

"EXPLORING FOR LCT PEGMATITES IN CANADA AND AUSTRALIA"

*Everyone's talking about Lithium... and they should be,
"It's the next gasoline." [Brian Colwell](#)*

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Nigel Brand, Geochemical Services
AIG Presentation 15 August, 2016**



Discussed



- granite fertility and LCT pegmatites;
- geological setting and controls of lithium deposits;
- exploration techniques;
- analytical methodology including conventional laboratory analysis and non-conventional non-destructive methods

Key References



Bradley, D., and McAuley, A. (2013): A preliminary deposit model for lithium-cesium-tantalum (LCT) pegmatites. *U.S. Geological Survey Open File Report 2013-1008 7p.*

Selway, J.B., Breaks, F.W and Tindle, A.G., (2005) A Review Of Rare-Element (Li-Cs-Ta) Pegmatite Exploration Techniques For The Superior Province, Canada And Large Worldwide Tantalum Deposits. *Exploration and Mining Geology, Vol 14, Nos 1-4 pp, 1-30.*

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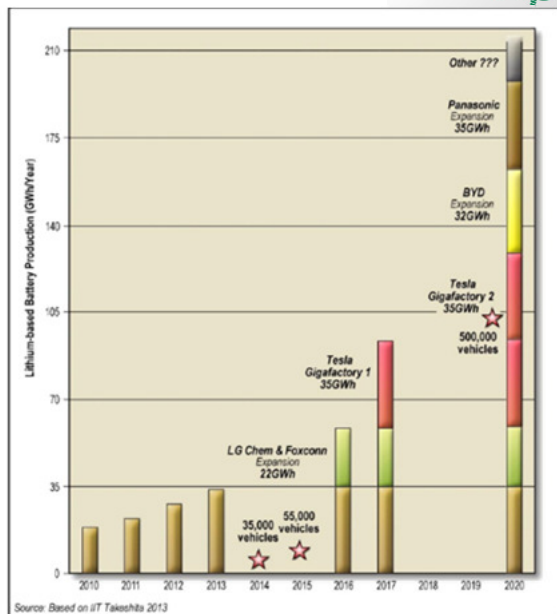
3	28	79
Li	Ni	Au
6.941	58.69	196.967

“Battery storage will revolutionize the renewable energy sector by reducing the need for network investment.”

Simon Corbell

From Kingsnorth 2016

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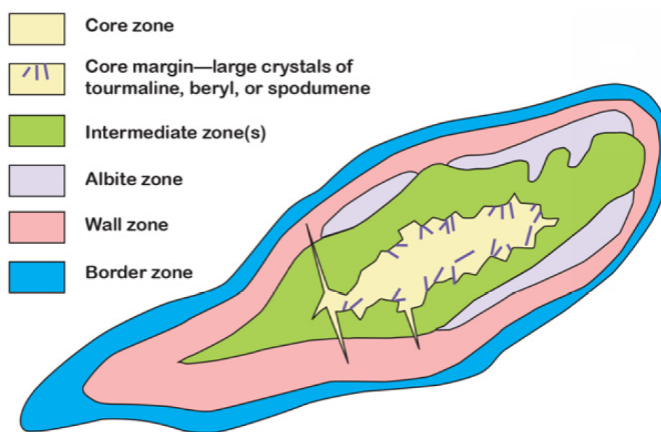
LCT Pegmatites represent the most highly differentiated and last to crystallize components of certain granitic melts.

- are typically derived from fertile zone of parental per-aluminous, S-type granite.
- Have, a 'granitic' primary composition: quartz, potassium feldspar, albite and muscovite.
- Are enriched in 'L' lithium, 'C' caesium, 'T' tantalum and rubidium.
- May therefore have spodumene, petalite, lepidolite, leucite and pollucite. Other diagnostic minerals include beryl and tourmaline.

LCT Pegmatite – Mavis Lake Ontario



LCT Pegmatites have a Structured Internal Zonation



Deposit-scale zoning patterns in an idealised pegmatite, (after Cameron (1949), Černý (1991), Fetherston (2004))

Prominent Core Zone at Pegmatite 008 (Pioneer Dome)



A First-order Filter in the Search for Fertile Granite is the Geological and Temporal Context.



- Occur along large regional-scale faults in greenschist and amphibolite-facies metamorphic terranes.
- Most commonly, age is that of orogenic granites: Ca 2650, 1800 525, 350 Ma, being times of collisional orogeny and supercontinent assembly.
- The largest emplacements of fertile granites and LCT pegmatites are of Archean age.
- Hosted in mafic metavolcanics or metasedimentary rocks, near peraluminous granitic plutons.
- Geochemically unusual elemental ratios: e.g. $A/CNK > 1$, $Li/Mg > 10$



Host Pillow Basalts—Mavis Lake Ontario

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Zonation Around the Source Granite: The Goldilocks Zone



- Greatest enrichment of economic elements occurs concentrically around fertile parent granite.
- LCT pegmatites are known to form as far as 10km from the parental granite.
- Pioneer's observations indicate that for lithium, the distance from the parent intrusion is commonly 1.0-4.0 km. The "**Goldilocks Zone**".
- Successive zones in the most fractionated pegmatites marked by beryl, then tantalite and spodumene, and finally pollucite.
- Most LCT pegmatite bodies show some sort of structural control in host rocks.

