AIG BASE METALS SYMPOSIUM

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EXPLORATION MODELS:

YOU CAN FLIRT WITH A MODEL.

YOU SHOULDN'T MARRY ONE

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Exploration models

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Models are used to interpret controls on ore localisation and to design appropriate exploration programmes

The paper looks at four sediment-hosted copper districts -

- **The Mount Gunson area in the Stuart Shelf of South Australia**
- **The Klein Aub area in the Kalahari Copperbelt of Namibia**
- **The Mount Isa and Lady Annie areas in the western Mount Isa Block of Queensland**
- **The Kopermyn area in the Kaoko Copperbelt of Namibia**

Empirical & conceptual models

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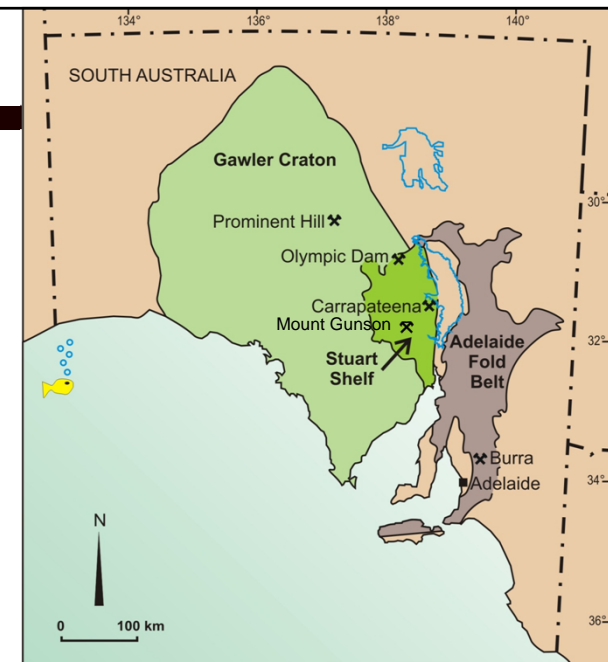Empirical models establish relationships between known deposits & host rocks. Problems -
• We might not recognise critical controlling factors
• We might emphasise controlling factors that are not valid for the entire range of possible deposit styles

Conceptual models establish how deposits form, then apply those concepts in the search for new deposits. Problem -
• Assumes a detailed knowledge of the ore-forming process. Our theory may be wrong or incomplete
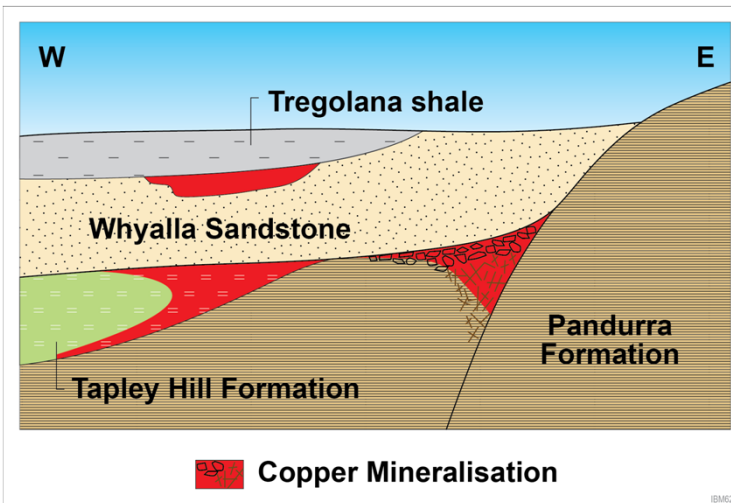
Mount Gunson,
Stuart Shelf,
South Australia

