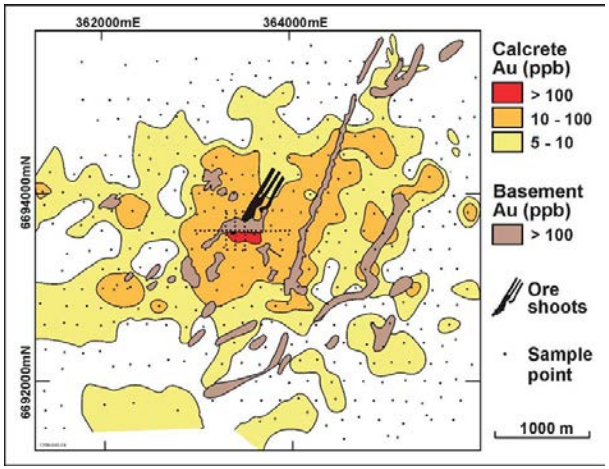
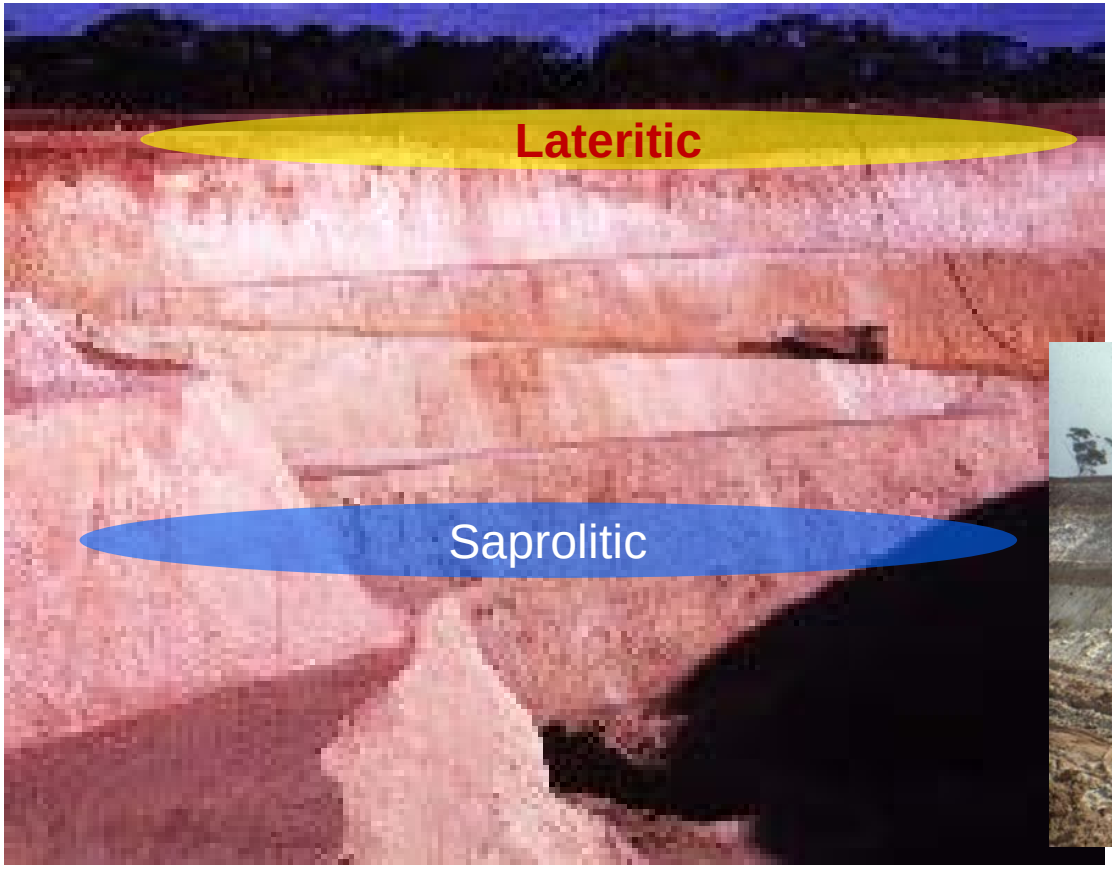
REGOLITH GEOCHEMISTRY - 2
SUPERGENE GOLD

Mehrooz F Aspandiar & Charles Butt



Distribution of gold in lateritic regolith

Economic to sub-economic accumulations of Au occur in lateritic regolith in most climates
Mostly secondary Au (grains) with some primary Au grains
Three main types: lateritic, saprolitic, paleochannel



Conditions for Au mobility during weathering

Metallic gold becomes mobile by becoming a complex

Au Complex	Dissolution conditions	Precipitation conditions	Product
Thiosulphate $(Au(S_2O_3)_2^{3-}$	Weathering of Au & pyrite in alkaline, mildly oxidizing	Dilution Acidification Oxidation	Electrum
Organic	Neutral-acid	Reduction	Fine grained
Chloride $AuCl_2^-$/ $AuCl_4^-$	Acid, oxidizing, saline	Dilution, increase pH	Pure gold
Cyanide $(CN)_2^-$ $AuCN_2^-$	Presence of cyanide – decomposing organics		Low fineness
Hydroxide $AuOH(H_2O)^0$	Alkaline, oxidizing	Dilution, decrease pH	High fineness

Potential Au-complexes in regolith profile – Climate related?

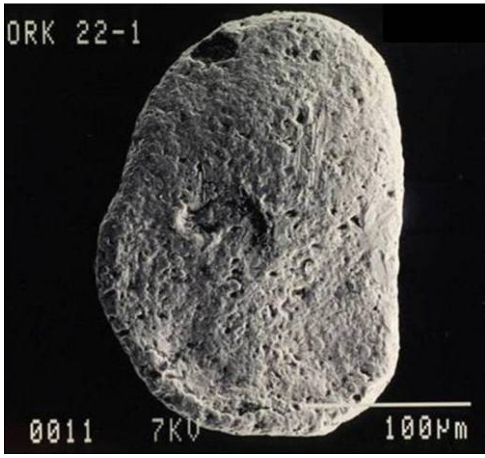
	Dominant complex	Likely climate	Gold character
Ferruginous	Organics – decomposed plants & animals Cyanide – root releases	High precipitation-higher biomass, humid, equatorial	 Ag poor, hexagonal or triangular habits
Saprolite	Chloride – saline groundwaters	Semi-arid to arid, low precipitation, high evaporation = saline	 Ag poor, hexagonal or triangular habits
	Thiosulfate – mildly oxidizing sulfide rich	Not critical	

Wetter Climate (Humid) Gold Mobilization

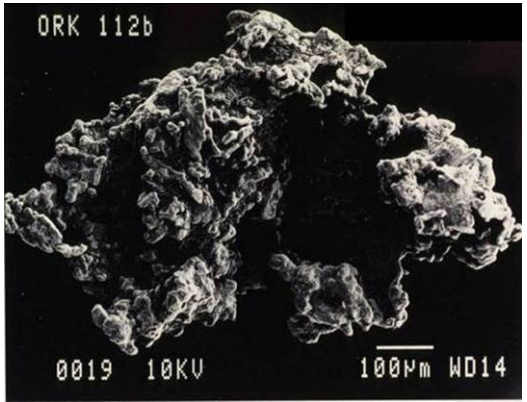
Kangaba, Mali

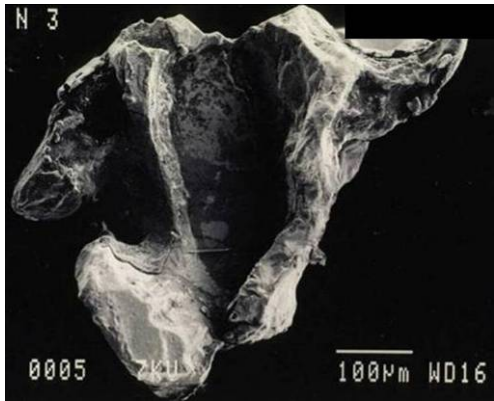
Secondary gold in lateritic duricrust; Dendritic Au on Goethite (fine grained)

Primary gold in lateritic duricrust; Etched and pitted

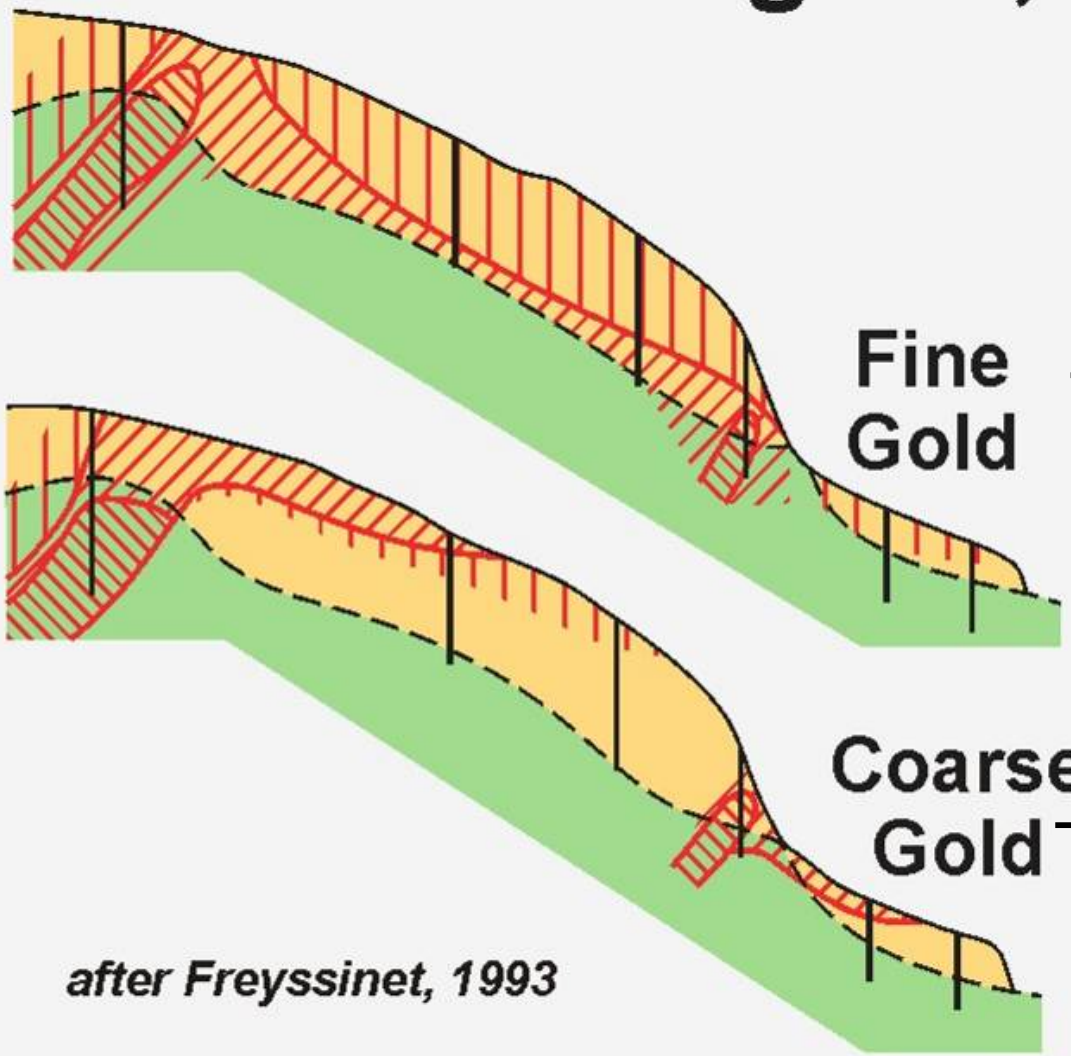


Primary gold in saprolite
No pitting; hardly affected; xenomorphic





Kangaba, Mali



Lateritic duricrust

Saprolite

Au (ppb)