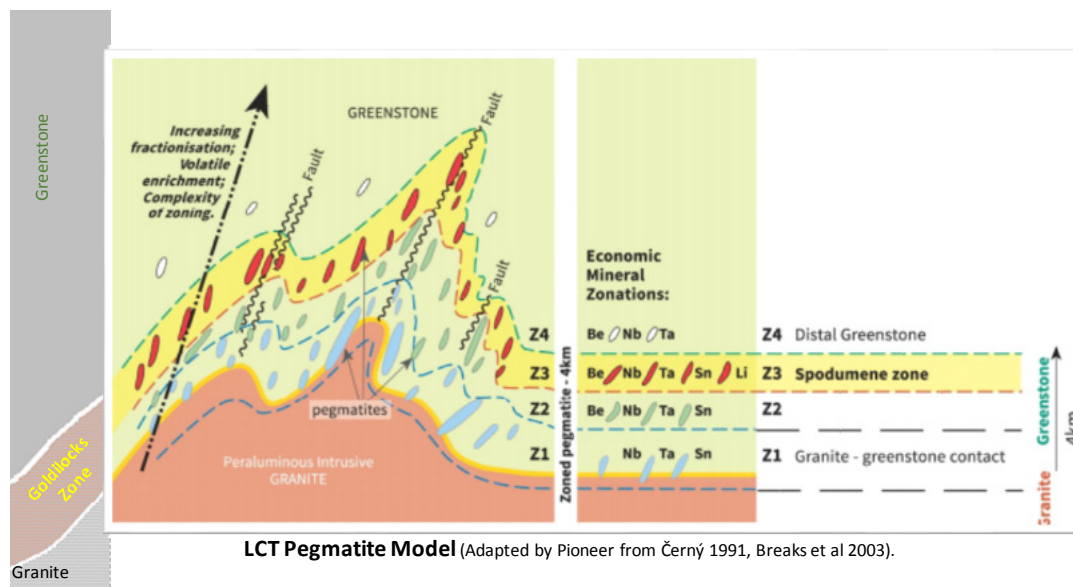
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Rare metal pegmatites occur along large regional-scale faults

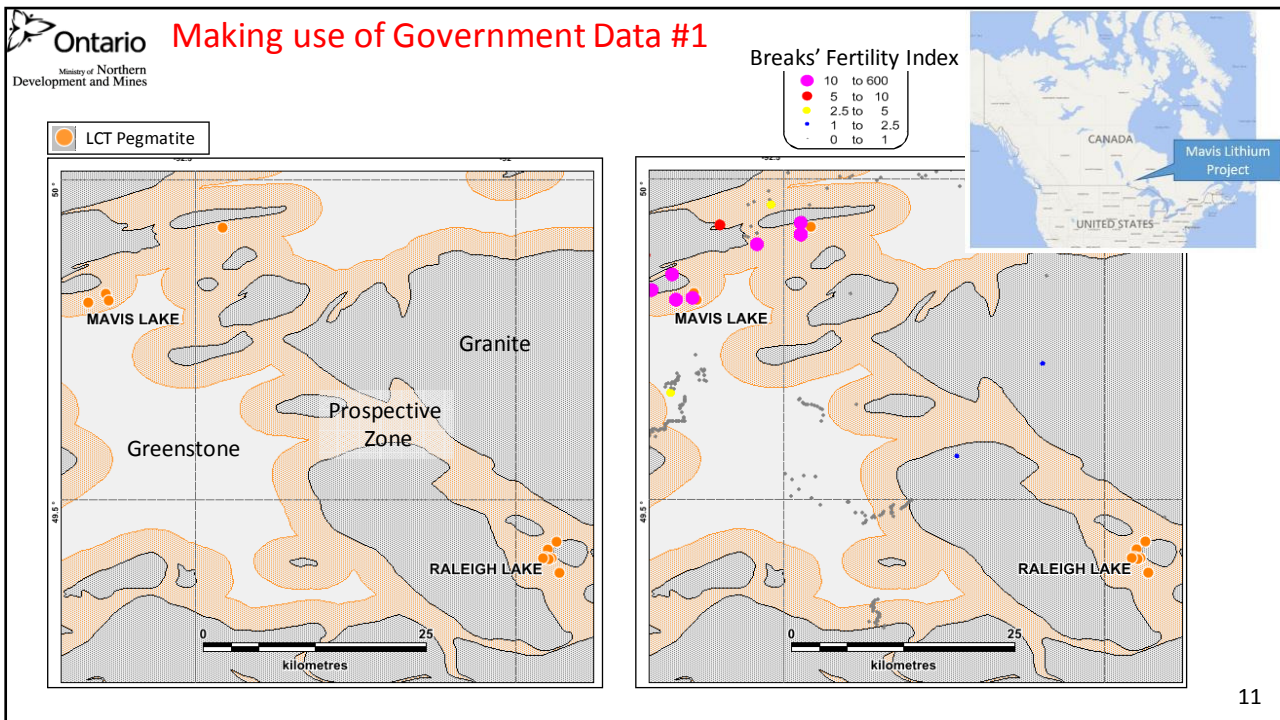


World map showing the locations of LCT pegmatite deposits or districts, including smaller districts in the United States. The symbols are colour-coded by age. Giant deposits are represented by larger symbols (Bradley and McAuley 2013) 9

