Basin Architecture and Fault Geometries in the Mt Isa Western Succession: implications for Mineral Exploration

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pmd*CRC

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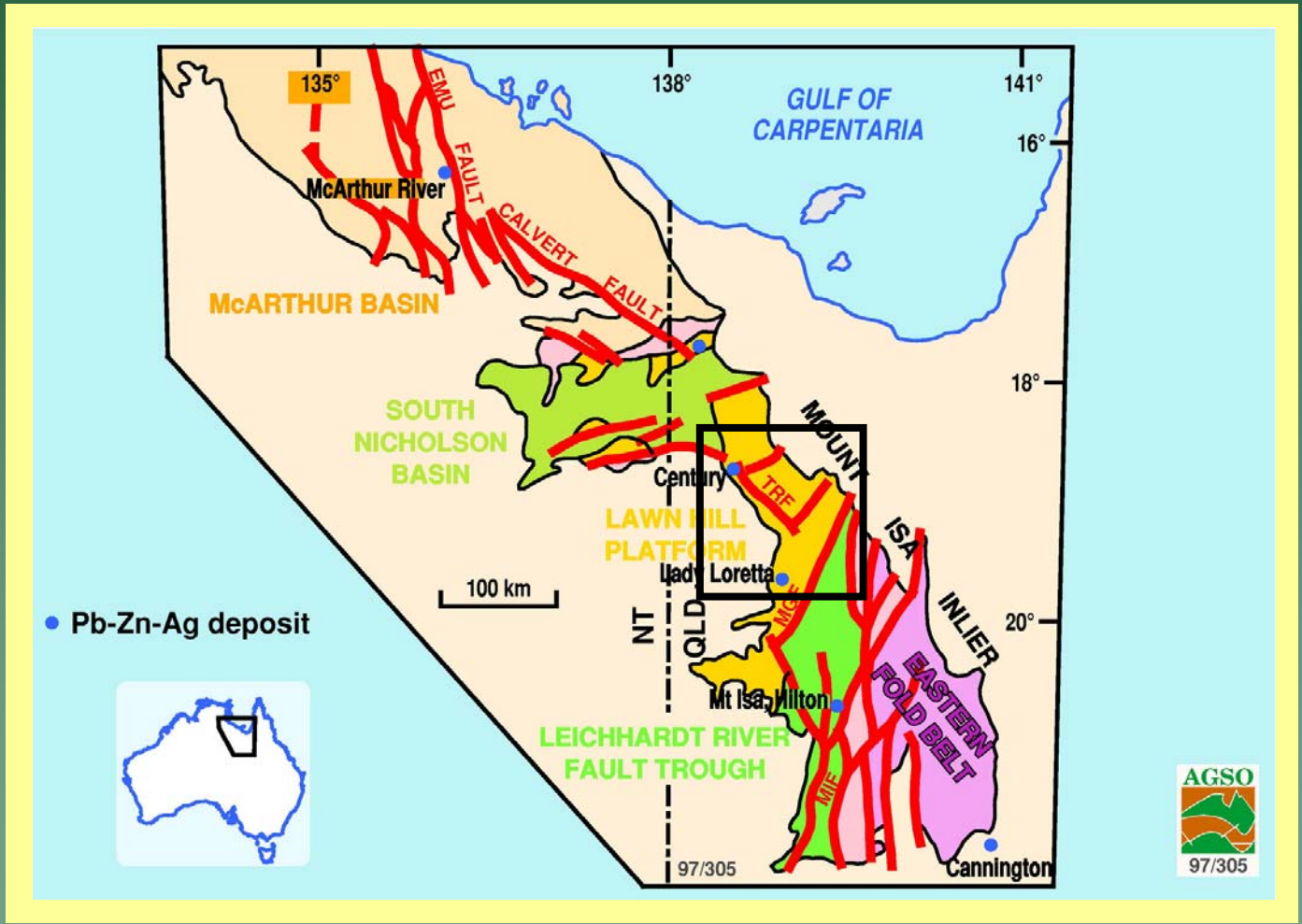
Mount Isa Pb-Zn-Ag Mineral Province



Pmd*CRC Core Questions & Issues

For any mineral system, what are:

- √ Geodynamic setting & PT history of system?
- √ Architecture of system?
- Fluid composition, source and/or reservoirs?
- √ Fluid flow drivers & pathways?
- Metal transport & depositional processes?

Project organisation

Four modules (regional-scale):

1. 3D basin architecture & fault geometries (GOCAD)
2. Sequence stratigraphy, sedimentary facies analysis & 3D isopach map (3D fence diagram)
3. 2D metamorphic, alteration & mineral map (hyperspectral imagery & ground-truthing)
4. Revised tectonic history & time-space plot

PhD study Century (Leo Feltrin) (Mine to Camp scale)

Module 1: Building the 3D Map

Integrating:

- Chronostratigraphic (sequence) boundaries & unconformities
- Thickness variation in sedimentary packages
- Geometry of bounding structures & faults
- Basin topography (erosion v. non-deposition)
- Potential field data

Deconstructing:

- Post-depositional structures (folds, faults)
- Tectonic excision v. structural repetition

Integration & testing of previous research

NW Queensland Mineral Province report

- Rift basin: 13 tectonic events (1800 Ma → Isa D3 event)
- Initial NE-SW rifting (ECV + Myally Gp.)
- Episodic NW-SE extension (Quilalar thro' McNamara time)

Monash University Rift Model

- Initial E-W (or SW-NE) trending half-graben; bounded by transfer faults (cf NW-SE half-graben favoured by NABRE)

NABRE (P552) Sequence Stratigraphy

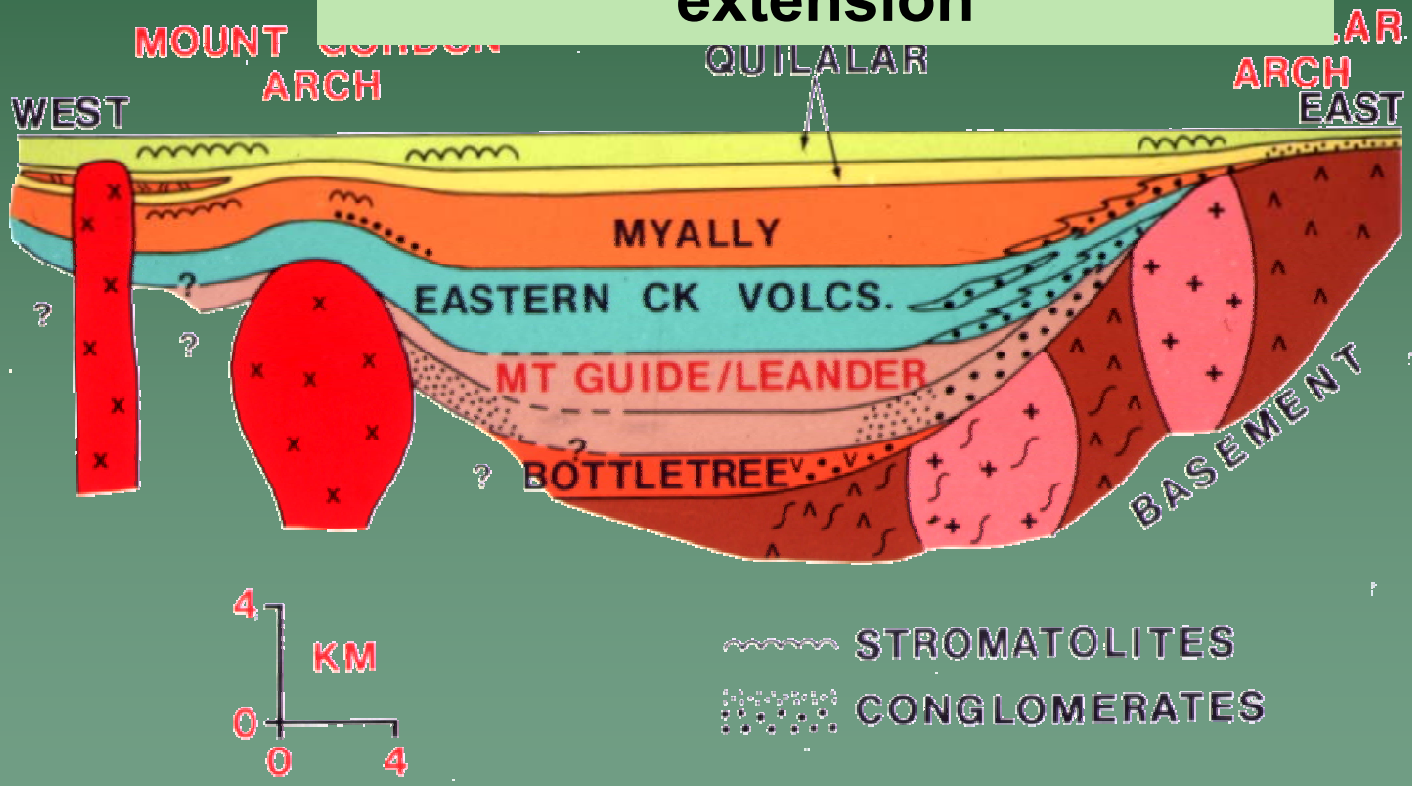
- Strike-slip basins - convergent margin (NW-SE thickening wedge)
- Post-Quilalar (Myally) age for NE-SW half-graben

Thrust Model (Bell, 1983)

- N over S directed thrusting & duplex development

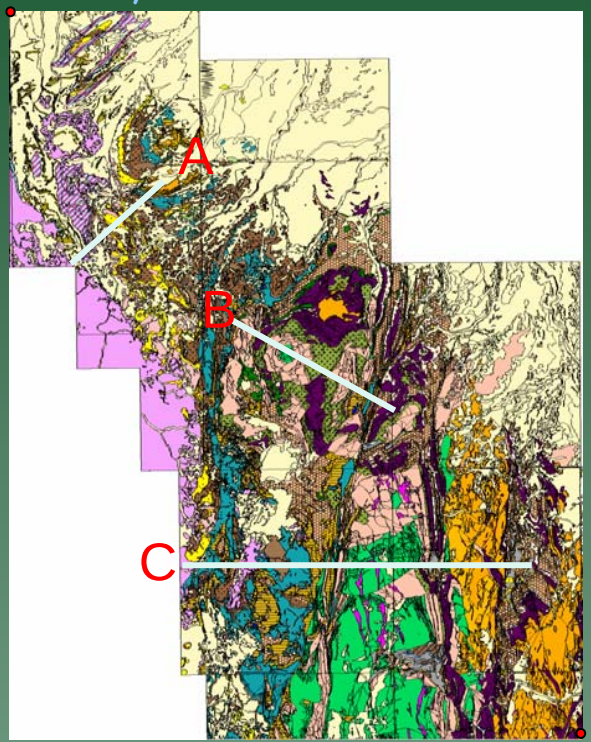
North-south trending rift - eastward-thickening wedge?