>1000

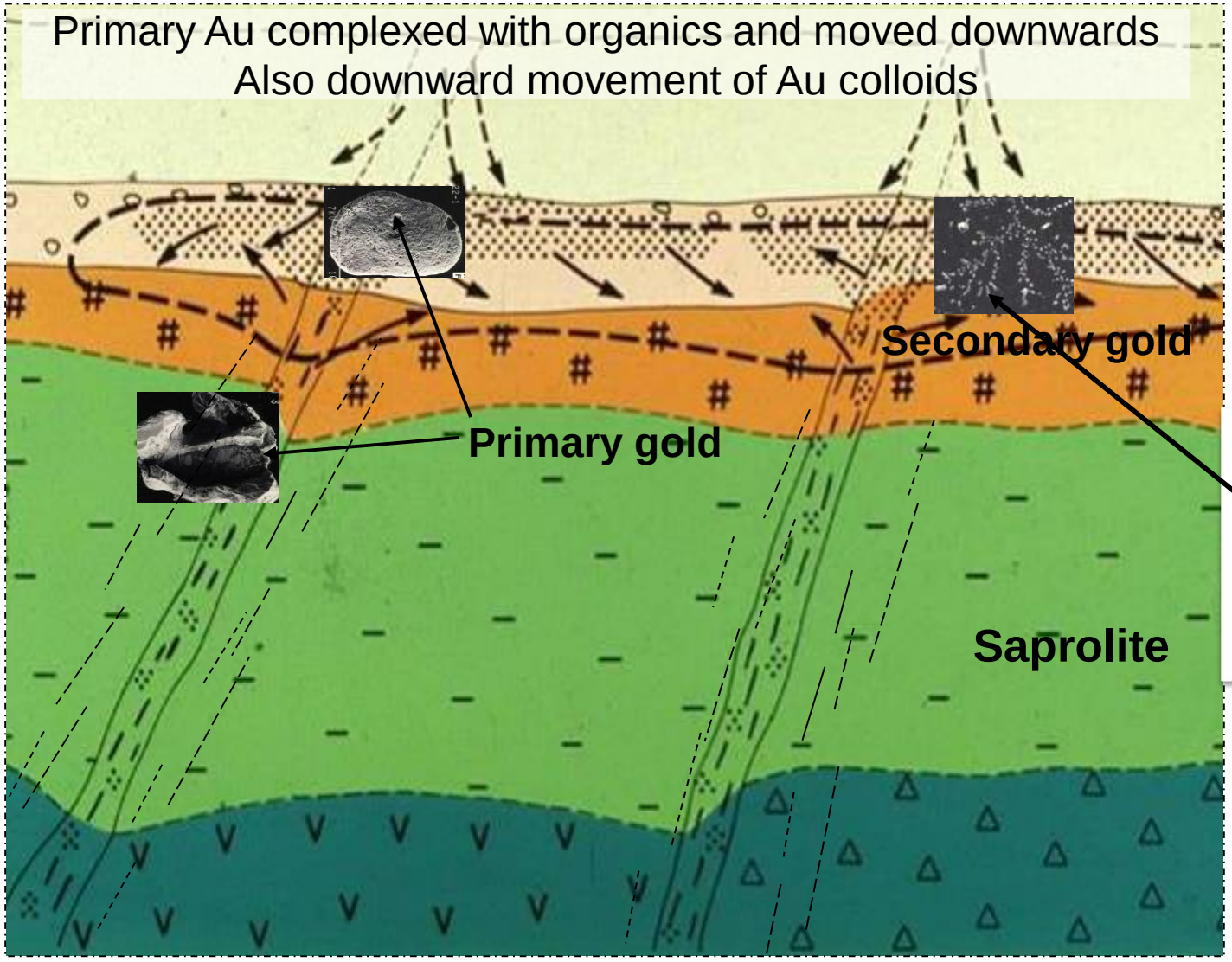
100-1000

<100

150 m

20 m

Gold dispersion during lateritic weathering
In humid environments



Original land surface

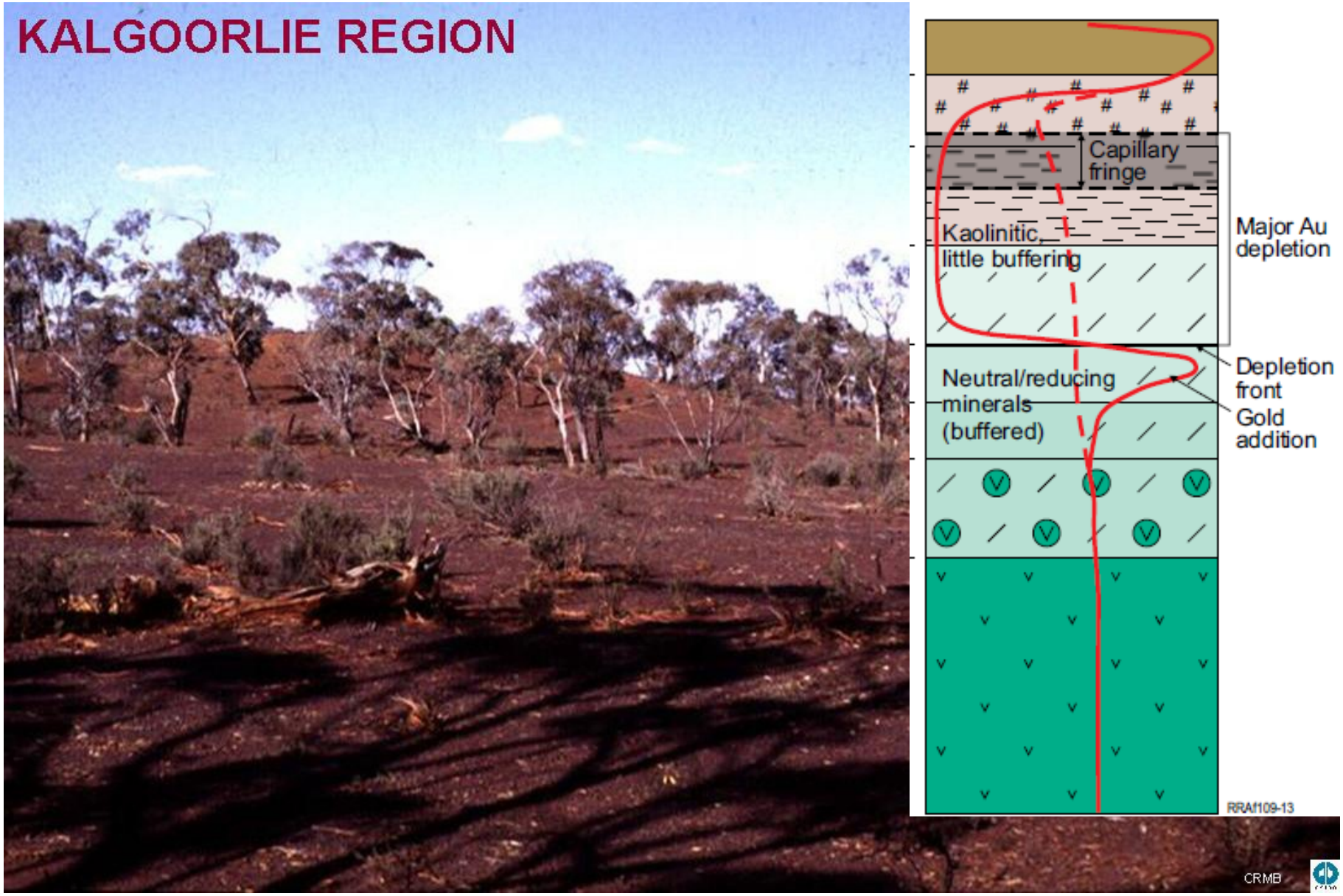
Lateritic duricrust

Mottled zone

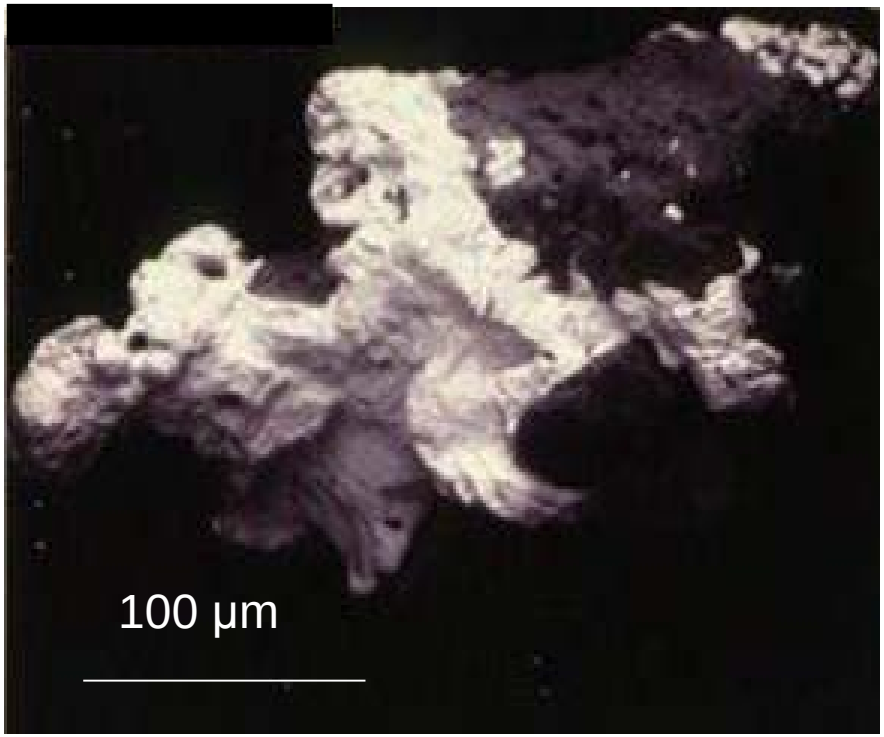
Au organic complex destabilized – reduced linked to iron oxide oxidation

