

OROGENIC GOLD WORKSHOP

ANGLOGOLDASHANTI
MEETINGS 2010

COLOMBIA
EGYPT
ERITREA
UGANDA

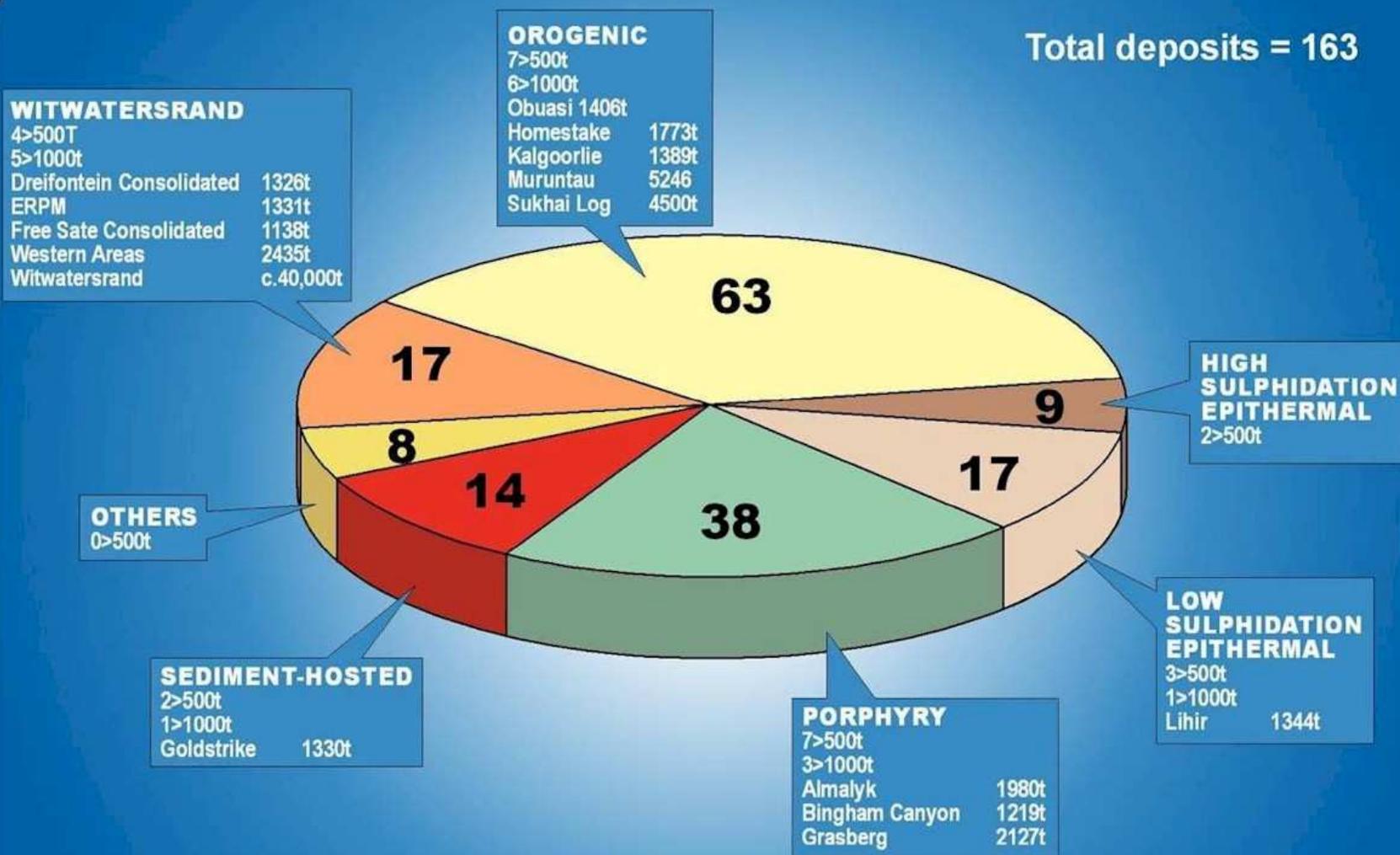


PRESENTER
PROFESSOR DAVID I GROVES

CONTENTS OF WORKSHOP

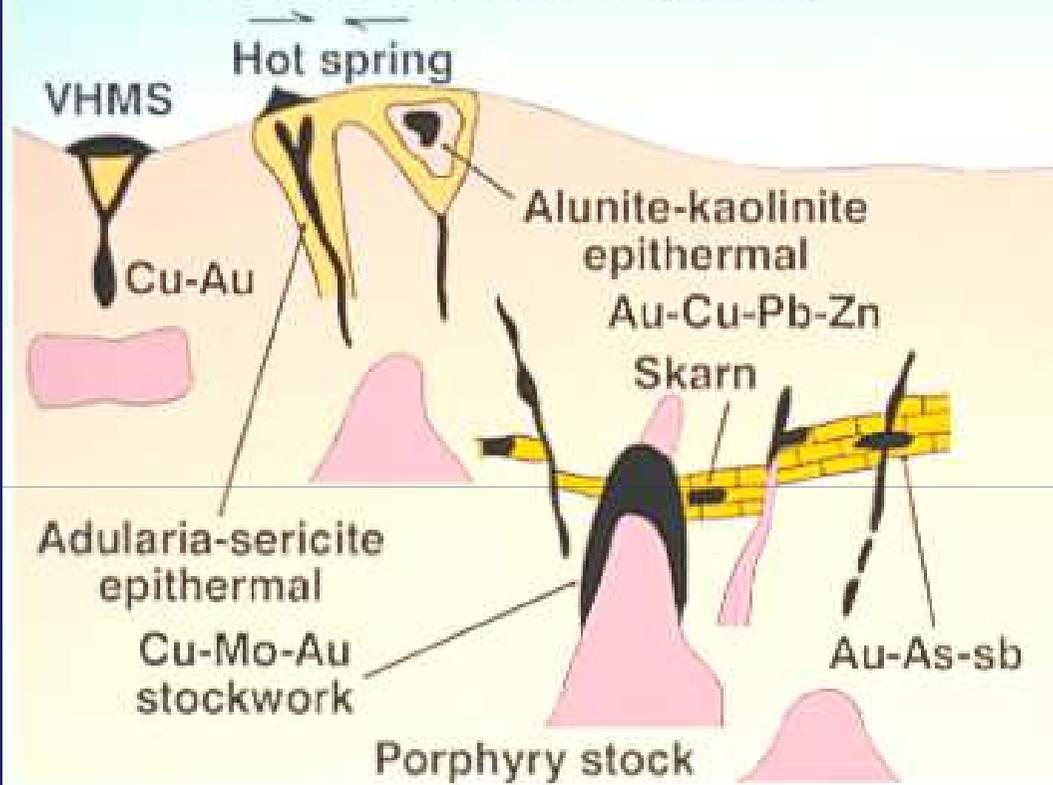
1. NATURE AND TECTONIC SETTING OF OROGENIC GOLD DEPOSITS
2. LITHOSPHERIC SCALE ENERGY SOURCES AND PROCESSES
3. TIMING OF OROGENIC GOLD SYSTEMS
4. DEPOSITS AT DIFFERENT CRUSTAL LEVELS
5. CRUSTAL CONTINUUM MODEL
6. CONSTRAINTS ON ORE GENESIS
7. AN OROGENIC GOLD MINERAL SYSTEM
8. STRUCTURAL AND HOST ROCK CONTROLS
9. PRODUCTIVE VS POORLY ENDOWED TERRANES
10. CONCEPTUAL TARGETING AND PROSPECTIVITY ANALYSIS

