

7th Annual Beer and Co Conference

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6th November 2019

RACV Club

Discovery

- ✦ In the mists of time but before 3,500 BC
- ✦ Copper discovery (both copper and tin metals soft; bronze is hard)
- ✦ Copper ores with arsenic
- ✦ Copper ores with tin
- ✦ Bronze (copper-tin alloy) – one of the earliest alloys discovered and used (*The Holy Bible* [3 places], Homer's *Iliad*)
- ✦ Later discovery in China and SE Asia

Discovery

- ✦ Ancient bronzes (Persia, Mediterranean)
- ✦ Direct smelting of stannite or cassiterite-chalcopyrite-arsenopyrite ores
- ✦ Smelting of copper ores, smelting of tin ores, metal mixing
- ✦ Smelting of cassiterite (heat, chemical reduction, bellows)
- ✦ Tin metal (low melting point 232 deg.C, high boiling point 2625 deg.C)
- ✦ Ancient uses (bronze, pewter)

Mineral deposit types

ENRICHED BY WEATHERING AND EROSION

- ✦ Alluvial (streams; Agricola 1556 AD)
- ✦ Eluvial
- ✦ Strand, offshore place and palaeostream

LATERITE

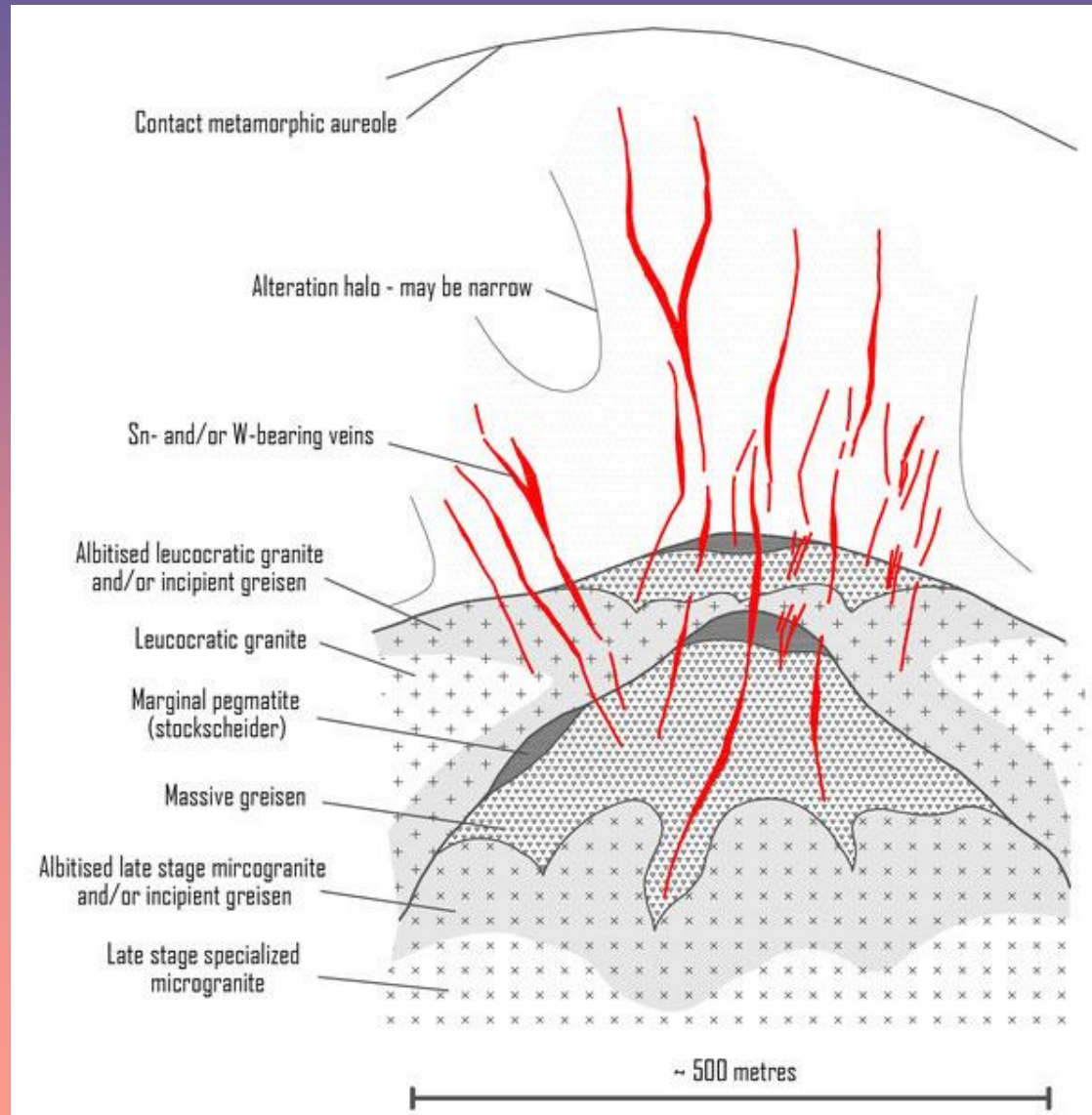
- ✦ Varlamoffite $(\text{Sn,Fe})(\text{O,OH})_2$ (Cornwall, Malaysia, Brazil, NSW)

