

# A Review of Lithium occurrences in Africa

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and Judith Kinnaird

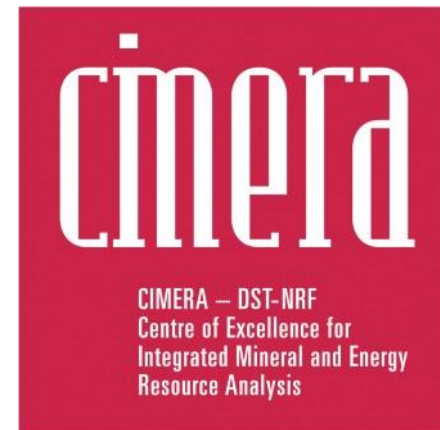


University of the  
Witwatersrand



**British  
Geological Survey**

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Lithium occurrences and exploration activity in Africa are dominated by pegmatite occurrences .

No known brine resources as yet, although

Botswana is being

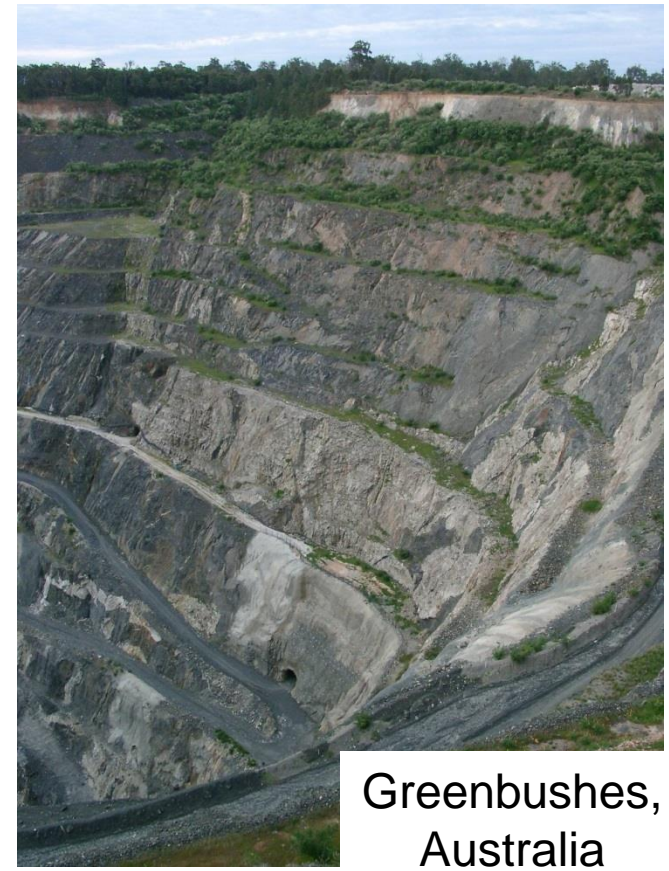
investigated:

(by Lithium

Consolidated Mineral Exploration Ltd-ASX)



Economist.com



Greenbushes, Australia

### Mineral

Spodumene

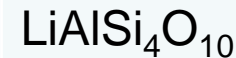
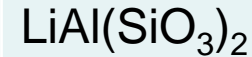
Petalite

Eucryptite

Amblygonite

Lepidolite

### Formula



Pegmatites: typically granitic, enriched in incompatible elements, occurrences correlate with times of collisional orogeny and supercontinent assembly.

Pegmatite classification needs reworking, however two types of interest -

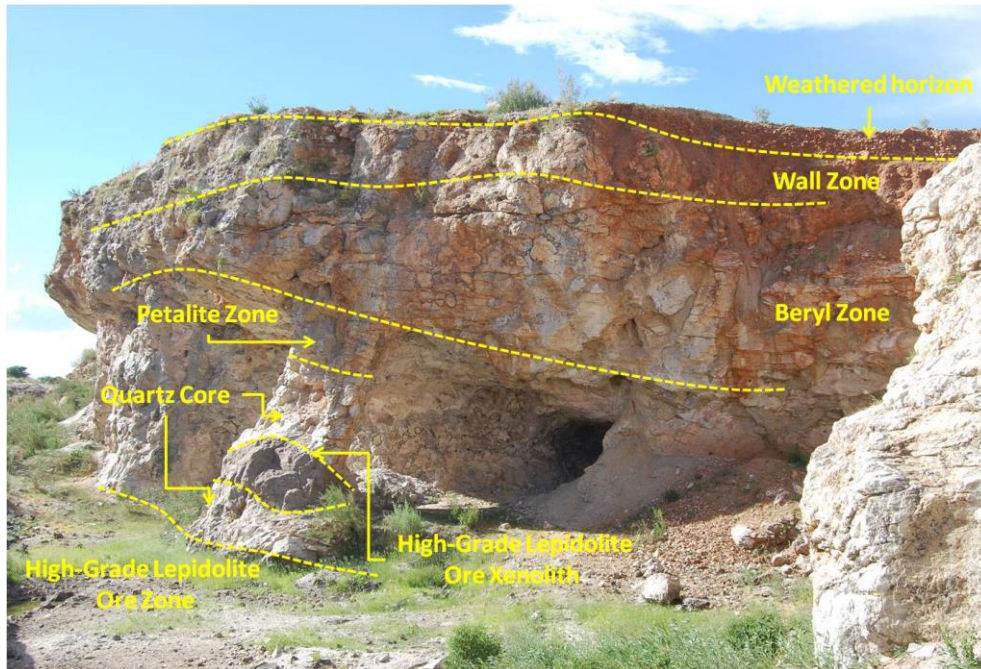
LCT: Lithium-caesium-tantalum

NYF: Niobium-yttrium-fluorine

Rubicon (Namibia)

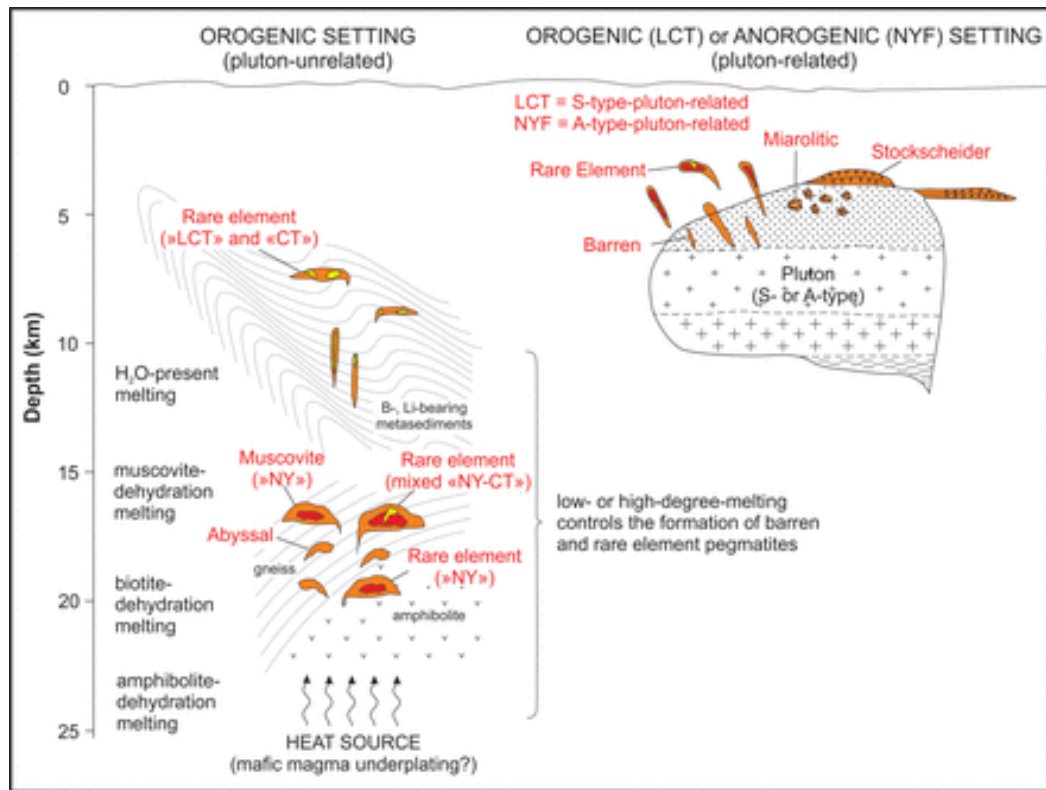


Bikita (Zimbabwe)

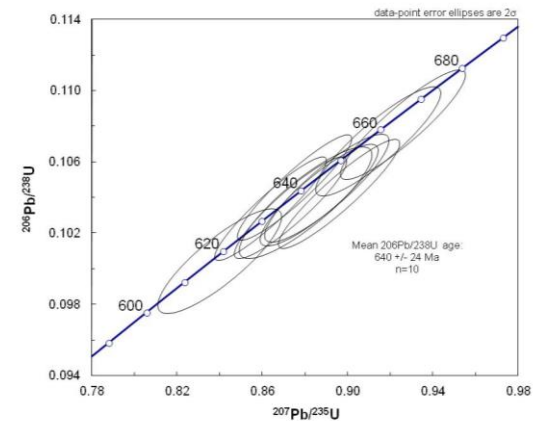


Two dominant genetic models:

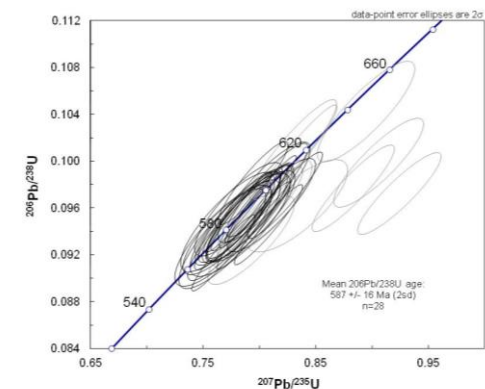
1. Products of the fractionation of a parental granite.
2. Products of low volume partial melting of metasediments during post-collisional orogenic collapse associated with decompression



Nigeria: Pegmatites are ~probably younger than 560 Ma. Contenders for parental granites are 640-600 Ma



or 60-580 Ma



Recent research in Norway (Muller et al 2017, “thousands of pegmatites without parental granites”), NW Scotland, Nigeria and Namibia suggests that the low volume partial melting model for the genesis of granitic pegmatites is more prevalent than previously appreciated.