GOLD DEPOSITS >100t Au : NUMBERS OF DEPOSITS



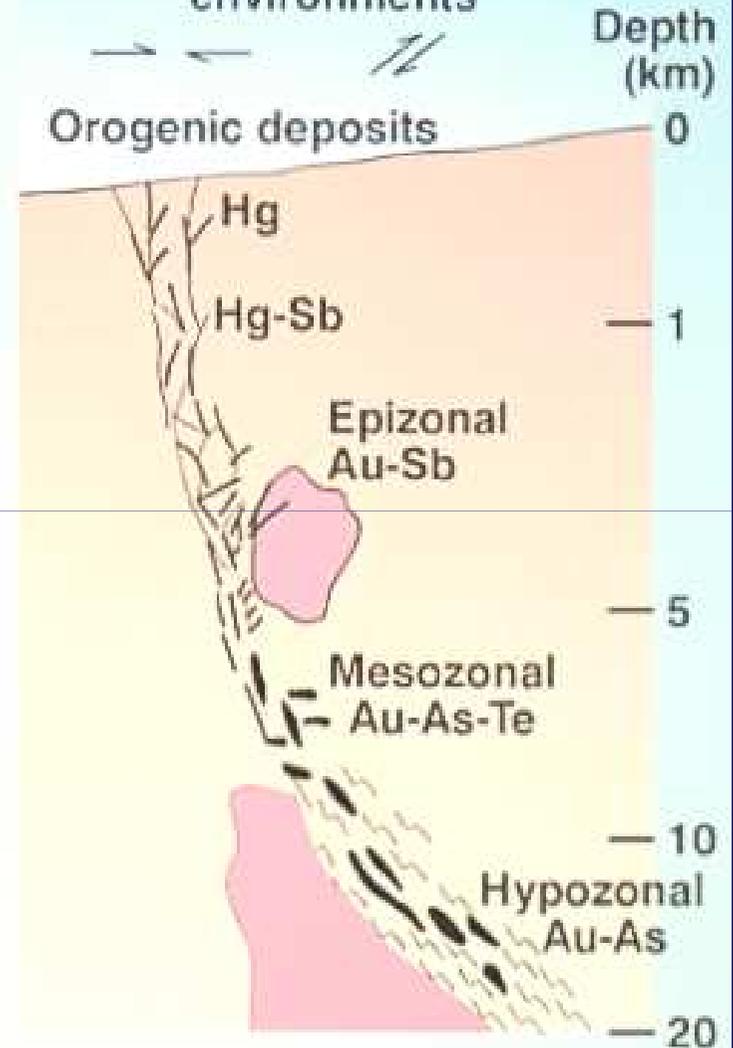
Total tonnage of deposits = 102,575tAu

More extensional domains in compressional to extensional environments



Constructional (volcanosedimentary) stage and post-orogenic extension

Compressional/transpressional environments



Orogenic stage

FEATURES COMMON TO MAJORITY OF OROGENIC GOLD DEPOSITS

1. At or near terrane boundaries (or other crustal-scale faults/ shear zones).
2. Strong structural control in lower-order structures.
3. Large vertical extent with subtle vertical zonation.
4. Typically K-mica and carbonate alteration at greenschist facies.
5. Characteristic addition of SiO₂, K, Rb, Ba+Na+B.
6. Characteristic ore metals : Au+Ag+As+Sb+Te+W with low Pb-Zn-Cu.
7. Low salinity H₂O-CO₂ + CH₄ ore fluid.
8. Radiogenic and stable isotope signatures indicate mixed sources.

CONTRASTS BETWEEN OROGENIC AND GOLD-ONLY INTRUSION - RELATED GOLD DEPOSITS

- 1. IRGD mostly Phanerozoic : few unequivocal Precambrian examples?**
- 2. IRGD restricted to shelf environments adjacent to Precambrian cratons?**
- 3. IRGD occur in provinces with Sn and W deposits**
- 4. IRGD related to transitional magnetite - to ilmenite-series granitoids : alkaline(?) lamprophyre(?) associations?**
- 5. Endocontact IRGD approx. 1 g/t Au : c.f. other magmatic deposits.**
- 6. IRGD systems zoned from Au (or Sn, W) to Zn, Pb, Ag.**

CONTINENT

OCEANIC ARC

BACK ARC

ACCRETED
TERRANES

CONTINENTAL
ARC

BACK-ARC
CRATON
MARGIN

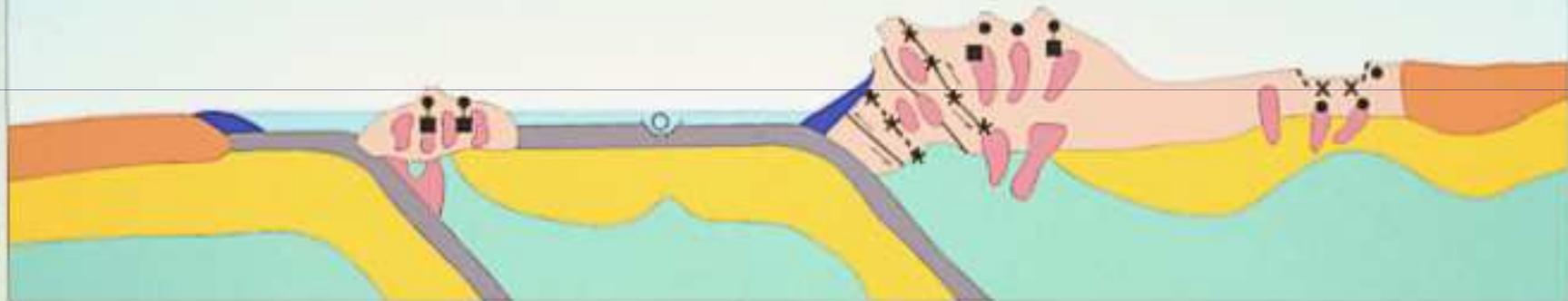
- Epithermal Au-Ag
- Porphyry Cu-Au (\pm skarns)

○ VHMS Cu-Au

* Orogenic Au

- Epithermal Au
- Porphyry Cu-Au-Mo (\pm skarns)

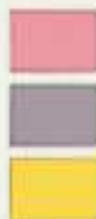
- Intrusion-related Au
- x Carlin-style Au