Fresh rock

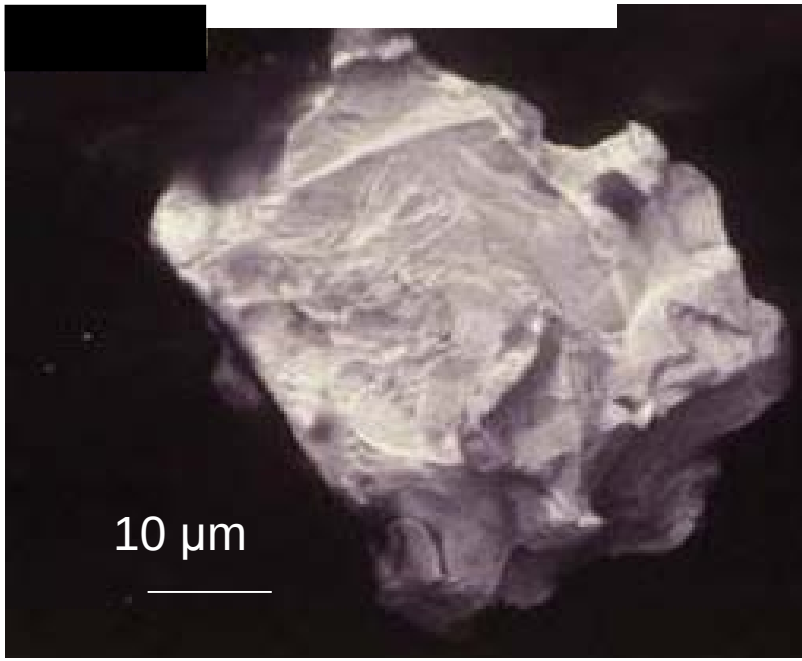
Gold mobility in semi-arid regions

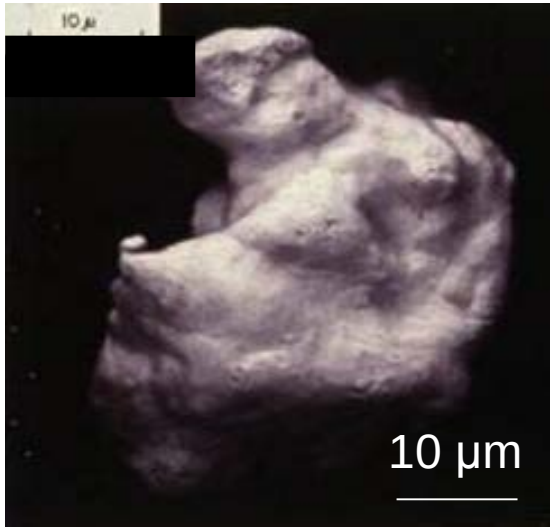


Yilgarn - BARDOC Primary Ag-rich gold at base of saprolite



Pristine, xenomorphic grains with imprints of quartz



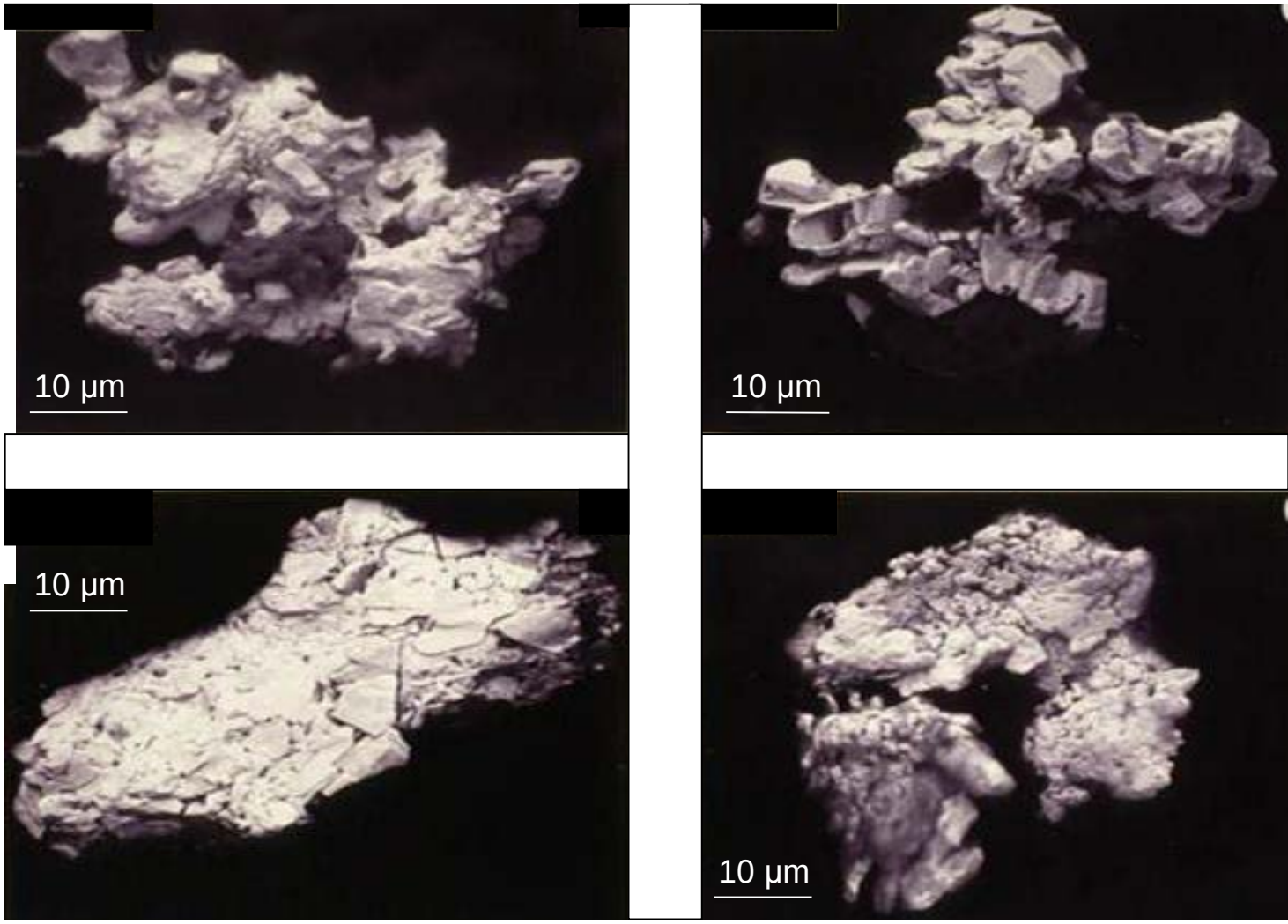


Corroded grain with minor secondary gold

BARDOC

Saprolite, 35m depth

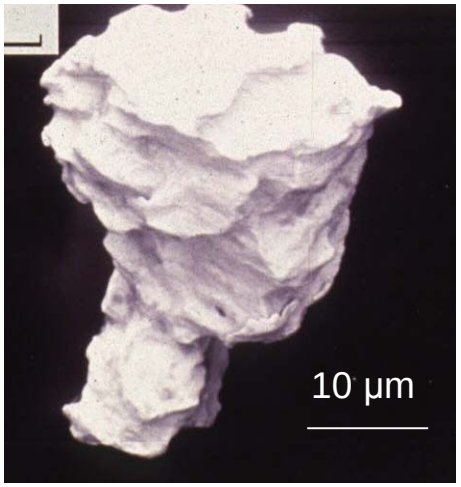
Aggregates of crystalline secondary gold



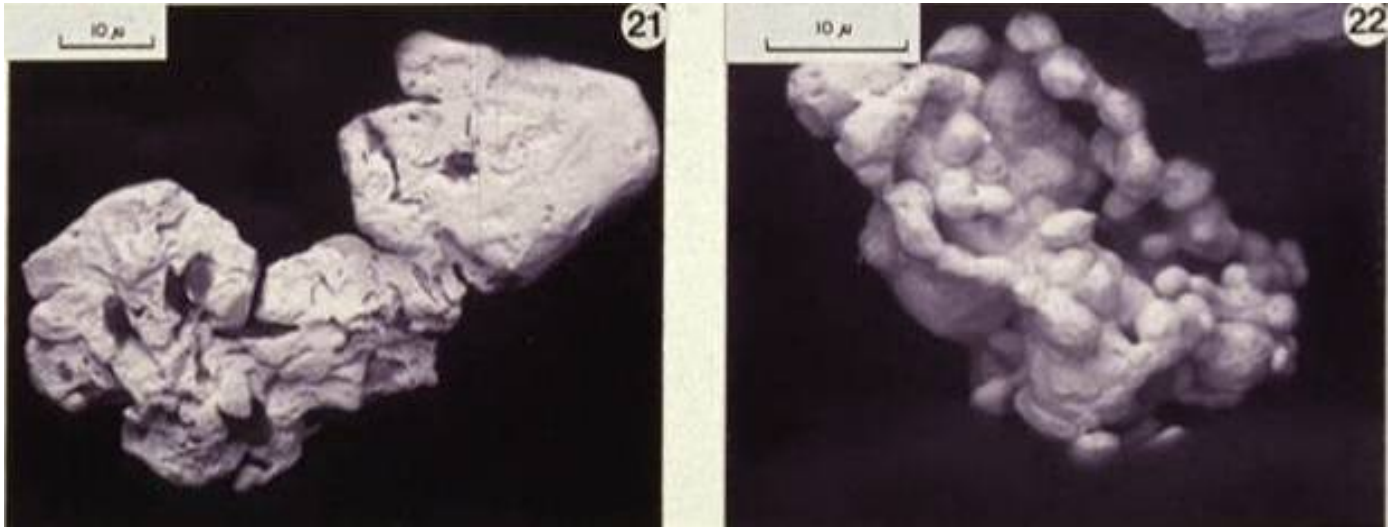
BARDOC Residual primary Au grains - Lateritic residuum

Corroded and rounded with etching pits

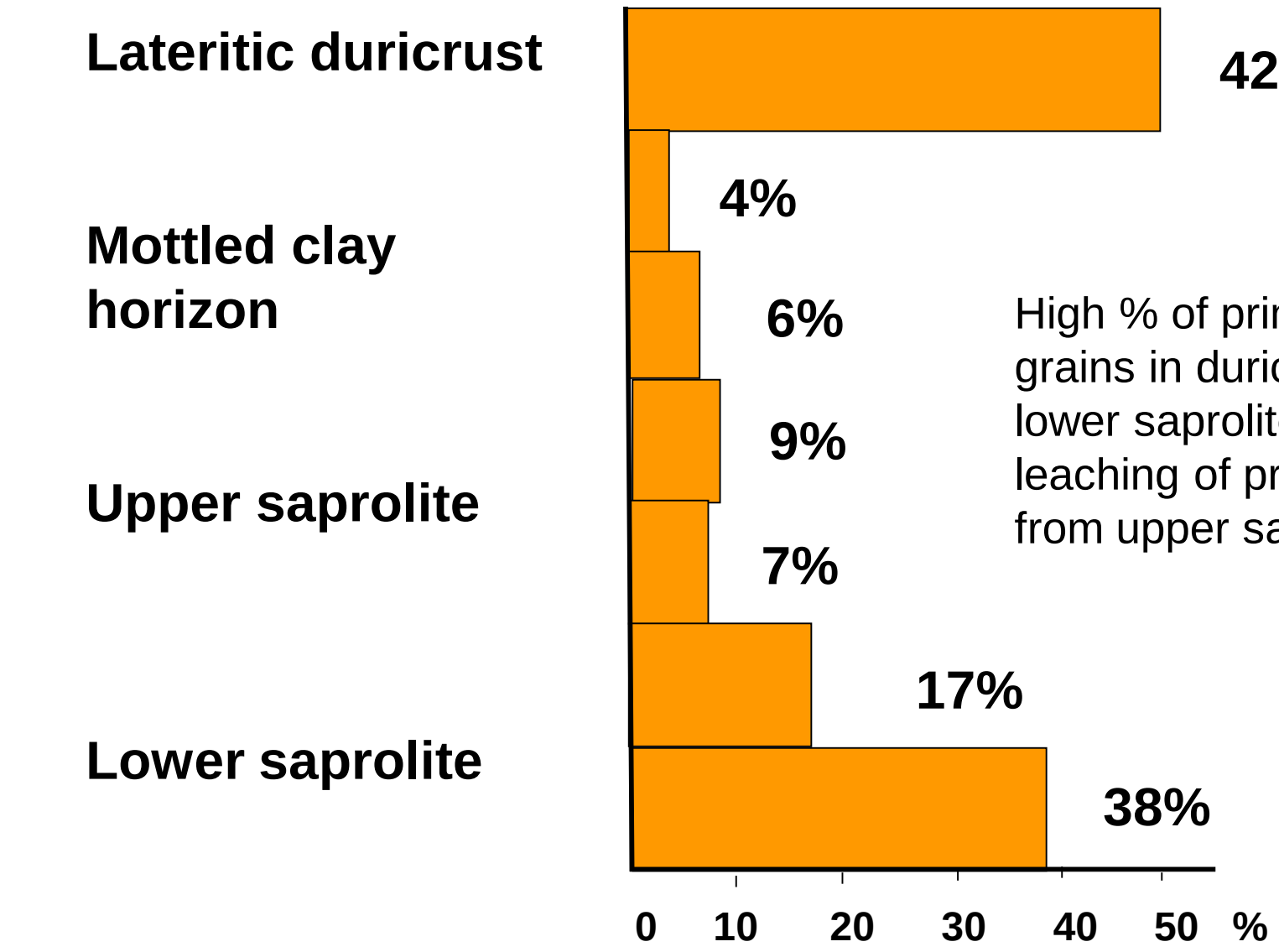
Xenomorphic and uncorroded



Aggregates of crystals and spherules and secondary gold



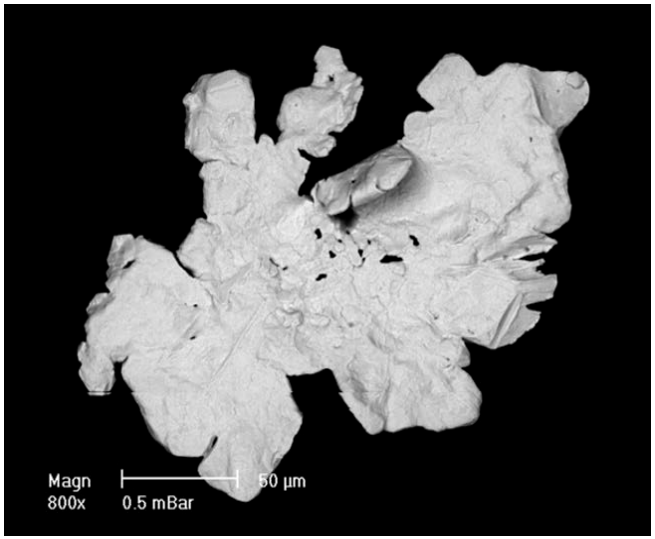
BARDOC: percentage of primary, Ag-bearing grains

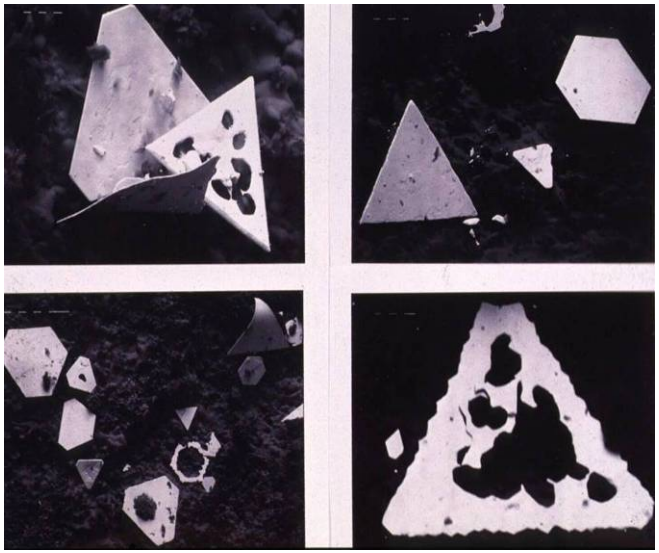


High % of primary Au grains in duricrust and lower saprolite. Significant leaching of primary Au from upper saprolite/mottle