GRANITE RELATED

- ✦ A-type or highly fractionated S- or I-type
- ✦ Gravity and magnetic low
- ✦ Radiometric high
- ✦ Rich in SiO_2 , K, U, F, REE, Nb, Ta, Li, Rb, B, Be, Ga, Mo, W, Sn
- ✦ Characteristic texture
- ✦ High level of intrusion
- ✦ Tin provinces

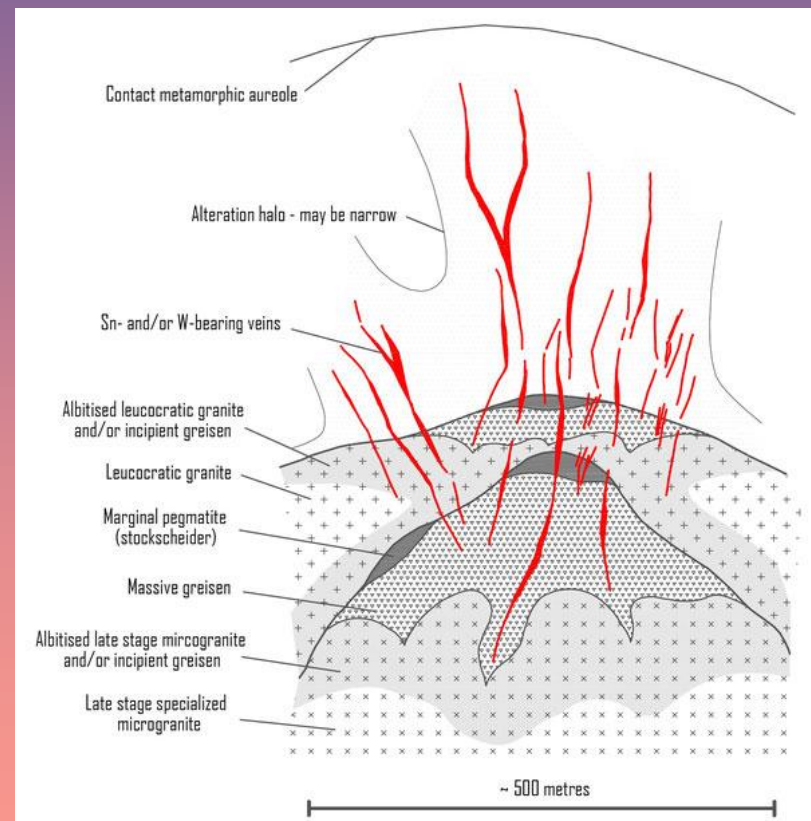