Accretionary wedge

Continental crust

Older craton



Granitoids

Oceanic crust

Subcrustal lithosphere



Asthenosphere

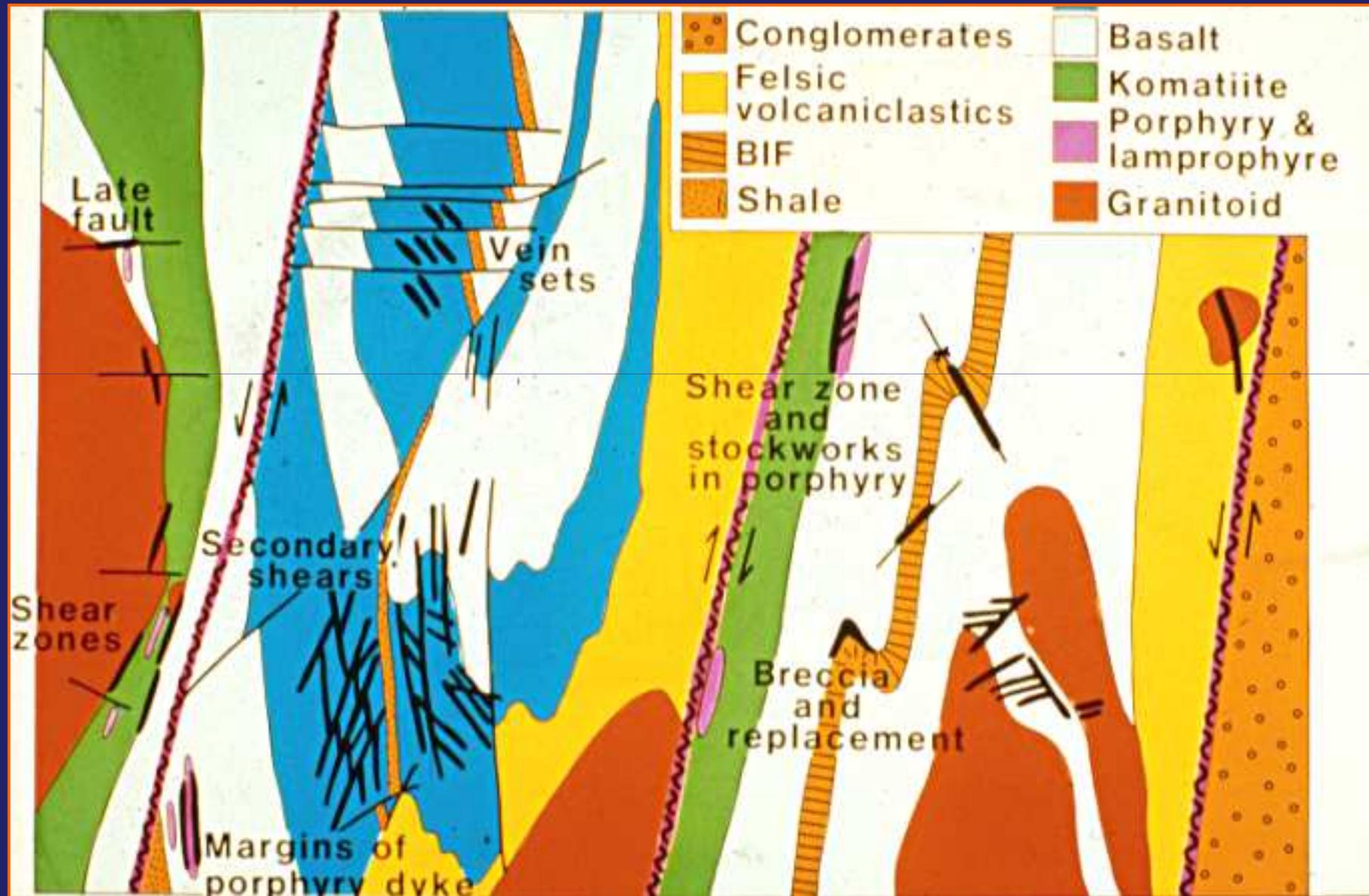
Extensional fault

Compressional fault/thrust

Paleozoic Tectonic Provinces of the Western U.S. Cordillera



TYPICAL DEPOSIT STYLES IN PRECAMBRIAN GREENSTONE BELTS

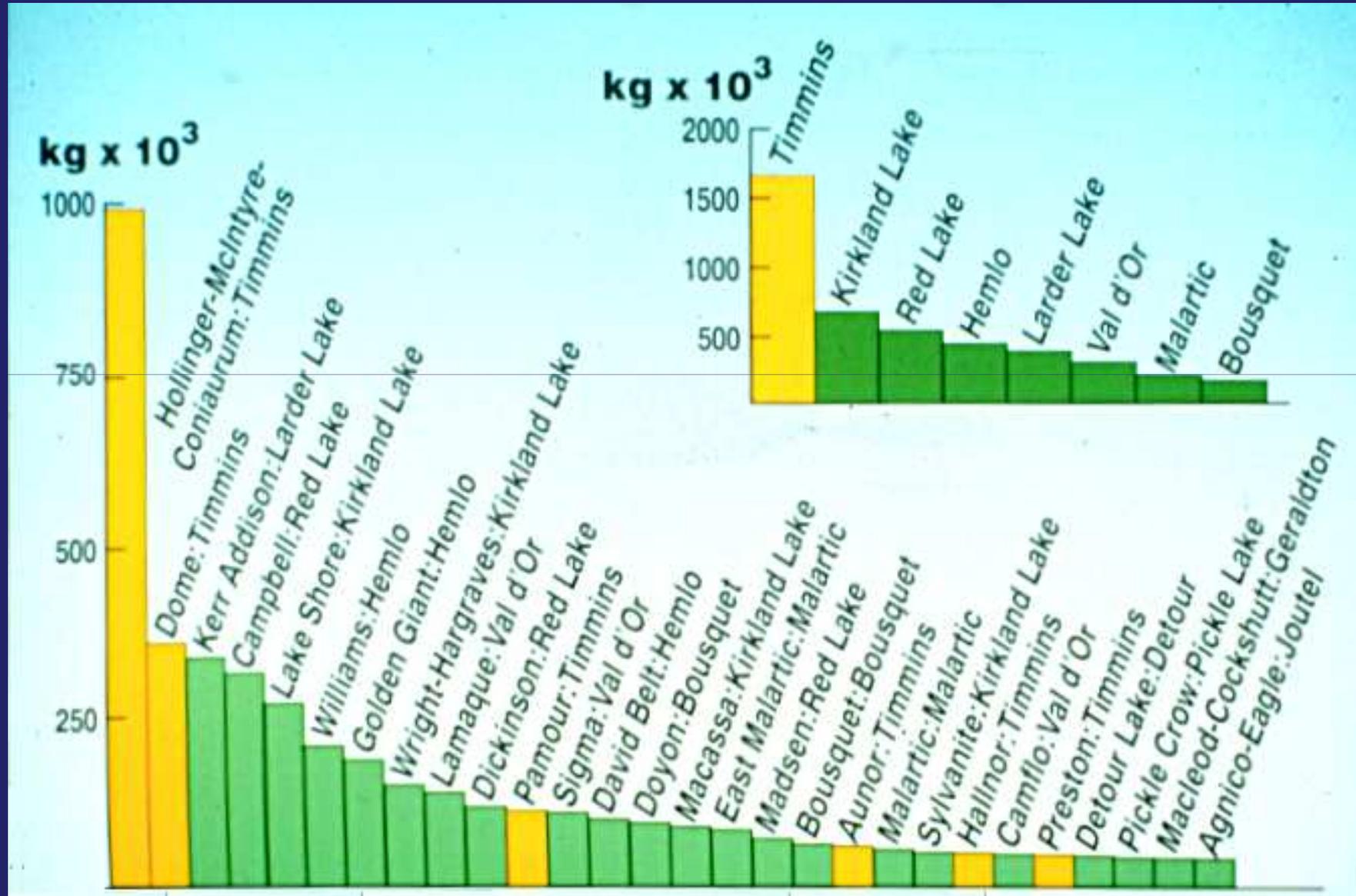


AVERAGE GOLD GRADE VS ORE TONNAGE BY DEPOSIT STYLE



- | | | |
|--|---|---|
| ■ Lode | ● Porphyry | ● Carlin Type |
| ▲ Epithermal | ■ VMS | ■ Muruntau |
| | | ● Witwatersrand |