Secondary gold in saprolite

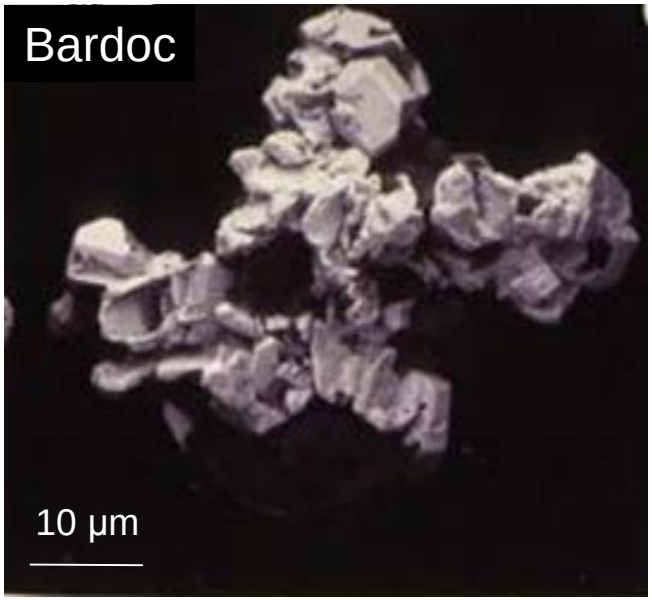
Moolart Well

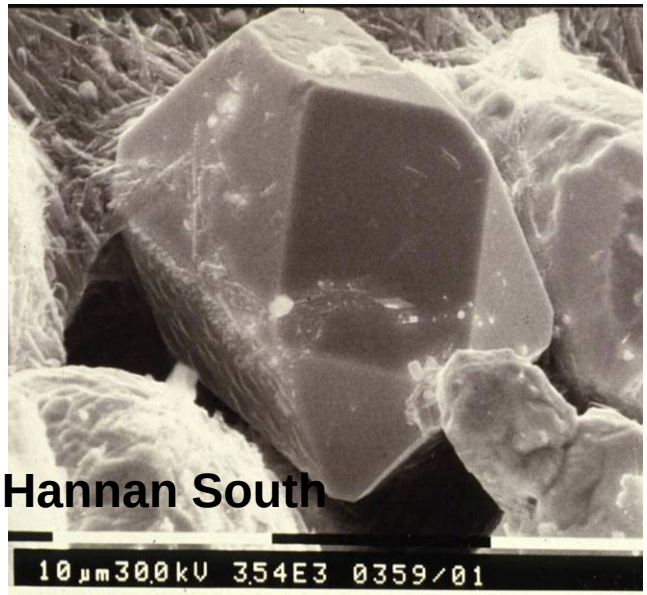




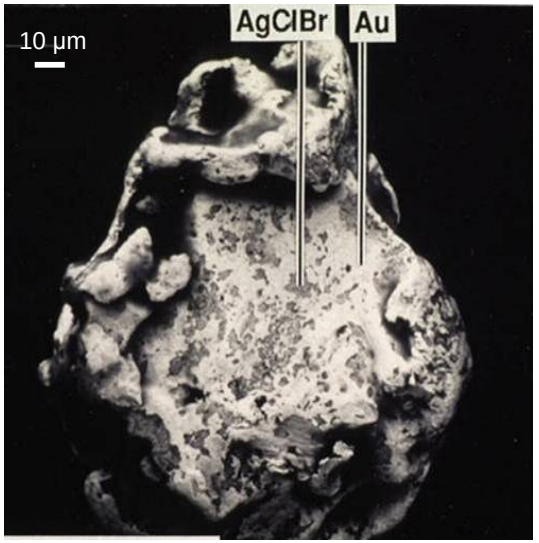
Queen Lapage

Images: C Butt and Lawarence & Griffin (1994)