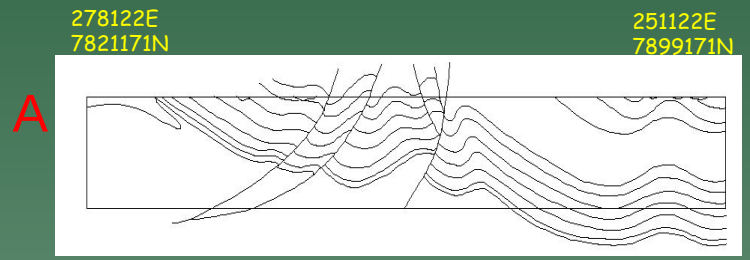
Conclusion: Early west-east extension



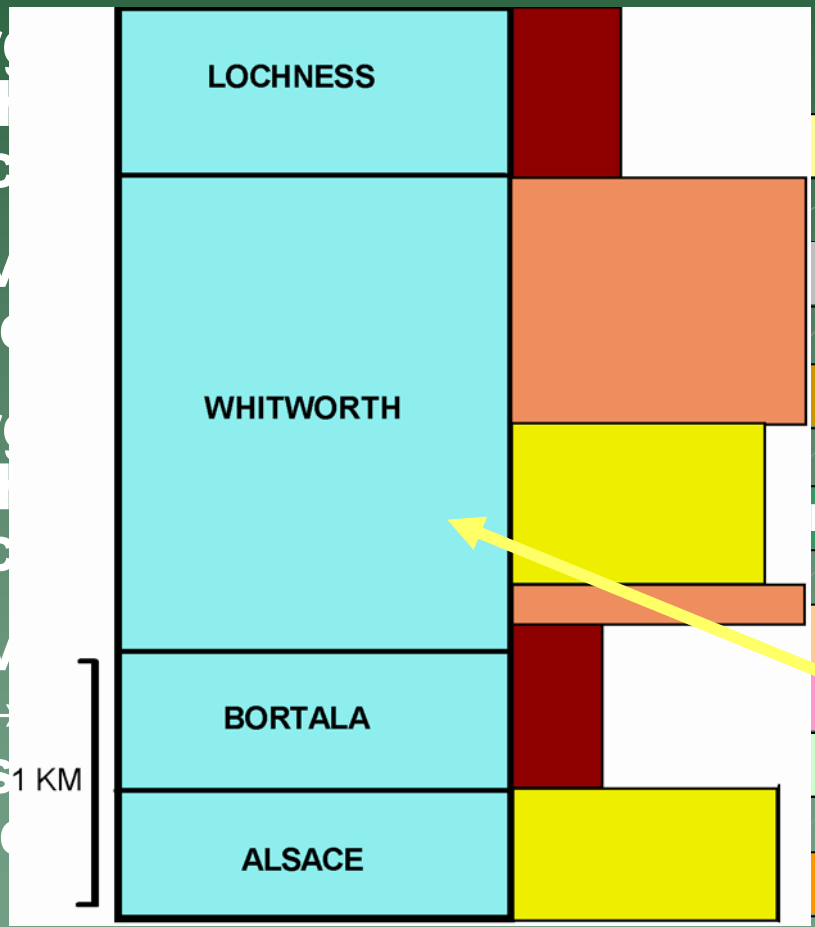
(Derrick et al., 1982)

- **3D structural geometry constrained by spatially referenced surfaces from cross- sections and solid geology**
- **Original extensional geometry modified by E-W shortening & thrusting**