CLASSIC SIZE DISTRIBUTION IN MATURE TERRANE



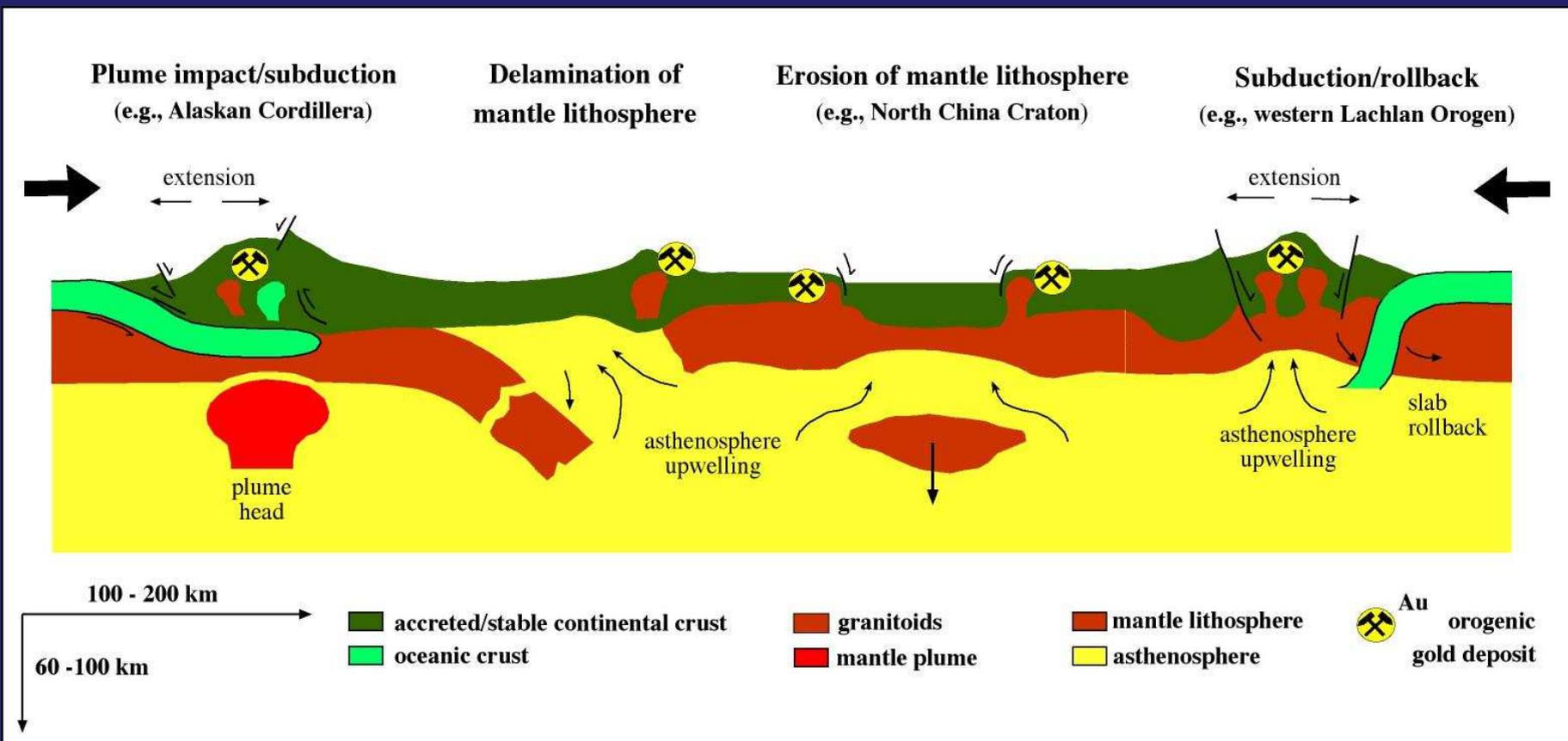


Pz Gold



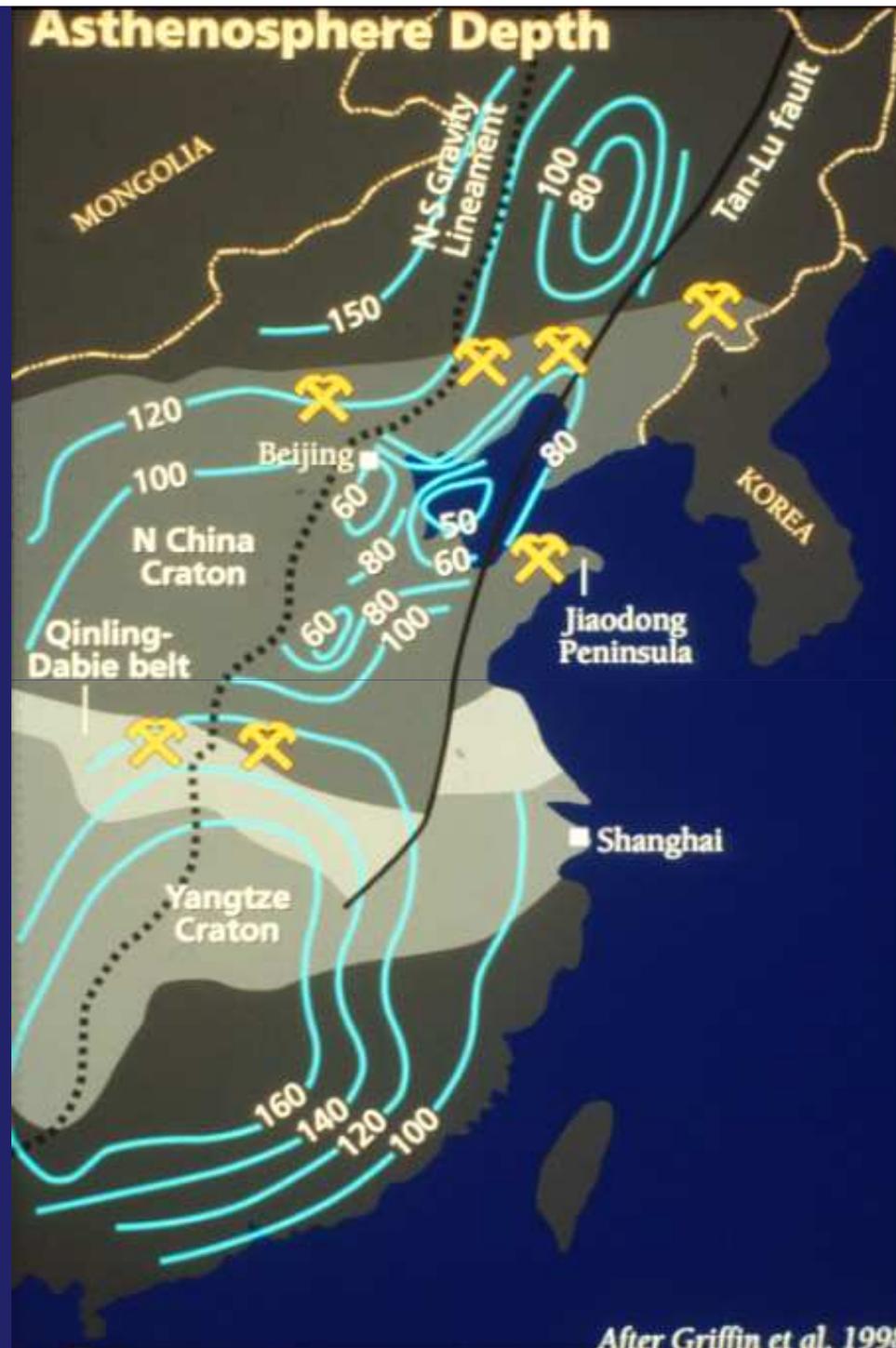
1. Thomson Fold Belt
2. Lachlan Fold Belt
3. Westland, S Island, NZ
4. Sierra Pampeanas
5. Northern Kazakhstan
6. Altai
7. Caledonides
8. Meguma
9. Carolina Slate Belt
10. Central Ural Mts
11. Bohemian Massif
12. Iberian Massif
13. Eastern Tian Shan
14. Western Tian Shan
15. Northern China Craton
16. Arabian-Nubian Shield
17. Hoggar Shield
18. Telfer
19. Brasília Fold Belt

LITHOSPHERIC THERMAL AND FLUID FLUX



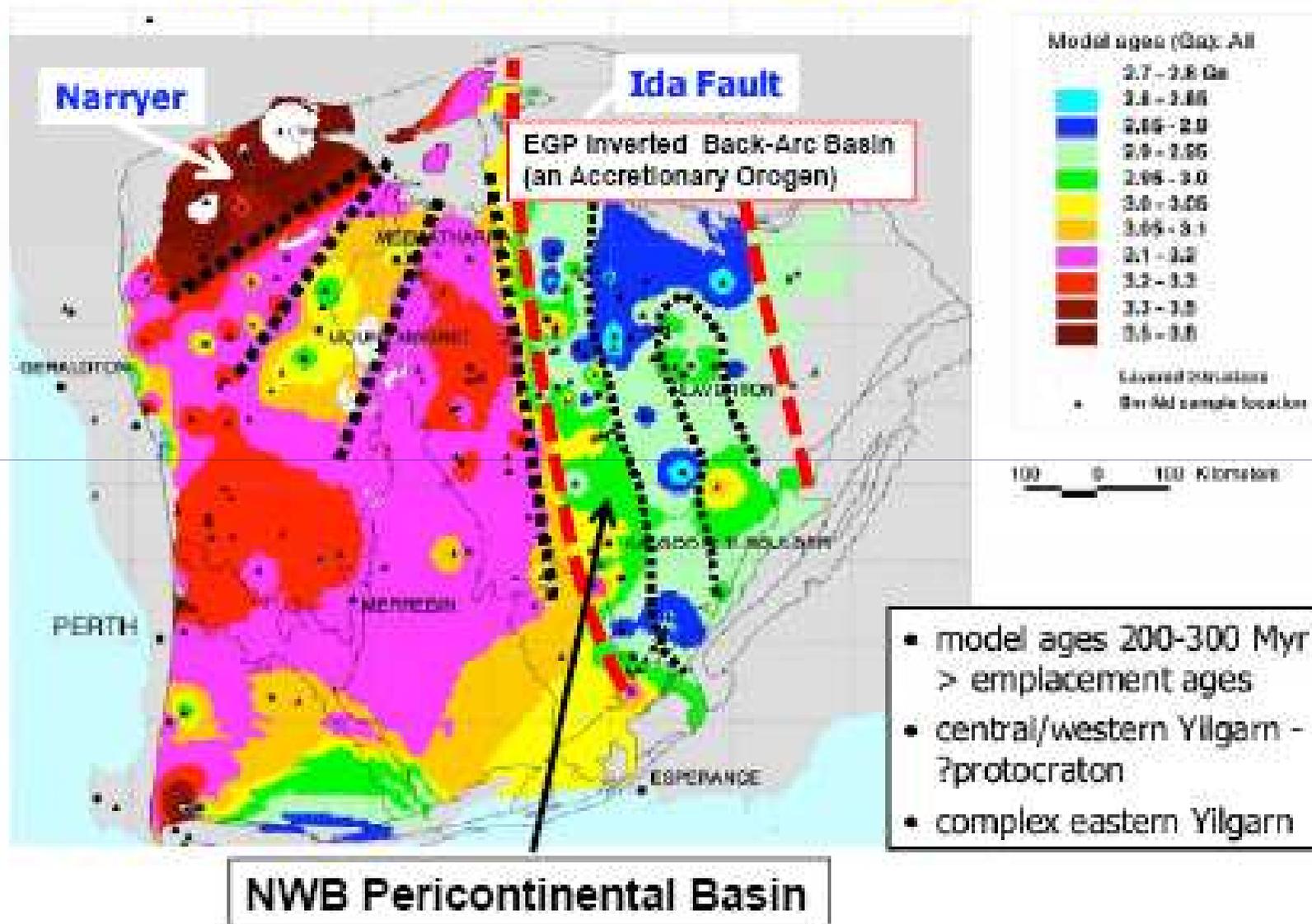
Bierlein et al. (2006)

