OVERVIEW OF TANTALUM - NIOBIUM MINERALISATION IN ZIMBABWE

Brent Barber - Oct 2016

INTRODUCTION: Ta & NB

- Transition metals that do not occur free nature
- Often found and extracted same minerals: columbo-tantalite (coltan)
- Ta & Nb not openly traded

TANTALUM ZIMBABWE

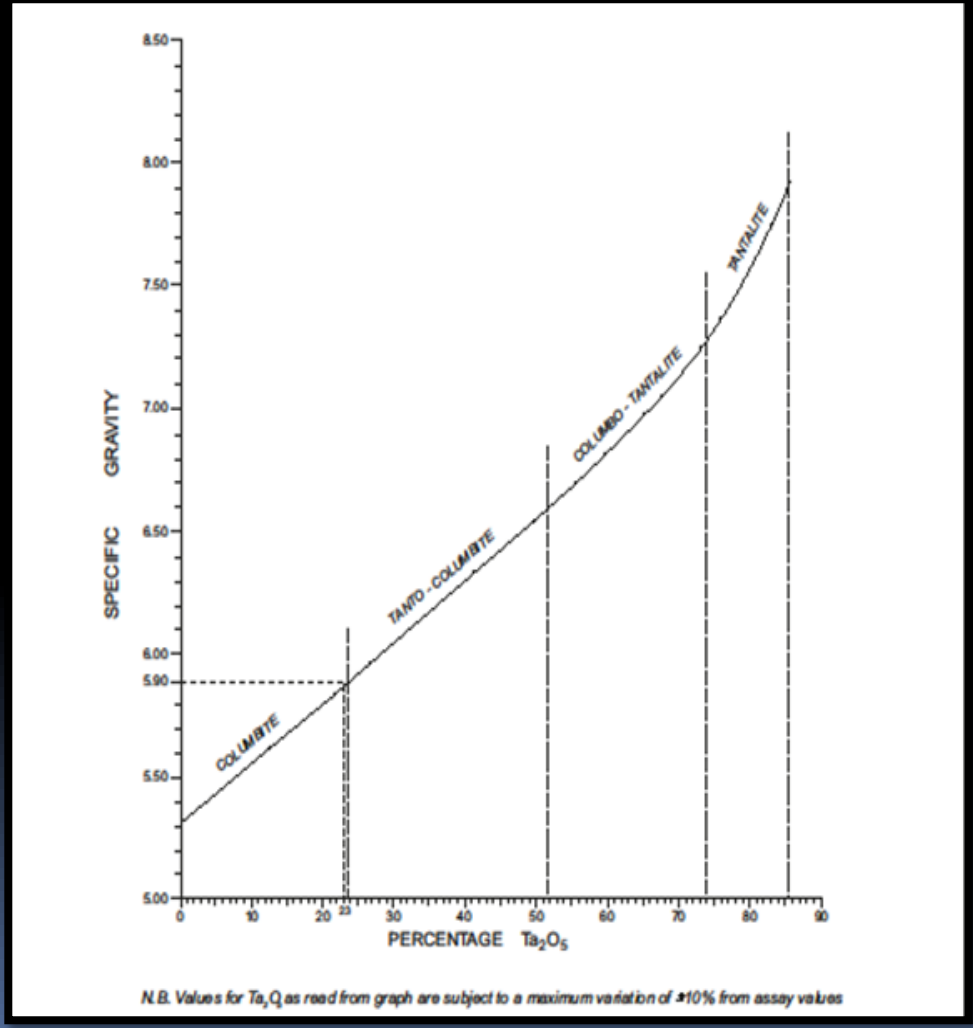
- Three minerals of tantalum (and niobium) exploited in Zimbabwe:
  - Columbo-Tantalite (Coltan)
  - Microlite
  - Simpsonite

- No pyrochlore mined Niobium

COLTAN (Tantalite) - 1

- Columbite (Nb) & Tantalite (Ta) end members isomorphous solid solution series
- Fe- and Mn-rich: Ferrotantalite and Manganotantalite
- Tantalite ≤86% Ta_2O_5 and Columbite ≤78% Nb_2O_5
- Orthorhombic stunted tabular or slender striated, radiating crystals
- Opaque, black to grey to brown, sub-metallic to -resinous lustre and dark red to black streak
- SG 5.3 columbite to 7.8 tantalite.

COLTAN: Relationship Tantalite Content And Specific Gravity



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COLTAN (Tantalite) - 2

- Mineral zoning: Coltan and microlite furthest and cassiterite closest parent intrusive.
- Trade purposes tantalite ≥12% Ta_2O_5
- Payment made percentage Ta_2O_5 - nothing Nb_2O_5.
- Presence of the radioactive minerals deleterious.

ASSOCIATED ECONOMIC MINERALS LCT PEGMATITES

- Beryl - beryllium
- Caesium - pollucite
- Lithium - lepidolite, petalite, spodumene
- Tin - cassiterite
- Gemstones - beryl (aquamarine, emerald and helidor), spondumene (hiddenites and kunzite) and tourmaline
- IRMs - feldspars, muscovite, quartz

TANTALUM SOURCE ROCKS

- **LiCeTa Pegmatites: Ta > Nb**
- **LiCeTa Leuco-granites,** typically **peraluminous S - type,** emplaced compressional tectonic settings.

NIOBIUM SOURCE ROCKS

- **Carbonatites** enriched Nb.
- **NbYF Pegmatites: Nb > Ta**
- Sub- to meta-aluminous A- and I-type Granites emplaced depleted crust / mantle settings often associated oceanic rifting.
- Alkaline to peralkaline **Granites and Syenites:** Nb > Ta hydrothermal or magmatic processes.