Regional Geology

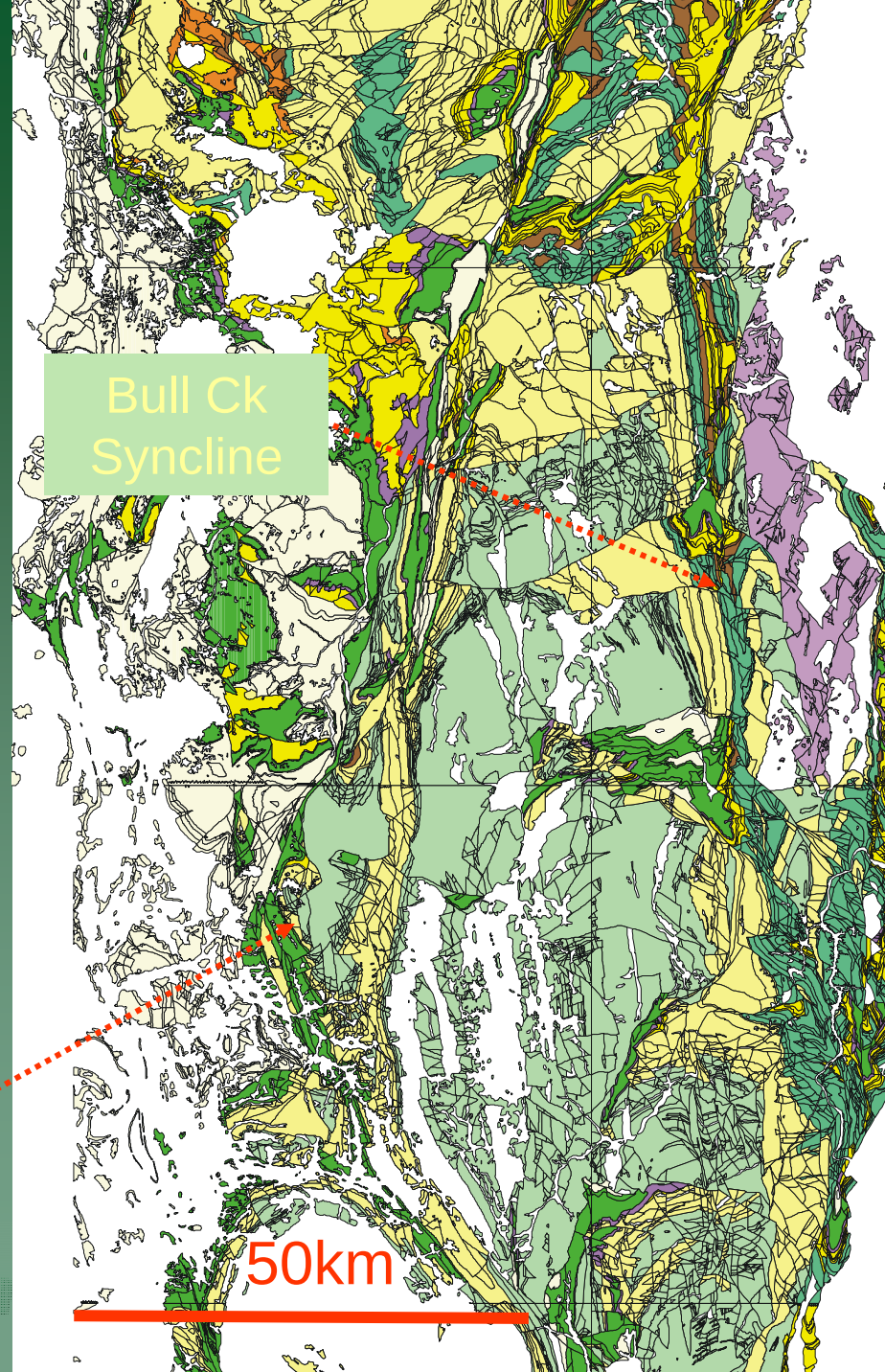


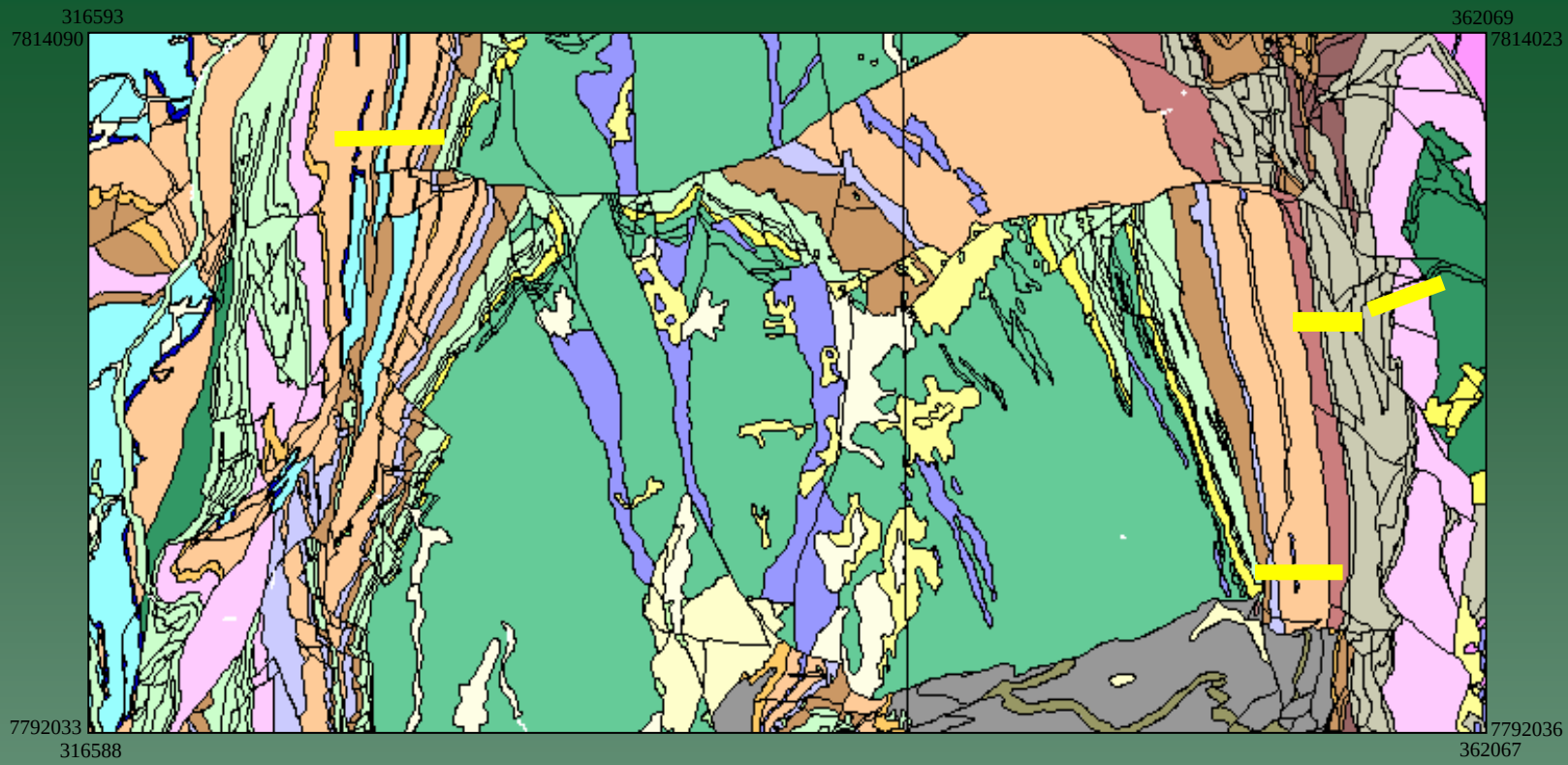
Simplified Geology

- Cover
- McNamara Group | Mount Isa Group
- Surprise Creek Formation
- Bigie Formation / Fiery Creek Volcanics
- Quilalar Formation
- Myally Subgroup
- Eastern Creek Volcanics
- Basement

Leichhardt River Fault Trough: original basin architecture

- Multiple rifting events
- Basement cutting faults
- Ramps & relay faults
- Key fluid conduits
- Focus on Myally Subgroup
- Early rift template (Leichhardt Superbasin)

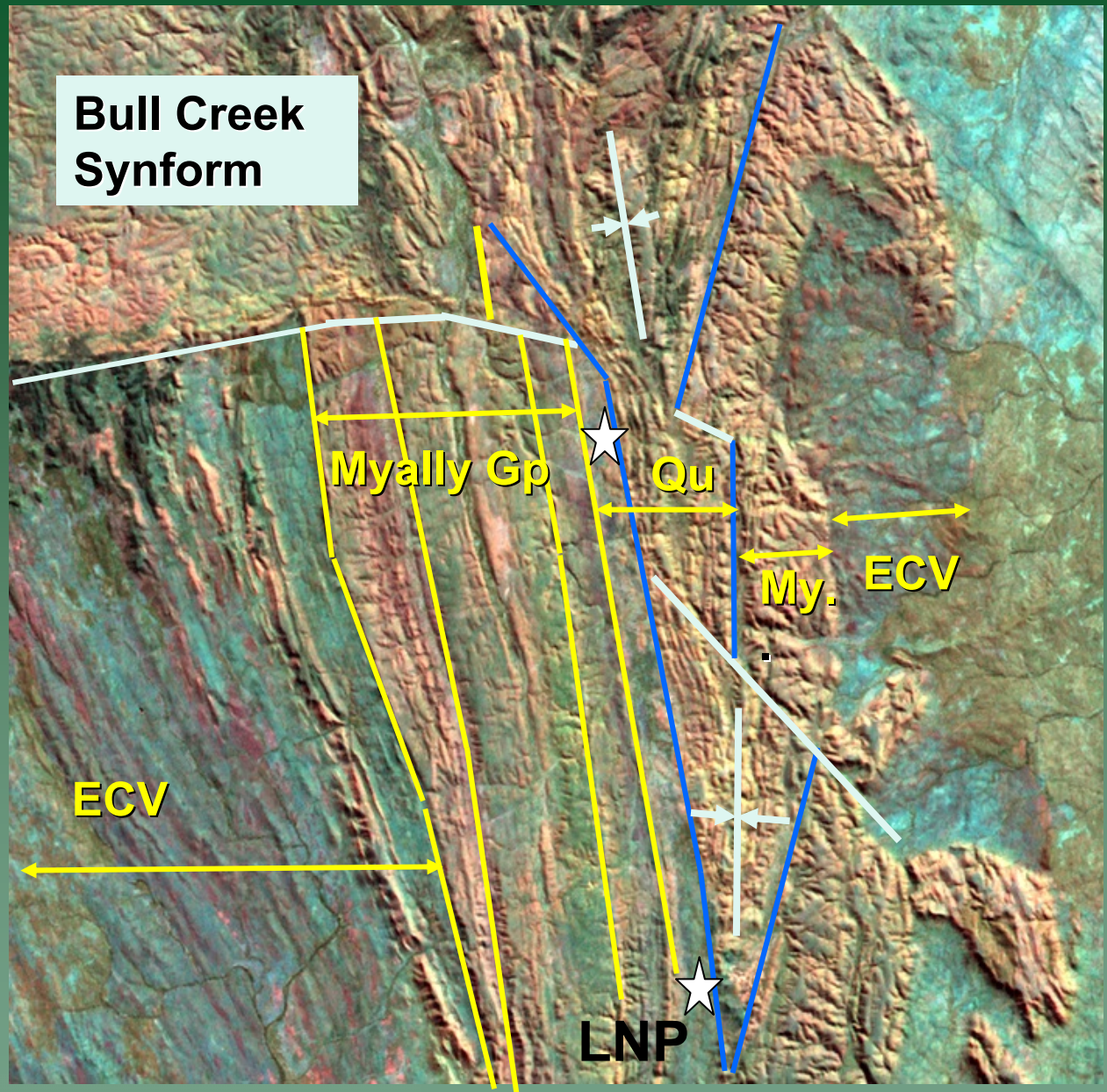


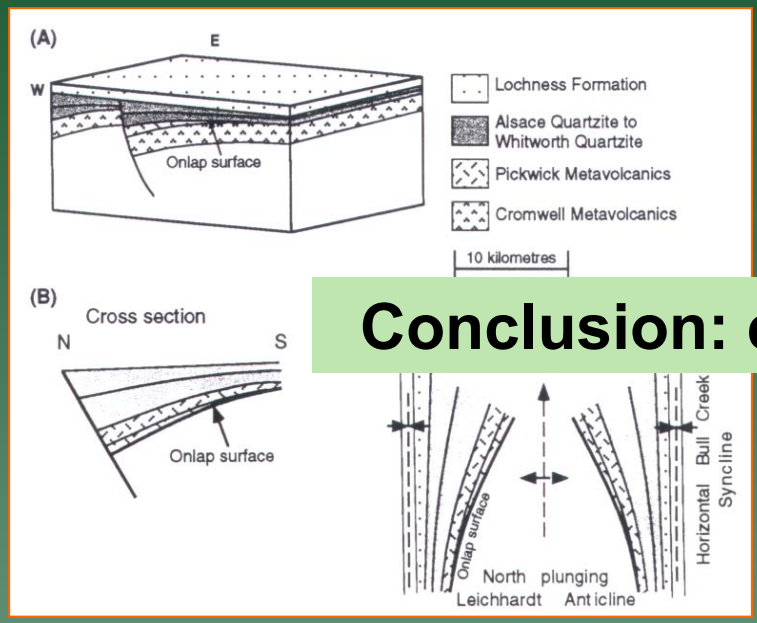


- North-plunging antiforms in ECV
- W-E cross-faults; N-S high strain corridors
- No symmetry in Loch Ness (red) or Quilalar Fm (grey)
- Loss of stratigraphy – tectonically controlled or erosion?