Asthenosphere Depth



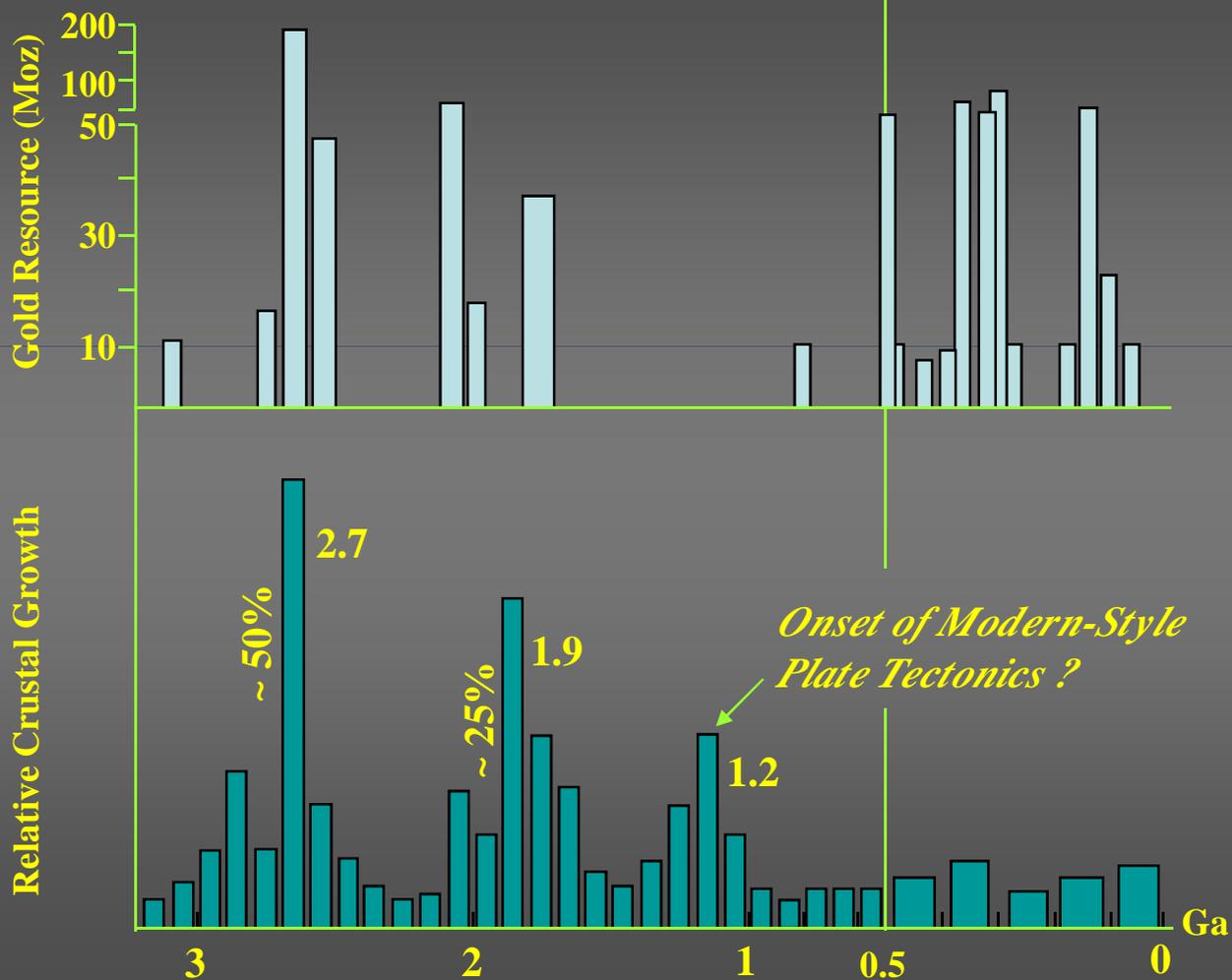
After Griffin et al. 1998

Yilgarn granites: Nd isotope map



Cassidy & Champion (2004)

OROGENIC GOLD VS CRUSTAL FORMATION EVENTS



CRUSTAL SCALE OF OROGENIC SYSTEMS

SCHEMATIC CROSS SECTION ACROSS VICTORIA, AUSTRALIA

W

E

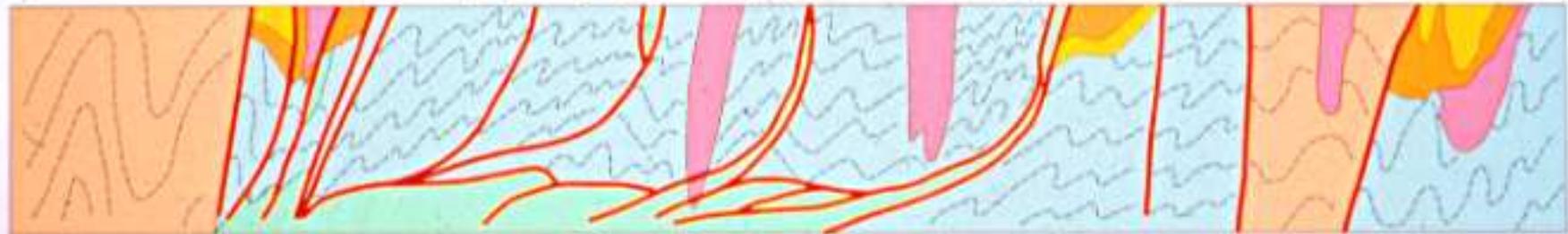
GLENELG

STAWELL

BALLARAT

MELBOURNE

BUCHAN



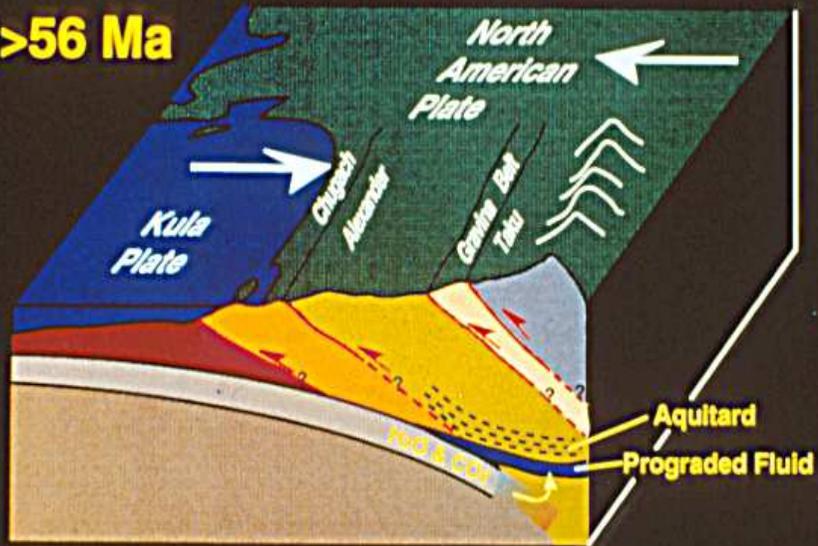
- Granitoid
- Devonian Felsic Volcanics
- Silurian to L. Carboniferous