SOUTH AUSTRALIA

Gawler Craton

Prominent Hill

Olympic Dam

Carrapateena
Mount Gunson

Stuart
Shelf

Adelaide
Fold
Belt

Burra
Adelaide

N

0   100 km

Mount Gunson - Stratigraphic setting of deposits
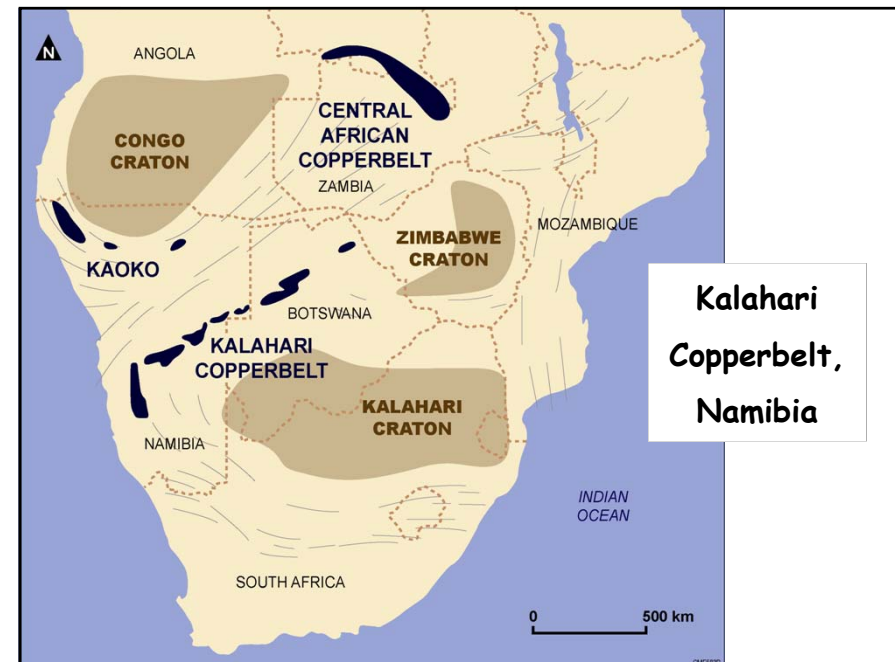
Mount Gunson - conceptual models

- Syngenetic / early diagenetic (sabkha model)
- Meteoric groundwater models
- Diagenetic - copper transported in connate groundwater towards basement high during basin compaction
- Epigenetic - copper pumped up reactivated faults during Delamerian (Cambrian) deformation

# Mount Gunson - exploration approach

1. Syngenetic / sabkha models
   - interpret depositional environments
   - stratigraphic drilling to locate favourable settings

2. Meteoric groundwater model
   - sample bedrock below lake mud

3. Diagenetic / basin compaction models
   - target reduced & permeable situations
   - stratigraphic drilling of favourable beds

4. Epigenetic model
   - target reduced & permeable zones adjacent to faults

Kalahari Copperbelt, Namibia

Klein Aub district - simplified geology
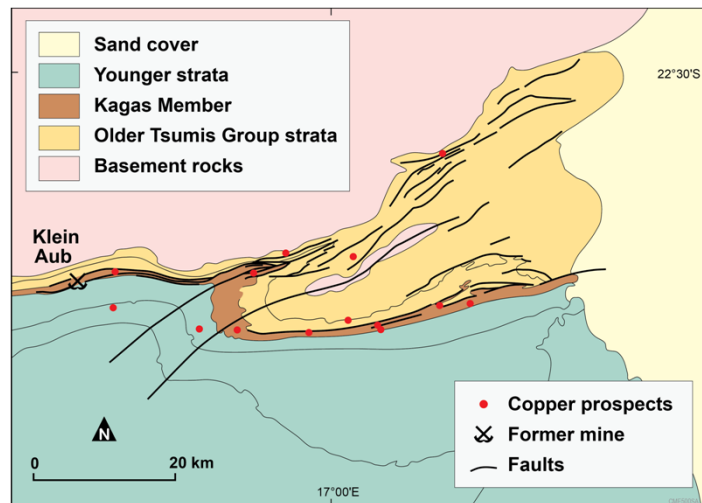
Klein Aub evolution
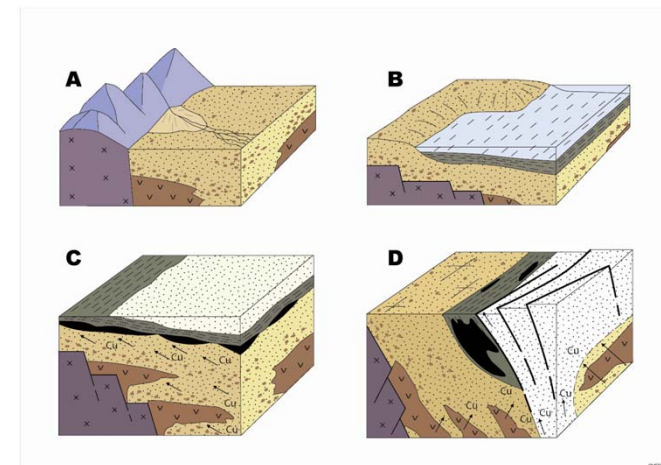
Chalcocite 'niches' in dolomitic slate
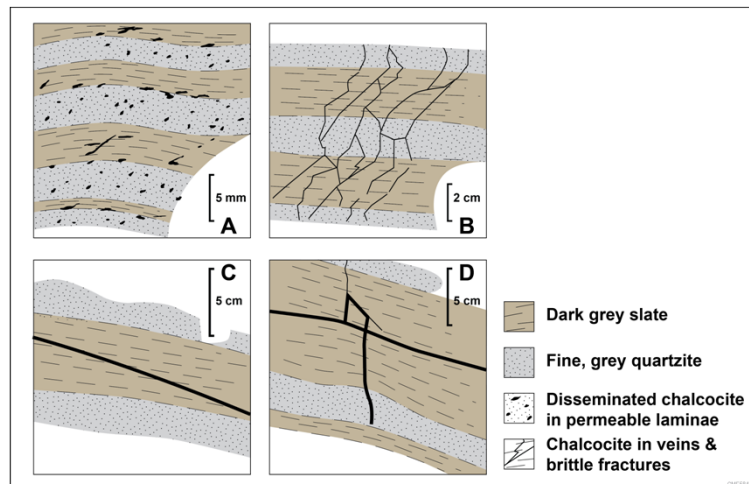
Sketch section, Klein Aub mine
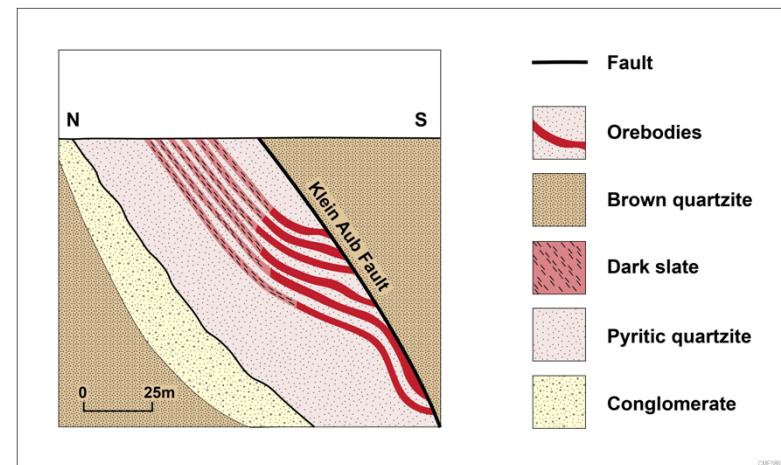
Klein Aub - conceptual models