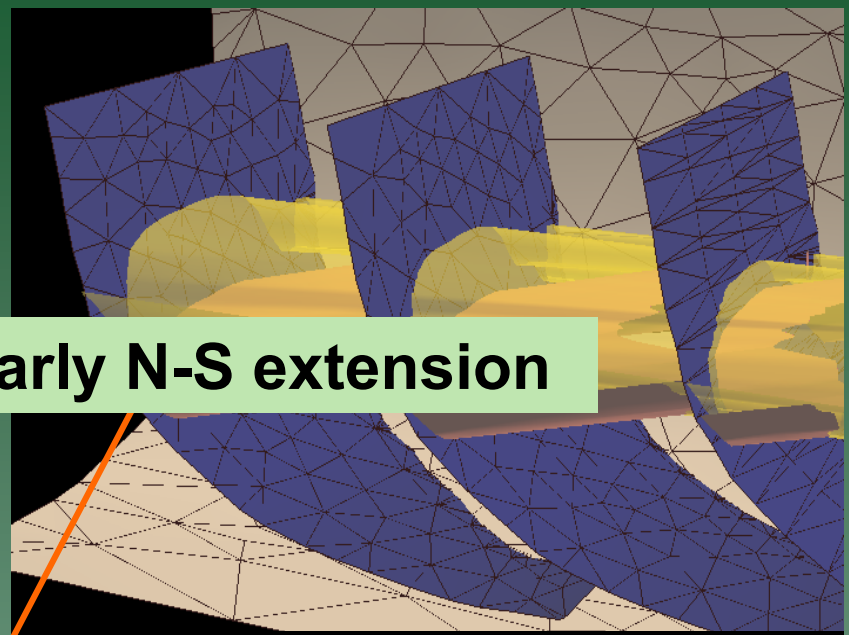
Loch Ness Prospect

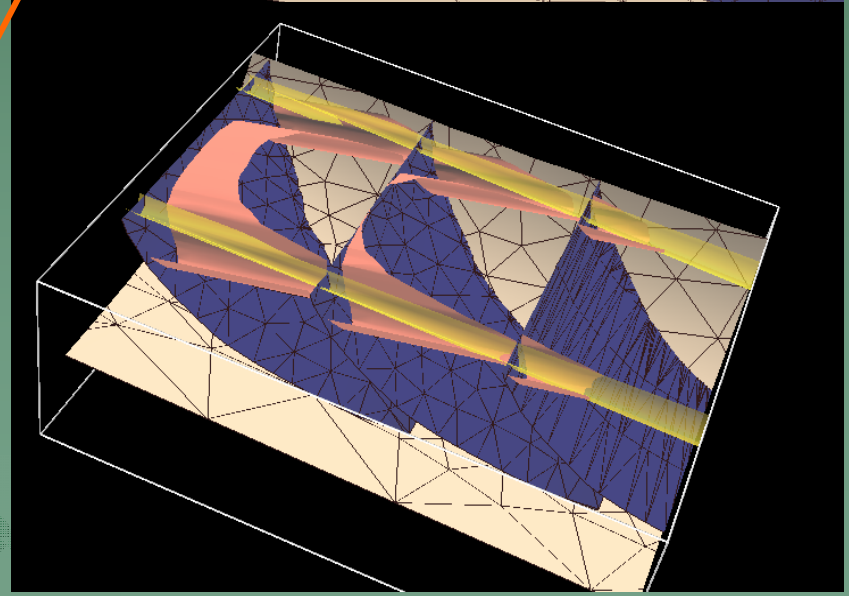
- Red beds (Loch Ness Fm) overlain by carbonate
- Quartzite seal = Quilalar Fm = unrecognised U/C or structural break
- Basement cutting growth fault
- Parallels with Irish Pb-Zn deposits
- Monster mineral deposit?





Conclusion: early N-S extension





Yellow = Base of Loch Ness Fm.

Pink = Top of ECV

Blue = growth fault

(after O'Dea 1997)

Whitworth & Alsace qzites

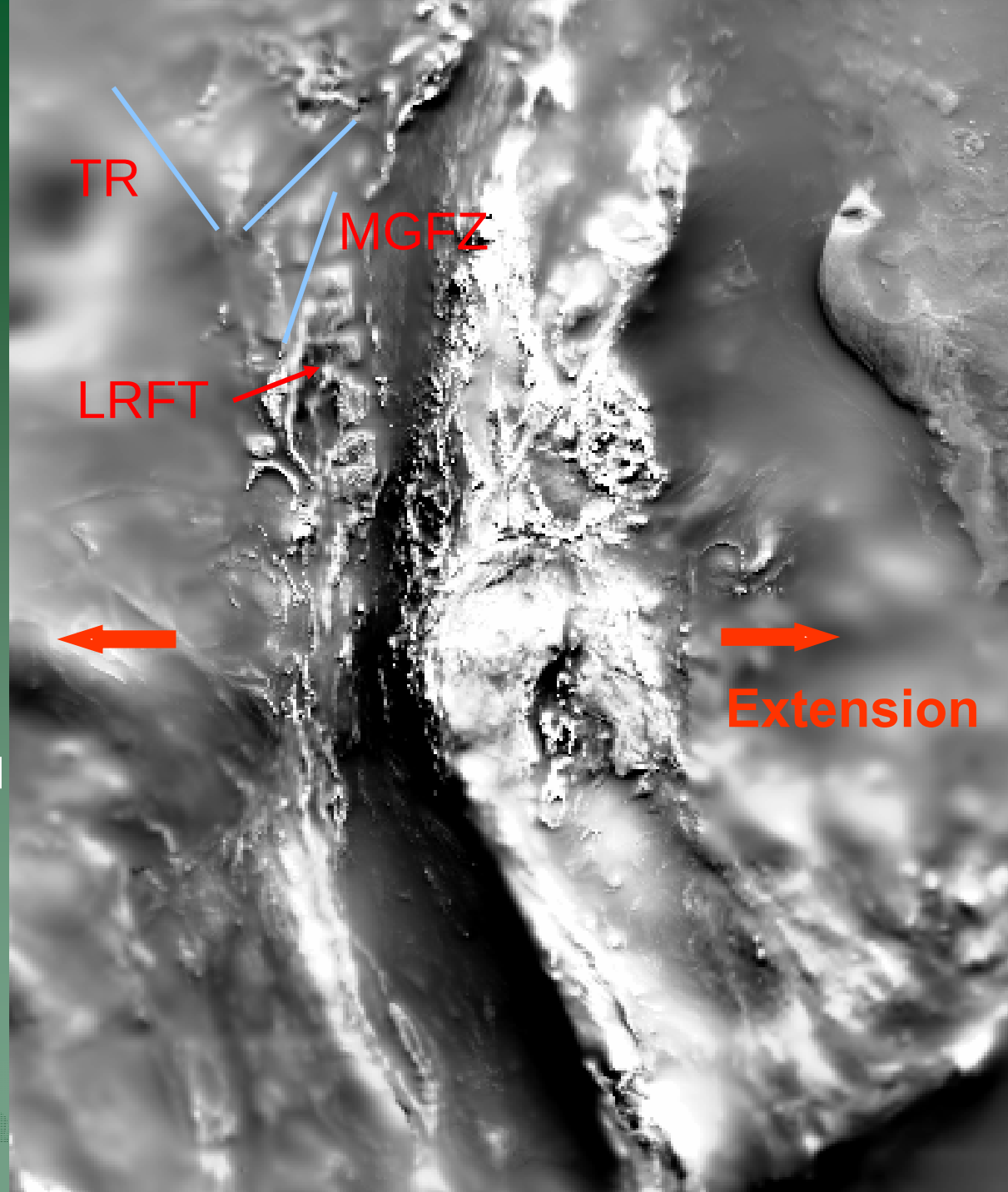
Regional structure: Aeromag 1VD

Early W-E extension supported by:

- **Dominant N-S trend**
- **N-S Dyking (= ECV?)**
- **Sedimentary facies**
- **Stratal thickening**

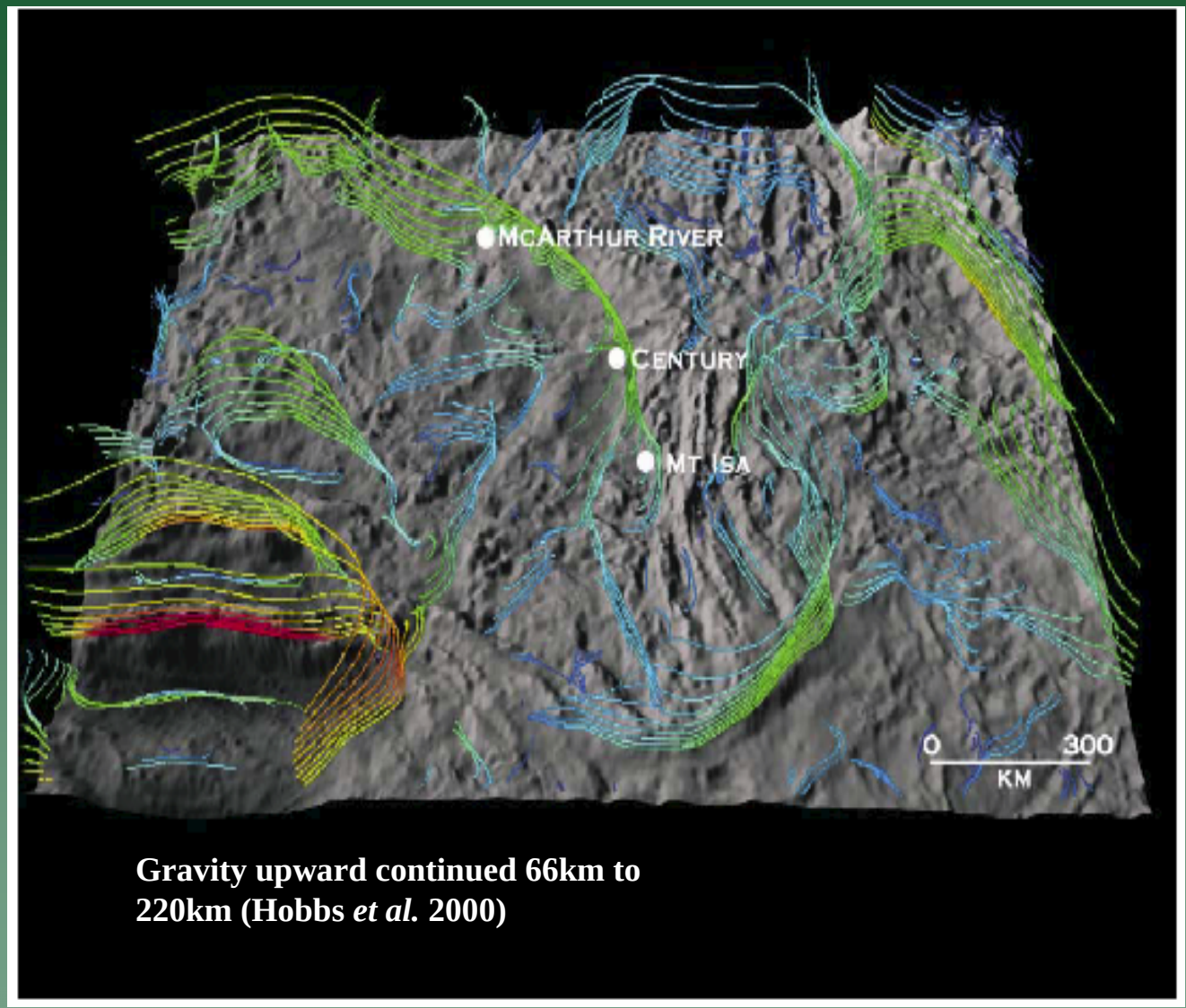
Original geometry modified by:

- **Post-rift shortening**
- **Dextral wrench faulting**



Barramundi Worm

- Deep crustal structure
- Boundary between rocks of contrasting density (gravitational response

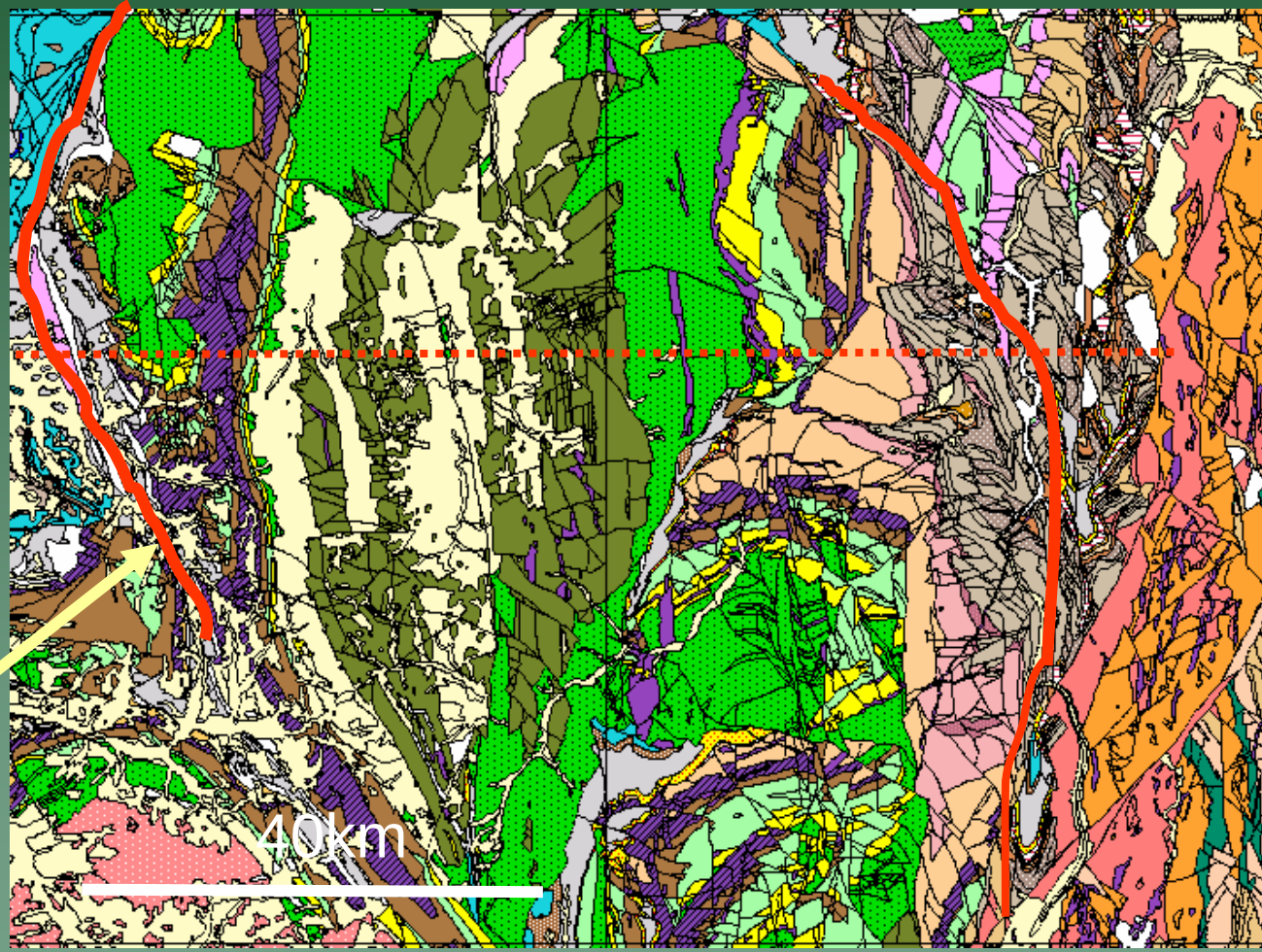


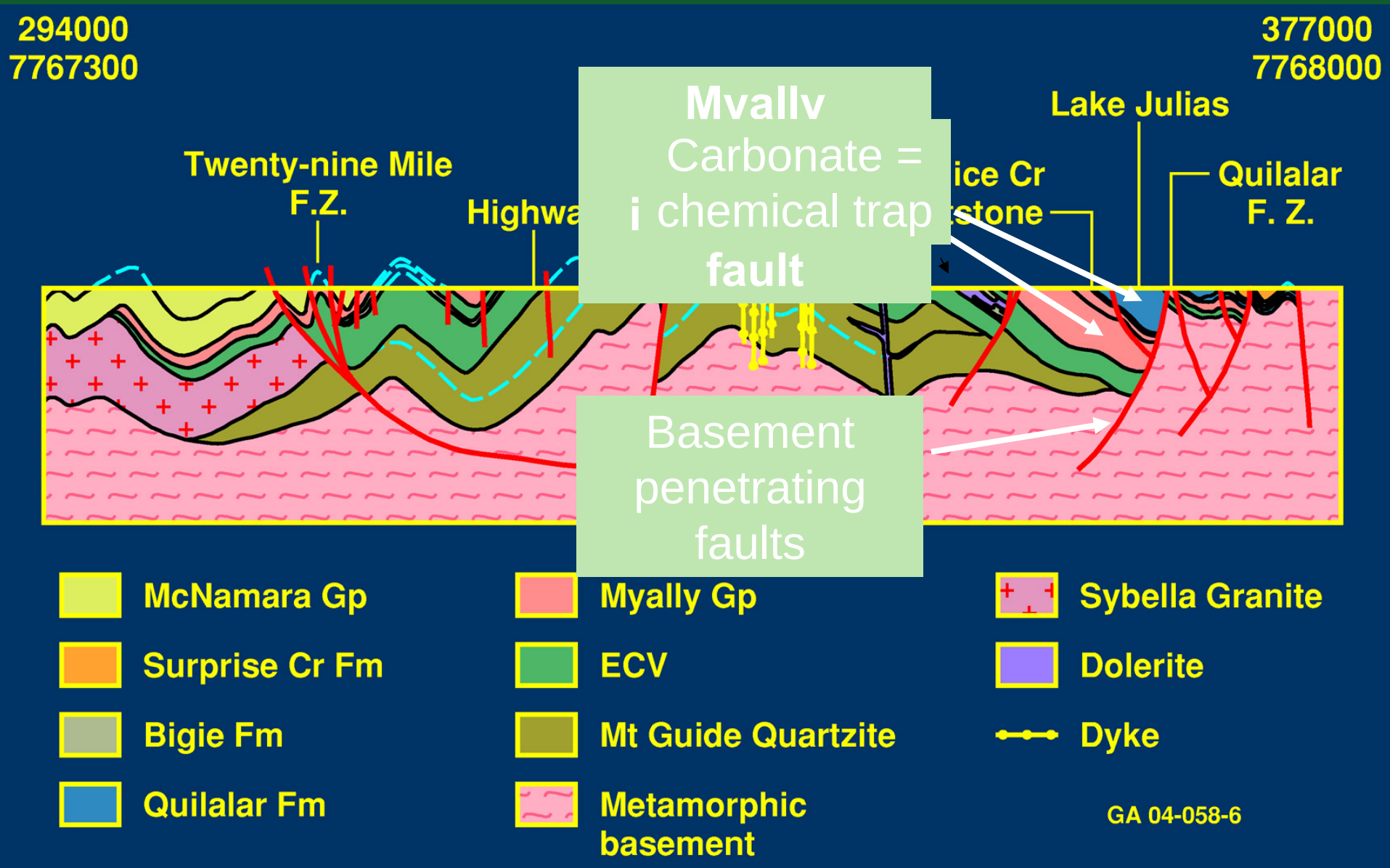
Gravity upward continued 66km to 220km (Hobbs *et al.* 2000)