Mineral deposit types

GRANITE RELATED



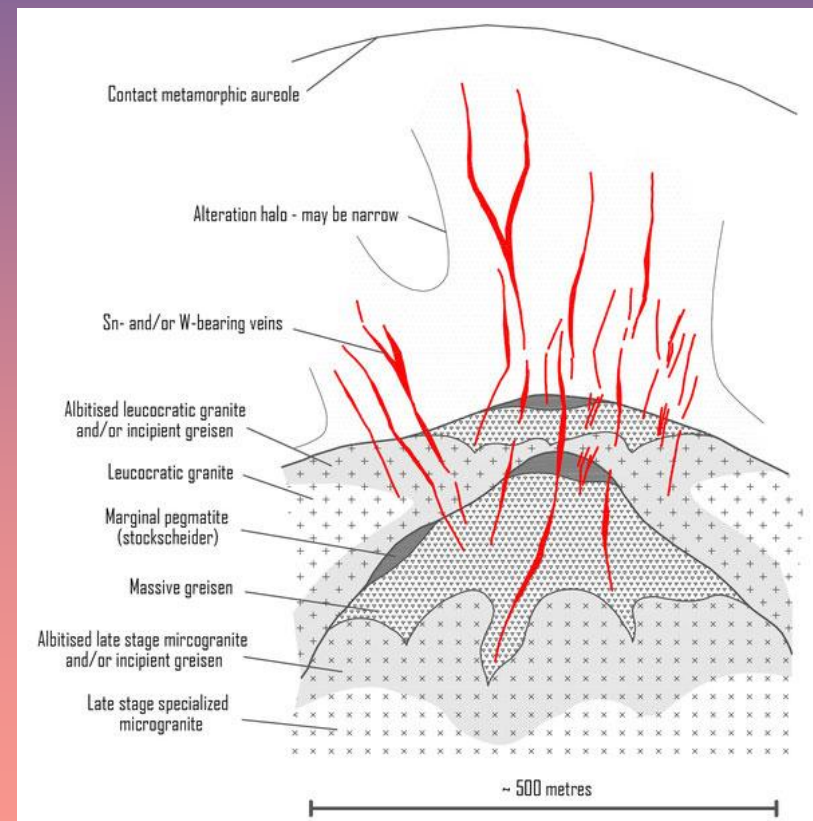
Mineral deposit types

GRANITE RELATED – sheeted vein (e.g Taronga NSW)



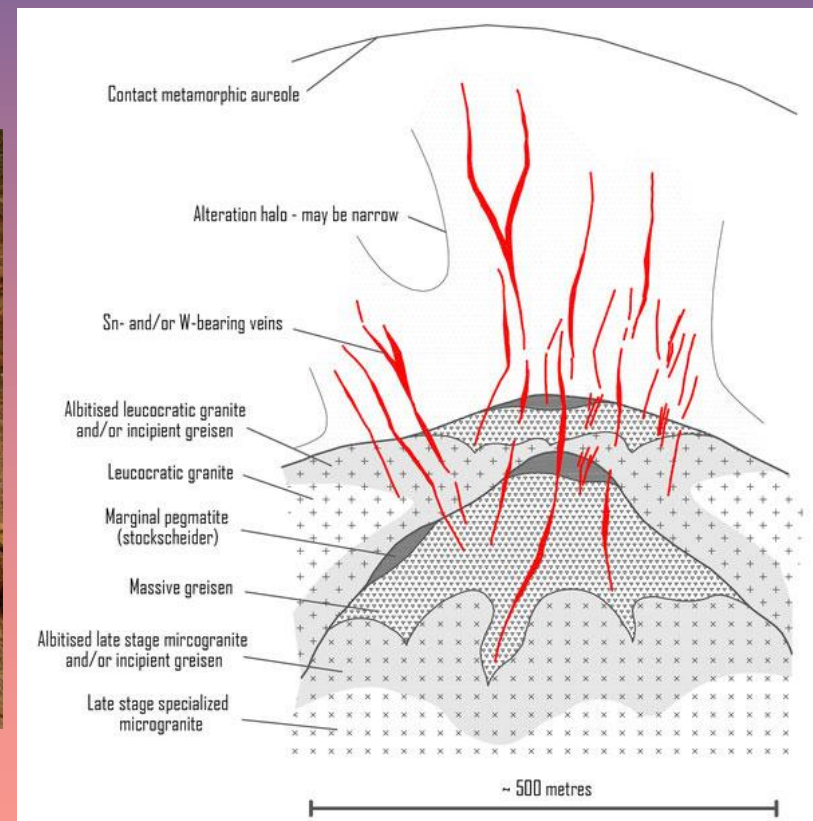
Mineral deposit types

GRANITE RELATED – stockwork (e.g Erzgebirge, Germany) and pipes (e.g. Ardlethan, NSW)