In Namibia, potential parental granites are ~25 Ma older than the pegmatites and are deformed while the pegmatites are undeformed

Most LCT Li-pegmatites contain either spodumene or petalite as the dominant economic lithium-bearing mineral. Some contain both.

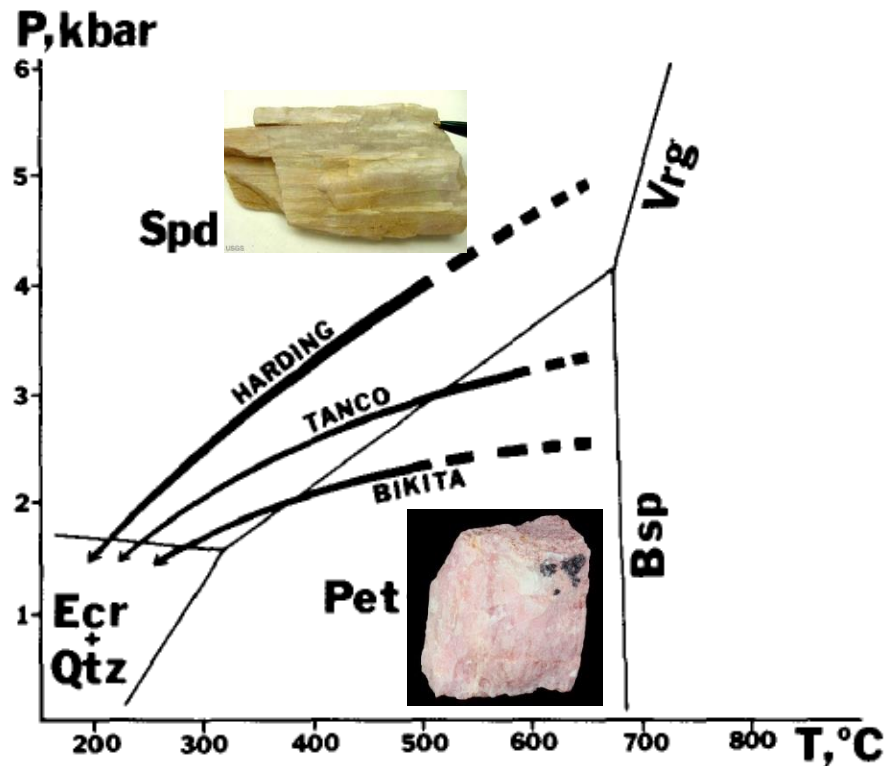
This is controlled by the P-T conditions of formation.

Monoclinic  
Typically striated  
1 cleavage  
3.7 % Li  
(Flat faces, lustrous)



Monoclinic  
2 cleavages  
1.6 – 2.27  
(Pink patina, dull)

- Petalite & spodumene:
- Can you tell the difference?



London, 1984

Country	Project	Company		Ore	Li <sub>2</sub> O	Ta <sub>2</sub> O <sub>5</sub>
Zimbabwe	Bikita	Bikita Minerals	Kesler ,1978	10.8 Mt	1.4%	
Zimbabwe	Bikita	Bikita Minerals	Clarke, 2011	10.8 Mt	0.58%	
Zimbabwe	Kamativi			100 Mt	0.28%	
Zimbabwe	Arcadia	Prospect Resources	JORC 2017	36.4 Mt	1.42%	127 ppm
Zimbabwe	Zulu	Premier African Minerals	SAMREC 2017	20.1 Mt	1.06%	51 ppm
Tanzania	Mohanga	Liontown Resources				
Namibia	Helicon & Rubicon	Desert Lion Energy	Historical	1.1 Mt	1.4%	
DRC	Manomo-Kitolo		Historical	7.86 Mt	0.76%	
DRC	Manomo-Kitolo		Historical	35 Mt	0.6%	
DRC	Manono Project	AVZ Minerals	Expl Tgt	1-1.2 Bt	1.25-1.5%	
South Africa	Blesberg (Noumas I)	Australian Vanadium	-	-	-	-
Ghana	Egyasimanku Hill	IronRidge Resources	Historical	1.48 Mt	1.66%	
Mali	Various	Blenheim Natural Resources	-	-	-	-
Mali	Bougouni / Goulamina	Birimian / Chinese Company?	JORC 2017	32.9 Mt	1.37%	

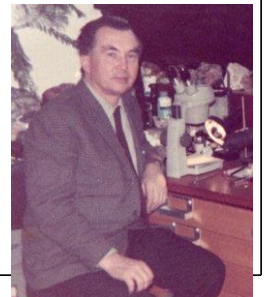
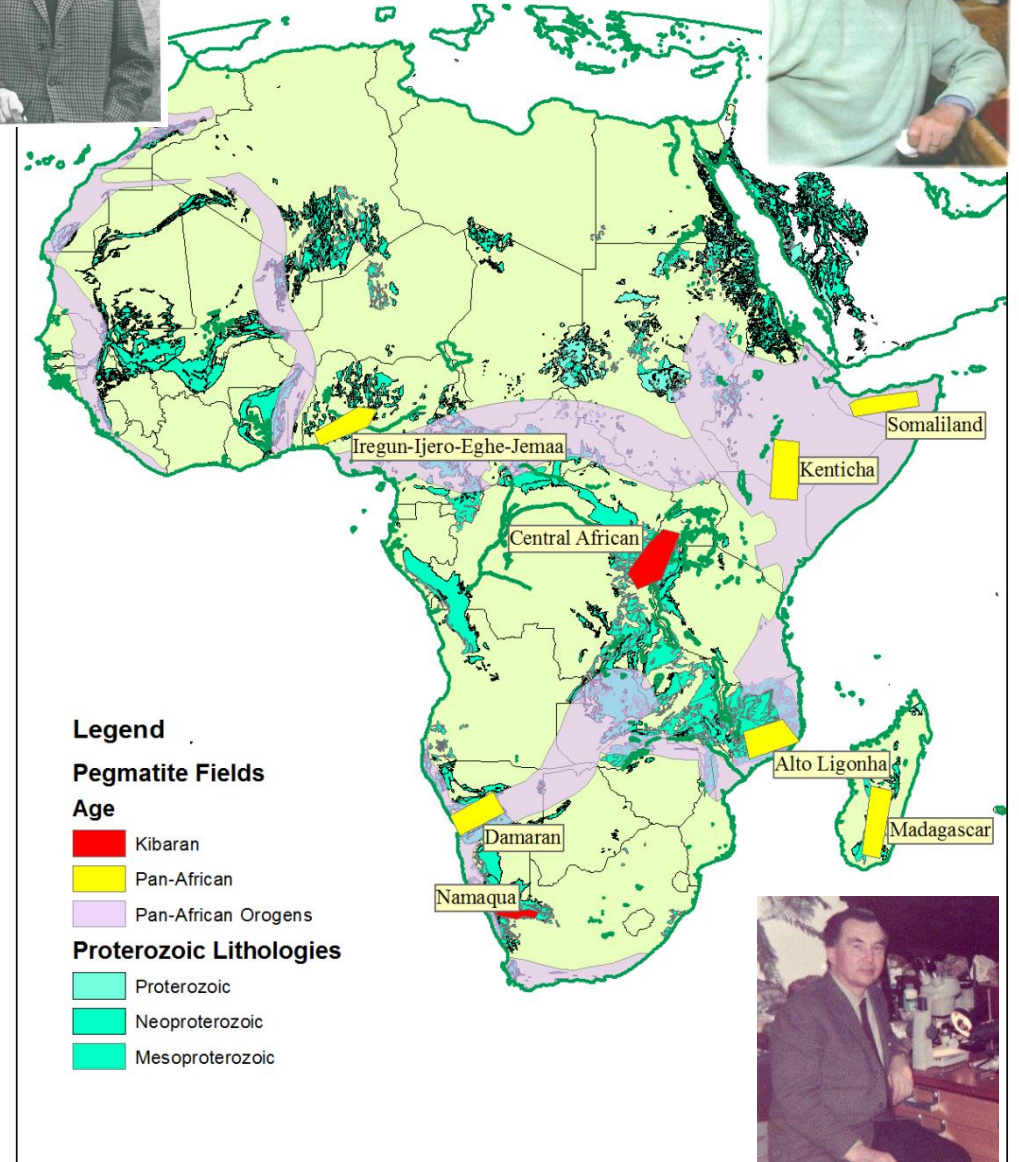
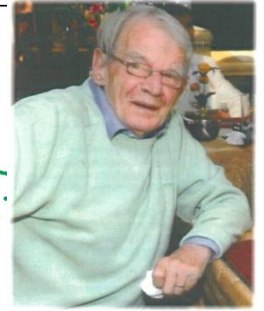
Pan-African pegmatites  
(~550-500 Ma)  
(Neoproterozoic-Cambrian)

W.Q. Kennedy (1964) coined the term Pan-African for the orogenic activity.