South Leichhardt River Fault Trough

- Eastward-thickening wedge
- Normal fault geometry in east
- Thrust boundary in west

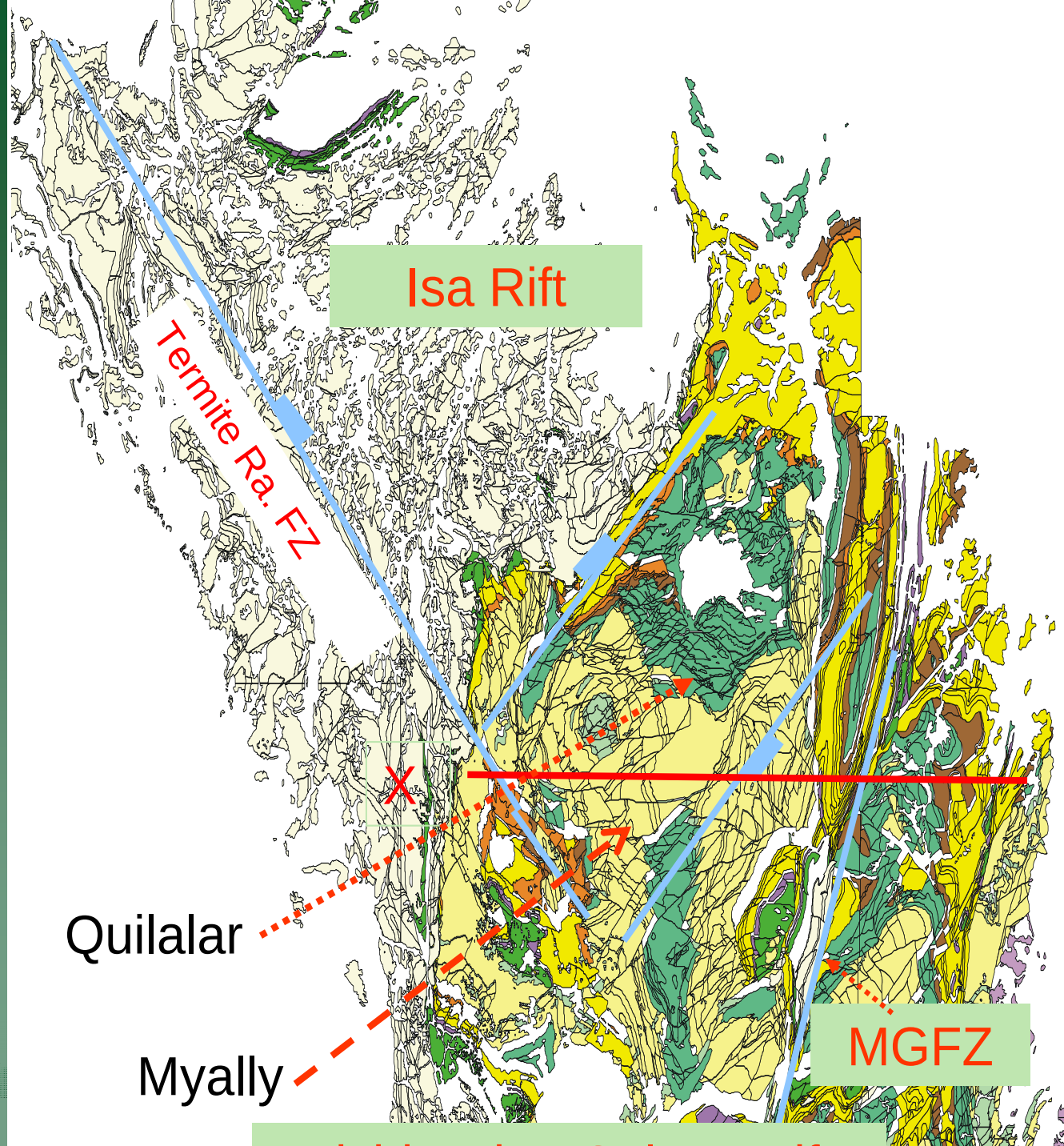
Twenty-nine Mile FZ

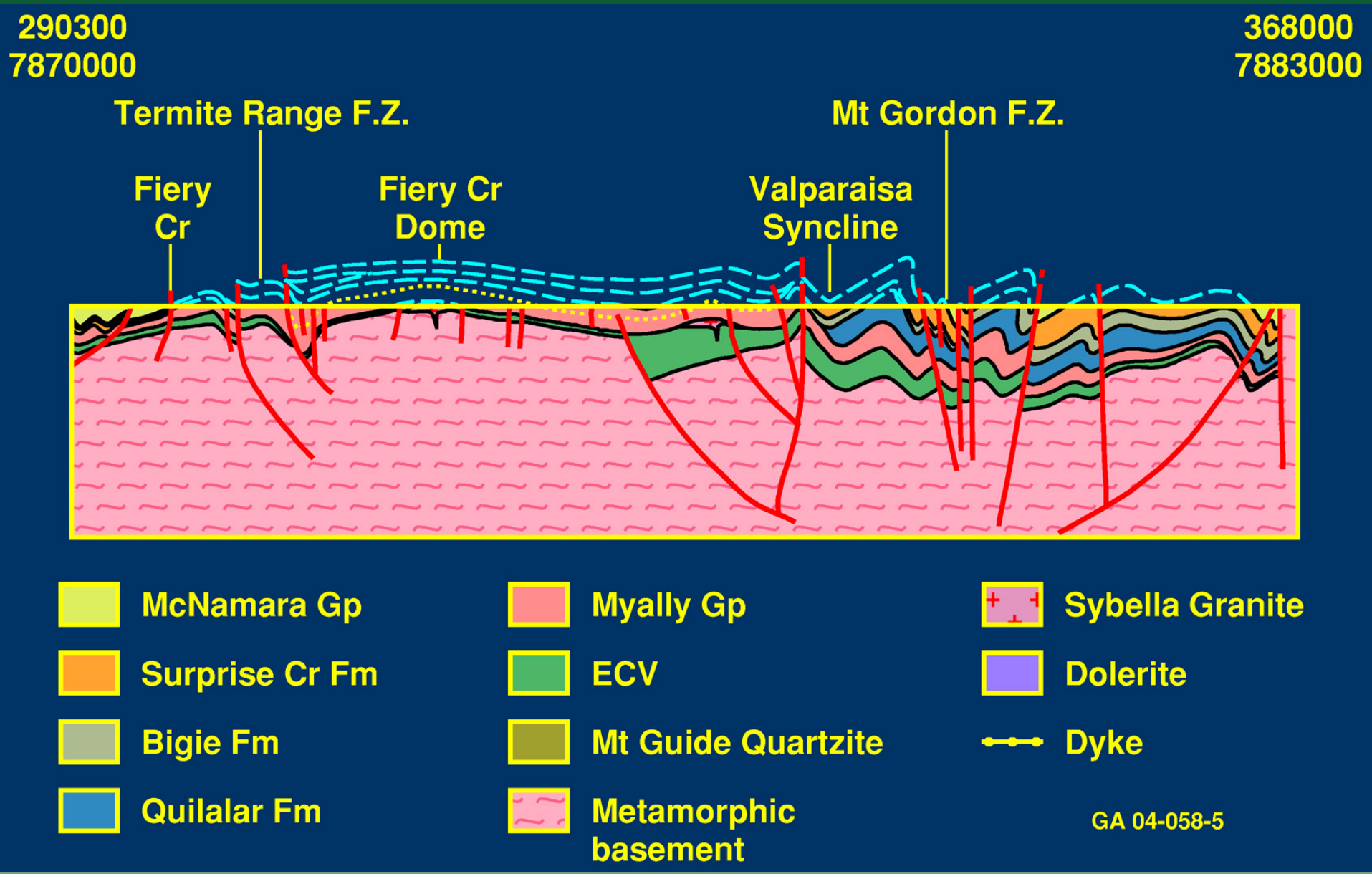



294000
7767300
377000
7768000
Twenty-nine Mile
F.Z.
Highwa
ice Cr
stone
Lake Julias
Quilalar
F. Z.
Mvallv
Carbonate =
i chemical trap
fault
Basement
penetrating
faults
McNamara Gp
Surprise Cr Fm
Bigie Fm
Quilalar Fm
Myally Gp
ECV
Mt Guide Quartzite
Metamorphic
basement
Sybella Granite
Dolerite
Dyke
GA 04-058-6