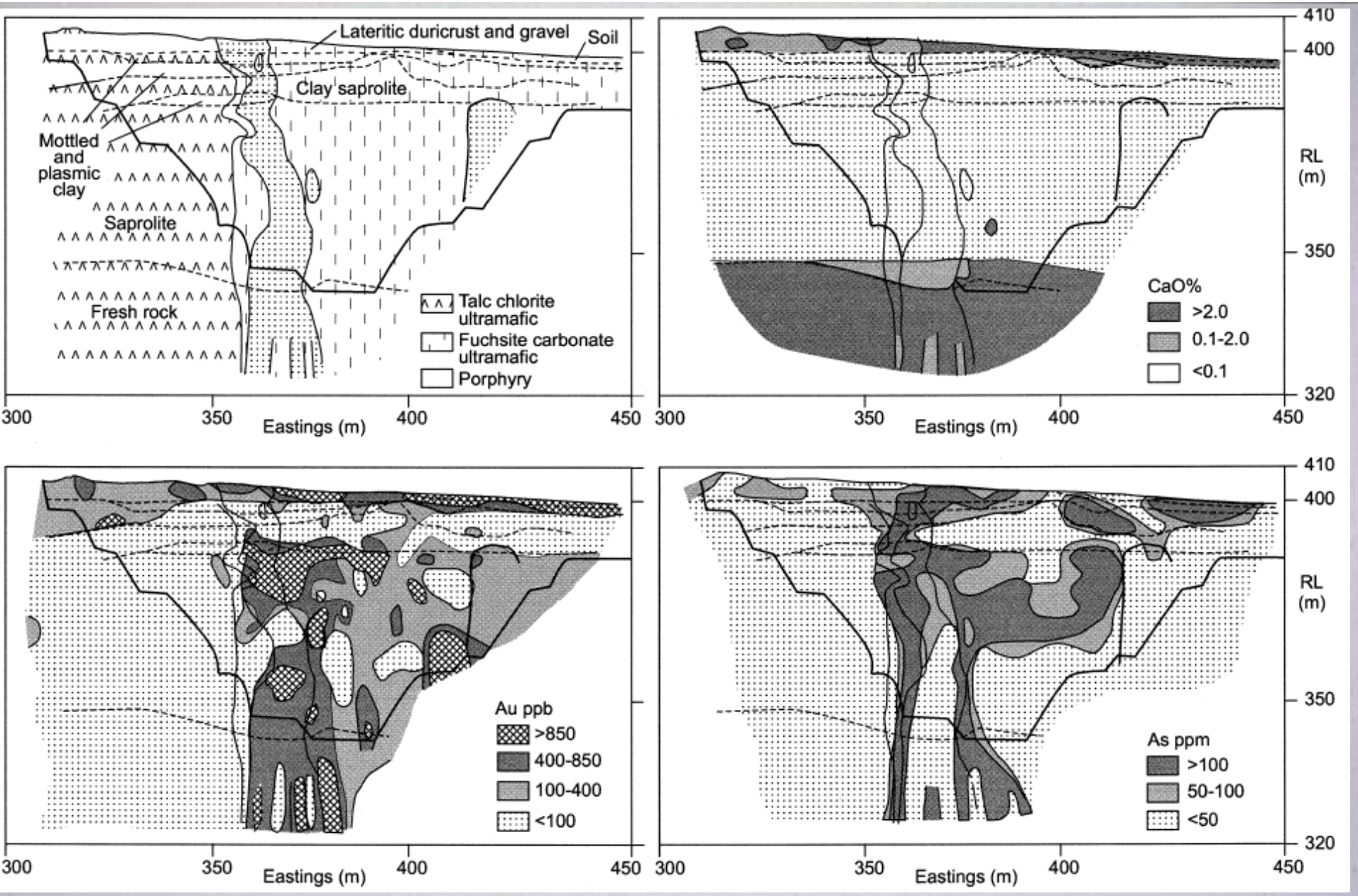




Mt Percy

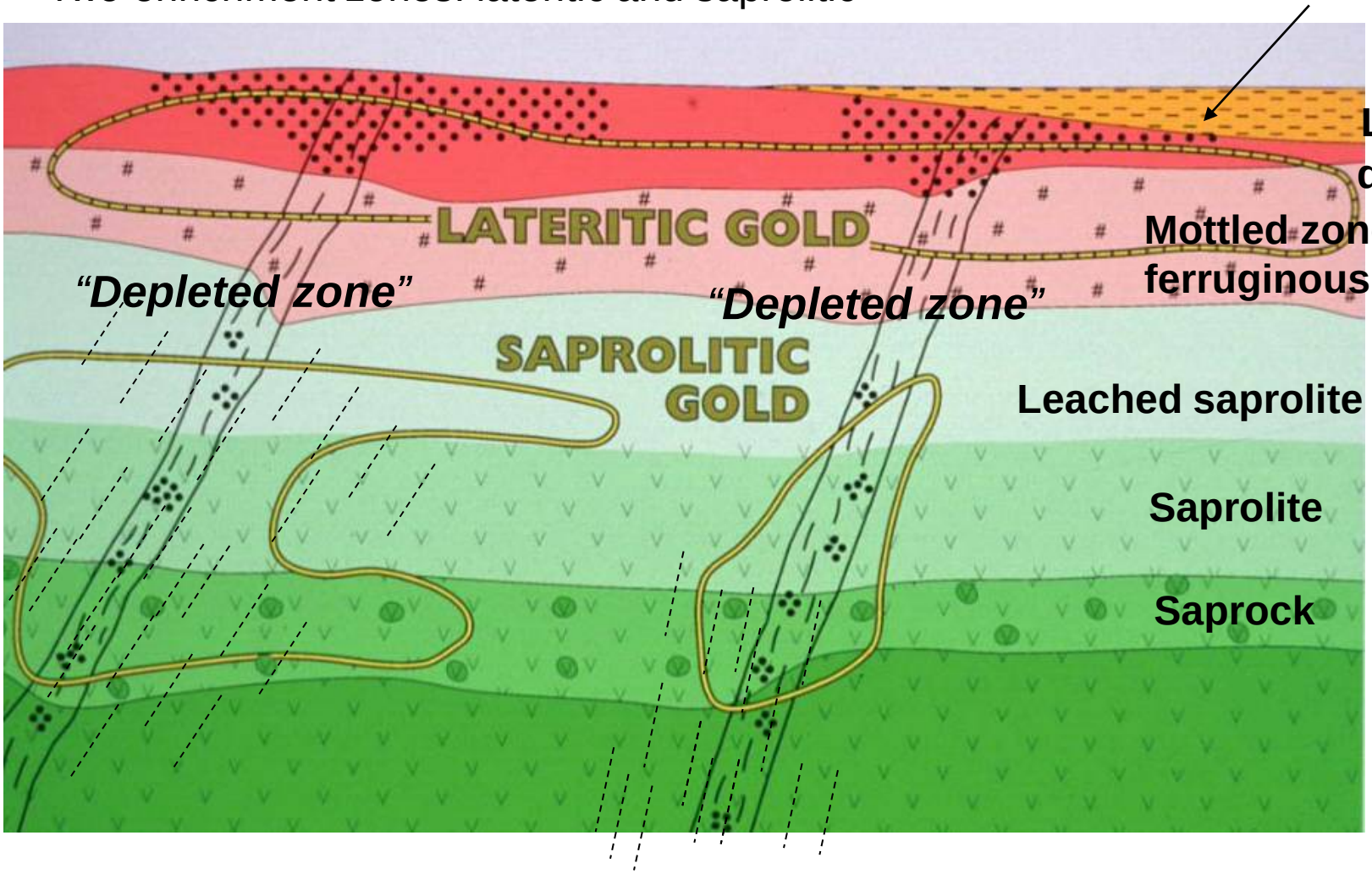


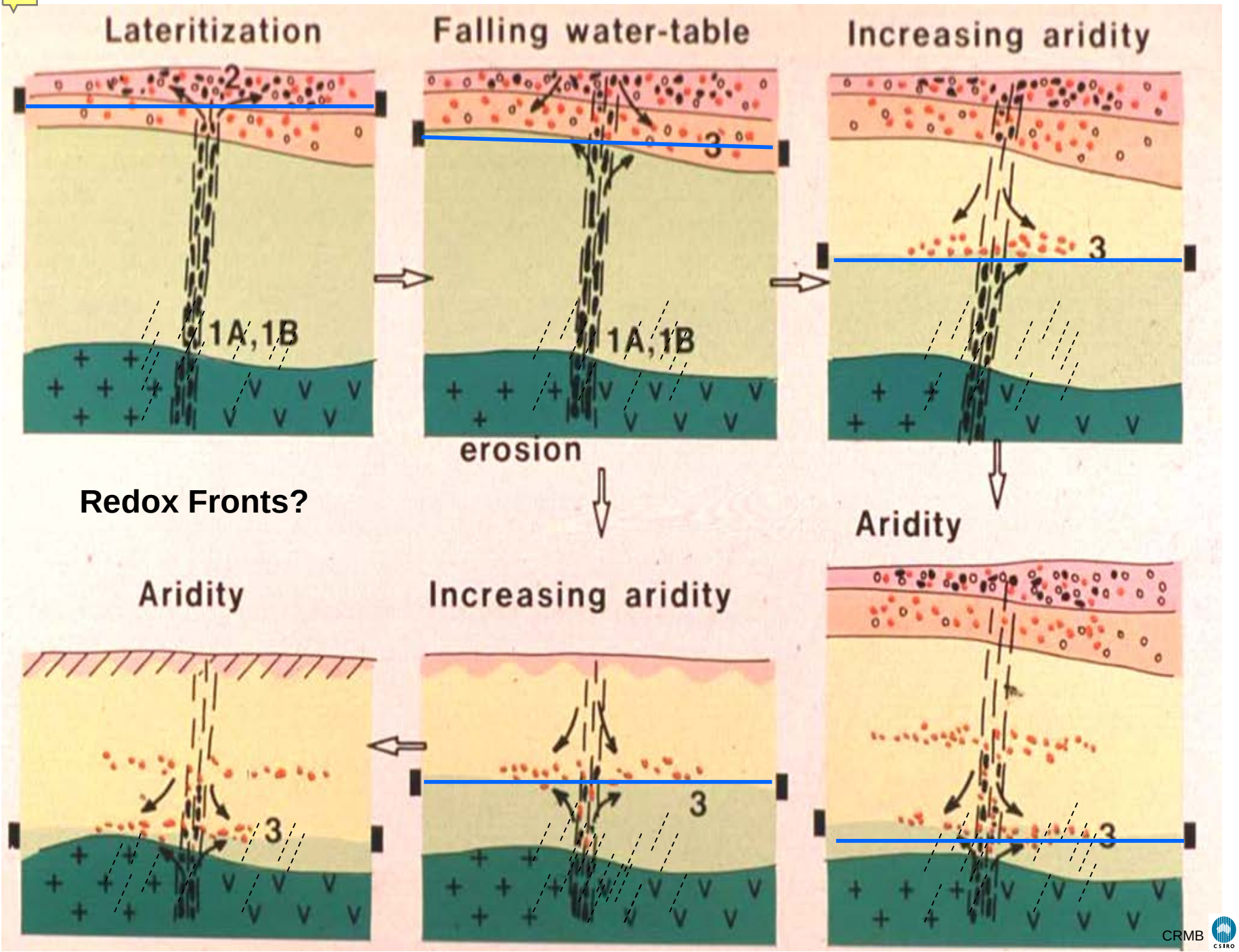
Mt Percy Supergene Gold deposit



Supergene gold deposits
South western Australia

Two enrichment zones: lateritic and saprolitic

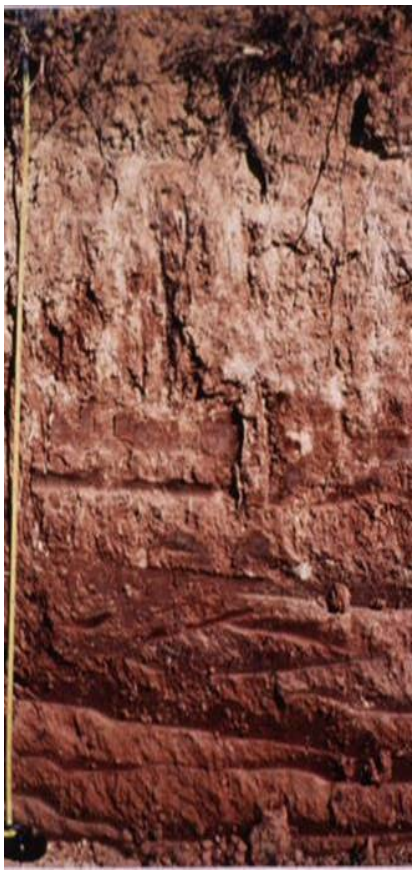


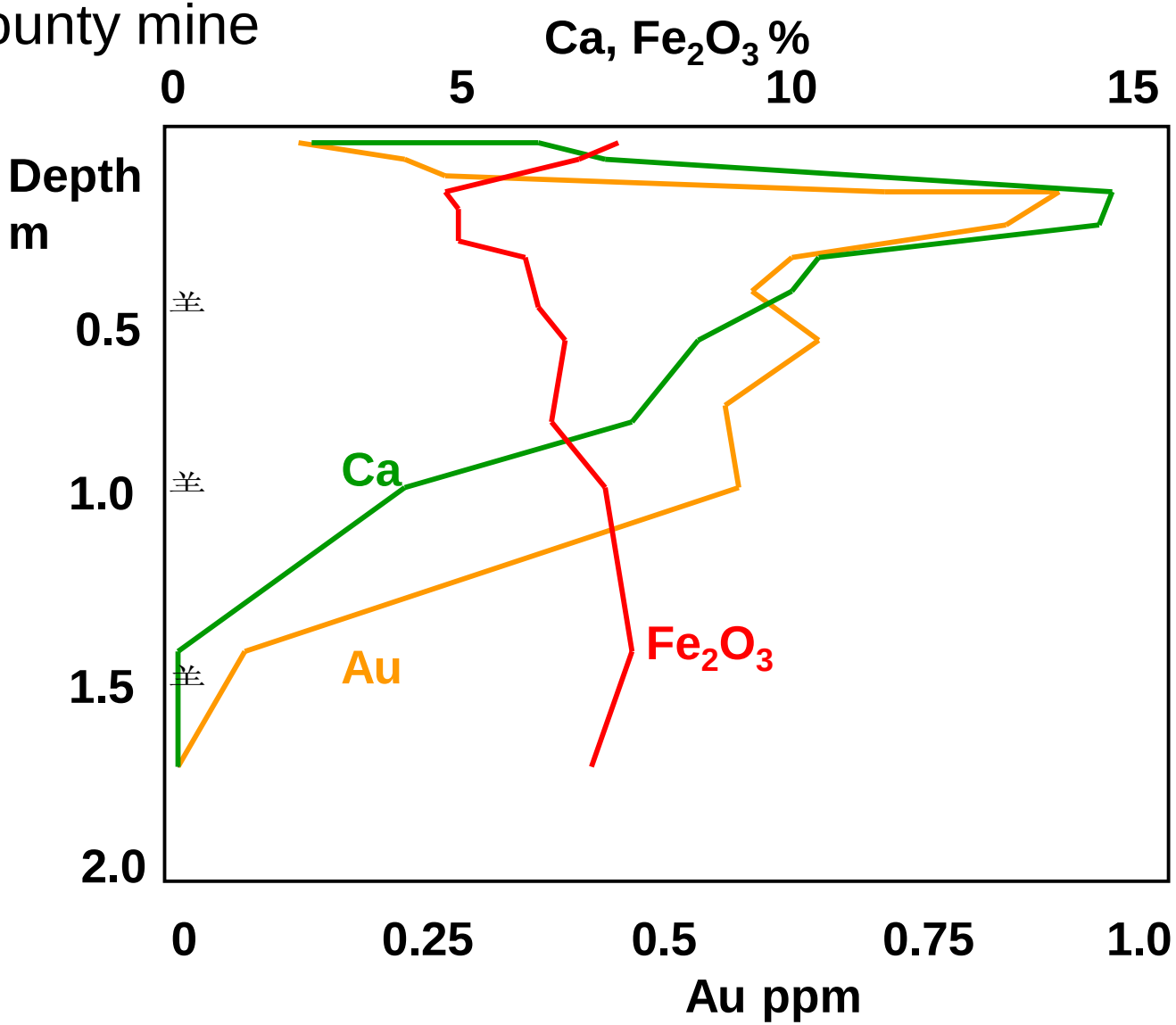

Lateritization
Falling water-table
Increasing aridity
2
3
3
1A, 1B
1A, 1B
erosion
Redox Fronts?
Aridity
Aridity
Increasing aridity
3
3
3

CRMB

Gold - Calcrete

MT HOPE – Bounty mine



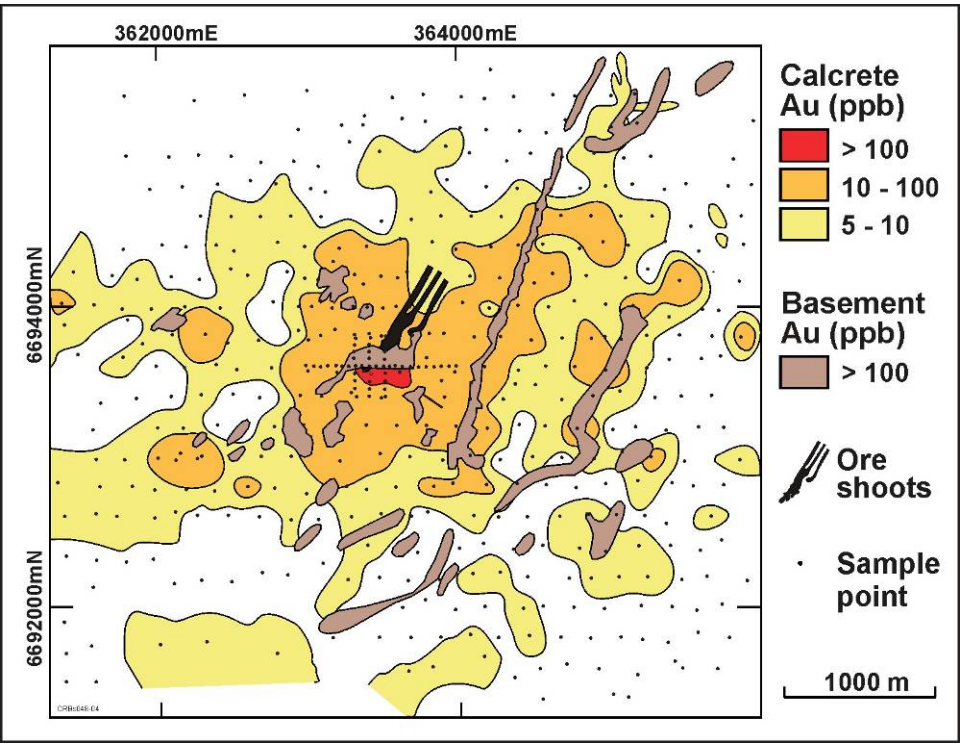


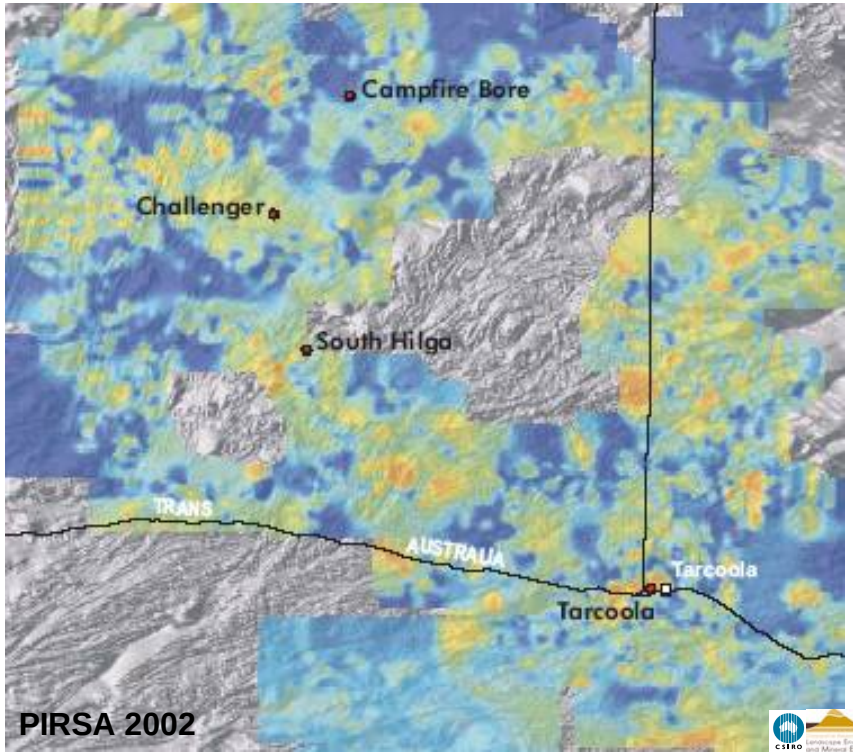
Gold – calcrete association; Secondary Au