RARE METAL PEGMATITES

- Despite economic importance general level understanding pegmatite mineralisation mining sector relatively low.
- Position compounded complex variations mineral composition and distribution.

CLASSIFICATON PEGMATITES

- Commonly - Cerny (1991) then as modifed Cerny & Ercit (2005).
- Rare Element - low temp / pressure pegmatites initially divided:

  - **LCT** (lithium / caesium / tantalum with B, Be, F, P, Rb and Sn)

  - **NYF** (niobium / yttrium / fluorine with Be, REE, Sc, Th, Ti, U and Zr)

  - **Mixed LCT / NYF**

LCT PEGMATITES - 1

- Commonly intrude meta-sedimentary rocks at low pressure, upper greenschist to amphibolite facies: temperatures of 350 – 550°C and relatively low pressures in the range of ±3kb.

LCT PEGMATITES - 2

- Geochemistry K-feldspar and muscovite, together extent albitisation, metamorphic grade and age, diagnostic identification Ta / Nb enrichment potential pegmatites.

PEGMATITES IN ZIMBABWE

- Little known mineralogy, geochemistry, magmatic sources and structural controls governing pegmatite distribution

- Absence pegmatites sub-divided tectonic setting, Archaean Shield (±2.65 Ga) / Palaeo-proterozoic (2.0 - 1.8 Ga), and geographic location

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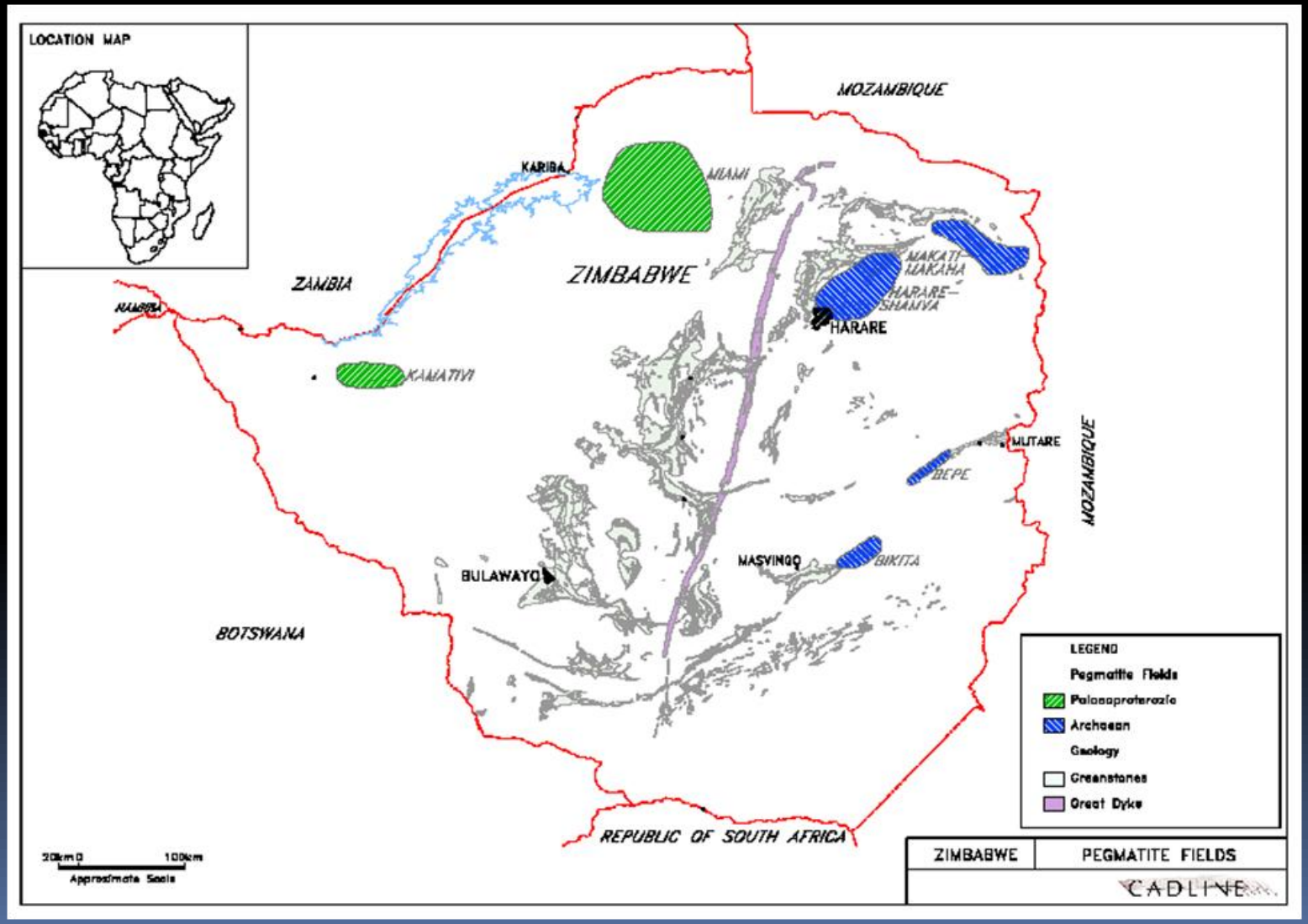
Pegmatite Fields Zimbabwe

Six pegmatite fields delineated:

- Kamativi and Miami emplaced Palaeoproterozoic terrain
- Bepe Hills, Bikita, Harare-Shamva and Makati-Makaha emplaced Archaean terrain

Note: Martin (1963) noted Ta:Nb ratio generally constant - variations attributable episodes intrusion and/or mineralisation

KAMATIVI PEGMATITE FIELD



KAMATIVI PEGMATITE FIELD - 1

- Pegmatites predominantly emplaced Palaeoproterozic age garnetiferous mica schists during late phase Kibaran Orogeny.