Tom Clifford (1970's) first continent-wide synthesis of pegmatites in a plate tectonic context

Oleg Von Knorring (1970's) major mineralogical investigations of most African pegmatites

Varlamoff (1972) first recognition of regional zoning in African pegmatites (West & Central Africa & Madagascar) – pre Cerny



Pan-African Orogenic Belts from Begg (2009)

Country	Project	Status	Company	Level	Ore (Mt)	Li2O (%)	Sn(%)	Ta2O5 (ppm)
Mozambique	Morropino	Closed mine	Noventa (until 2013)	Historical	21.7			190
Mozambique	Morrua	Closed mine	Noventa (until 2013)	Historical	7.5			700
Mozambique	Muiane	Closed mine	Unknown	Historical	7			160
Namibia	Helicon & Rubicon	Exploration	Desert Lion Energy	Historical	1.1	1.4		
Namibia	Rubicon	Exploration	Desert Lion Energy	Expl Tgt	10	2.5		
Namibia	Petalite	Closed mine	Unknown					
Ethiopia	Kenticha	Mine		Historical	116			150

## African LCT projects of Pan-African age

Note that many have been tantalum resources with possibly Li credits.

Pegmatite zoning is idealised

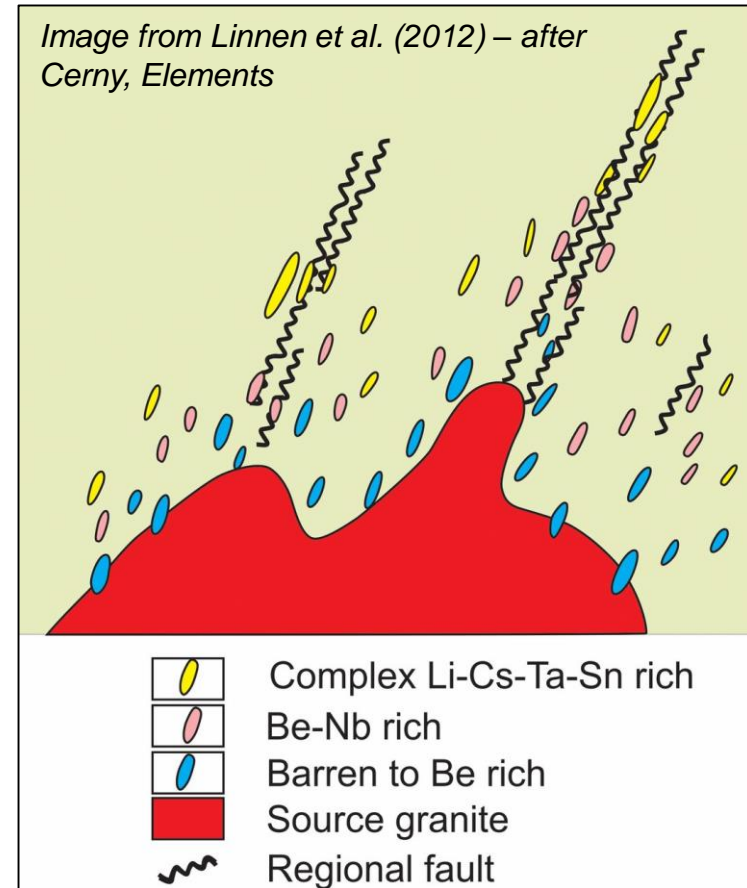
Pegmatite types are distinct in different areas (Clifford, von Knorring):

Namibia & Zambia – includes Sn

Mozambique & Madagascar – no Sn

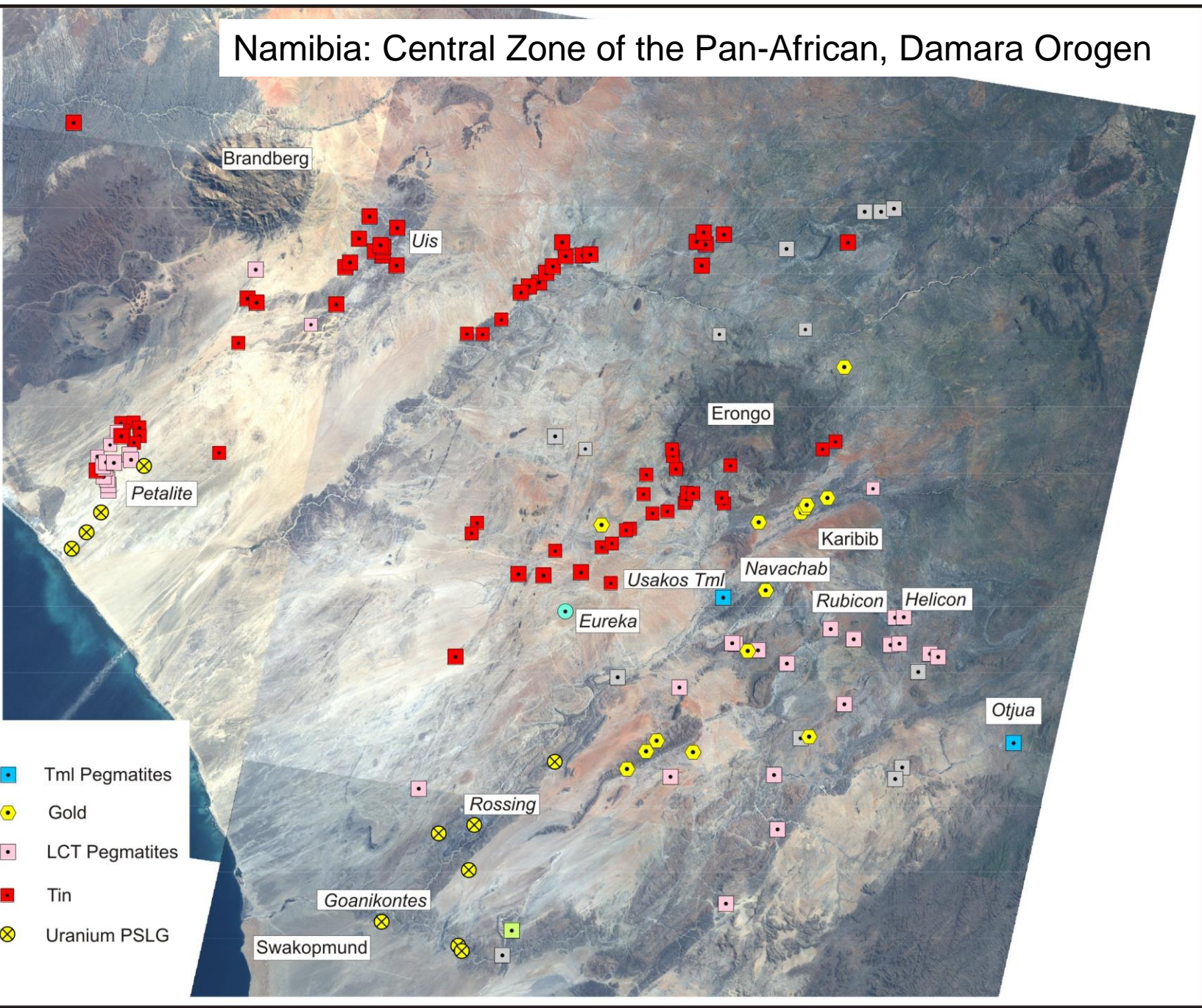
Mozambique & Madagascar – generally enriched in REE compared to those in Namibia