Erosional Terrain

Calcrete and calcareous soil

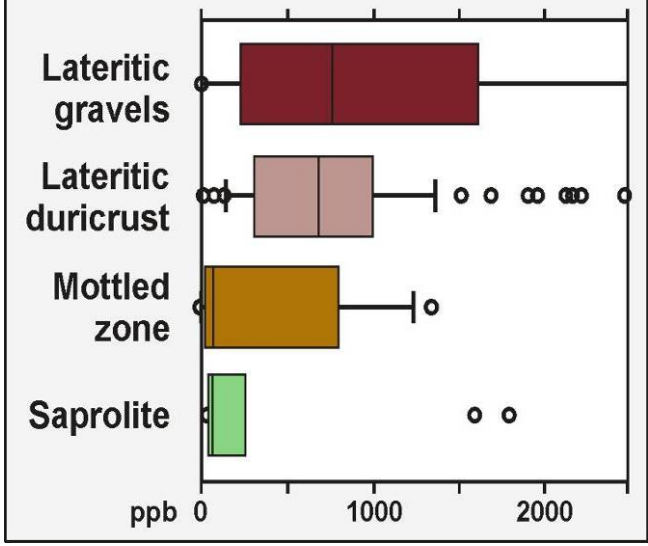
Regional to prospect-scale surveys

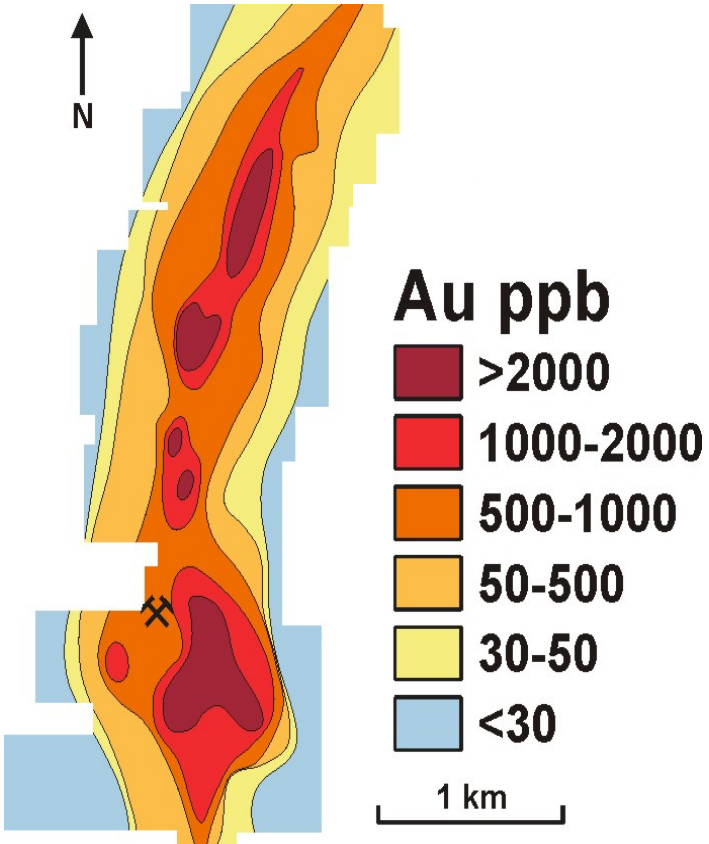


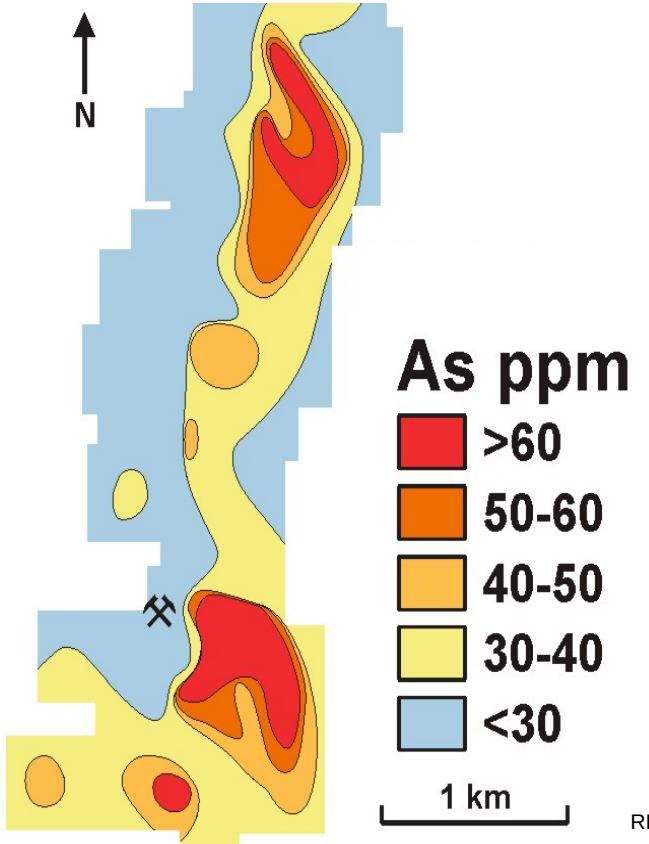


Exploration for Supergene Gold

Mt. Gibson (semi-arid)
Laterite geochemistry

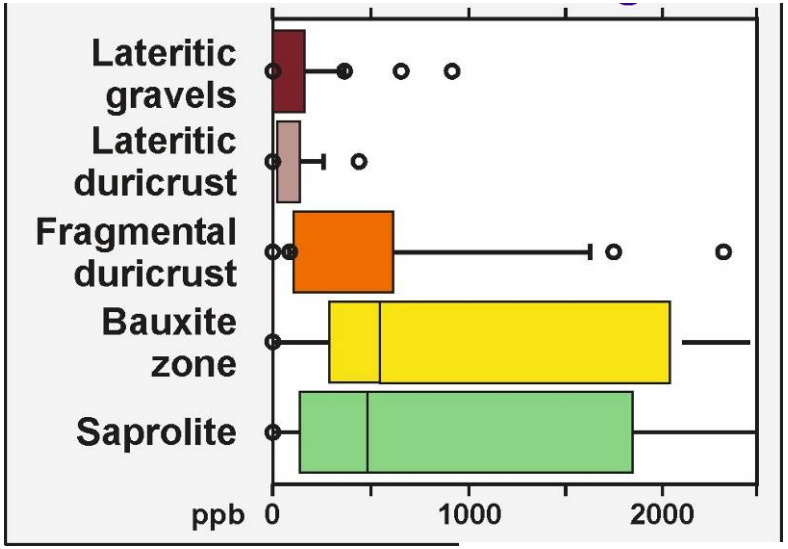


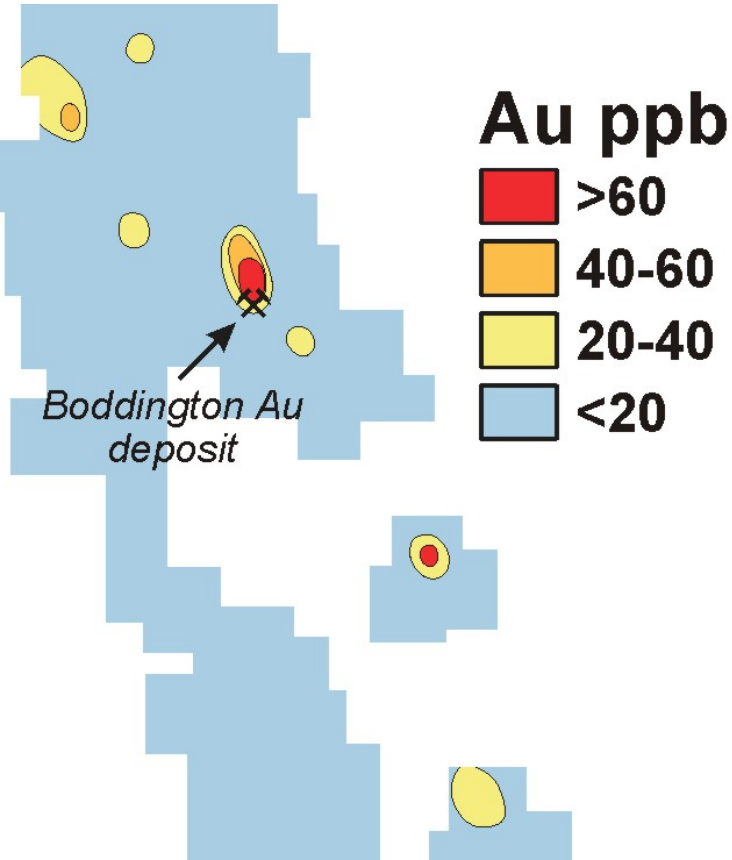


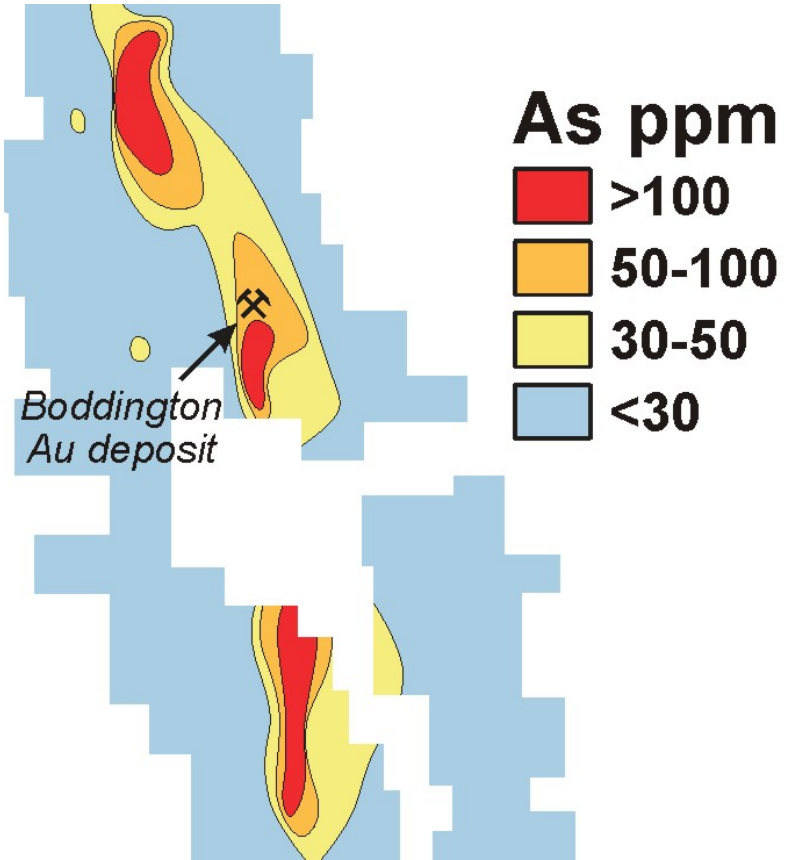


Boddington (wetter climate)