- Not truly zoned but three distinct mineralogical phases:

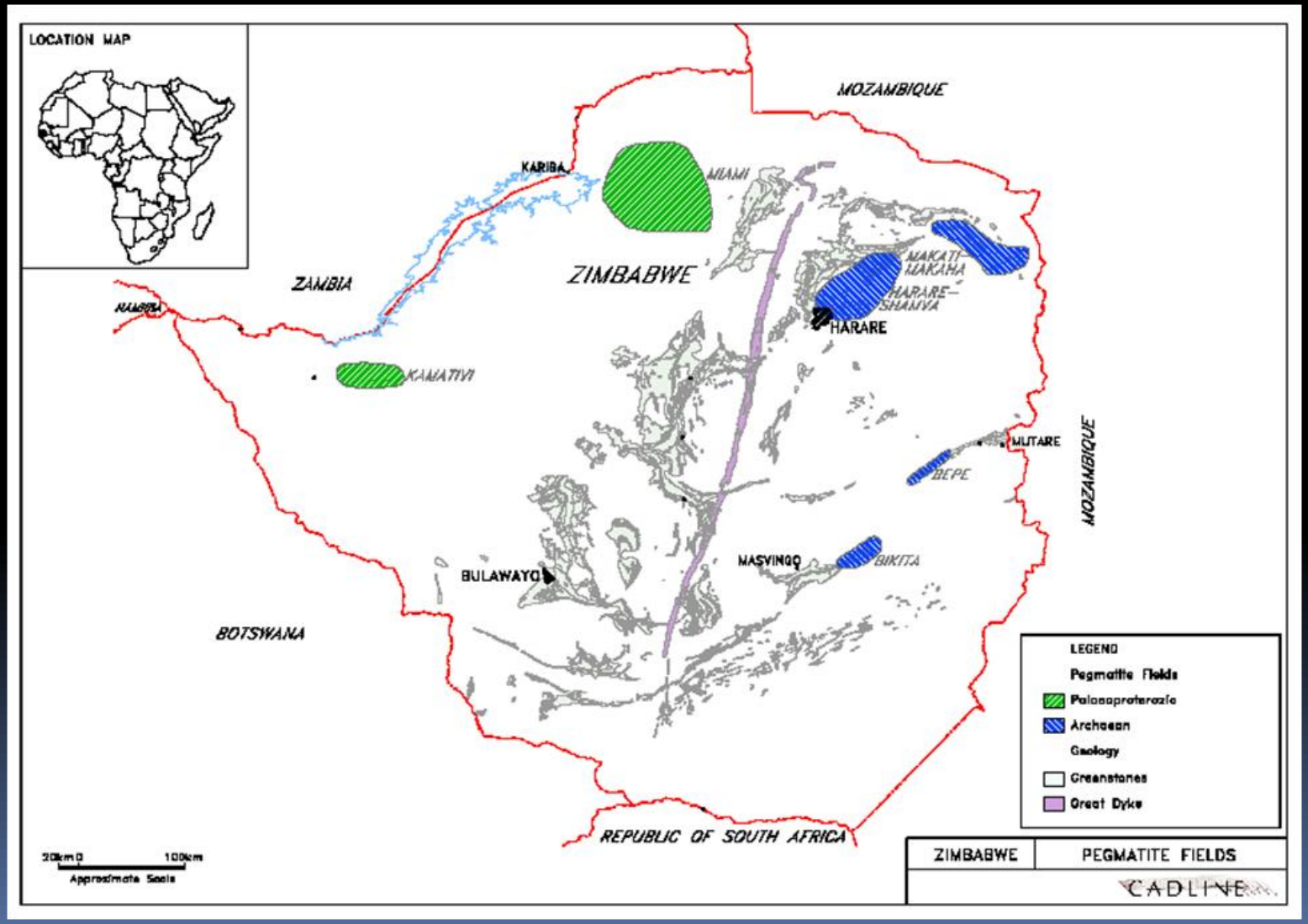
  - **Potash feldspar**
  - **Albite-rich**
  - **Muscovite-quartz**

KAMATIVI PEGMATITE FIELD - 2

- Pegmatites divided four groups:
  - Cassiterite bearing
  - Mineralised Tourmaline Bearing Quartz
  - Non-mineralised Tourmaline Bearing
  - Quartz

- Cassiterite bearing pegmatites predom:
  - Steep dipping widths ≤8m / strikes ≤3,000m
  - Flat lying widths ≤30m / strikes >2,000m.

