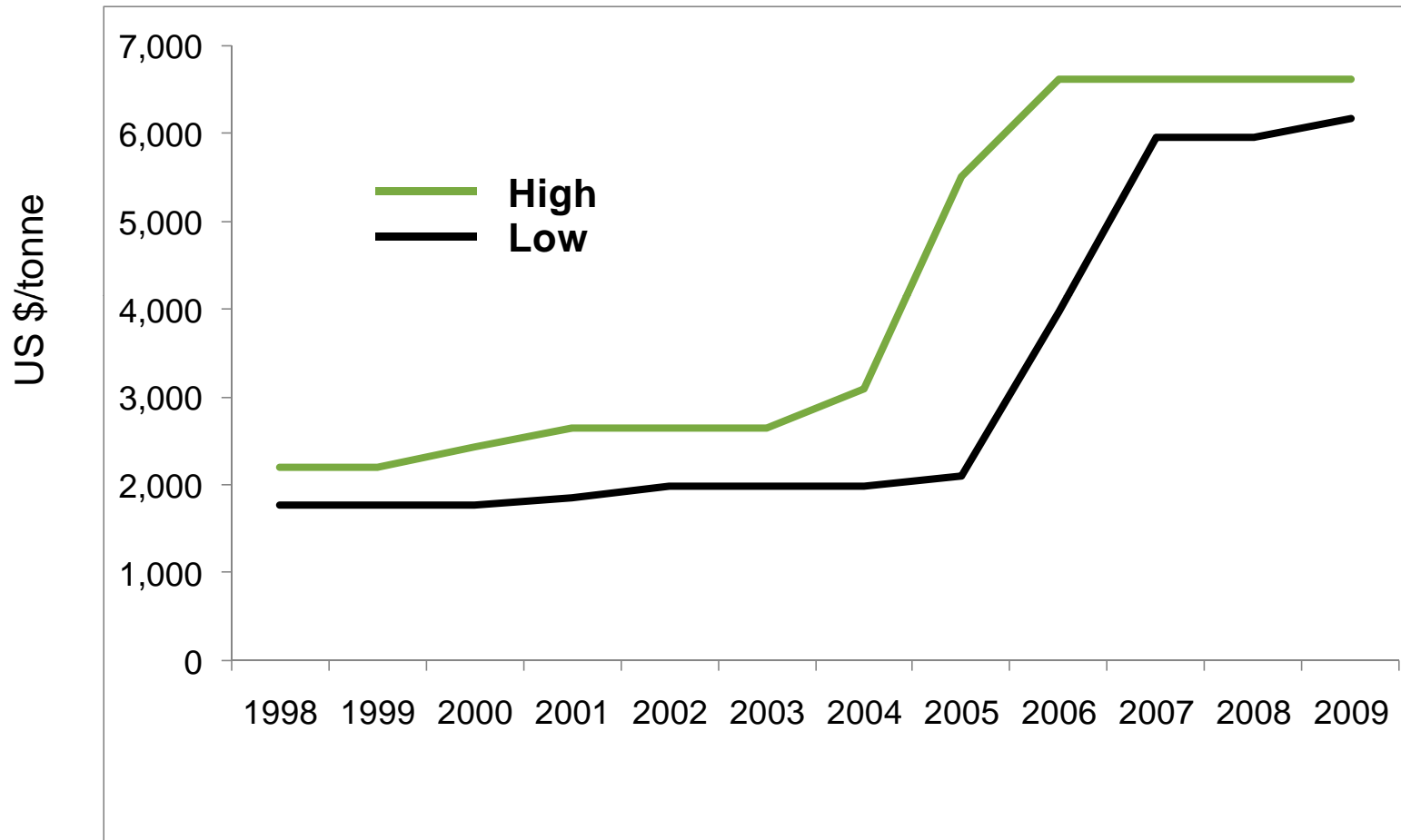


CHILE: Lithium Export  
© Ehren-González Limitada



LCE ton/year    Li<sub>2</sub>CO<sub>3</sub> ton/year    Li<sub>2</sub>CO<sub>3</sub> price US\$/year

# Lithium Carbonate Price



Source: Industrial Minerals. Lithium carbonate, del continental, USA large contracts, US\$ per lb.