Mineral deposit types

GRANITE RELATED – pegmatite stockscheider (e.g. Erzgebirge, Germany)



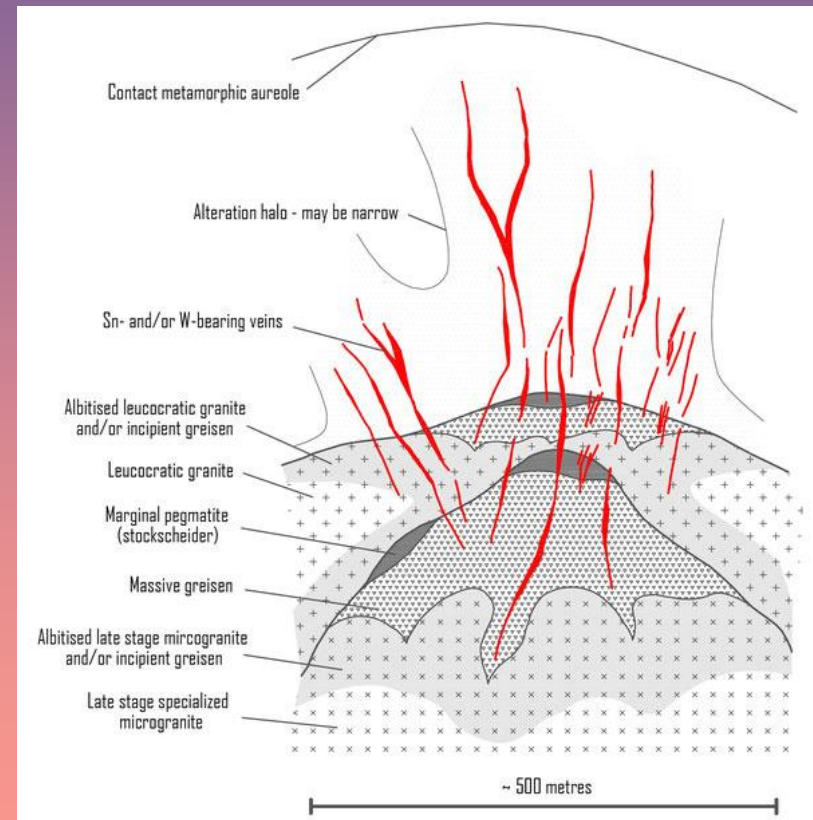
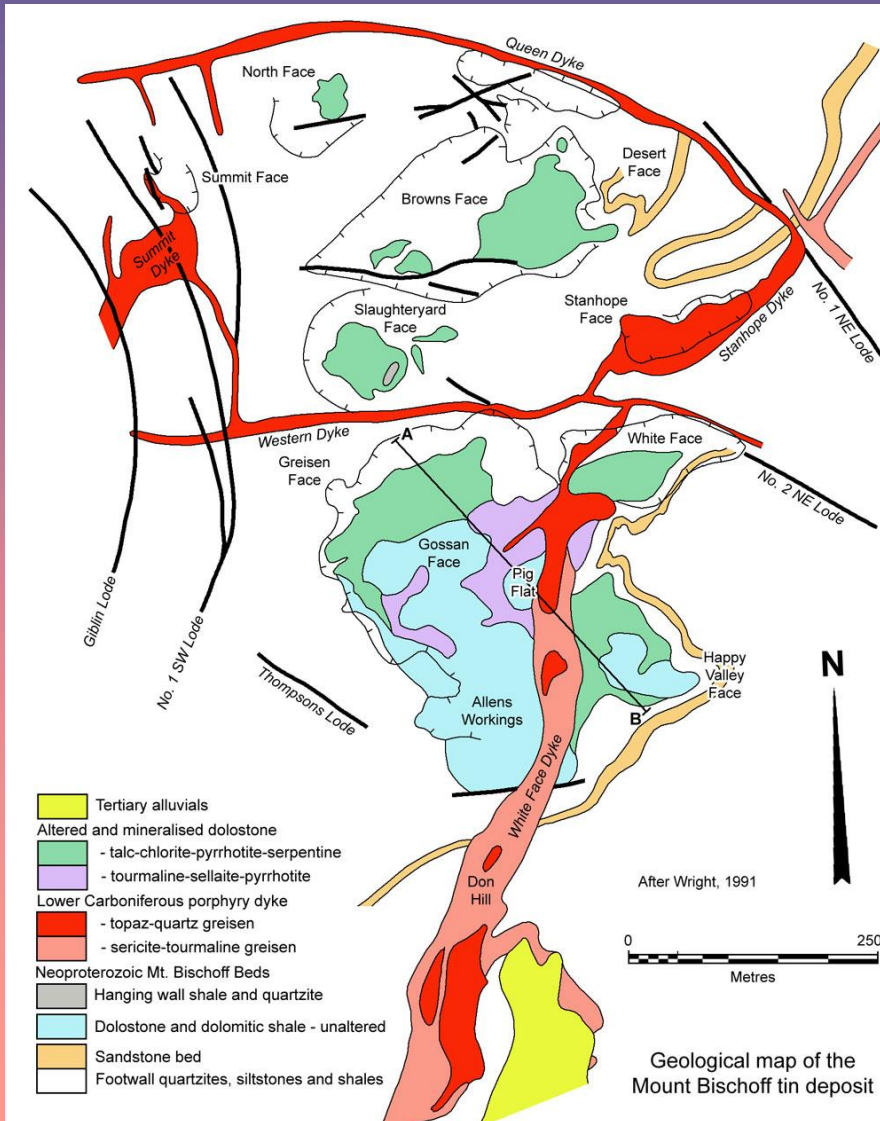
Mineral deposit types