Suggests fundamental source control

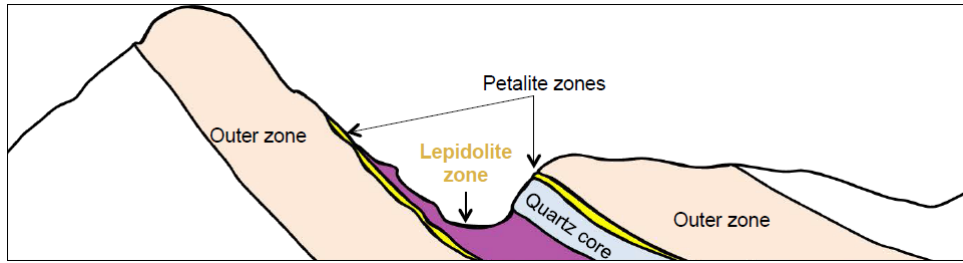




# Namibia: Central Zone of the Pan-African, Damara Orogen



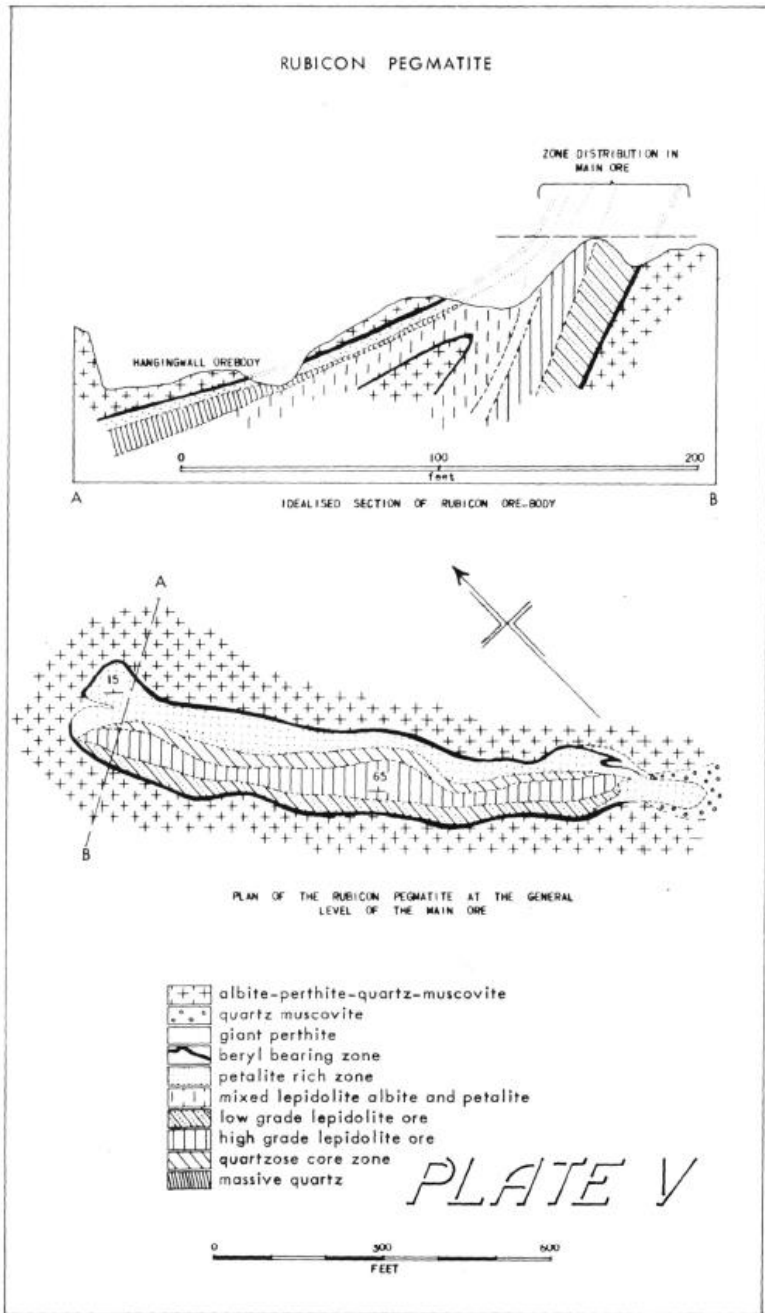
# Namibia: Rubicon (& Helicon)



Cross section and aerial view from Desert Lion Energy investor presentation

Petalite historically, currently abundant lepidolite (Li-mica with 1.39-3.6 % Li)

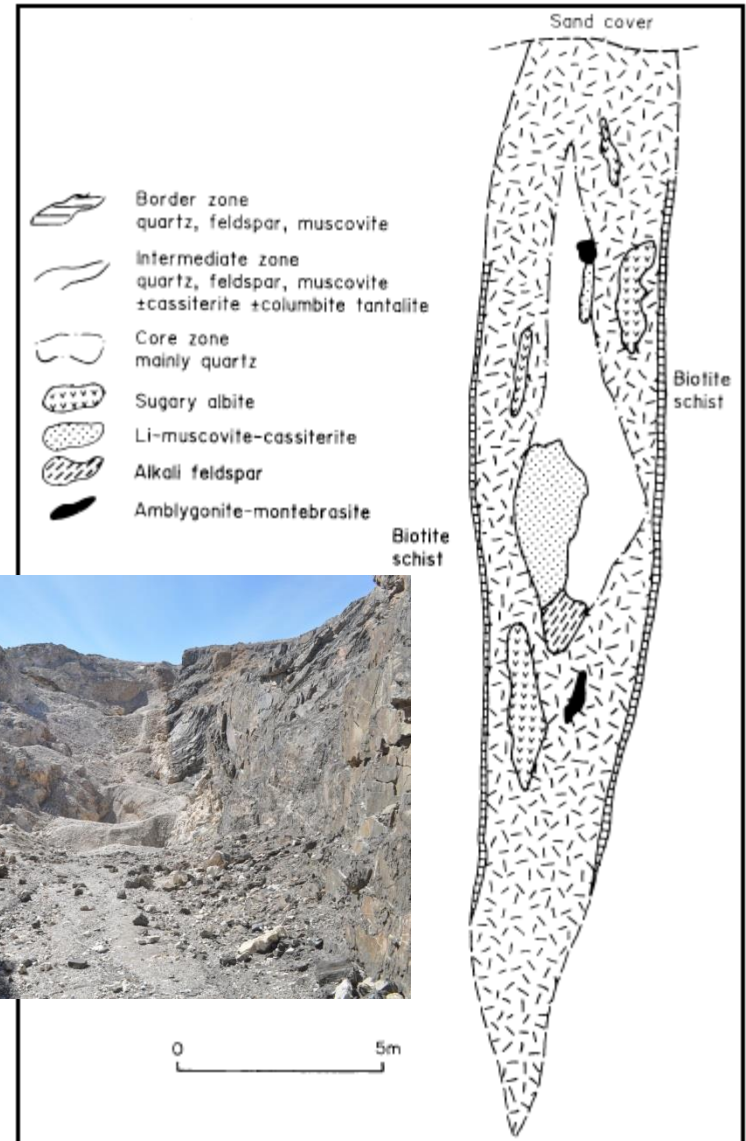
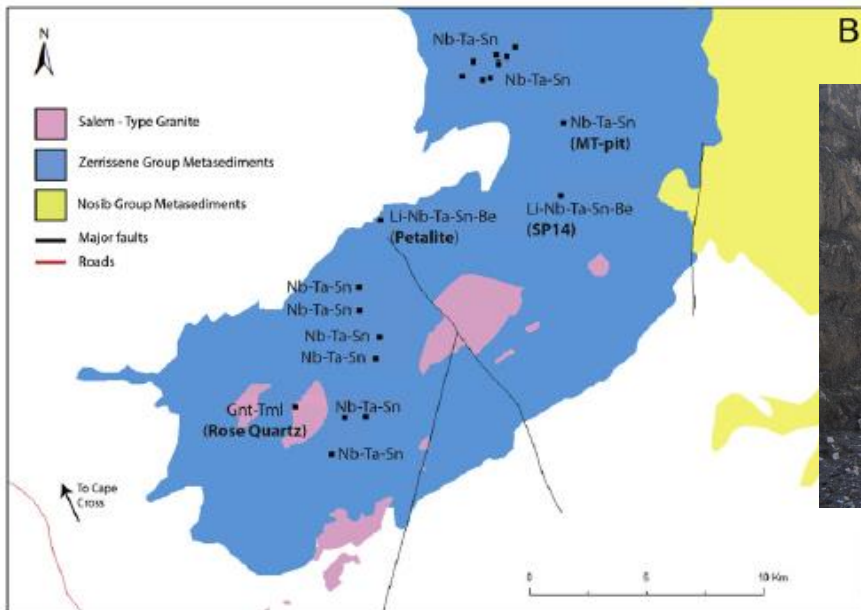
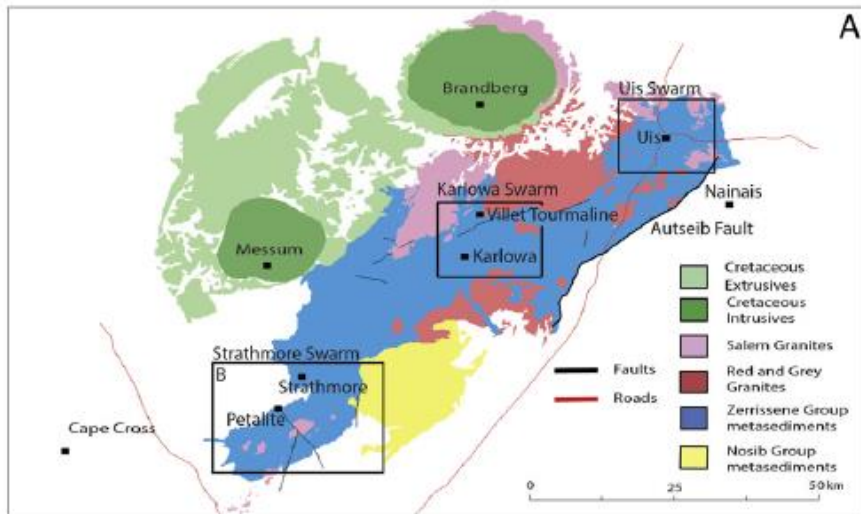




Rubicon pegmatite, Roering 1963 PhD Wits



# Namibia: Petalite/Molopo & SP 14



- **Abyssal class**
  - K feldspar
  - corundum
- **Rare earth class**
  - beryl-columbite
  - beryl-columbite-U
  - beryl-columbite-P
  - chrysoberyl
  - emerald
- **Rare earth NYF**
  - allanite-monazite
  - monazite - Sc
  - bastnaesite
- **Complex LCT**
  - lepidolite
  - amblygonite
  - elbaite
  - danburite

(Pezzotta, 1999)