# Lone Domestic Producer of Lithium

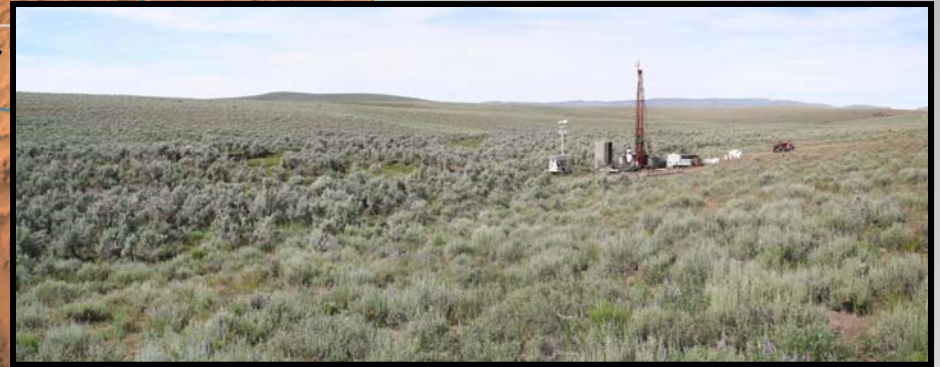
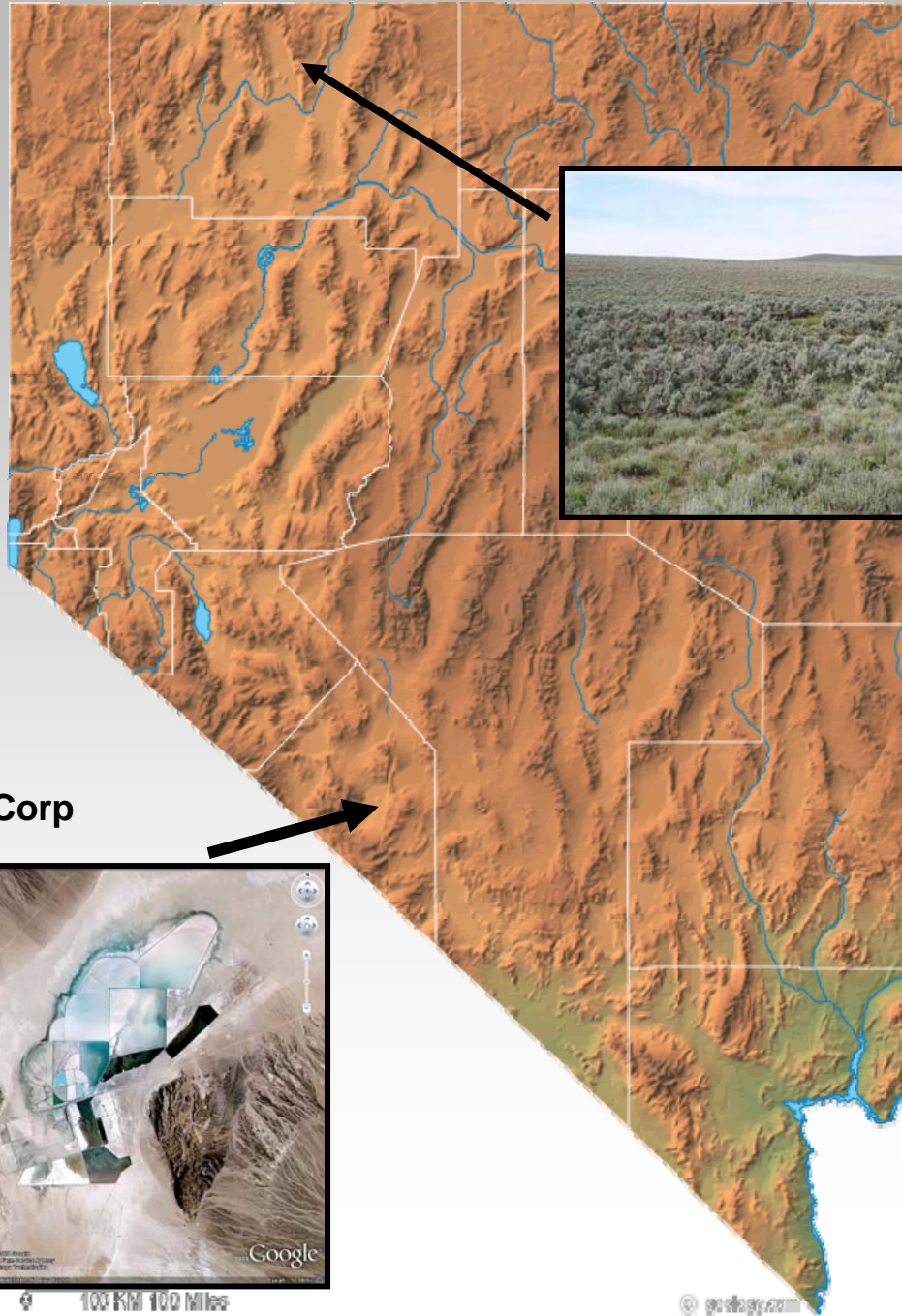
Brine