GRANITE RELATED – rootless pegmatite (Sn, Ta, Li) (e.g Greenbushes and Wodgina, WA)



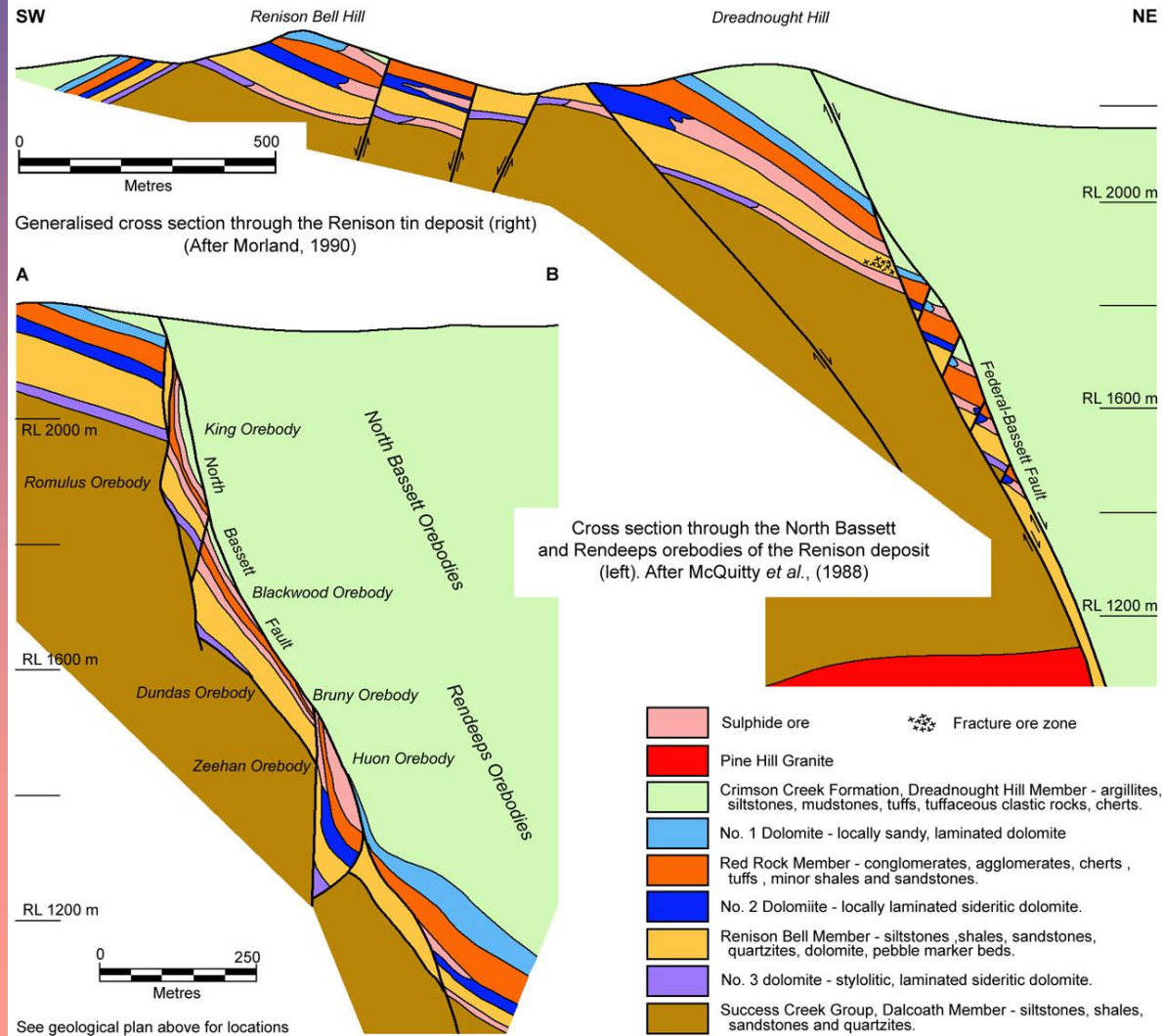
Mineral deposit types

GRANITE RELATED – greisen (e.g Mt Bischoff)