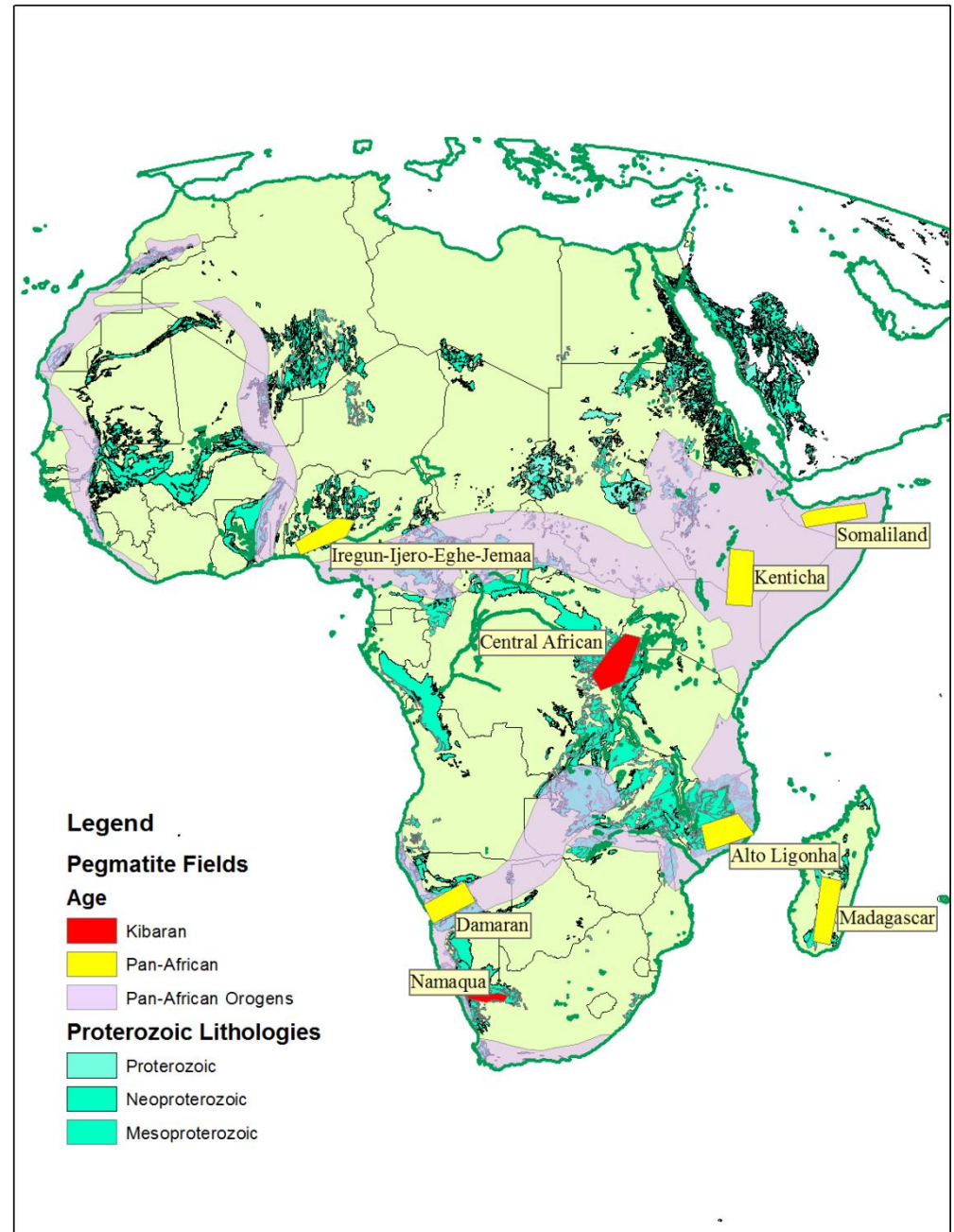
Kibaran pegmatites (~1000-900 Ma)  
(Mesoproterozoic-Neoproterozoic)

Namaqua pegmatites in the NW  
Cape (South Africa)

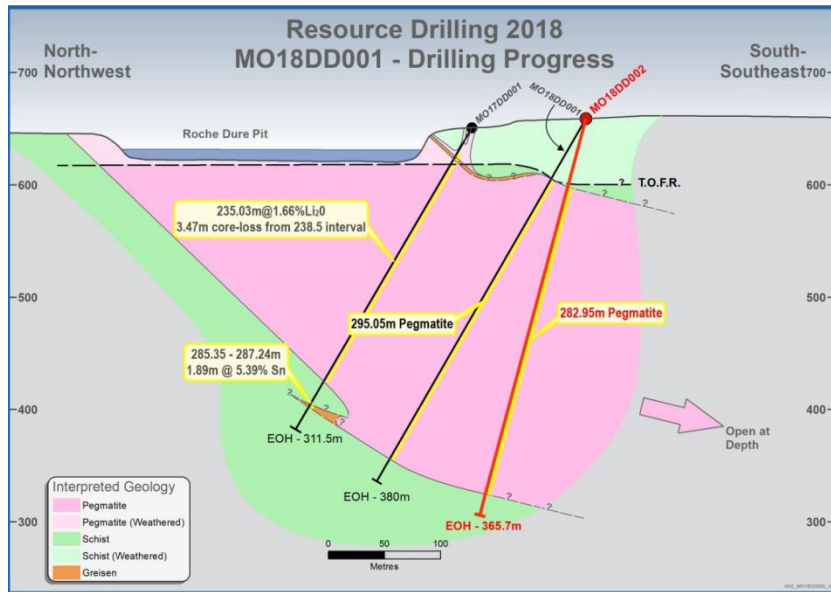
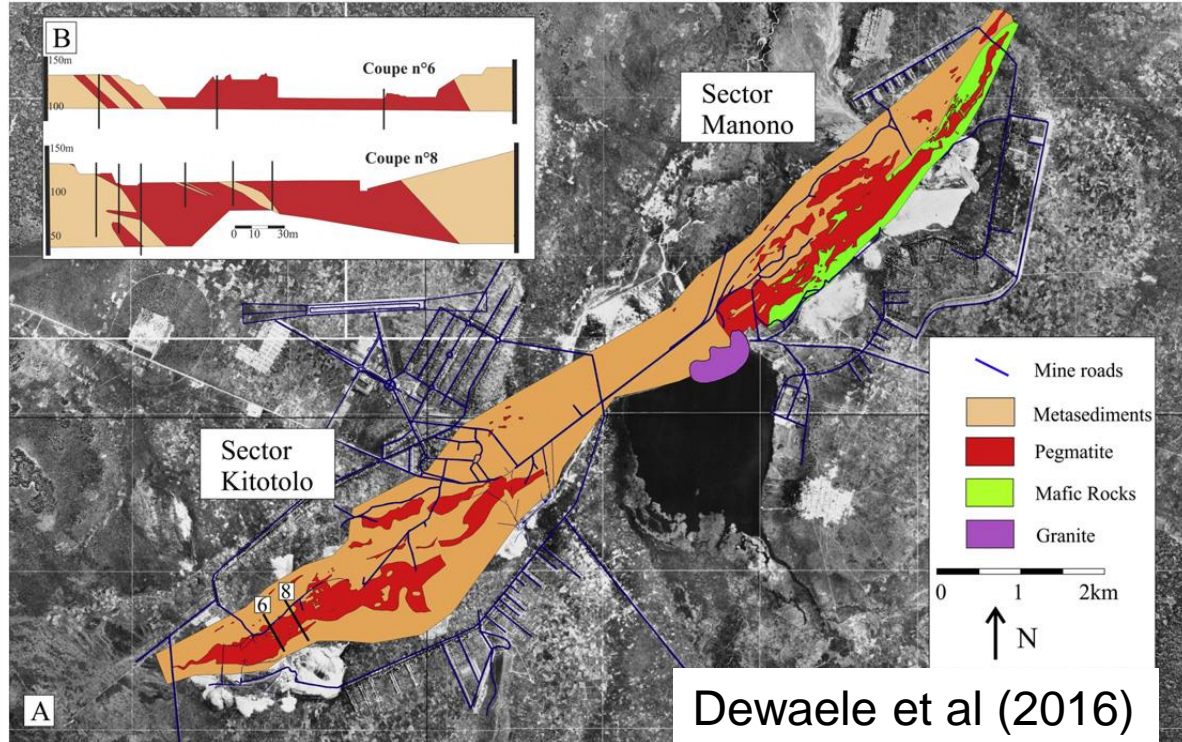
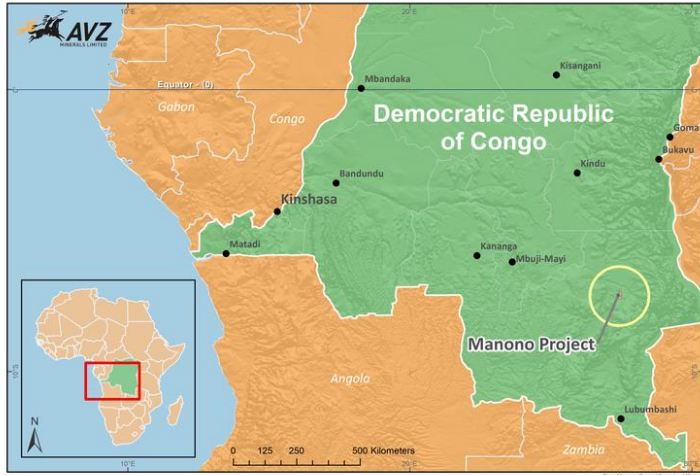
Central African pegmatites in  
DRC, Rwanda, Burundi and SW  
Uganda.

The Manono-Kitololo project(s)  
are probably the most exciting  
within this pegmatite field.

Mined for tin in the past and the  
lithium was essentially ignored.



# DRC: Manono-Kitololo



Multiple pegmatites, Sn, Nb-Ta, Li

15 km in length, 800 m wide

6<sup>th</sup> March ASX press release, AVZ Minerals intersects 282.95 m of spodumene-bearing pegmatite.