Nevada

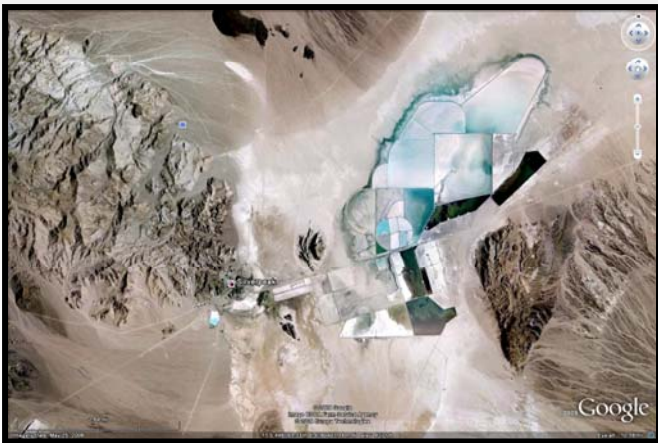
Chemetall Foote Corp



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100 KM 100 Miles

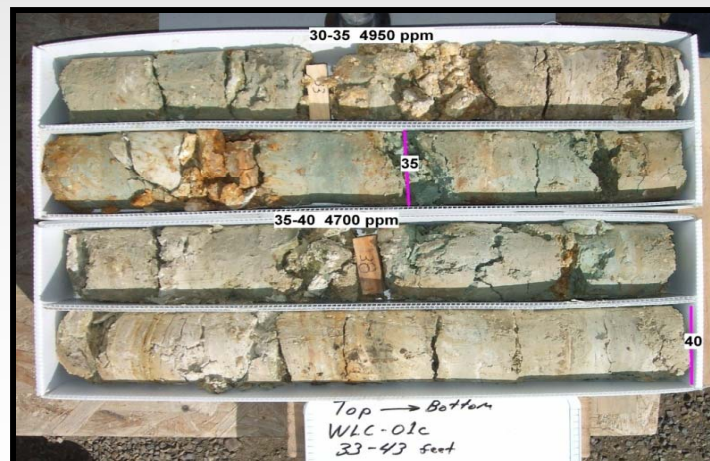
© geology.com



# Hectorite – The Next Source of Lithium?

- **Rare – first discovered in Hector, California**
- A magnesium, lithium silicate clay mineral (hydrated aluminum silicate)
- Member of the smectite group of clays –expanding lattice with exchangeable cations (Na, Ca, Mg, OH, K) where Li substitutes for Mg
- Unique physical properties: high viscosity, gel strength, temperature stability, color, suspension properties, rheology control - (paints, cosmetics, greases, coatings, drilling muds)
- Precipitated in a lake environment and associated with hydrothermal fluids rich in

Mg & Li



# Stage I (PCD) Lens



# Potential Impediments to Domestic Resource Development

**Lack of Comprehensive Mineral Policy**

**Potential Downside of Mining Law Reform**

**Restrictive Regulations – Federal, State, Local**

**Restrictive Mineral Access to Public Lands**

**NIMBY Attitude**

**Competing Land Uses**

**Lengthy Regulatory/Permitting Environment**



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