Mineral deposit types

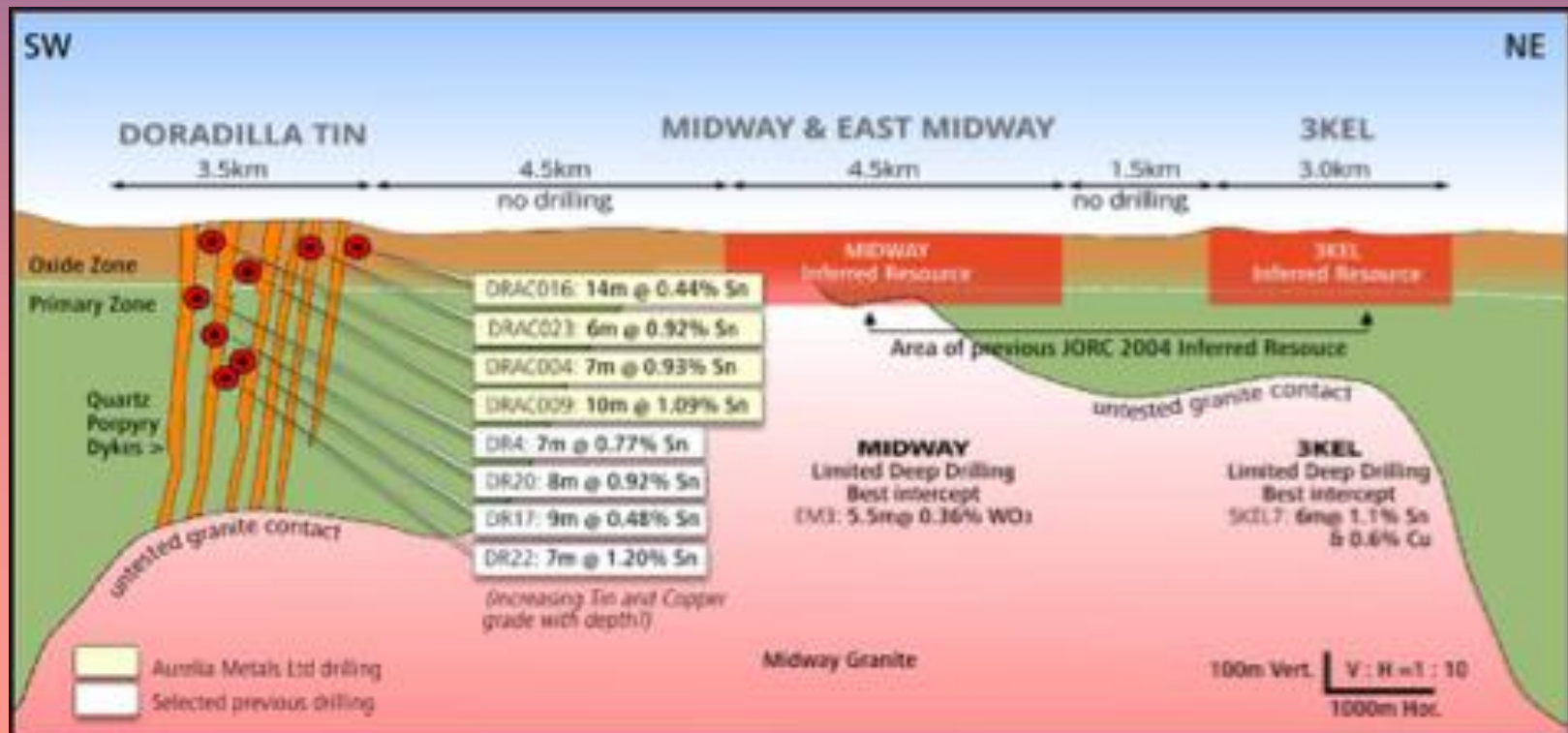
GRANITE RELATED – replacement cassiterite (e.g. Renison Bell, Tas.)



Mineral deposit types

GRANITE RELATED – replacement tin silicates (e.g. Doradilla, NSW)

Laterite plus metallurgically difficult primary ore



Mining and processing

MINING

- ✦ Underground vein
- ✦ Bulk mining

PROCESSING

- ✦ Crush, grind
- ✦ Gravity (spirals, jigs, tables, sluice)
- ✦ Flotation
- ✦ Recovery

Smelting and refining

DESULPHIDATION

- ✦ Oxidising
- ✦ 550 deg. C

SMELTING

- ✦ Reducing
- ✦ Reverberatory furnace 1300-1400 deg. C

REFINING

- ✦ Electrolytic

Mined and refined supply

Mined tin supply (2017)	Refined tin supply (2017)
Indonesia (26.3%)	China (48.2%)
China (26.0%)	Indonesia (22.0%)
Myanmar (21.2%)	Malaysia (7.5%)
Bolivia (5.8%)	Peru (5.0%)
Peru (5.6%)	Bolivia (4.4%)
Africa (5.0%)	Brazil (3.5%)
Brazil (4.4%)	Thailand (2.7%)
Australia (2.3%)	Other (6.5%; Belgium, Poland, Russia)

Uses

METAL

- ✦ Tin plate **16.0 %**
- ✦ Coatings
- ✦ Glass **2.0 %**

ALLOYS

- ✦ Solder (183 deg C., eutectic at 62%Sn 38%Pb) **52.0 %**
- ✦ Bronze, brass, pewter **5.5 %**
- ✦ Engine bearings, blocks, crankshafts, axles, brake drums, transmission
- ✦ Stainless steel
- ✦ Aerospace Al-Sn
- ✦ Reactors (zircalloys)