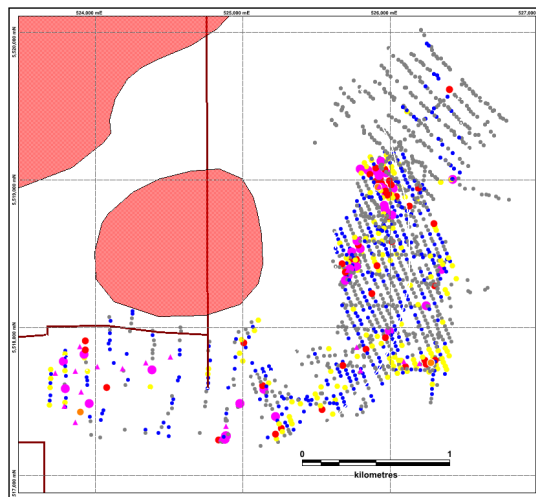
Zonation Around the Source Granite: The Goldilocks Zone



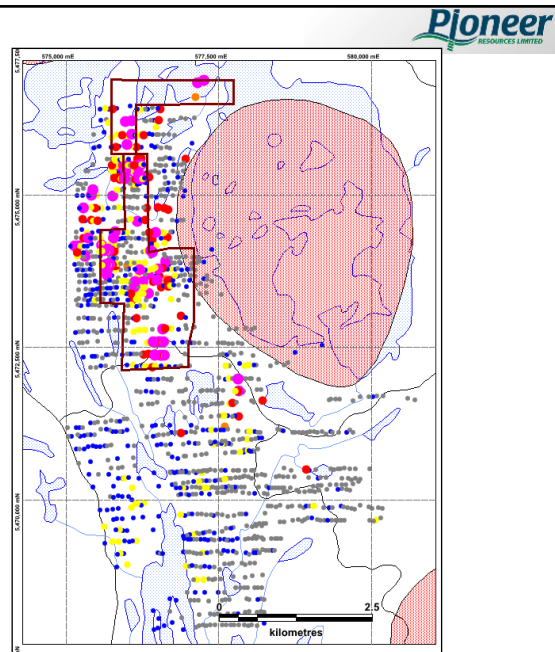
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Lithium Litho geochemistry Results



Mavis Lake



Raleigh

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Glacial pavement, muskeg and pine forest.
Soil is not ubiquitous. Rock chip chemistry is the norm.



Fred Breaks, ILC and Pioneer geologists and First Nation Representatives at Mavis Lake PEG003, May 2016.

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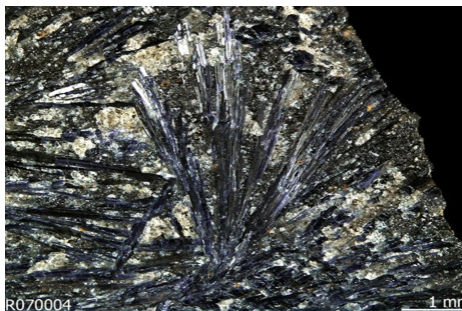


Rock sampling at Mavis Lake PEG018, Ontario, Canada.

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Holmquistite needles from Raleigh (Breaks)



Holmquistite, Uto, Sodmanland, Sweden. (Breaks, 2012)

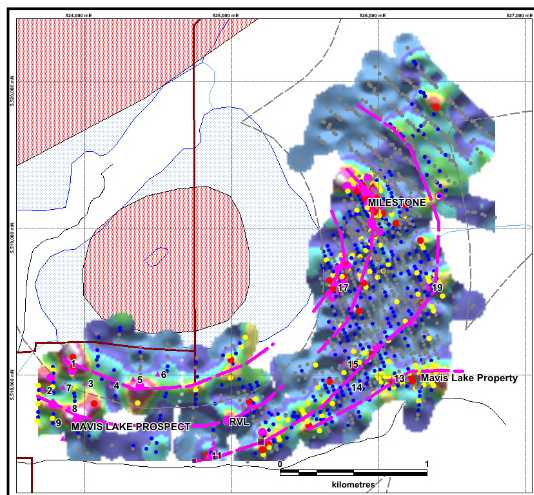


Holmquistite from Greenbushes (GSWA)

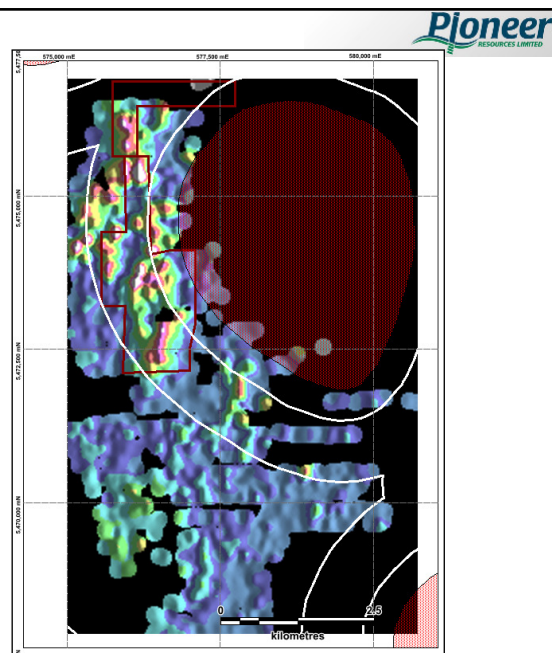
Characteristic dark blue radiating crystal arrays are an important mineralogical indicator of lithium dispersion from pegmatite bodies.