Exploration is ongoing,

# Namaqualand pegmatites

Mined historically,  
infrastructure challenges

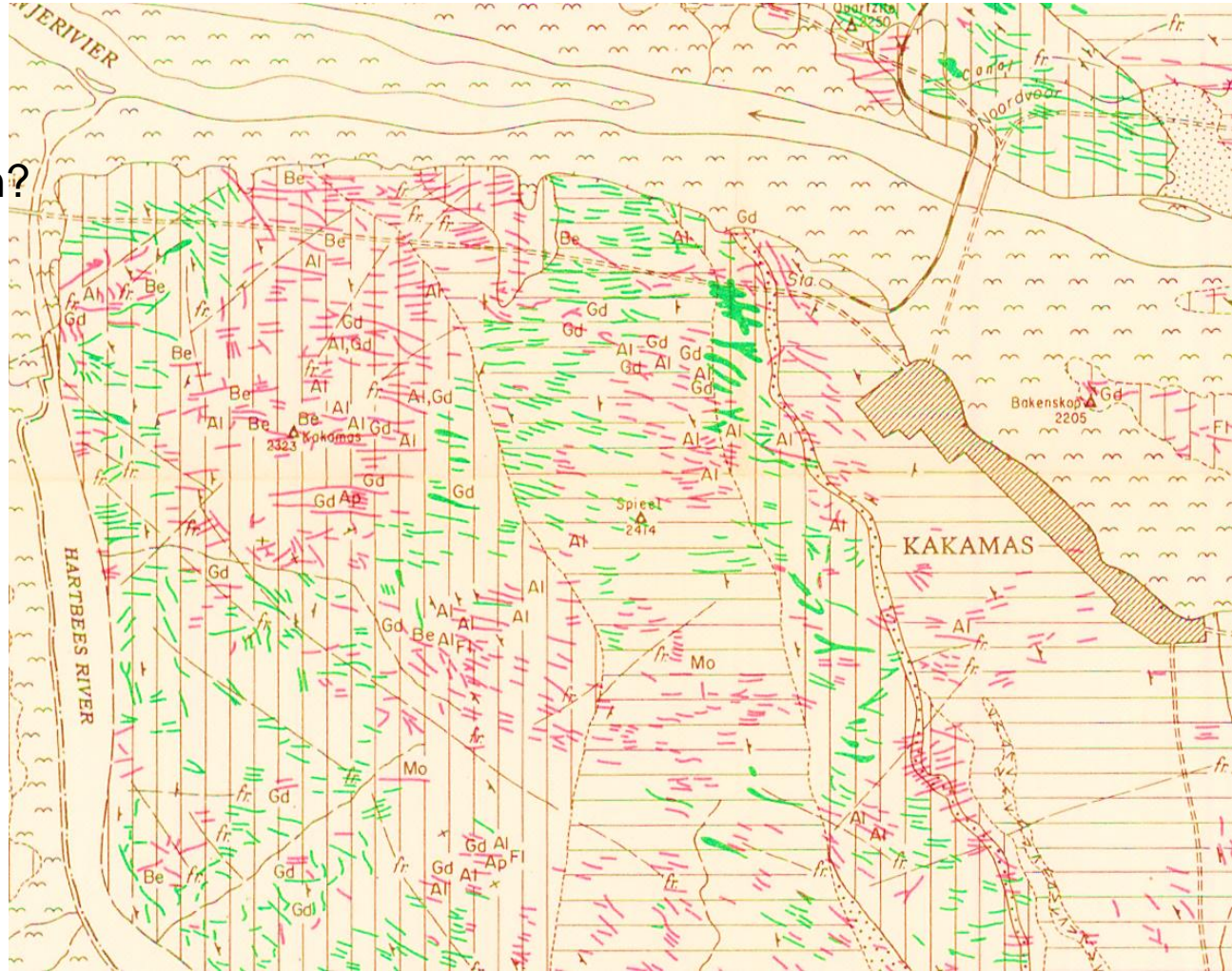
~950 Ma

resurgence of exploration?

Bleskop pegmatite

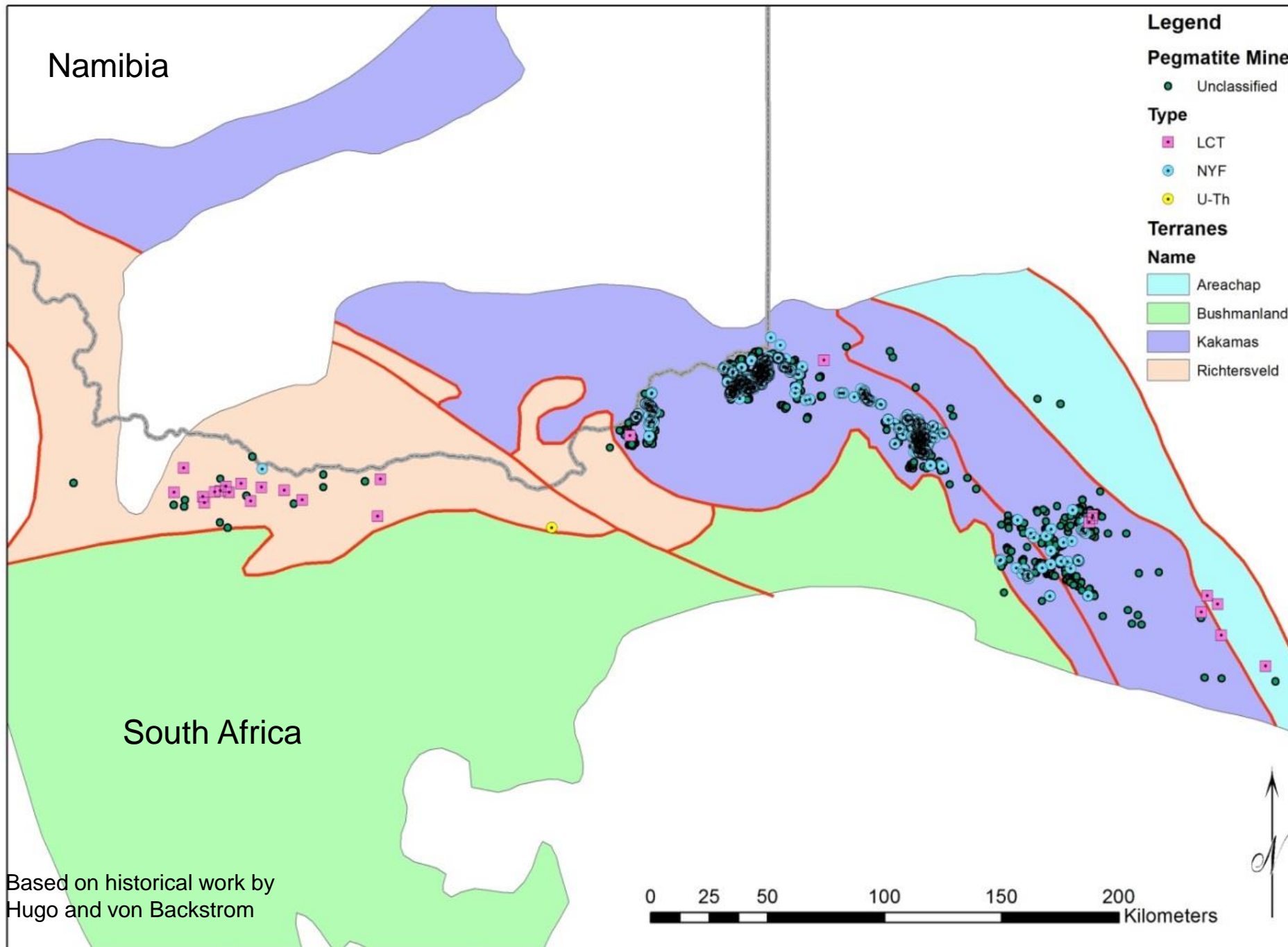
Spodumene Kop

Regionally intriguing  
zonation



• Hugo (1969)





Archaean ~ (4000-2500)  
 (Most Archaean pegmatites in Africa are poorly dated)