- Cambrian to L. Devonian
- Cambrian Basalts
- Cambrian-Ordovician

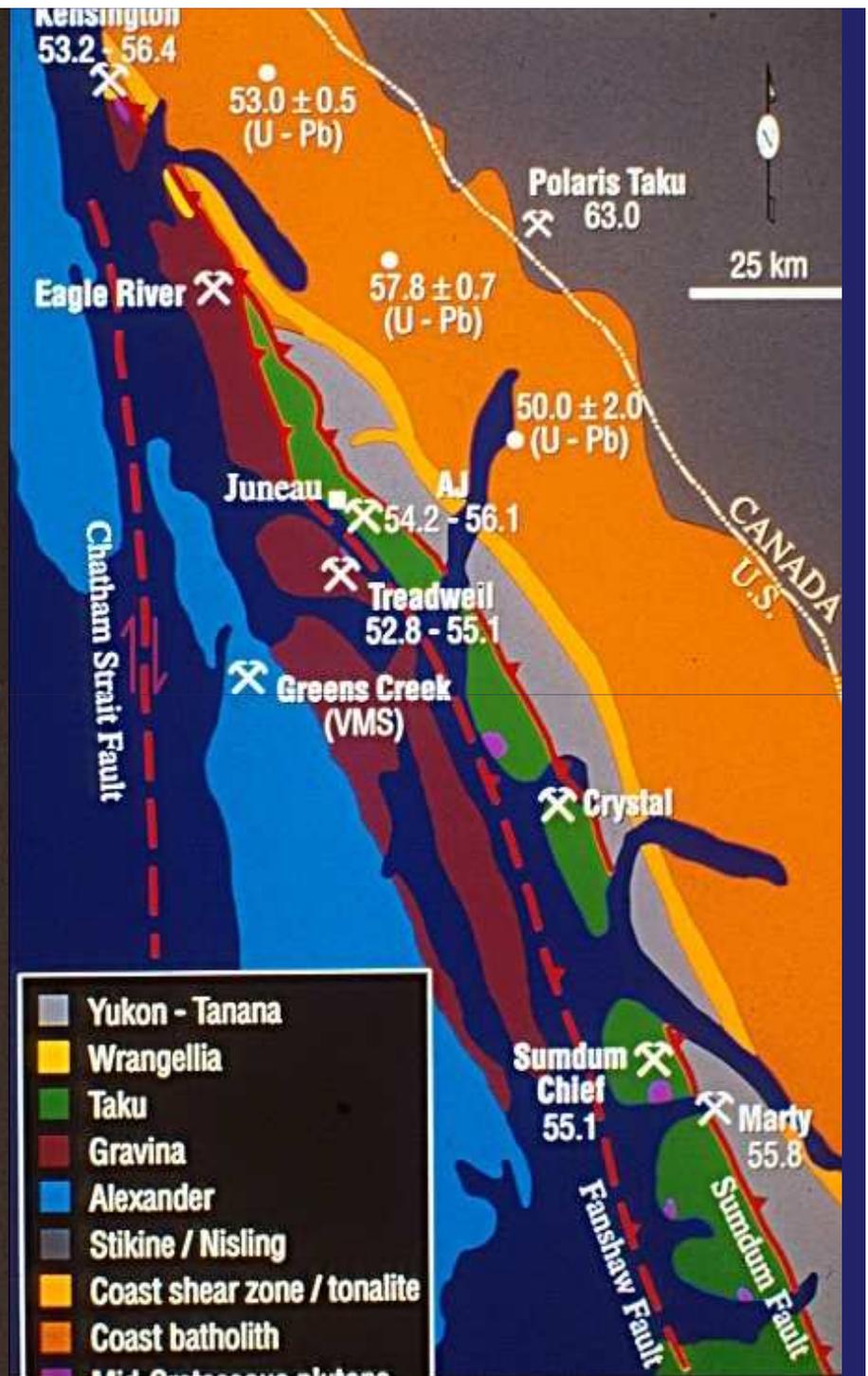
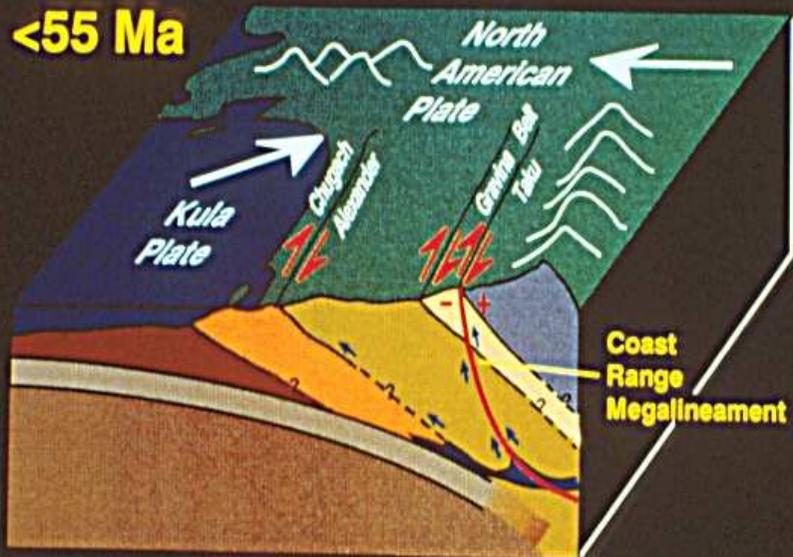
Major fault/thrust zone

100 km
(approx.)

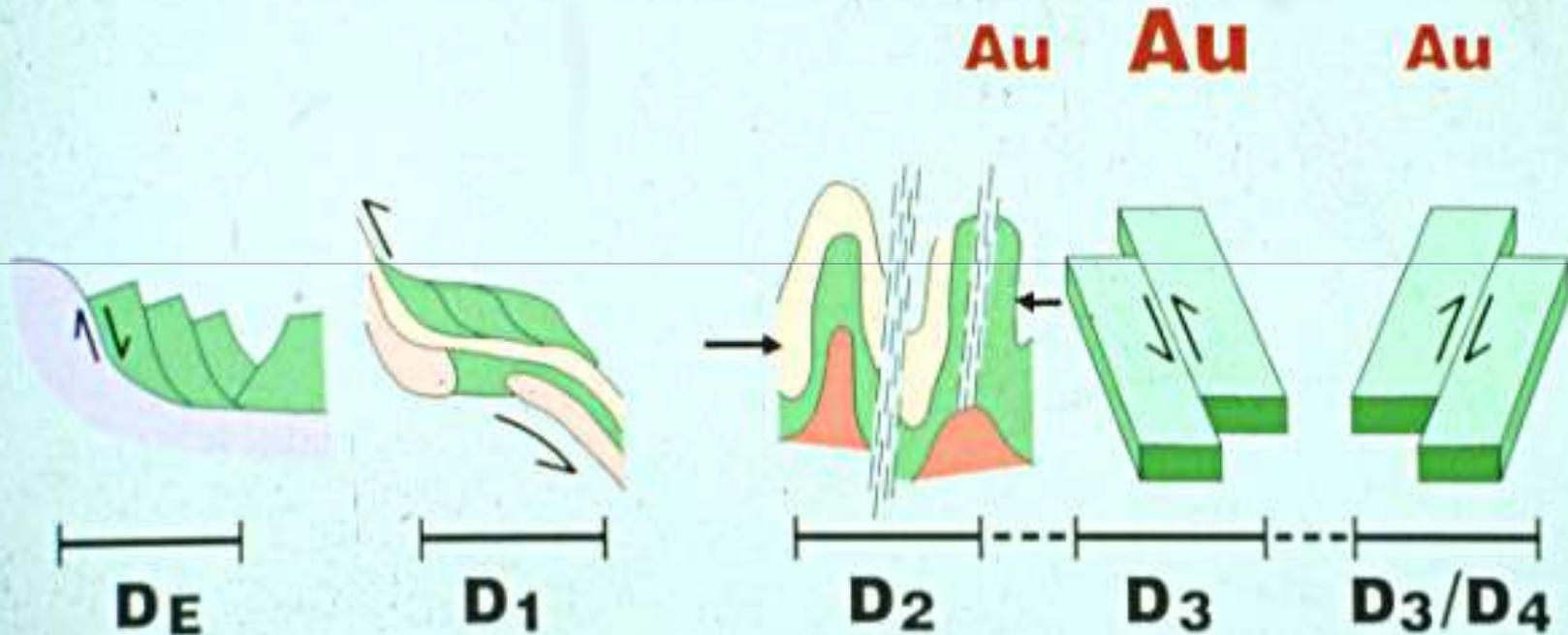
>56 Ma



<55 Ma



SCHEMATIC DEFORMATION AND GOLD TIMING (Sketches based on greenschist facies terrains)