MIAMI PEGMATITE FIELD



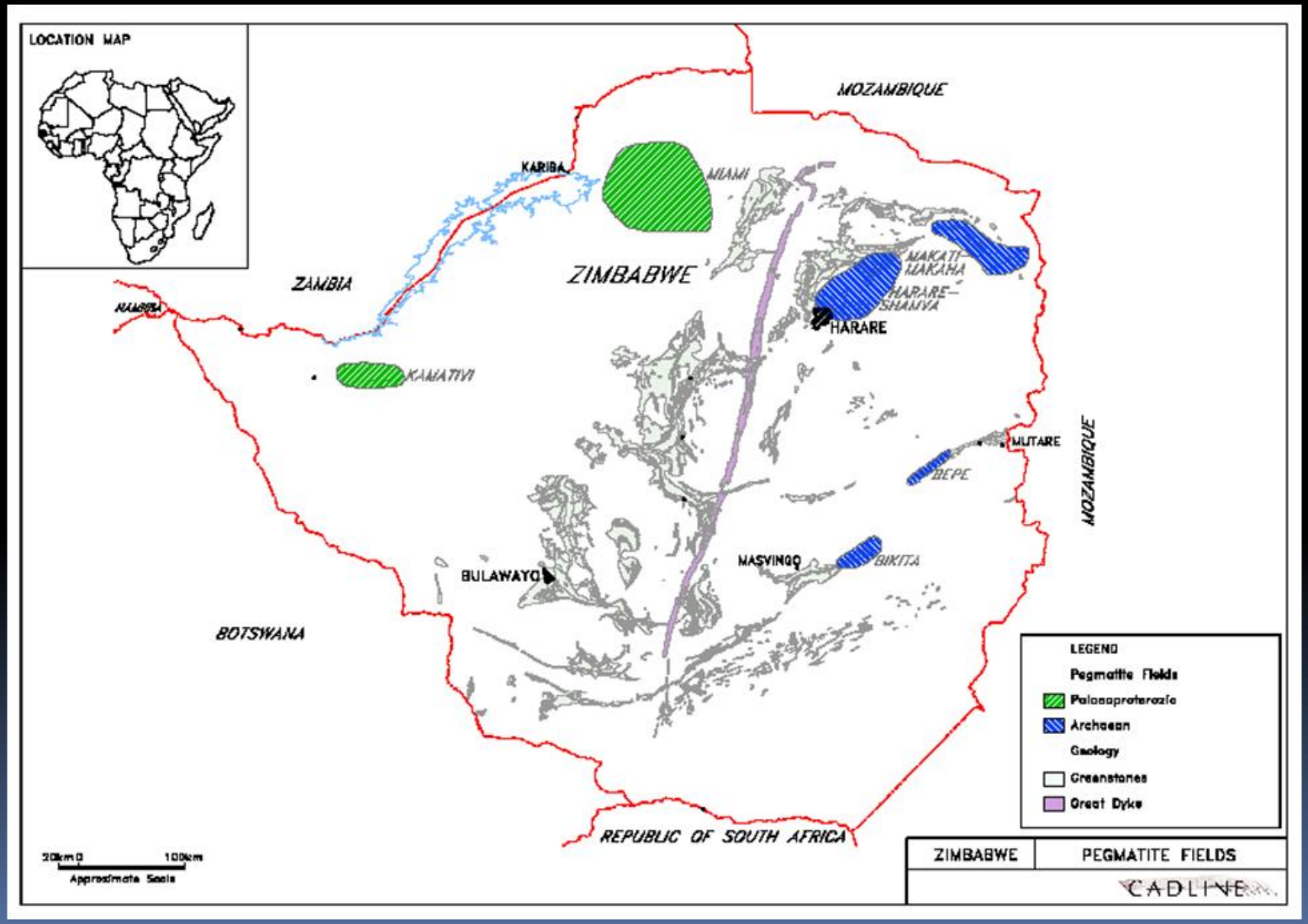
MIAMI PEGMATITE FIELD - 1

- Pegmatites predominantly emplaced garnetiferous mica schists and metapelitic gneisses Magondi Mobile Belt.
- Divided 3 groups:
  - Uneconomic barren
  - Economic mica bearing
  - Economic beryl bearing
- Complex origins postulated - assimilated countryrock indicative igneous or metamorphic metasomatism

MIAMI PEGMATITE FIELD - 2

- Restriction Economic Mica Pegmatites amphibolitic facies, as opposed widespread distribution Economic Beryl Pegmatites, suggested indicative metamorphic control
- Significant quantities beryl and mica produced
- Additionally many pegmatites, vicinity Magugisi Beacon, exploited Nb-rich coltan
- Coltan present radioactive
- Small quantities amblygonite, cassiterite and magnetite also produced