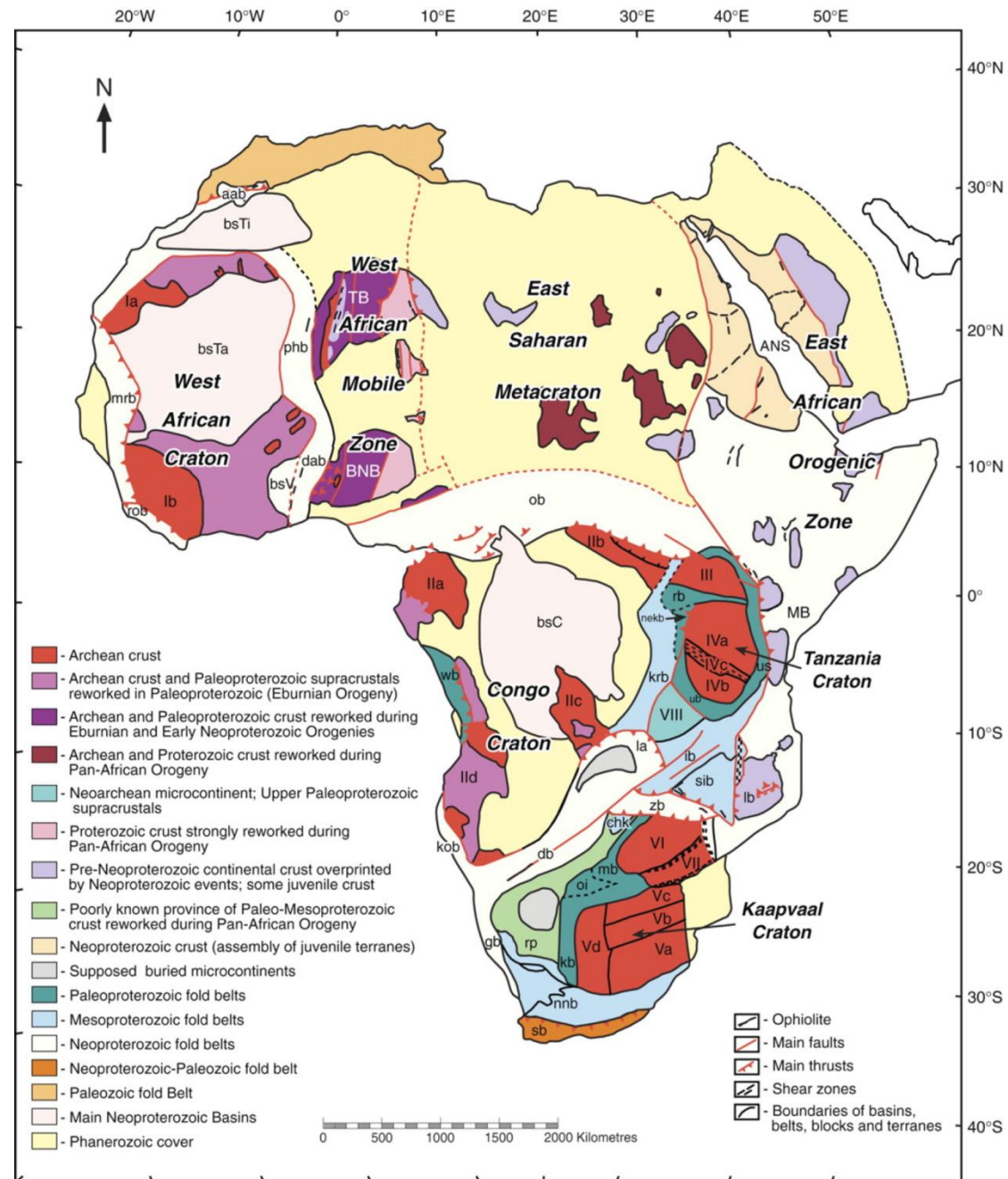
Why Archaean cratons:

The three most economically important LCT pegmatites are Archaean in age:

- Greenbushes (Australia)
- TANCO (Canada)
- Bikita (Zimbabwe)

We do not understand the fundamental reason for this!

Proterozoic and Phanerozoic pegmatites are orogen-related, its more difficult to understand Archaean orogenesis



(Begg et al 2009)

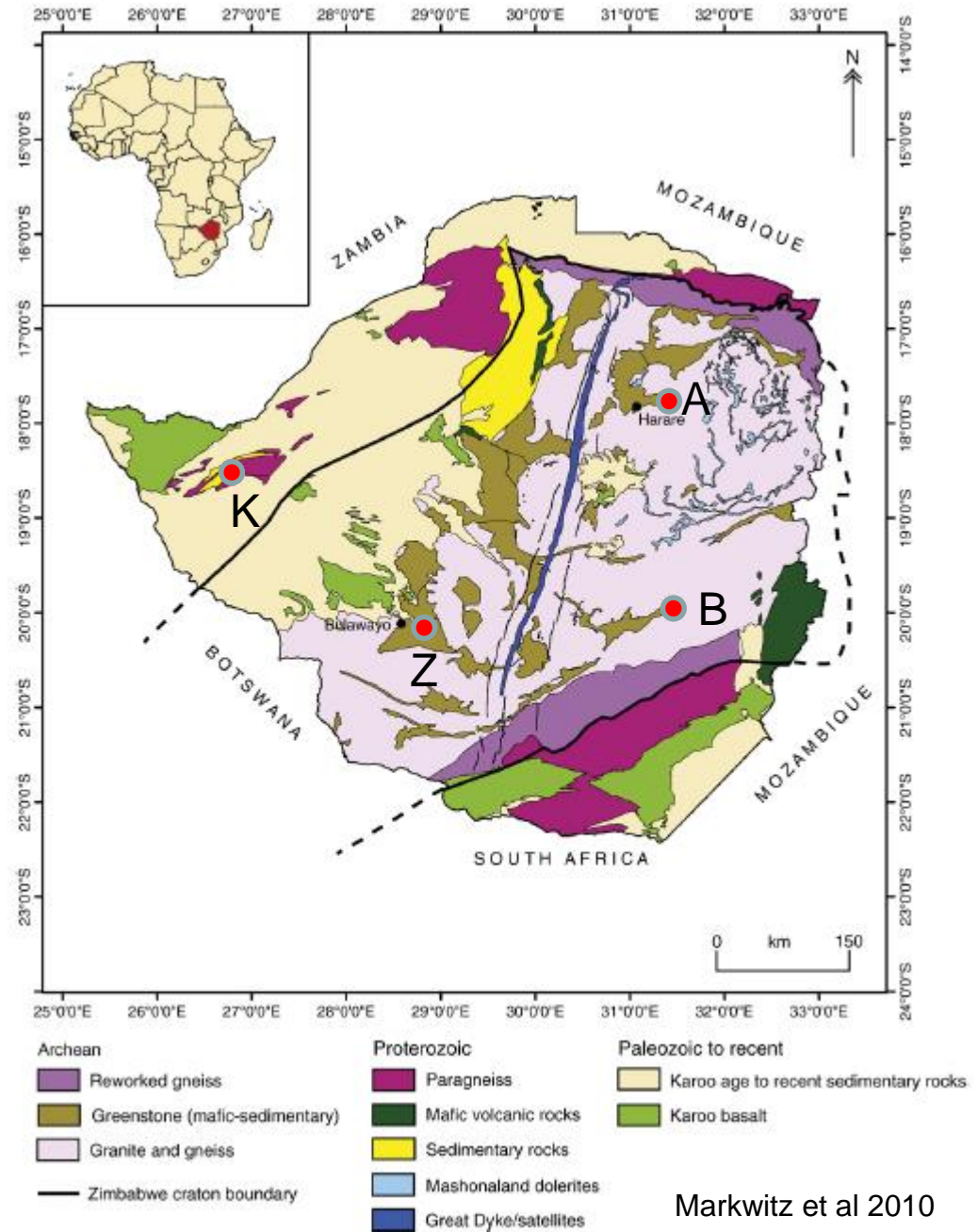
# Zimbabwe:

A lithium exploration boom?

Underexplored  
Changing political conditions  
Prospective for LCT pegmatites

“Zimbabwe has the potential to meet 20% of global lithium demand” (Eyewitness News Feb, 2018)

- A – Arcadia Project
- B – Bikita Minerals (Active Mine)
- K – Kamativi Project
- Z – Zulu Project



# Bikita

Historically the largest Li producer in Africa and frequently ranked 3<sup>rd</sup> in the world after Greenbushes and Tanco.

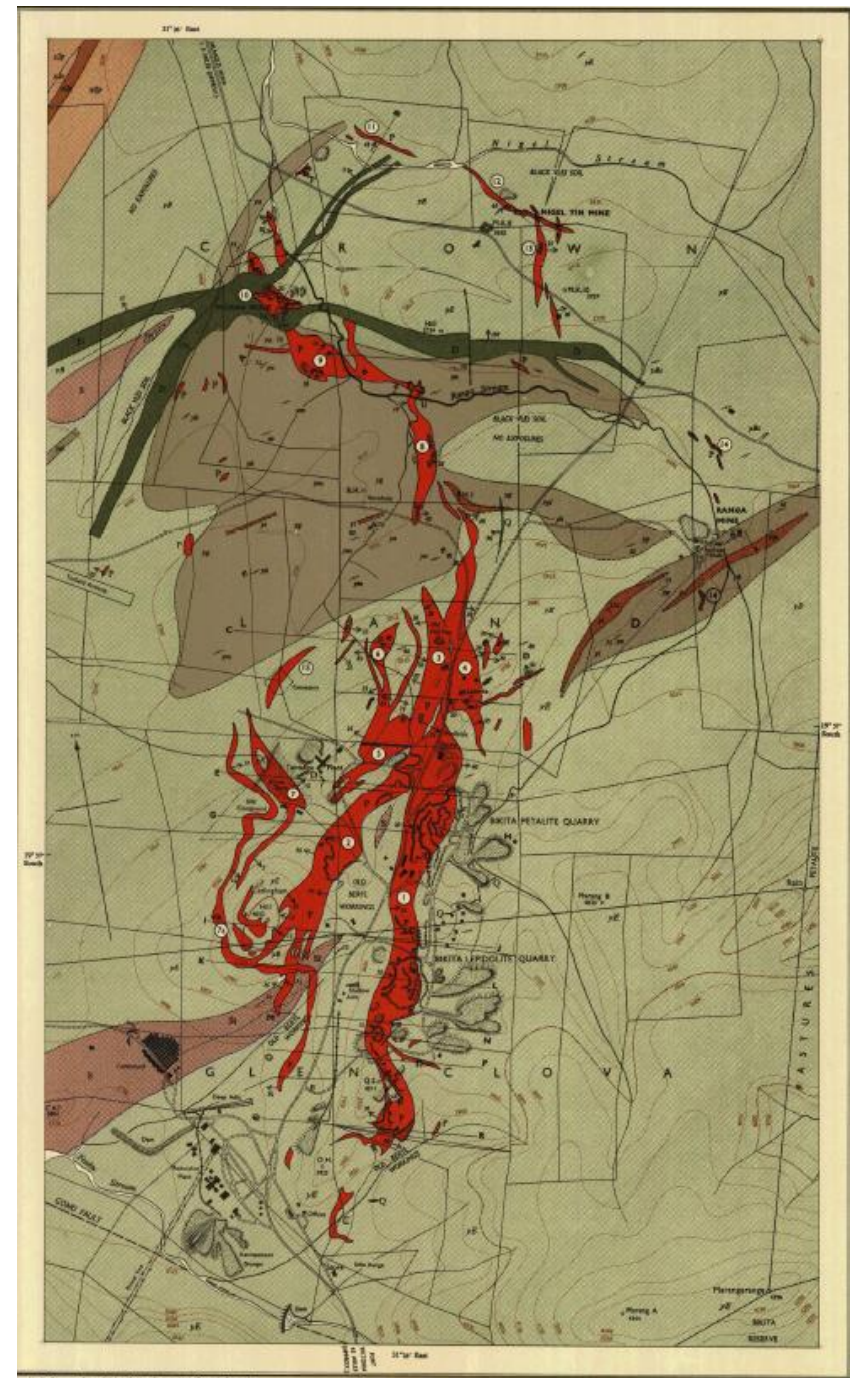
Mined for 70 years, initially for tin, also has tantalum, beryllium and caesium (from pollucite) credits.