- Syngenetic copper in playa lakes & near-shore marine setting
- Copper transported in connate groundwater towards basement high during basin compaction
- Copper pumped up reverse faults & thrusts during Damaran (Cambrian) deformation

Klein Aub - exploration approach

1. Syngenetic models
   - interpret depositional environments
   - stratigraphic drilling to locate favourable settings

2. Diagenetic / basin compaction models
   - identify reduced beds above red bed sequence
   - stratigraphic drilling of favourable (reduced) units

3. Epigenetic model
   - identify reduced & permeable zones adjacent to
       possible controlling structures
   - deep drilling down structure

Western

Mount Isa Block,

Queensland

MOUNT ISA BLOCK
GEOLOGICAL SETTING
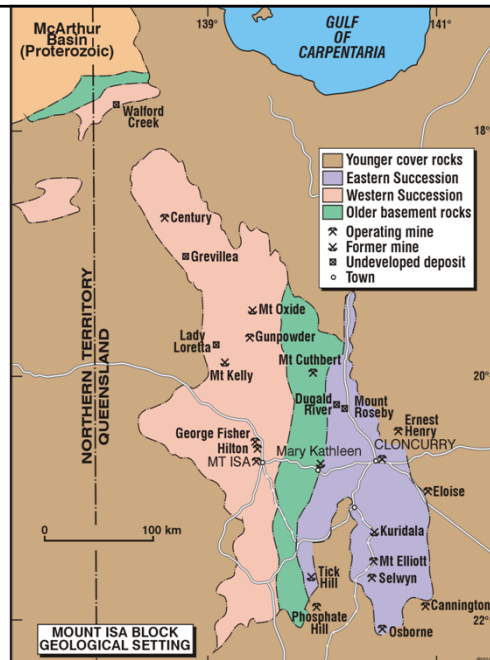
Mount Isa - observations

- Some copper deposits stratabound, others transgressive

- Copper in quartz-carbonate veins & breccia zones

- Deposits terminate against Basement Fault

- Copper associated with silica-dolomite alteration

- Highest ore grades (+3% Cu) associated with brecciated & silicified rocks adjacent to controlling faults

- Copper overprints cleavage

Epigenetic model (Perkins, 1984)