BEPE HILLS PEGMATITE FIELD

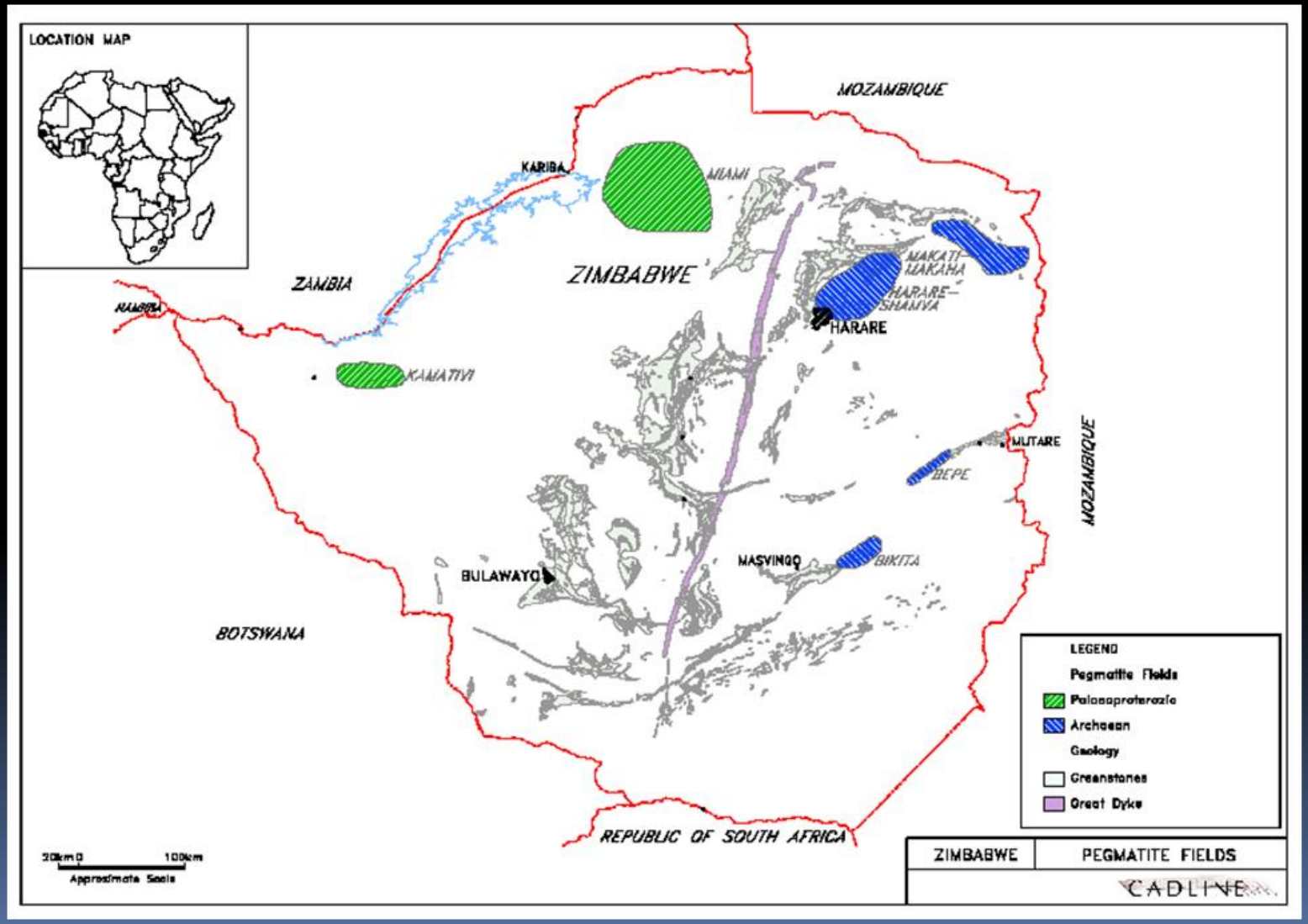


BEPE HILLS PEGMATITE FIELD

- The Bepe Hills, ±70km WSW Mutare, contains numerous, commonly tabular, irregular shaped pegmatites emplaced in Archaean aged strata Mutare Greenstone Belt.

- Beryl, cassiterite, coltan, microlite and lithium minerals mined

BIKITA PEGMATITE FIELD



BIKITA PEGMATITE FIELD

- Pegmatites, exhibiting degrees zoning, emplaced sub-parallel arrays rocks Masvingo Greenstone Belt, ±2650 Ma
- Dasent (1981) subdivided pegmatites:

  - Soda-rich (Na-K): Commonly good hanging-, poorly defined and non-persistent intermediate hanging- (± coltan), intermediate foot- (beryl and ±coltan) and foot-walls

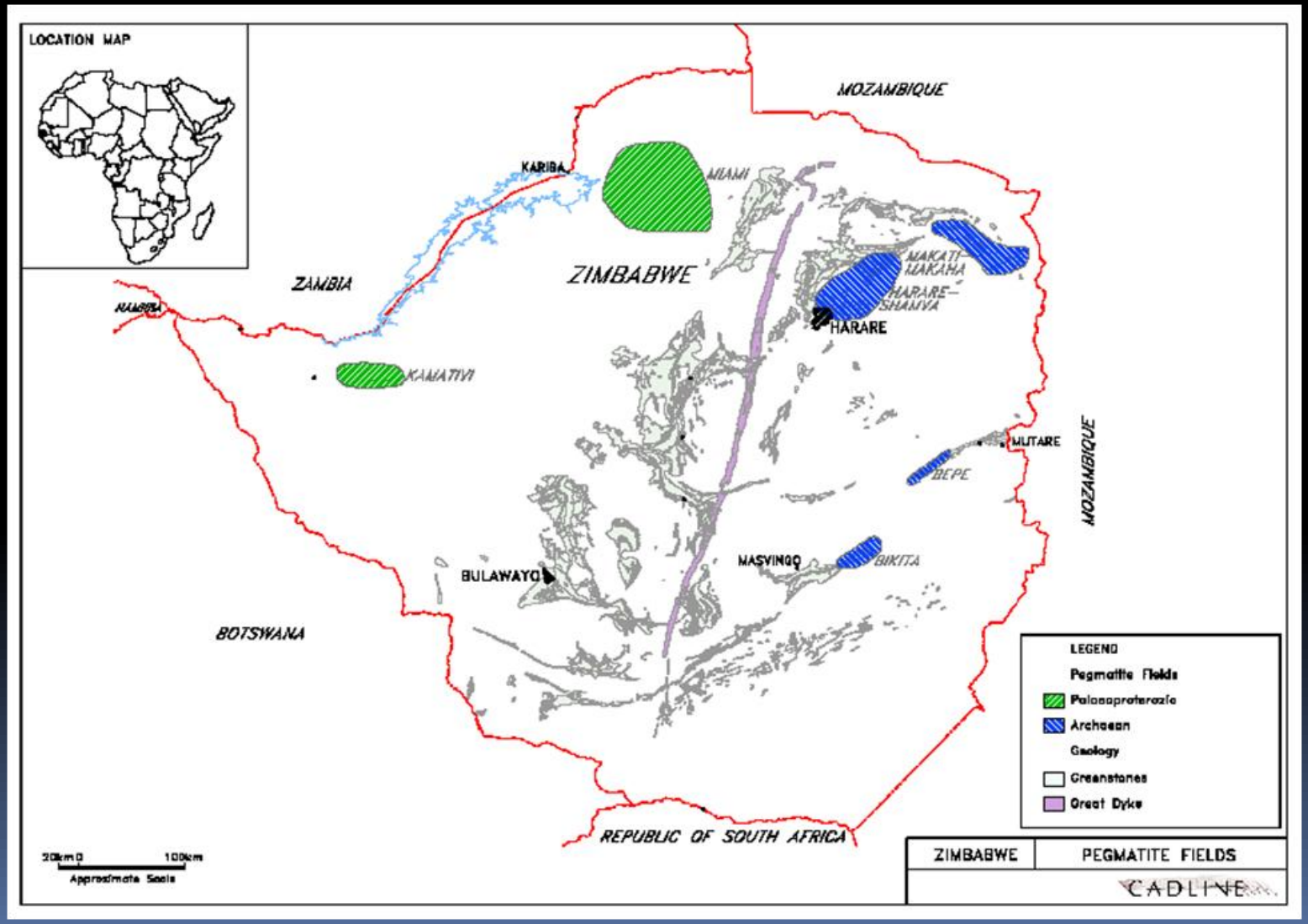
  - Potash-rich (K-Na): Commonly narrow with central bodies quartz. Significant beryl and sometimes coltan margins quartz cores. Both foot- and hanging-walls often narrow