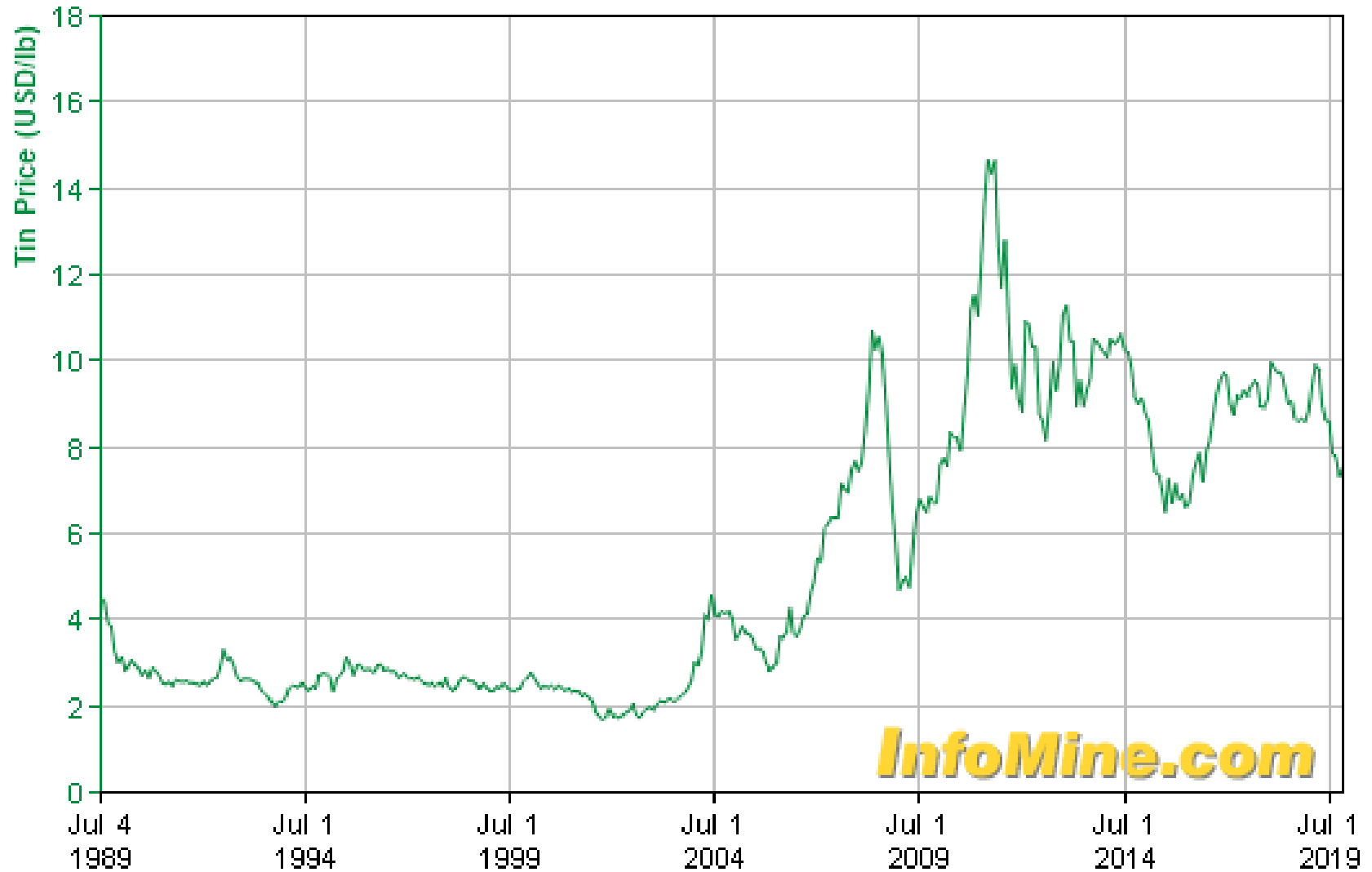
ORGANIC

13.0%

- ✦ PVC manufacture
- ✦ Fungicides, wood preservatives, anti fouling
- ✦ Glass coatings
- ✦ Catalysts

The past

Tin Price
7.52 USD/lb
1 Nov '19



The past



The future