Laterite geochemistry



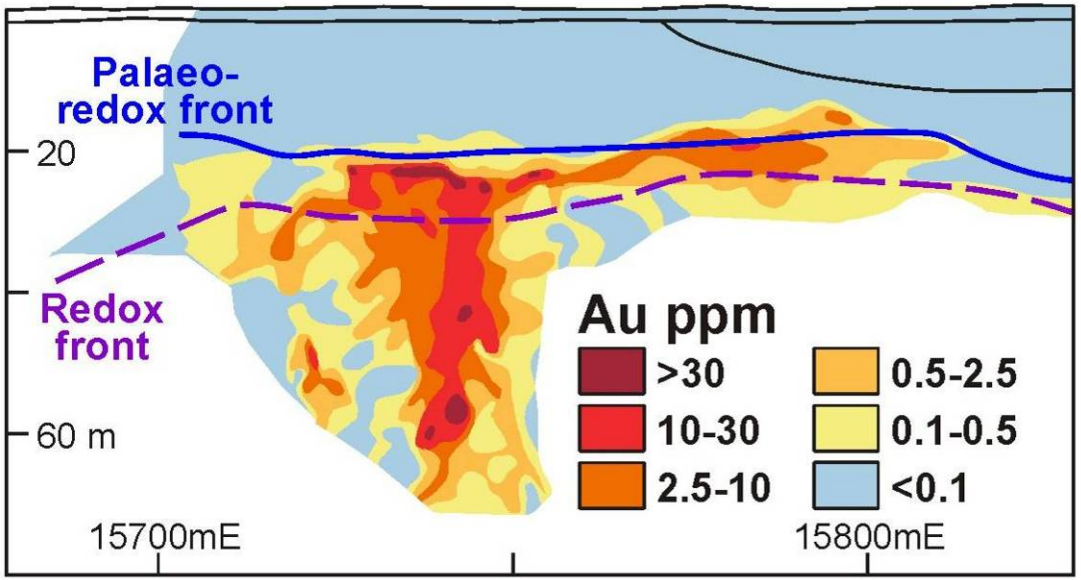


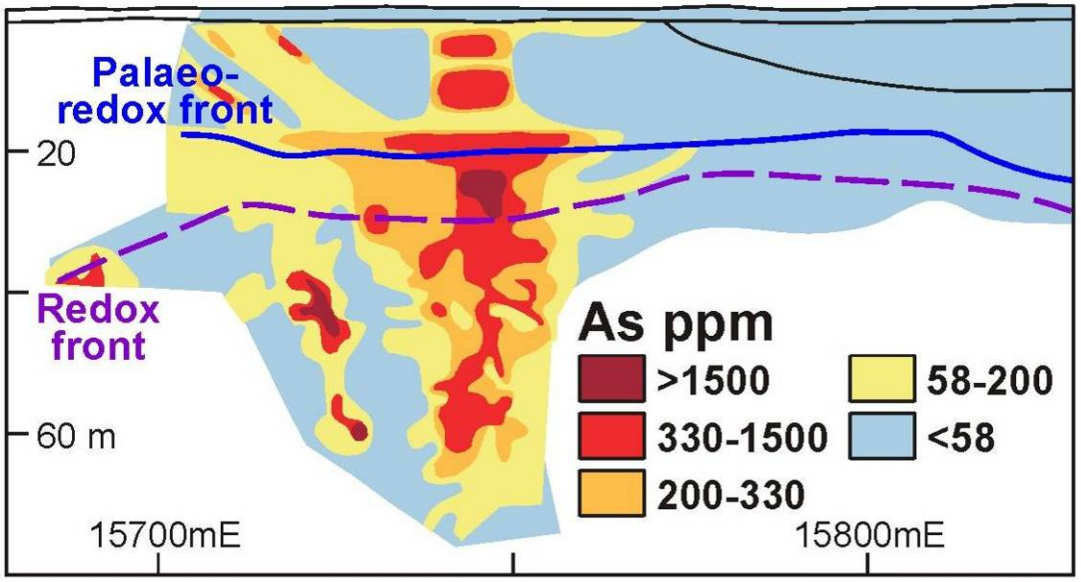


Exploration in southern Yilgarn – saline, acidic groundwaters

Au and Pathfinders: Need pathfinders as they may not be leached as much as Au

Hannan South

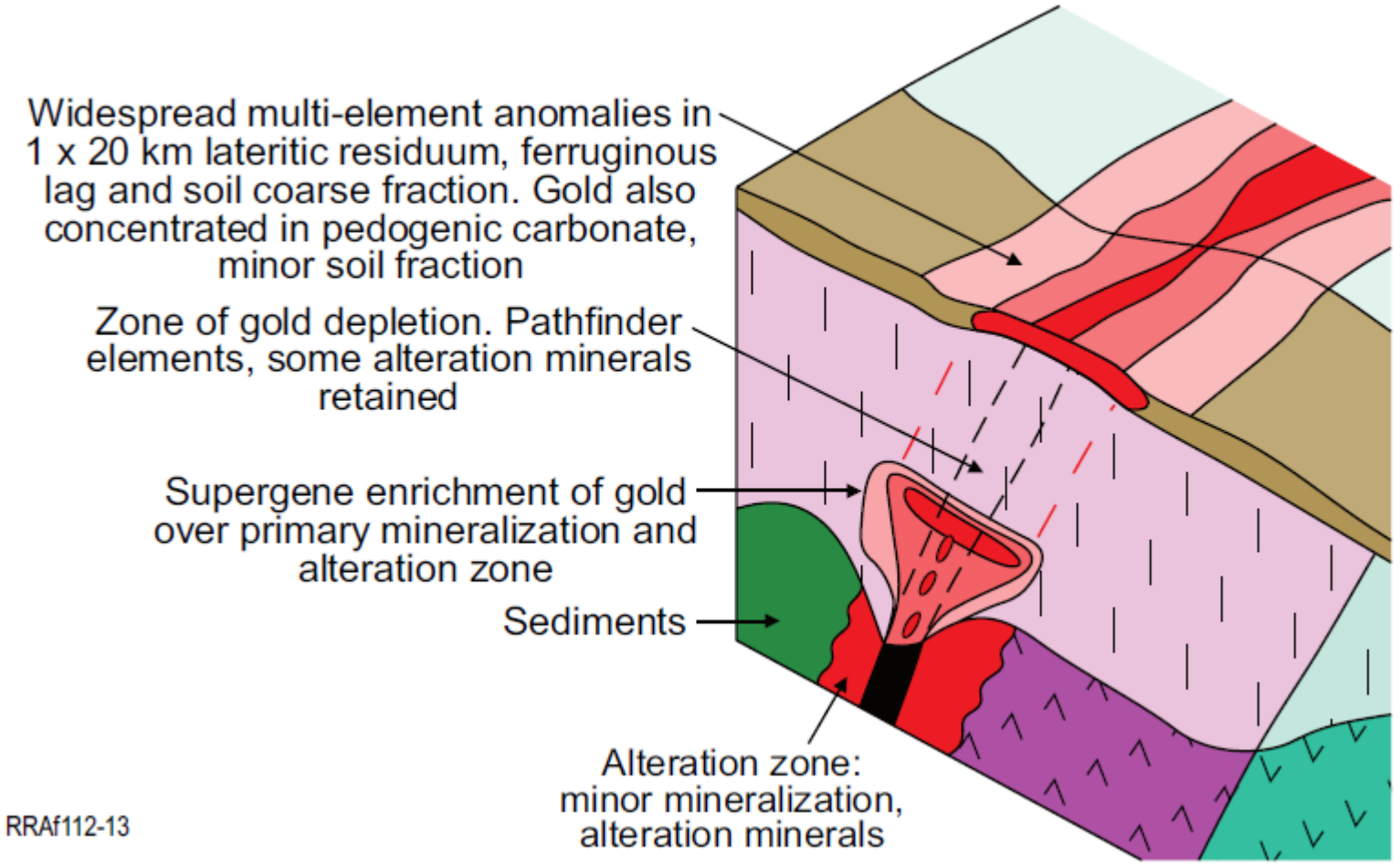




after Lawrance, 2001

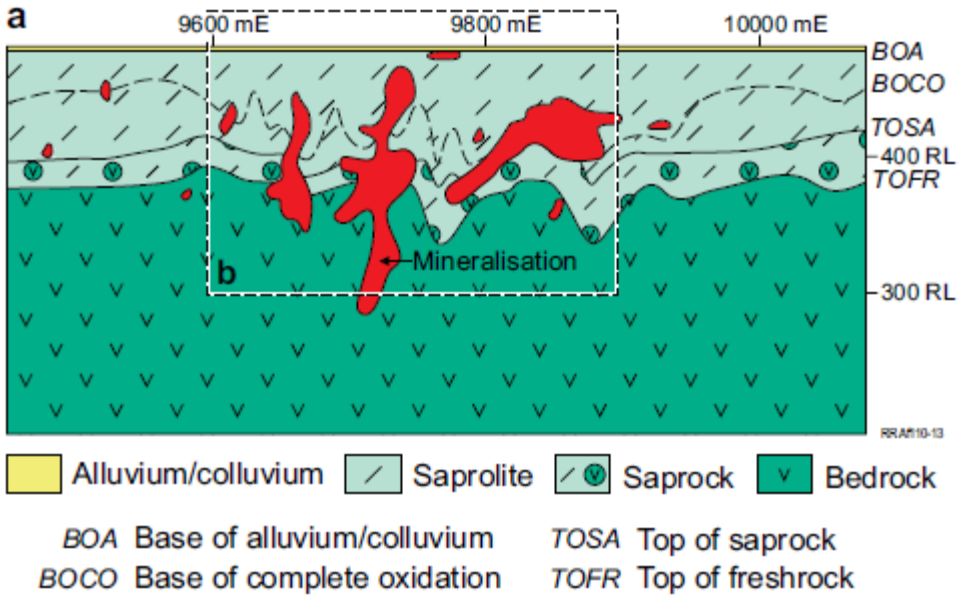
Bs056-04

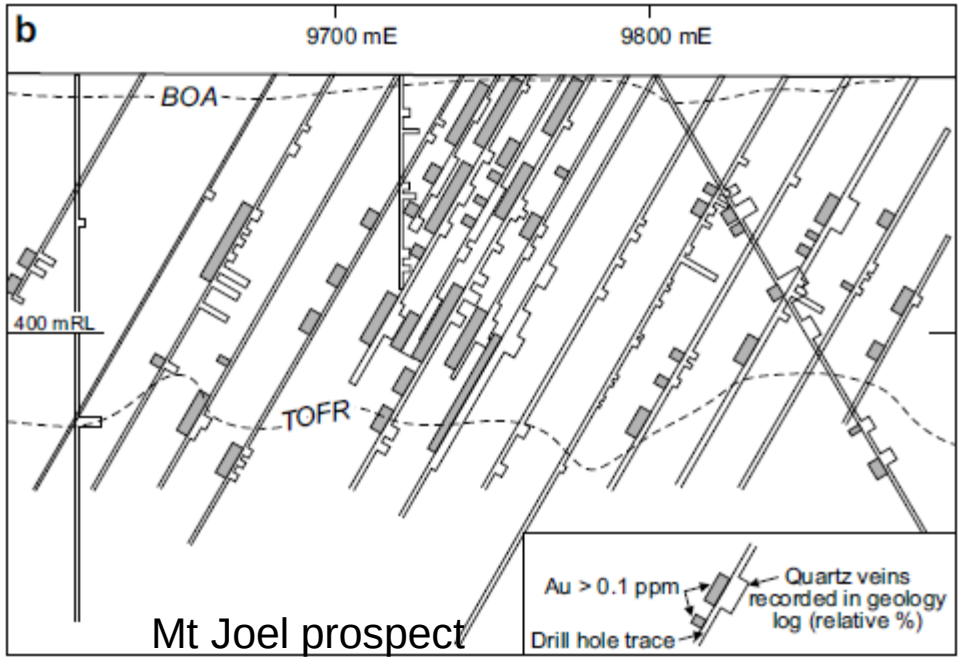
Exploration in southwest Yilgarn – saline, acidic groundwaters



After Anand & Butt (2010)