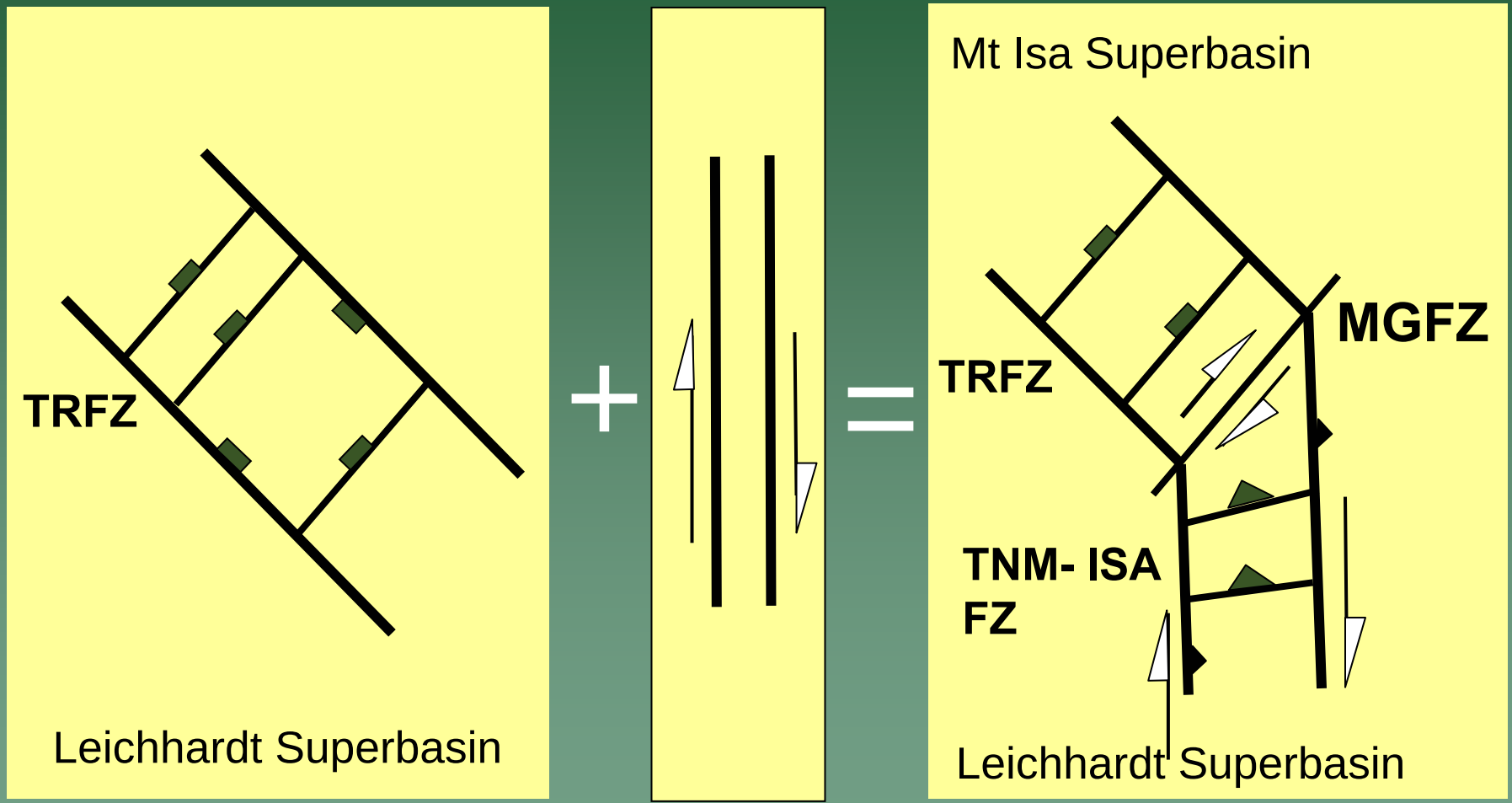
Fiery Creek Dome

- TRFZ = NE-dipping normal fault
- Late or early?
- Basement high (gravity low)
- Veneer of Myally Fm +ECV
- TRFZ = Continuation of Twenty-nine Mile-Isa FZ?

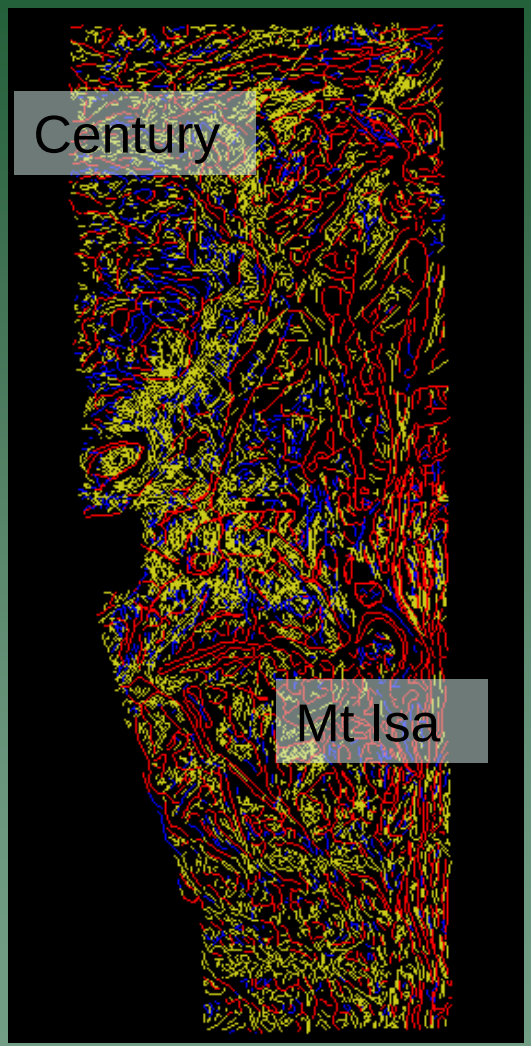



290300
7870000
368000
7883000
Termite Range F.Z.
Mt Gordon F.Z.
Fiery Cr
Fiery Cr Dome
Valparaisa Syncline
McNamara Gp
Surprise Cr Fm
Bigie Fm
Quilalar Fm
Myally Gp
ECV
Mt Guide Quartzite
Metamorphic basement
Sybella Granite
Dolerite
Dyke
GA 04-058-5

Late Dextral Wrench Faulting



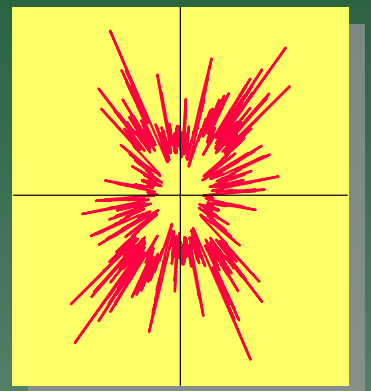
Statistical Analysis of (Aeromag) Worms

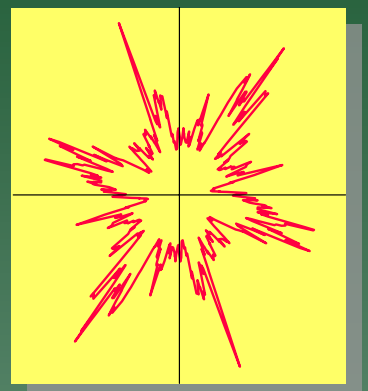


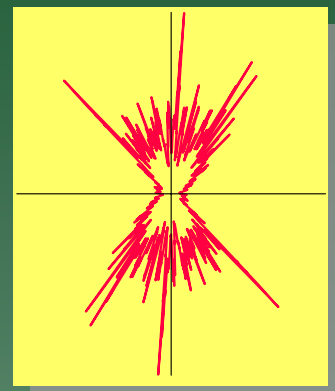
Sheet 1 (north)

Sheet 2 (south)