ca. 2.7 Ga

Relative Timing

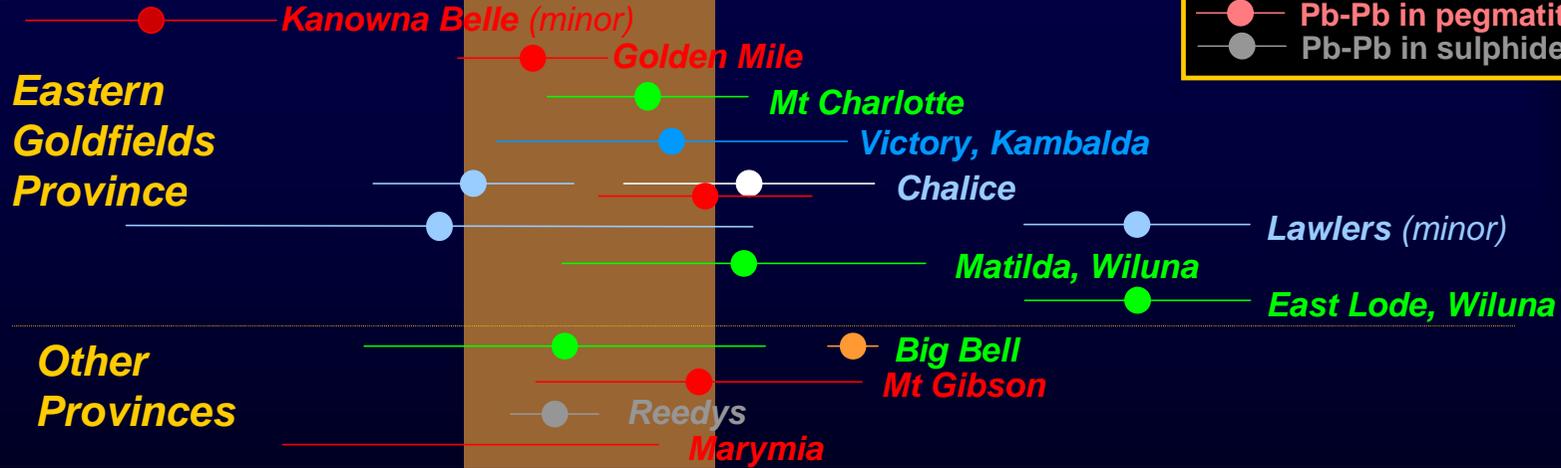
ca. 2.6 Ga

TIMING OF YILGARN GOLD

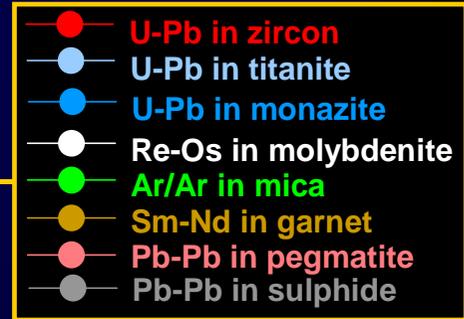
Youngest rocks hosting gold mineralisation



Ages of gold mineralisation



Oldest rocks syn to post gold mineralisation



2680Ma 2660 2640 2620 2600 2580 2560Ma

Eastern Goldfields Province
Scotia
Other Provinces

YILGARN CRATON SHOWING PLUTONIC (15) IN RELATION TO EGP

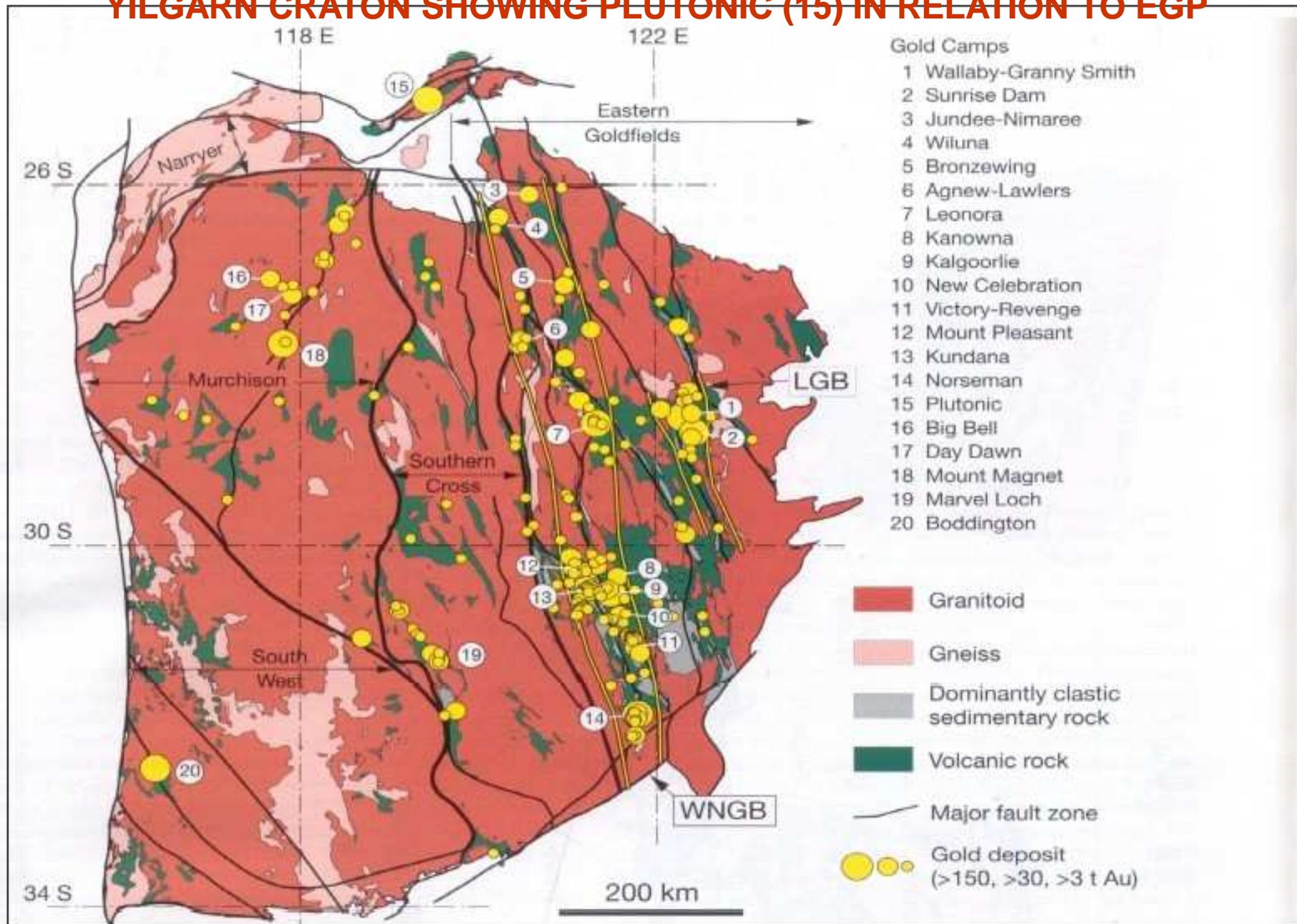
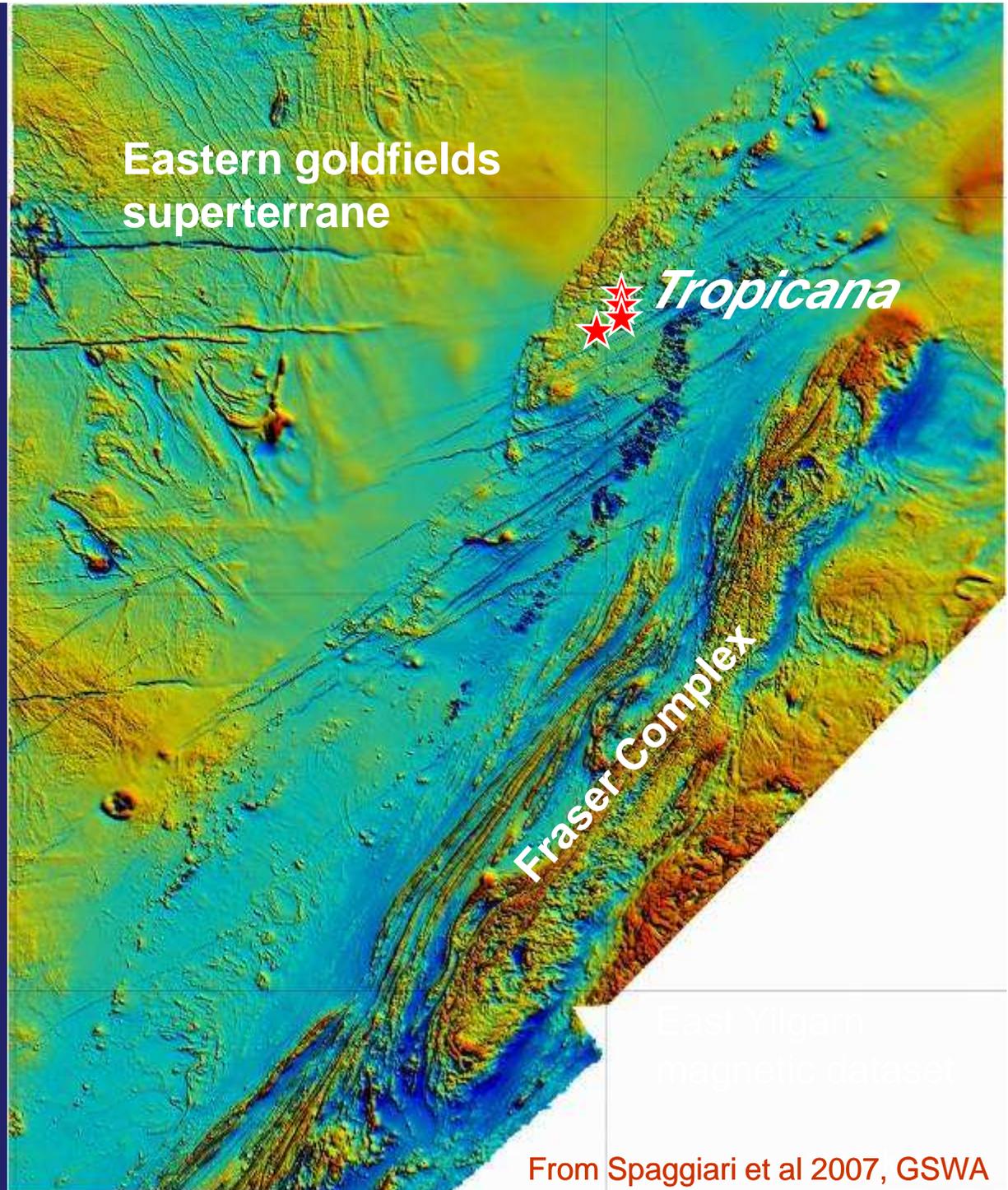