Exploration for Au in northern Yilgarn – non-saline groundwaters





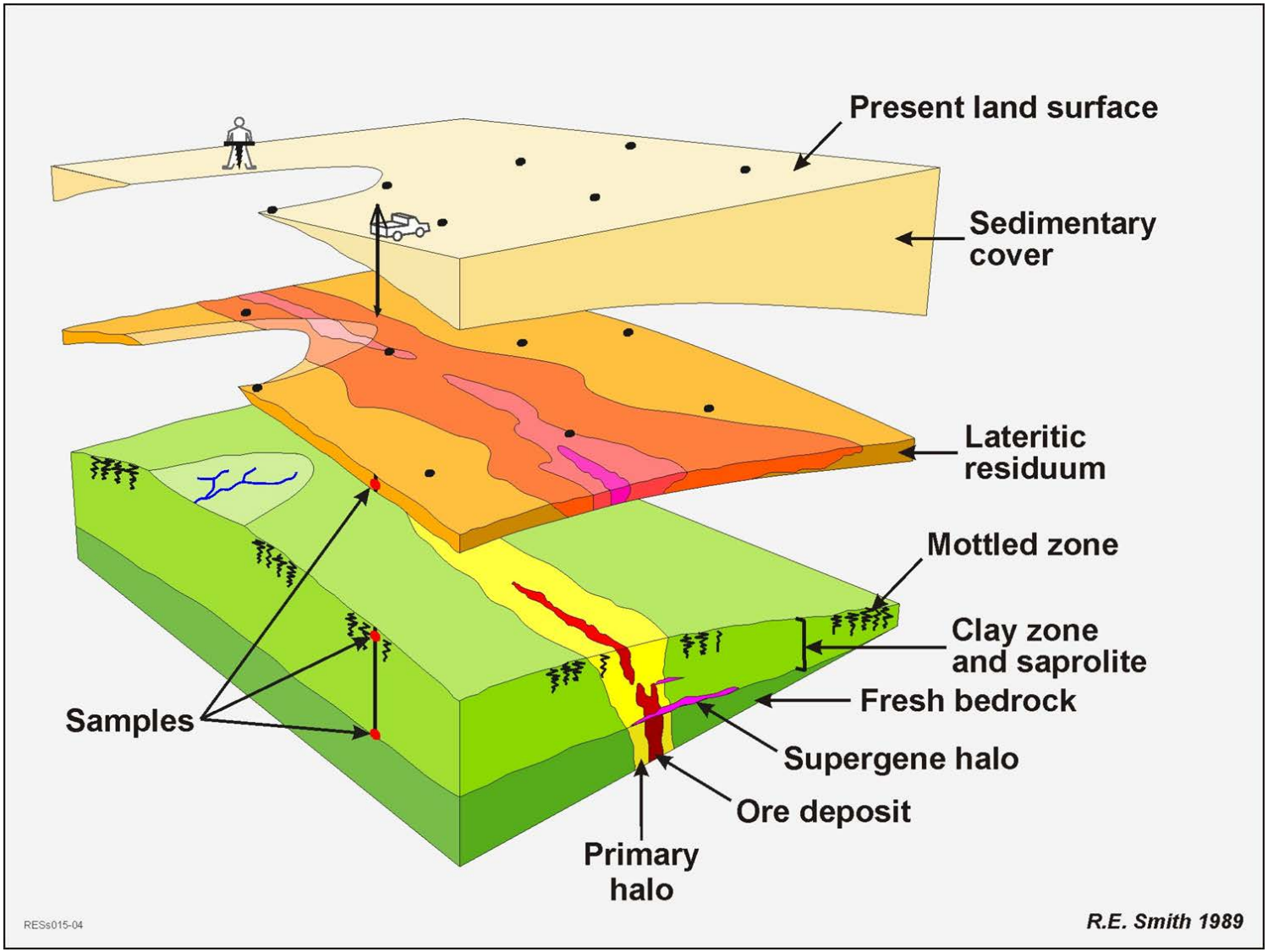
Mt Joel prospect

Au is strongly related to quartz veins even in saprolite– no mobilisation

Surface sampling

- Ferruginous lag with multi-elements
- Soil (<100m) multi-element for coarse (0.5 mm) and fine fractions
- Saprolite: Au and pathfinders throughout the profile with minimal vertical or lateral dispersion

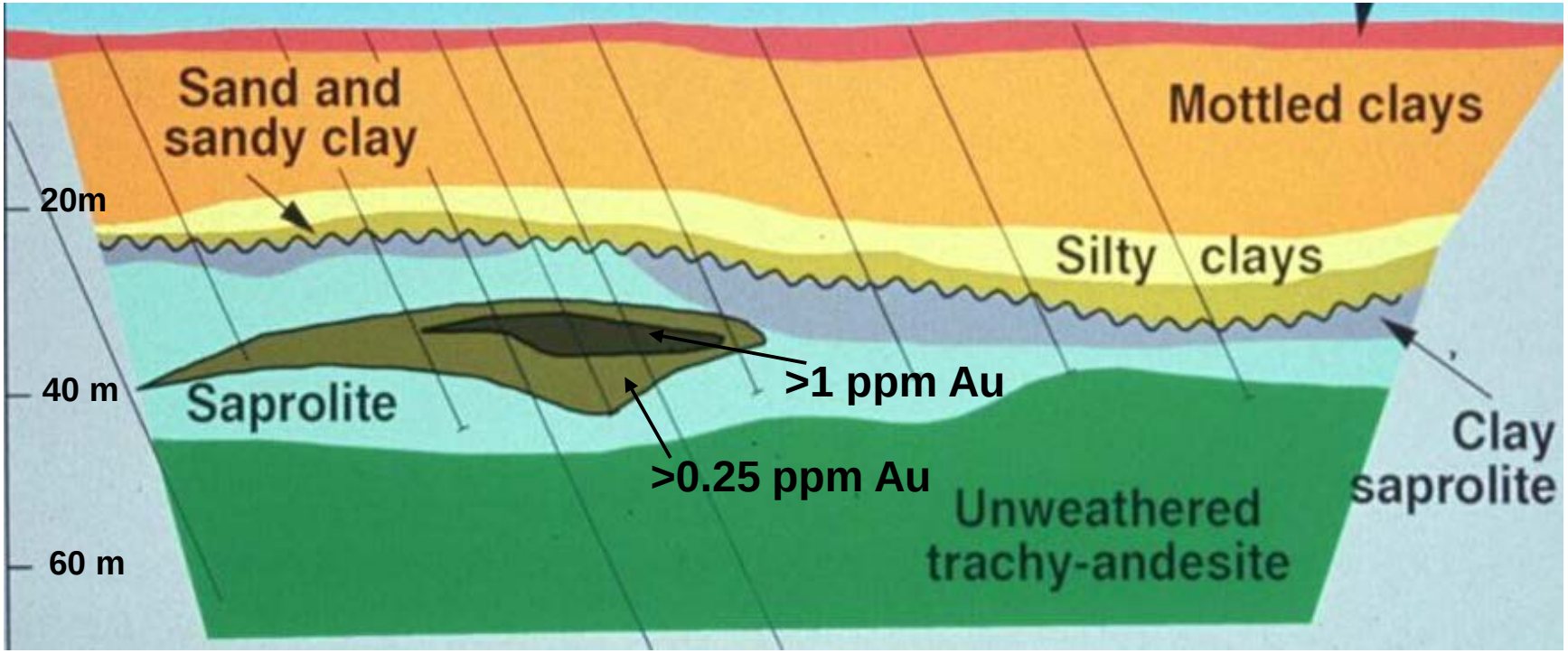
Exploration strategies in deeper depositional terranes?



Palaeochannel gold enrichments

SW Yilgarn, Au occurs in basal sediments or saprolite immediately below the channel base

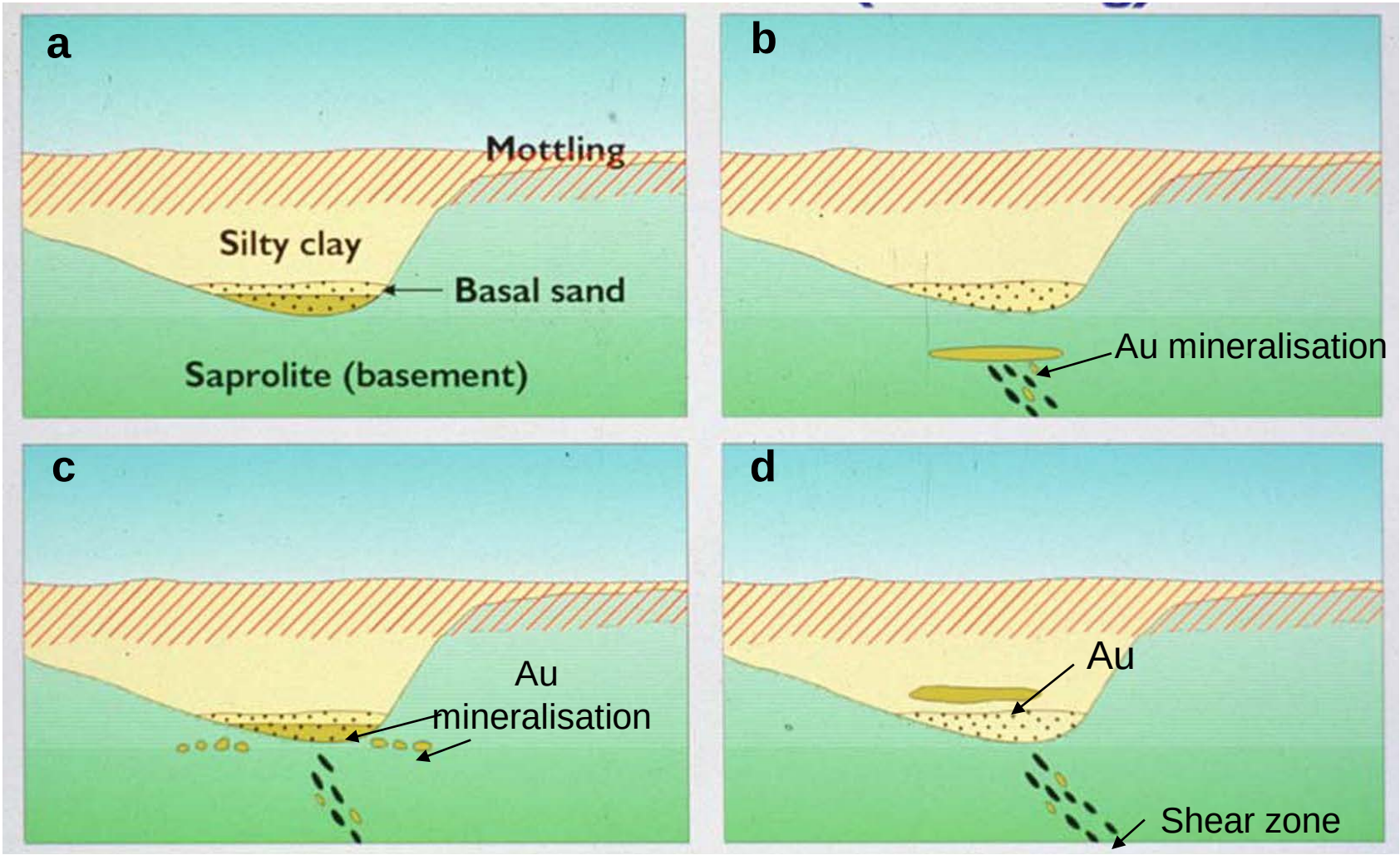
Au grains are Ag poor



Steinway paleochannel cross-section

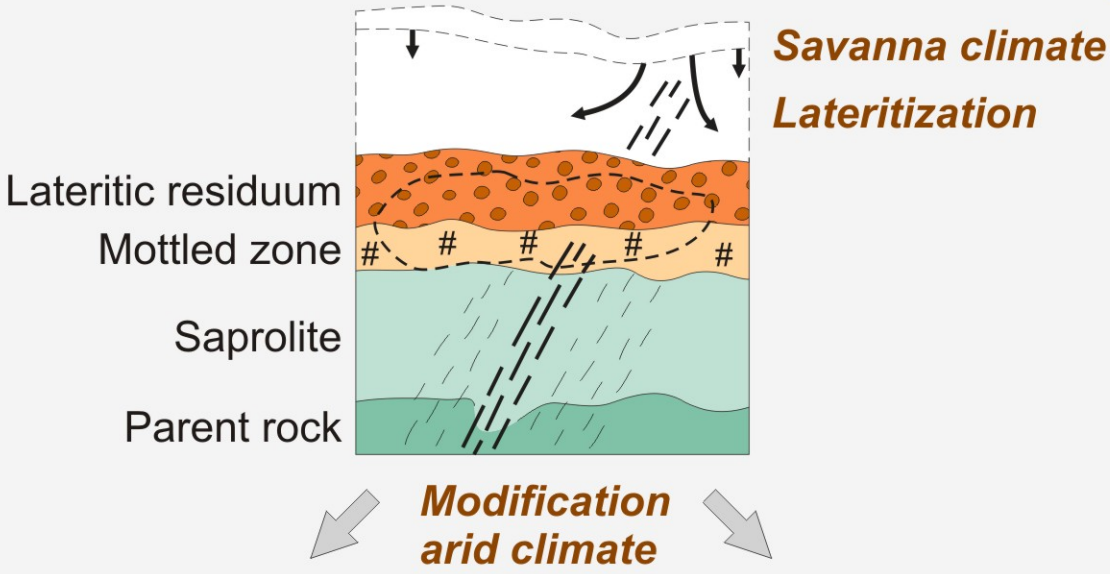
Supergene enrichments of Au in paleodrainages

Au likely sourced from underlying shear hosted mineralisation
Au grains are Ag poor and often grade cross-cuts facies boundaries



Butt (1998) Supergene Au deposits. AGSO Journal, 17(4)

Supergene Gold Deposits



Summary of processes – arid terrain

Weathering

Gold mobilization

Early climate – Cretaceous to early Miocene

Warm to tropical, humid savanna; or possibly Mediterranean?

Deep weathering

Physical and chemical enrichment in laterite

Lowering of land surface

Minor loss from saprolite

Lateritization

Mobile as *organic (& hydroxide?) complexes*

Later climate – mid-Miocene to present

Semi-arid

Lowering of water-table and redox front

***In south:* formation of depletion zone**

enrichment in saprolite: *chloride*

Erosion

destruction of lateritic enrichments

Continued slow weathering

dispersion into surface horizons, concentration in pedogenic carbonate: *biogenic/organic complex*

***In north:* little gold mobility**