BIKITA PEGMATITE FIELD

At Bikita several large pegmatites mined Li and Be minerals with cassiterite, coltan and microlite recovered by-products. Largest , the Main, ±1650m long by 38m - 53m wide

- Martin (1963) recorded coltan Bikita Pegmatite Field contains between 40 – 75% Ta_2O_5.

HARARE-SHAMVA PEGMATITE FIELD

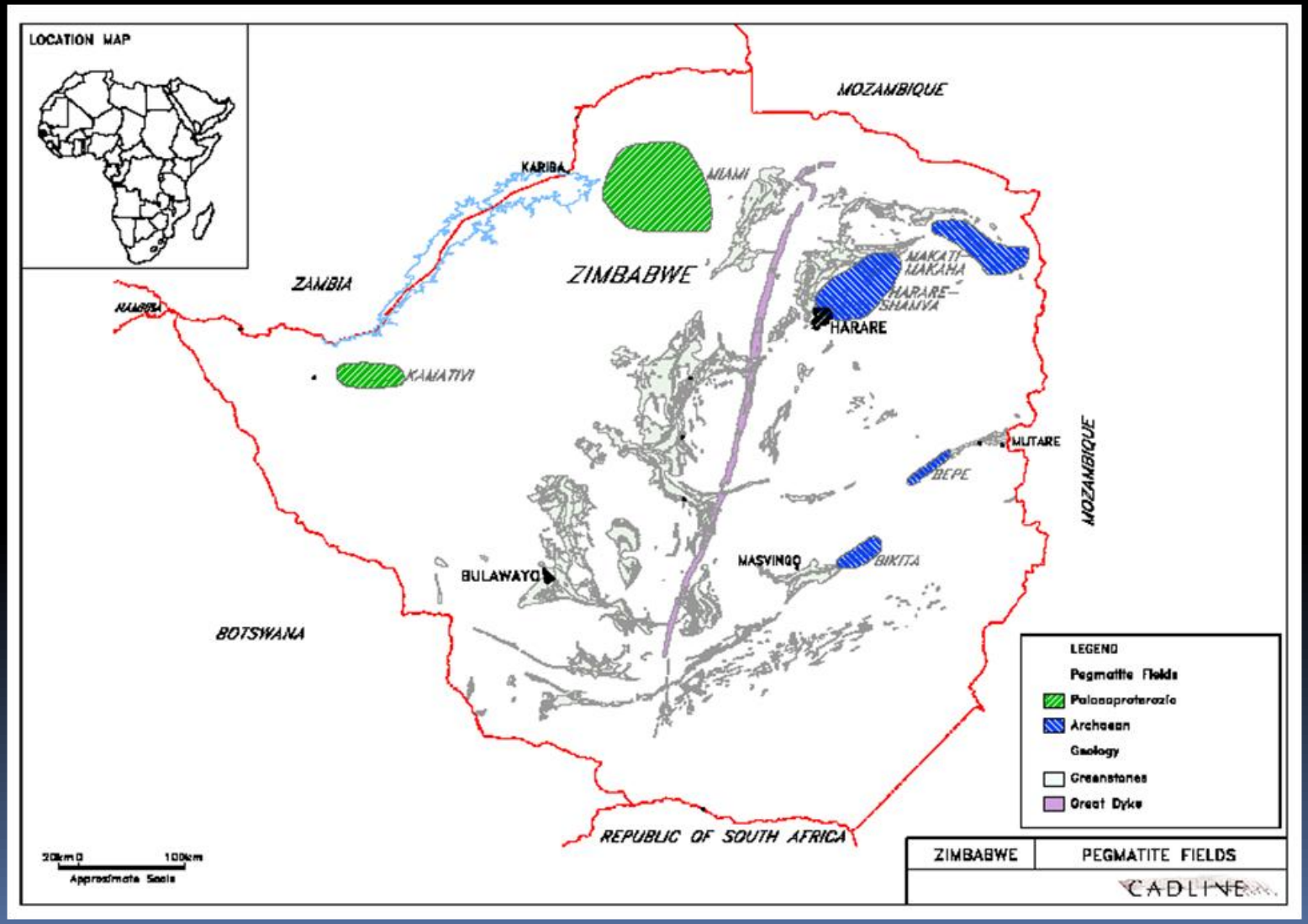


HARARE-SHAMVA PEGMATITE FIELD

- The late-Archaean age pegmatites intruded rocks meta-basaltic, gabbroic and gneissic composition in proximity Chinamora and Muhrehwa Batholiths.