Holmquistite alteration halos in areas at Mavis Lake, in excess of 25m, are quite possibly the most extensively developed examples of its type in North America.

Lithium Litho Geochemistry Results

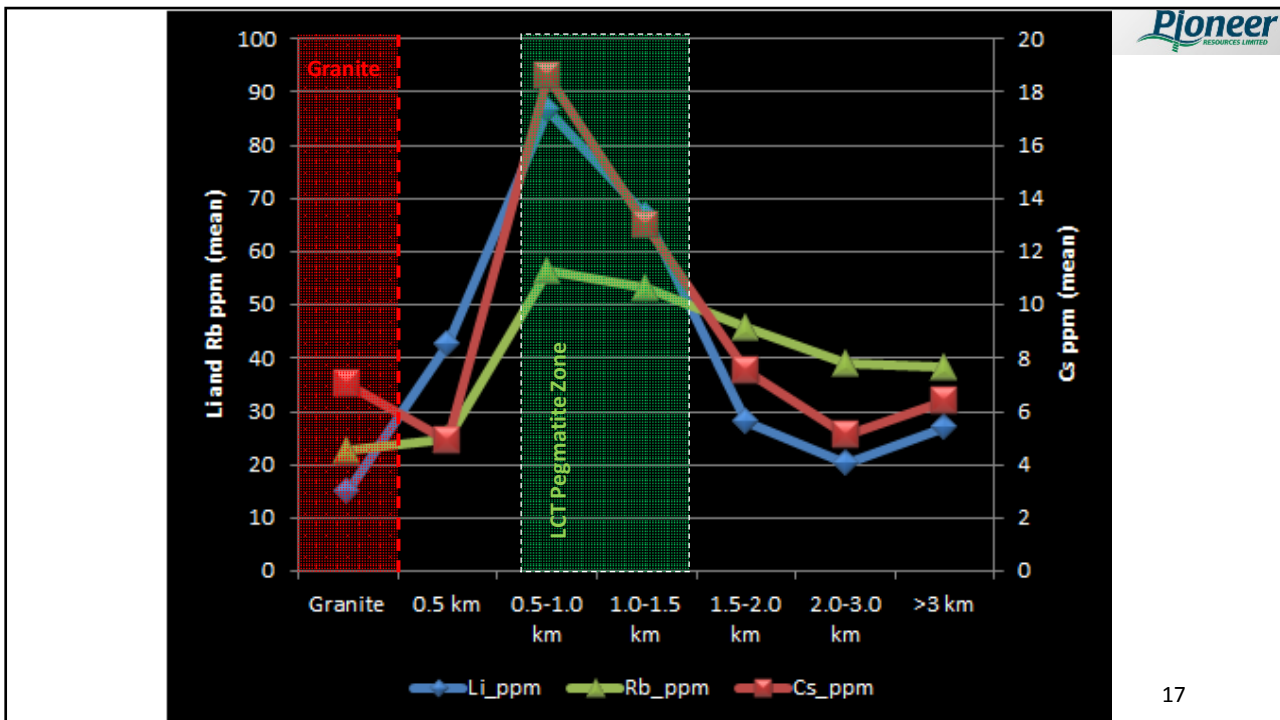


Mavis Lake

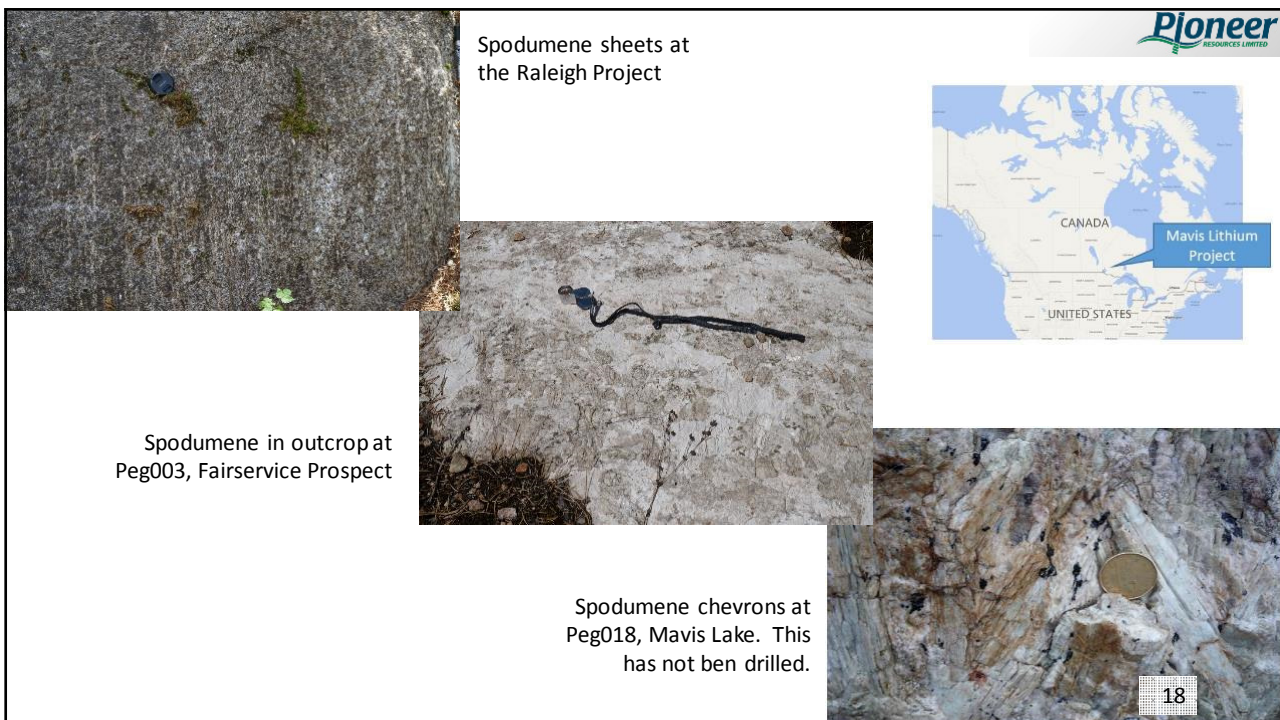


Raleigh

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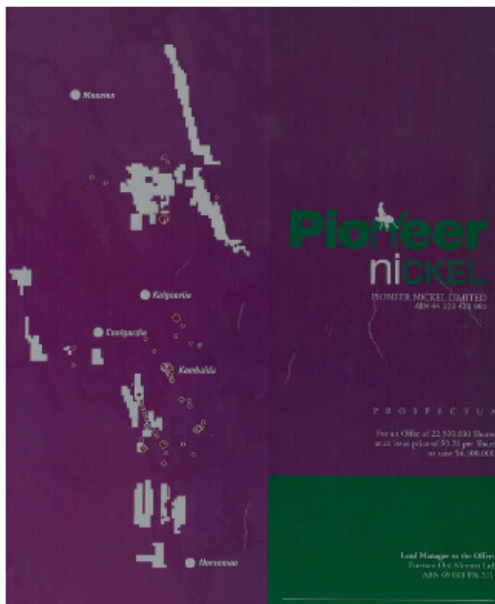