Several individual pegmatites, quite structurally complex, spodumene and petalite both present – detailed distribution unknown.

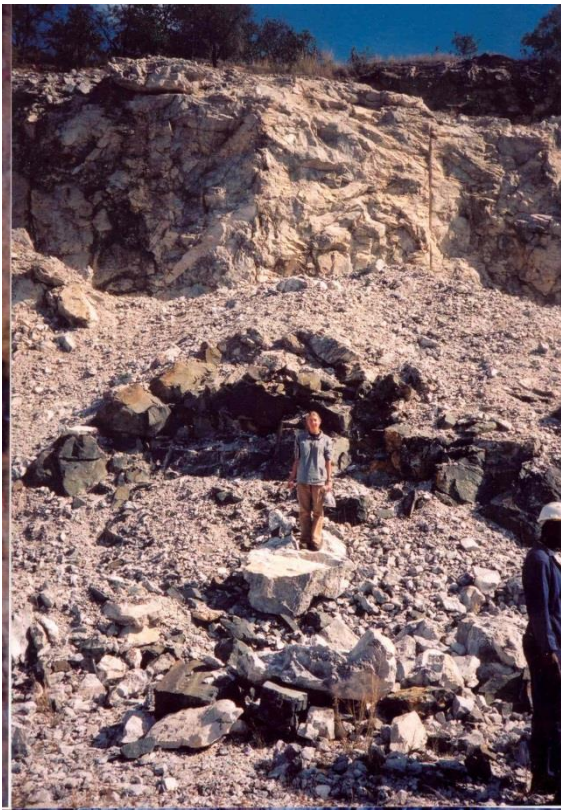
Two open cast pits (Bikita & Al Hayat)

Main pegmatite is complexly zoned, ~1.5 km in length & 50 m wide

Resources / Reserves are currently historical and any up-dates are not in the public domain – Bikita Minerals is a private company.



Wilson & Martin (1964)



# Arcadia Project

38 km east of Harare  
historical open pit (1966-1972)  
pegmatites emplaced into metabasalts  
~flat lying ( $045^{\circ}/10^{\circ}$  NW)  
both petalite and spodumene present  
poorly zoned, tantalite credits



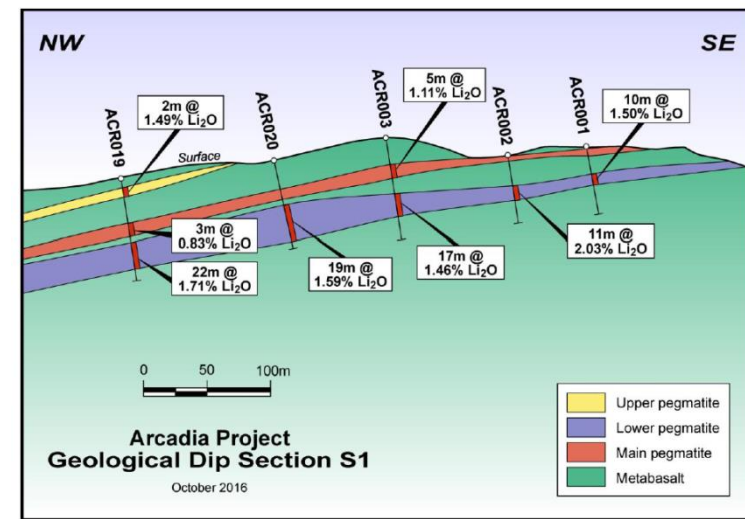
Thanks to Roger Tyler (Chief Geologist, Prospect Resources) for the pictures

up to 14 stacked pegmatite sheets, 4 used in the resource statement (Upper, Main, Lower Main, Middle)

Maiden Mineral Resource (March 2017): 36.4 Mt @ 1.42% Li<sub>2</sub>O, 127 ppm Ta<sub>2</sub>O<sub>5</sub>

Ore Reserve Estimate (June 2017) 15.8 Mt @ 1.34% Li<sub>2</sub>O, 125 ppm Ta<sub>2</sub>O<sub>5</sub>

“Africa's Largest JORC compliant Li resource”

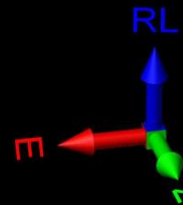


>1% Li<sub>2</sub>O Mineral Resource Estimate Looking South

Arcadia Pit Outline

Mashonganyik Fault Zone

Dolorite Dykes



July 2016 Drilling commences

October 2016 Maiden JORC resource

December 2016 Scoping Study Complete

June 2017 PFS complete

2018 Production?

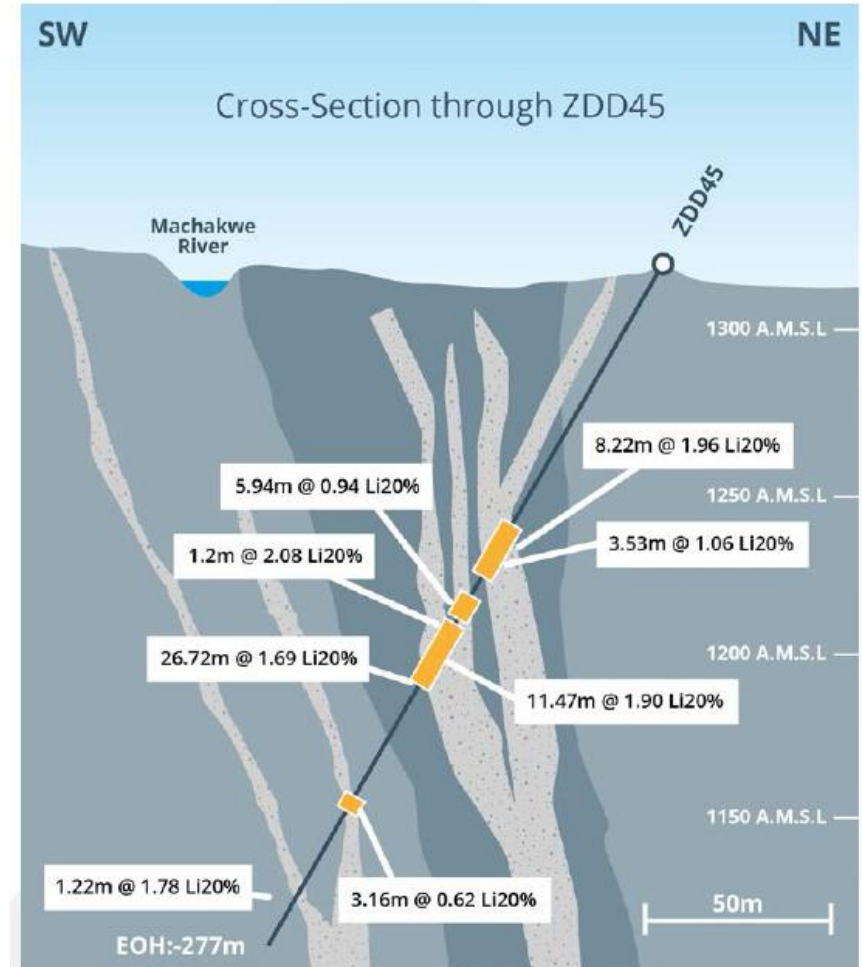
# Zulu Project: Premier African Minerals

Multiple, anastomosing sub-vertical pegmatites

Spodumene and petalite present

Drilling 2016-1017 followed by a maiden SAMREC compliant resource: 20.1 Mt @ 1.06%  $\text{Li}_2\text{O}_5$ , 51 ppm  $\text{Ta}_2\text{O}_5$

November 2017 Scoping Study completed



Cross-section from Premier African Minerals presentation



# Exploration implications

- You do NOT necessarily need a parental granite (but regionally the presence of granites indicate the required metamorphic conditions for anatexis)
- Find an orogenic belt, the older the better. – why is the Archaean so well-endowed?
- If you can spit across it, its not worth looking at (Kevin Burke, about Be in pegmatites ~ 1970's) but if you find a stacked pegmatite system then it may be very interesting.
- How many grains of a particular mineral do you need in a pegmatite to be able to refer to it by that mineral name eg it's a spodumene pegmatite, or an allanite-fluorite pegmatite?
- How much lithium do you need before you can call it a “lithium pegmatite”?

Thank you