- Mines historically small but, notably, have produced microlite.

MAKATI-MAKAHA PEGMATITE FIELD



MAKATI-MAKAHA PEGMATITE FIELD

- Commonly zoned pegmatites emplaced Makati-Makaha Greenstone Belt
- Martin (1963) noted pegmatites <60m length and <6m width
- Barton et al. (1991) used presence / absence outer zones, characterised graphic intergrowth quartz and perthite, sub-divide pegmatites
- Coltan, manganotantalite and microlite, present both, predominantly footwalls quartz cores.
- Non-graphic subdivision, which includes many Benson Mine pegmatites, also contains amblygonite, beryl, lepidolite and spodumene,

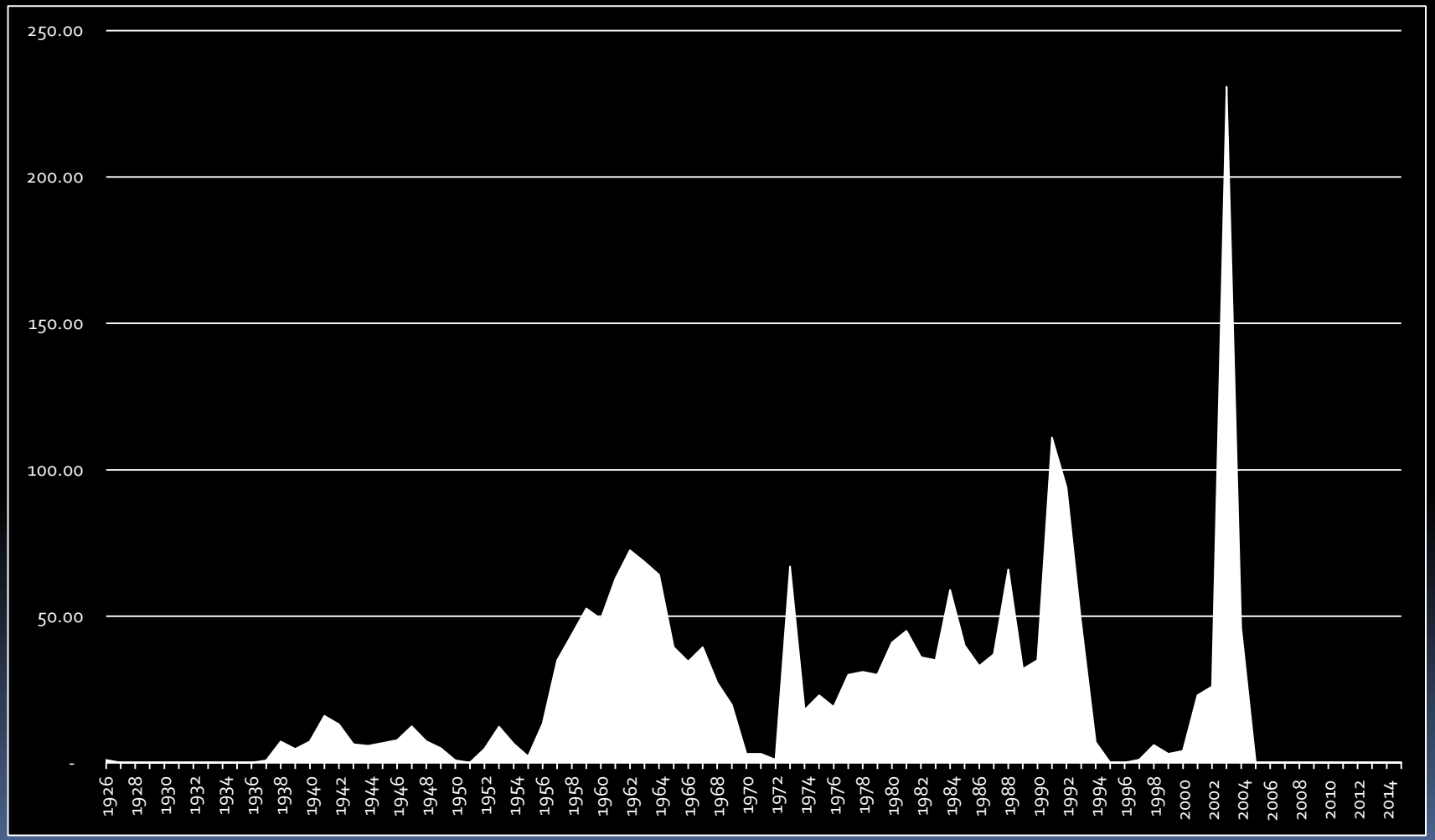
SUMMARY: Ta–Nb ZIMBABWE

- Coltan first discovered Zimbabwe on Ebonite claims near Bikita in 1911
- First production Ebonite-A Claim in 1926 - 0.91t coltan concentrate
- Mining elsewhere Bikita area commenced and continued throughout World War II
- Coltan and microlite mined, often by-product beryl and cassiterite, majority deposits produced <1t tantalum conc
- Highlighted recovery coltan, by-product Kamativi tin slag 1959 -1994 dominated production: 1979 - 81% of 29t Ta conc.