Not Just Geochemistry – Continuous-Reading Ground Magnetics



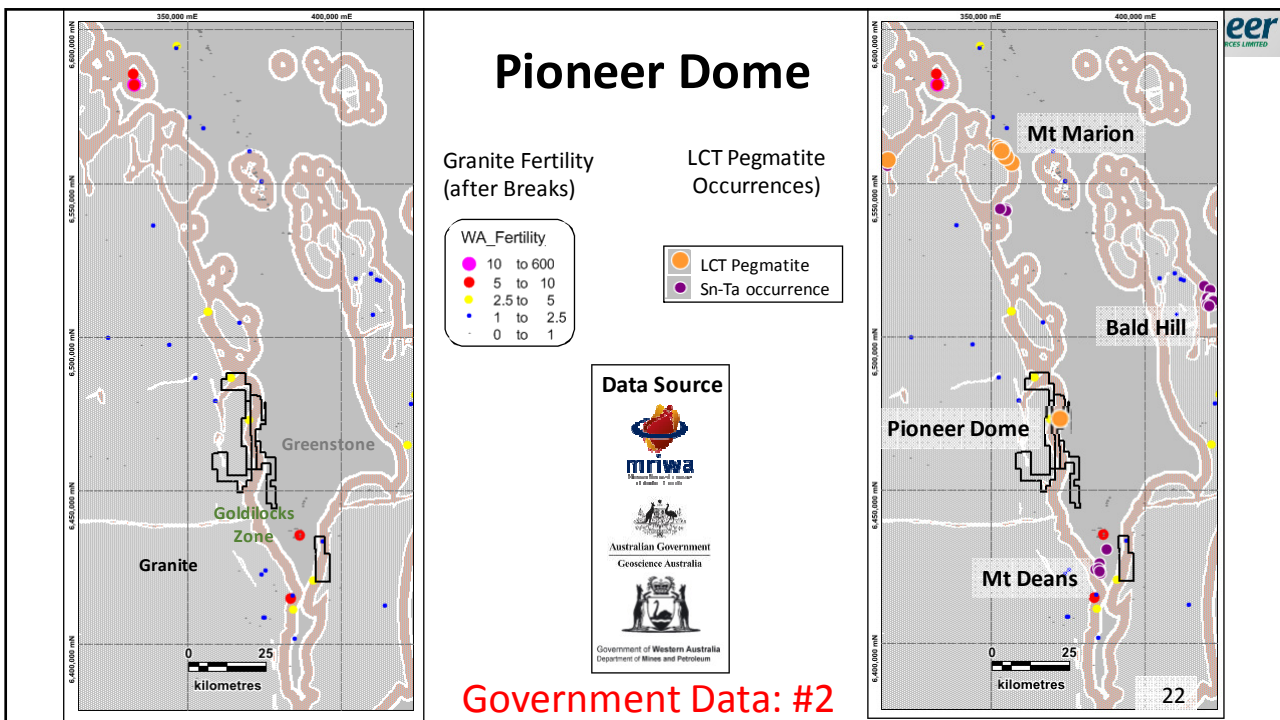
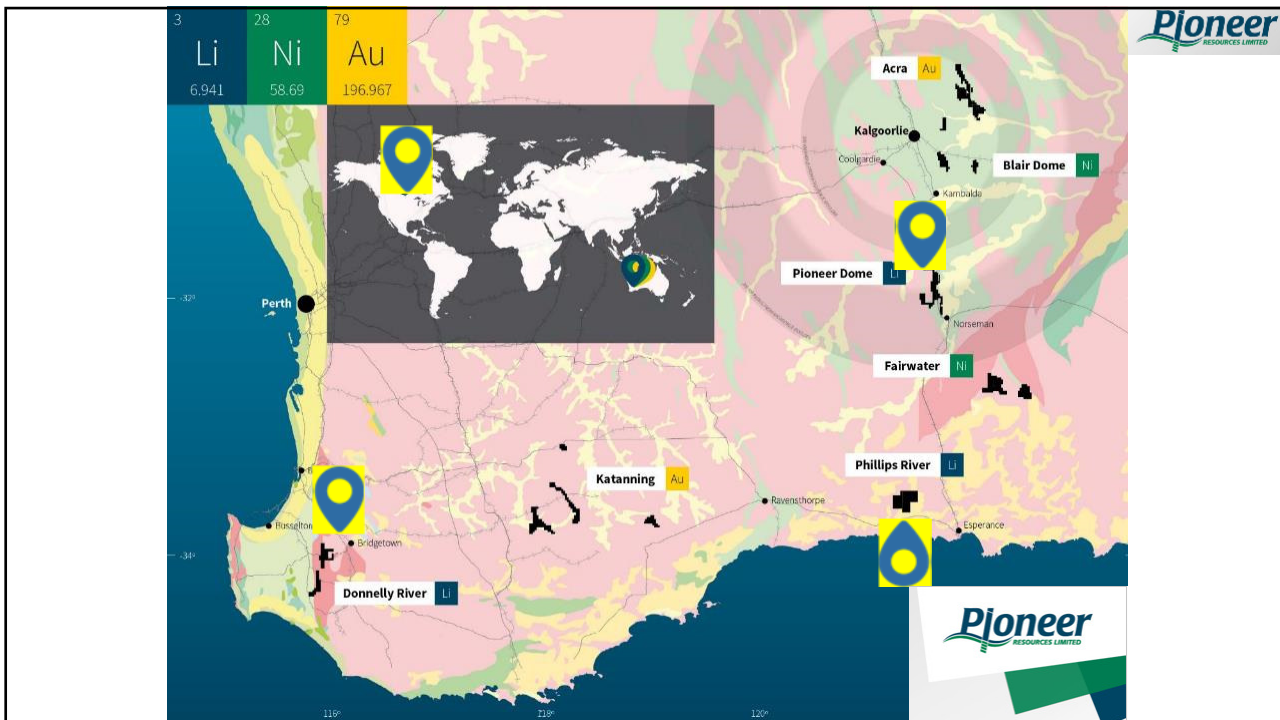