- Deposits post-peak metamorphism & cleavage development
- Copper leached from basalt into hydrothermal fluids
- Active faults tapped hydrothermal fluids
- Reaction with dolomitic rocks created alteration zones
- Copper precipitated in brecciated & altered rocks
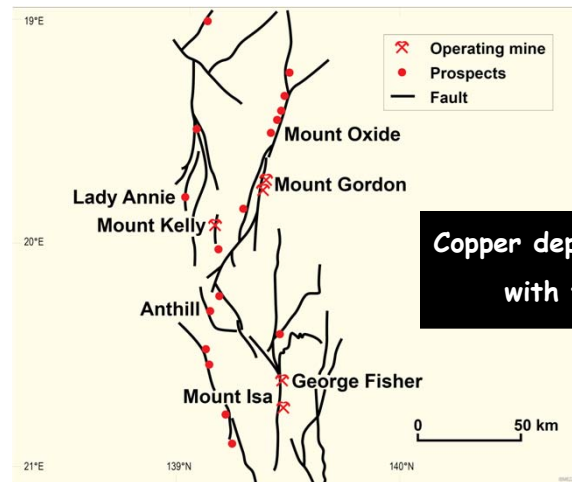- Multiple overprinting hydrothermal events

Mount Isa copper system
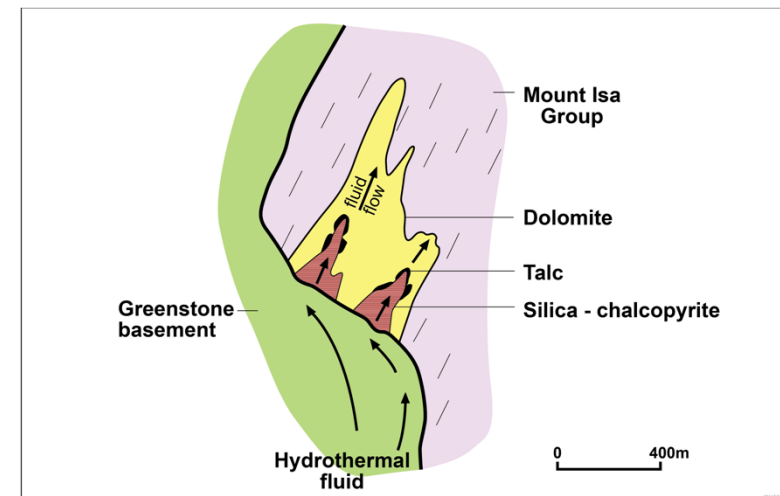
Epigenetic model - exploration implications

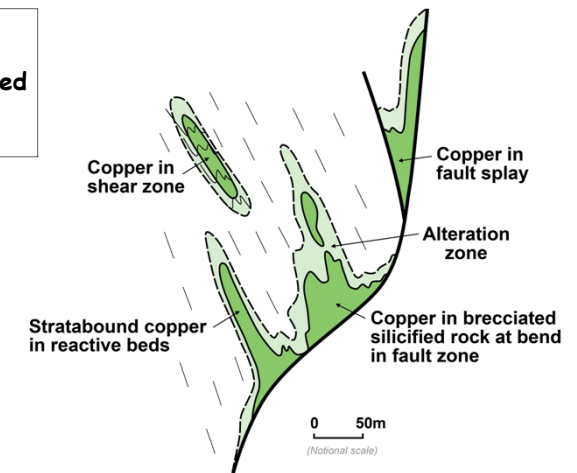**Copper deposits associated with fault zones**