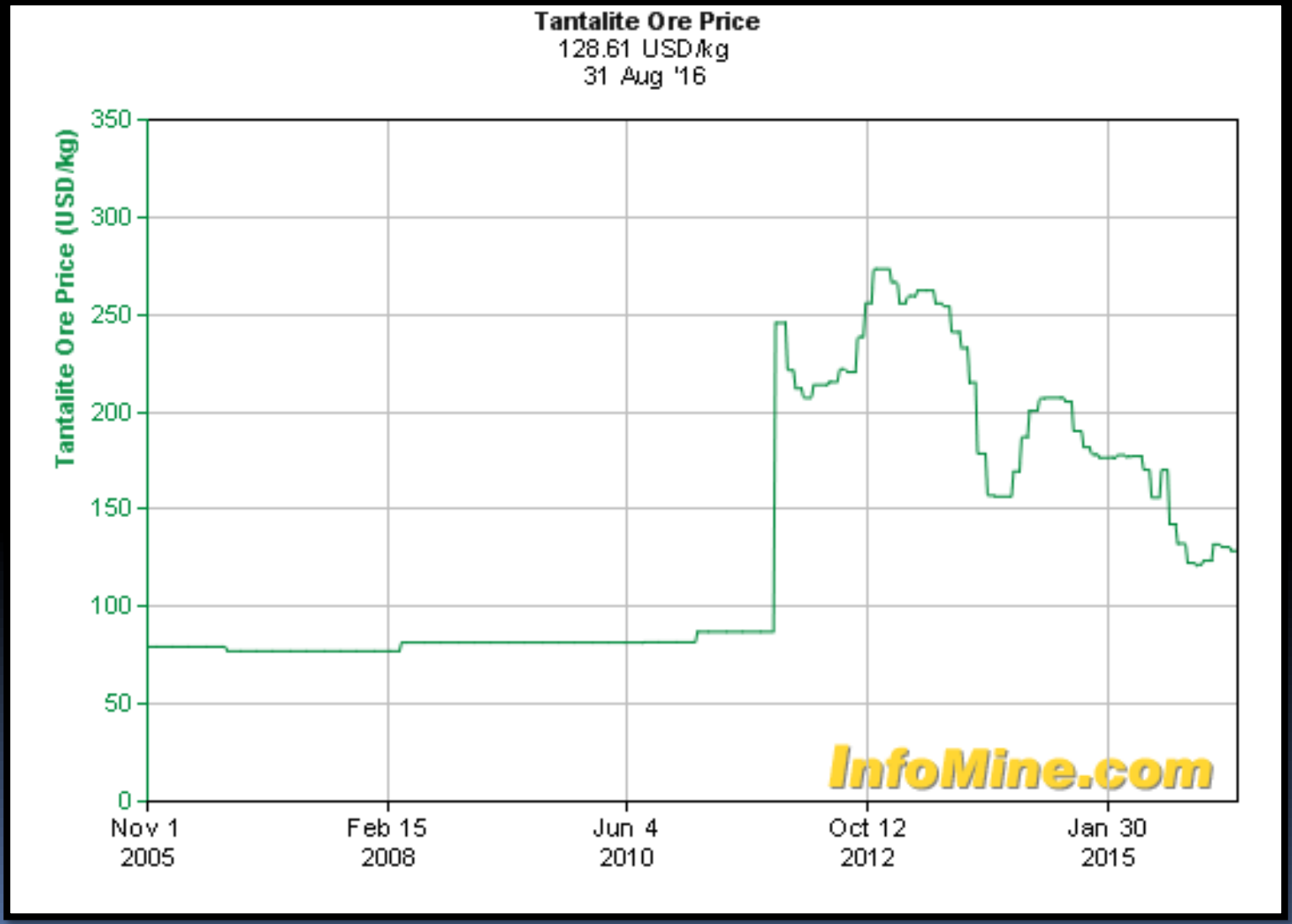
SUMMARY: Ta–Nb ZIMBABWE

- Apart small tonnage 1948 – 9 Patronage Claims, NE Harare, no tantalum concentrate produced outside Bikita area until 1953 when Kapata Claims, Kamativi mined
- Mid-1950's tantalum concentrate produced by-product beryl, mica, and scheelite mining, but although widespread tonnage declined
- Trend halted recovery coltan slag Kamativi Tin Mine in 1959 – 1994: ±400 tonnes of tantalum concentrate recovered

TANTALUM CONCENTRATE PRODUCTION IN ZIMBABWE



Tantalite Price: 2005 - 2015



INFORMATION INDIVIDUAL DEPOSITS ZIMBABWE

- Anderson (1981)
- Barber (2002)
- Batholemew (2003)
- Dasent (1981)
- Martin (1963).

CONCLUSSIONS

- Pegmatites difficult evaluate - rapidly changing composition and distribution
- Price highs periodically rejuvenates small scale mining
- Cost exploration pegmatites significant and often inappropriate and unaffordable
- Consequence often mined lack under-standing by operators meagre funds, equipment and skills – deposits sterilised

KNOWN MINE TANTALUM PRODUCTION IN ZIMBABWE UNTIL 1980's