Mavis Lake Project: The Wet Part

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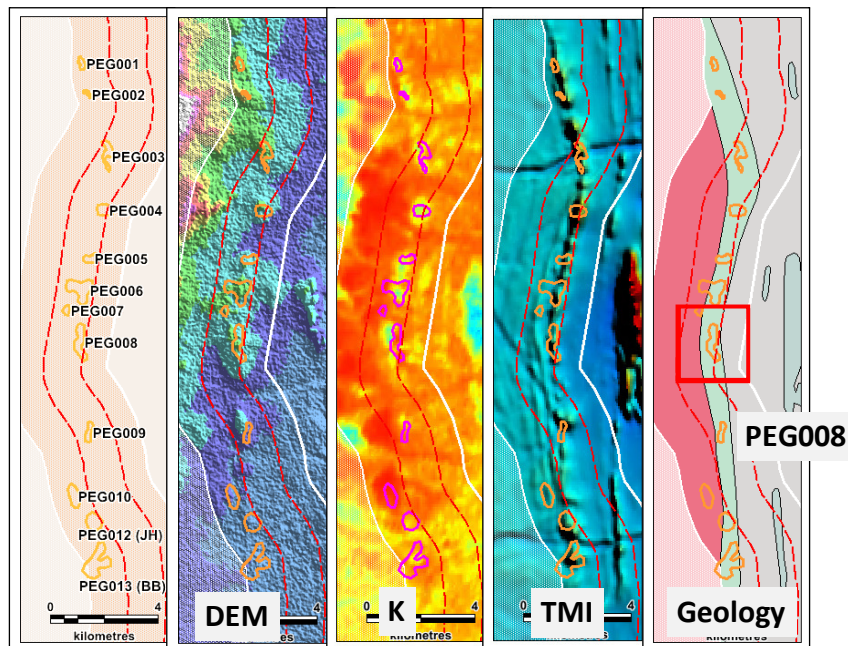