Epigenetic model - exploration implications

Copper focussed in structurally-controlled dilatant sites

Mount Isa - exploration approach
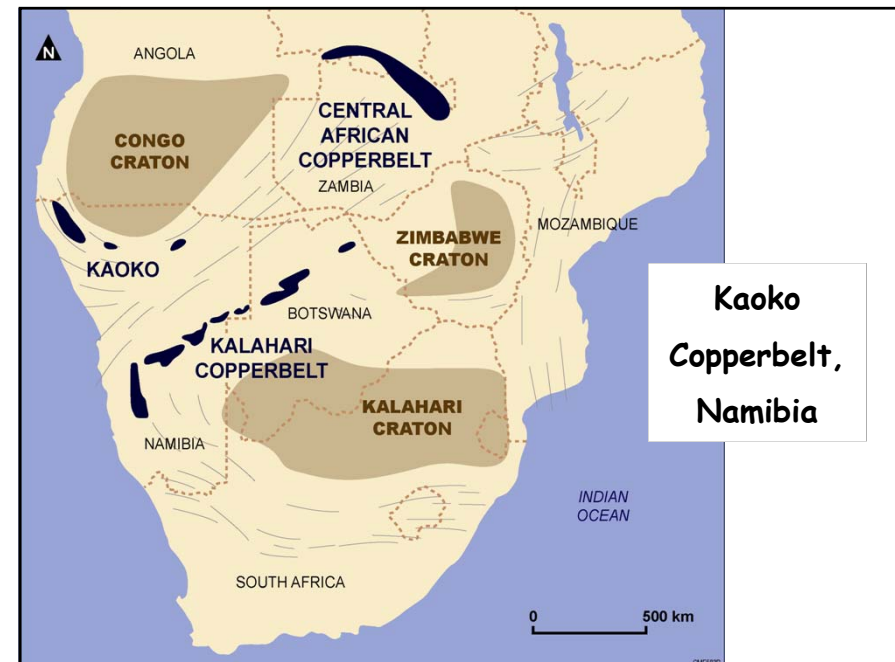
1. Syngenetic models

- interpret depositional environments

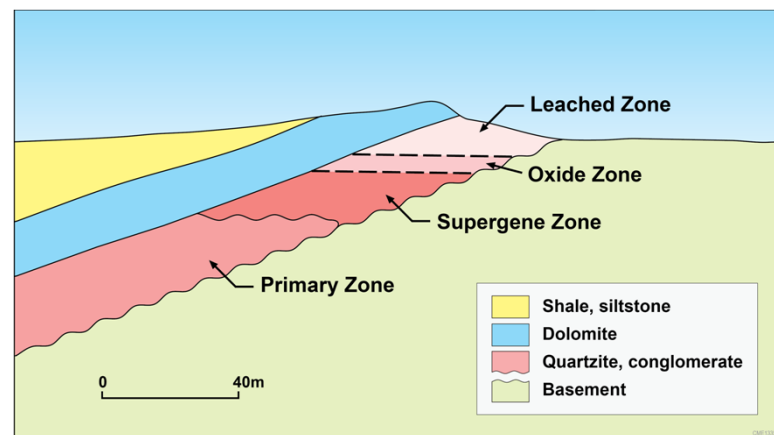- stratigraphic drilling of favourable rock units

2. Epigenetic model

- identify possible controlling structures

- look for zones of structural complexity

- look for alteration, veins, breccia zones

- deep drilling down structure

Kaoko
Copperbelt,
Namibia

Kopermyn deposit - stratabound model

Leached Zone

Oxide Zone

Supergene Zone

Primary Zone

🟨	Shale, siltstone
🟦	Dolomite
🟥	Quartzite, conglomerate
🟩	Basement

0   40m

Kopermyn - conceptual models

- Distal or sub-seafloor VHMS

- Porphyry copper

- Diagenetic - copper transported in connate groundwater towards basement high during basin compaction

- Epigenetic model - copper pumped up late structures during Damaran (Cambrian) deformation

Kopermyn - exploration approach

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1. VHMS models - focus on volcanic centres

2. Porphyry model - look for disseminated sulphide (I.P.)

3. Basin compaction model - onlap onto basement high

   - stratigraphic drilling of favourable beds

4. Epigenetic model

   - identify possible controlling structures

   - look for zones of structural complexity

   - look for alteration, veins, breccia zones

   - deep drilling down structure

Exploration targets for different models

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- Syngenetic models - near-shore reduced strata
    - → focus on favourable sedimentological situation
- Diagenetic models - reduced beds near basement highs
    - → focus on favourable strata along strike
- Epigenetic models - dilatant sites & reactive strata in zones of structural complexity
    - → focus on controlling structures

Stratigraphic controls - exploration heritage

Because of the former focus on stratigraphic controls (the 'favourable horizon') -

- Drilling tested along strike, not down-dip or down-structure

- Copper occurrences not in the 'favourable horizon' were not adequately tested

- Copper in veins was considered as 'minor remobilisation' rather than potentially part of the halo to a larger structurally-controlled deformation-related deposit

→ **Many targets remain to be explored**

Implications of epigenetic models

- Much previous exploration poorly directed
- Many copper occurrences ignored or under-explored
- Expect deposits associated with alteration & brecciation
- May be a range of deposit styles, with differing
  - host rock types
  - geometry
  - alteration assemblages
  - styles of mineralisation
  - structural relationships to host rocks

In summary …

You can flirt with a model ...

In fact, you should flirt with lots of models...

(the technical term is Multiple Working Hypotheses)

But you shouldn't marry one !