Figure 8.3: Simplified geologic map of the Yilgarn Craton, Western Australia showing subdivisions of gold provinces; illustrating the occurrence of large gold deposits in association with thin slices of greenstones in extensive granitoids and gneisses (map adapted from Robert et al., 2005).

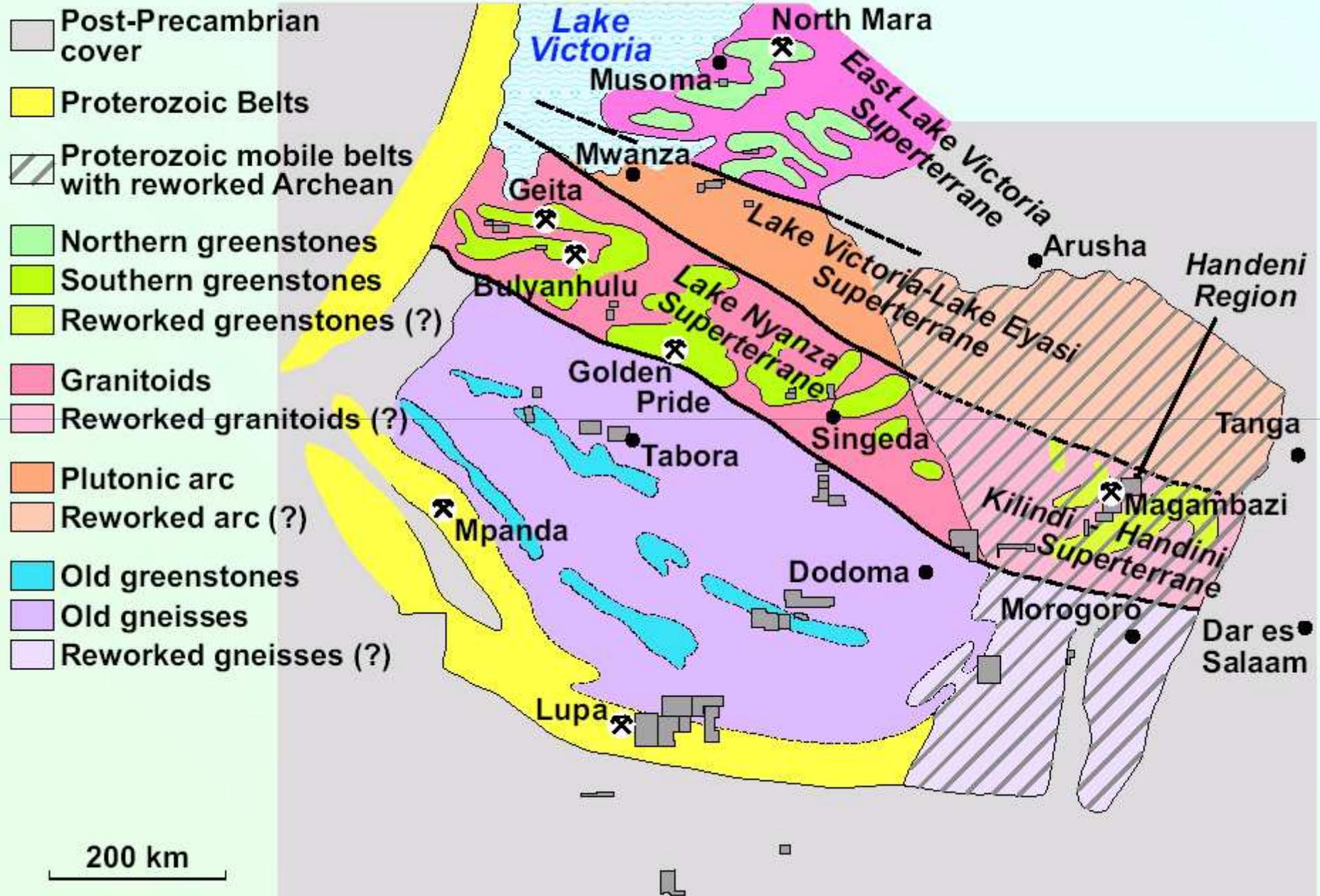
TROPICANA GOLD DEPOSIT (4Moz Au)

- AngloGold Ashanti /Independence greenfields gold deposit
- High-grade intersections, e.g. 29m@5.1g/t Au from 57m
- Appears to be located within reworked Yilgarn Craton margin



From Spaggiari et al 2007, GSWA

SCHEMATIC MAP OF TANZANIA CRATON



New terminology of Kabete et al., (2007)

MAGAMBAZI SETTING STRATIGRAPHIC MINERALIZATION