Back to the Future Pioneer Dome Revisited

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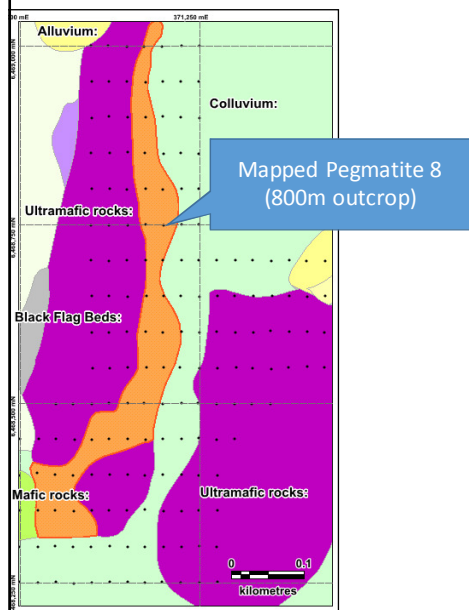


The Goldilocks Zone: Pioneer Dome



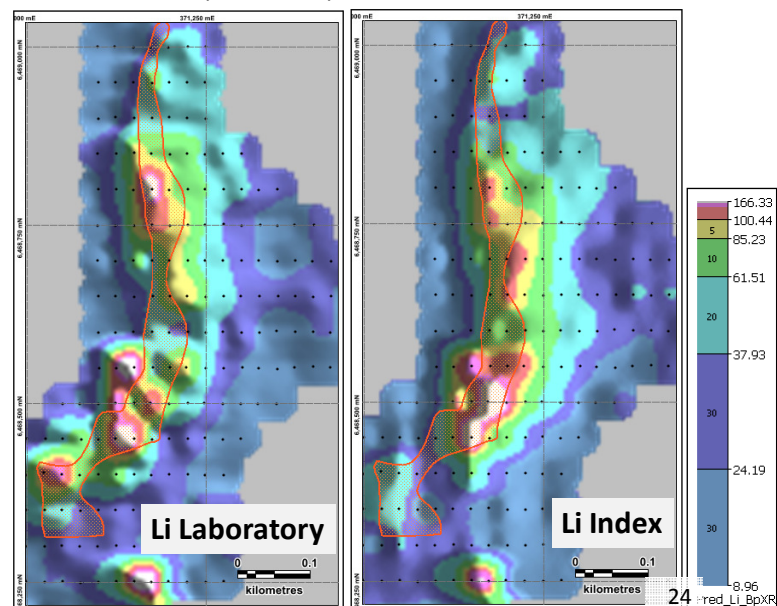
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Using a pXRF for Lithium Exploration: PEG008 A Blind Test Case



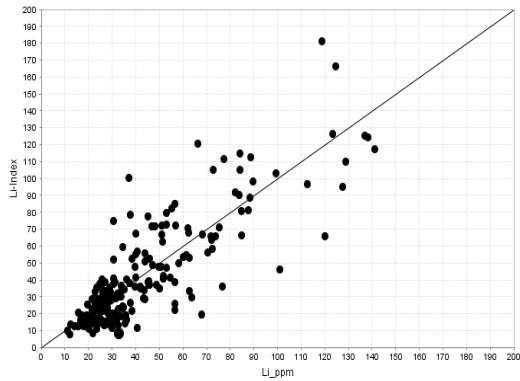
Lithium Geochemistry: Laboratory

Lithium Geochemistry: Index by pXRF

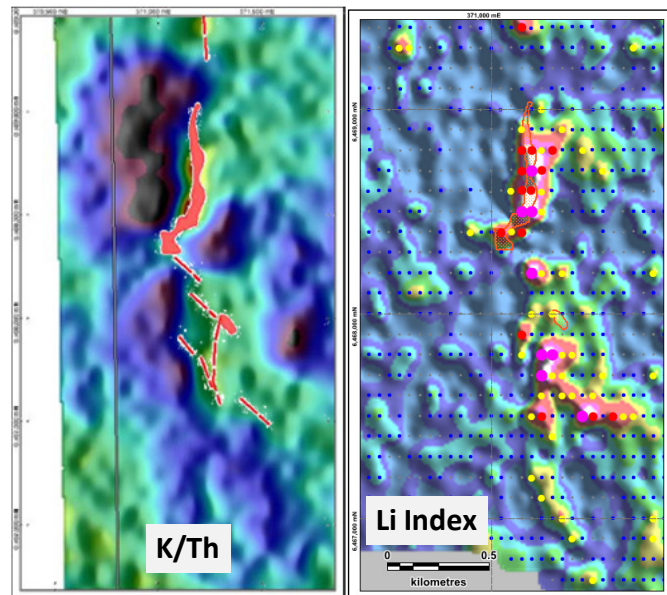


Pioneer Dome PEG008: Extended

Lithium Wet Chemistry vs Lithium Index



Pegmatite 8 geochemical anomaly (LITHIUM Index) now 2.7km long.



Proof is in the pudding..... Drilling Starts September 2016

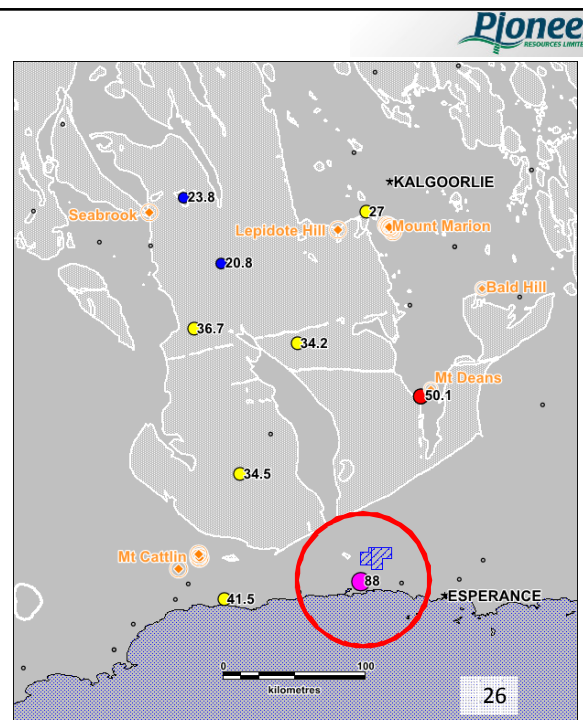
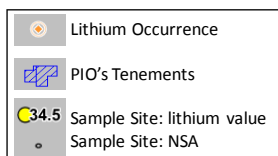
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Data Source



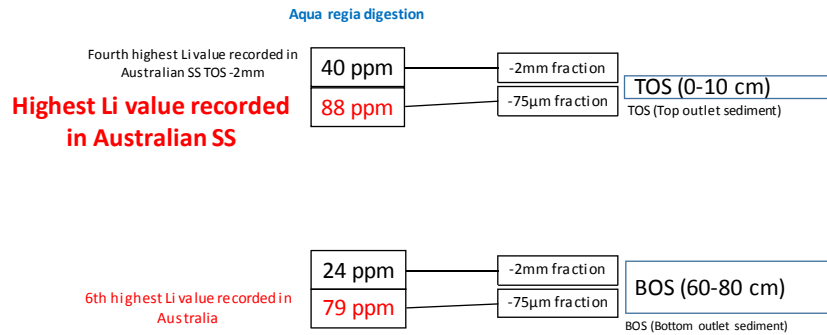
Making use of Government Data: #3

Map showing the distribution of lithium in stream sediments, known lithium occurrences and the Phillips River Project



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Phillips River Stream Sediment Sampling



de Caritat, P. & Cooper, M., 2011. *National Geochemical Survey of Australia: The Geochemical Atlas of Australia: Dataset*. Geoscience Australia, Canberra.
<http://dx.doi.org/10.4225/25/54CAB00B4C9AB>

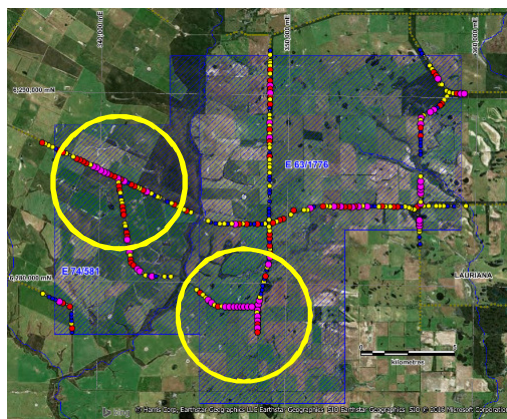
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Making use of Government Data: #4

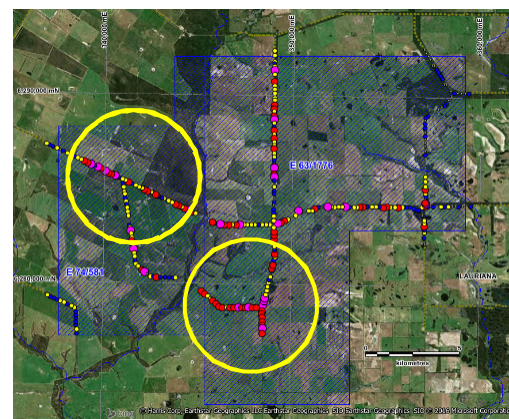
Mineral exploration reports (WAMEX)



Map showing lithium targets from roadside soil sampling



Map showing lithium values in roadside soil sampling



Modified PEG-4 (f(As,Sb,Sn,Nb,Ta))
values from regional road sampling
(After Smith et al, 1986)



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Conclusions



- The Pegmatite emplacement model is reasonably simple and seems predictable
- Government datasets make an invaluable start
- In Canada, where soils are inconsistent, rock geochemistry and mineralogy (holmquistite) provides a key vector
- In Western Australia, soil geochemistry seems to work. Drilling will confirm shortly!
- Modern pXRF's show capacity for estimating lithium content by providing a lithium index

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Wise, M. A. (1995). "Trace element chemistry of lithium-rich micas from rare-element granitic pegmatites". *Mineralogy and Petrology. 55 (13): 203–215.*

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3 Li 6.941	28 Ni 58.69	79 Au 196.967
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