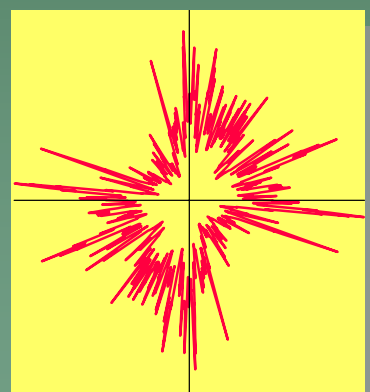
Northern sheet

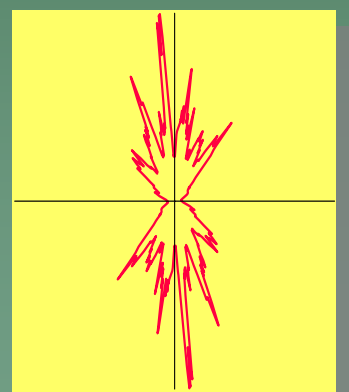


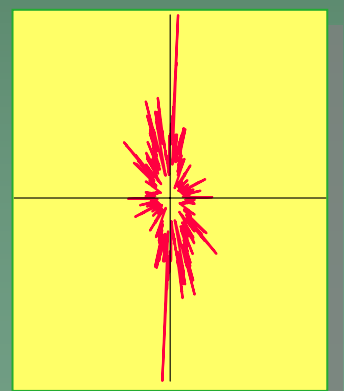




Southern sheet

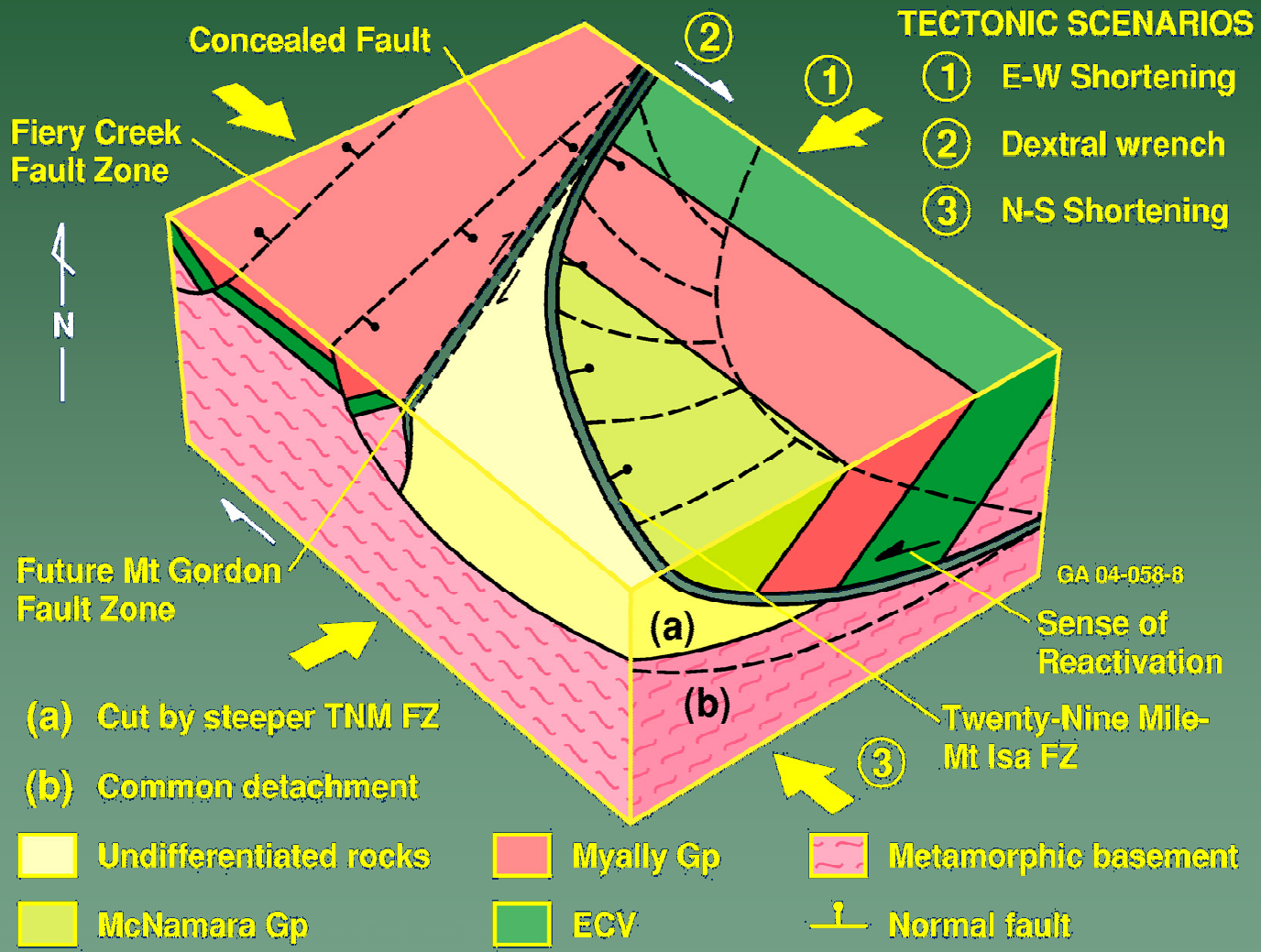






Numerical modelling: regional scale

- Fluid conduits & trajectories
- Outboard normal fault
- Reactivated structures important in mineralisation?
- Isa FZ = Termite Range FZ

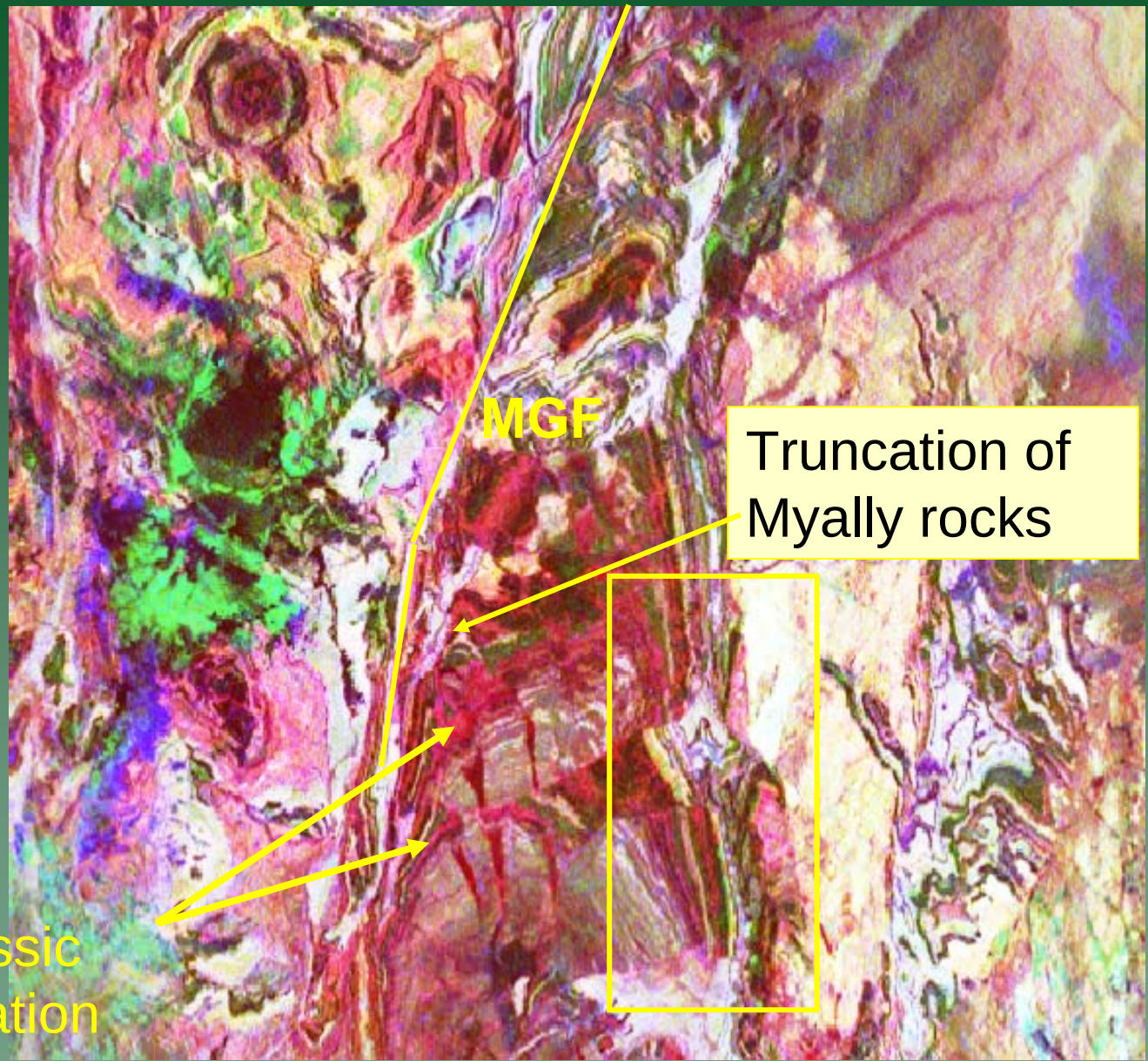


Module 3 (Remote sensing): radiometrics; marrying PIMA with hyperspectral analysis

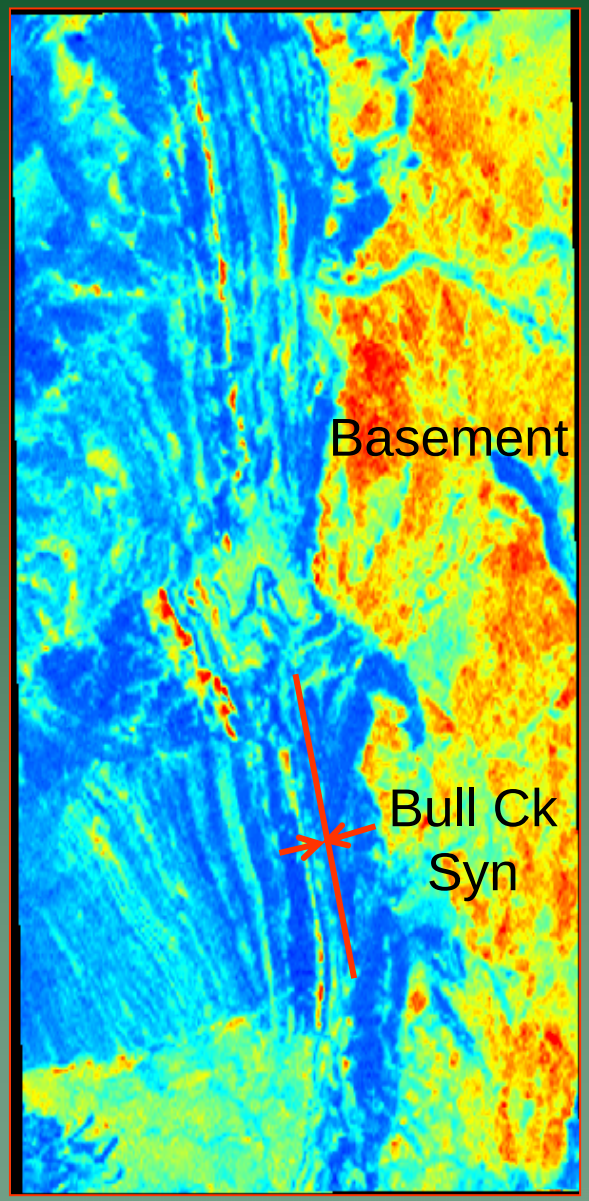
- Differentiation of lithological units through mineralogical content (clays, micas, chlorites)
- Mapping of hydrothermal alteration patterns (fluid conduits)
- Identification of major stratigraphic/structural breaks
- Regional and mine scale changes in mineralogy
- Pilot studies: Termite Ra. Fault & Bull Creek syncline (Eastern Creek Volcanics versus overlying sedimentary rocks)
- Employing Landsat (Band 157 RGB), ASTER & Hyperion

Module 3: Radiometrics

- K alteration in older rocks (ECV-Myally Fm)
- Fault controlled
- Pre-surprise Ck
- Regional-scale

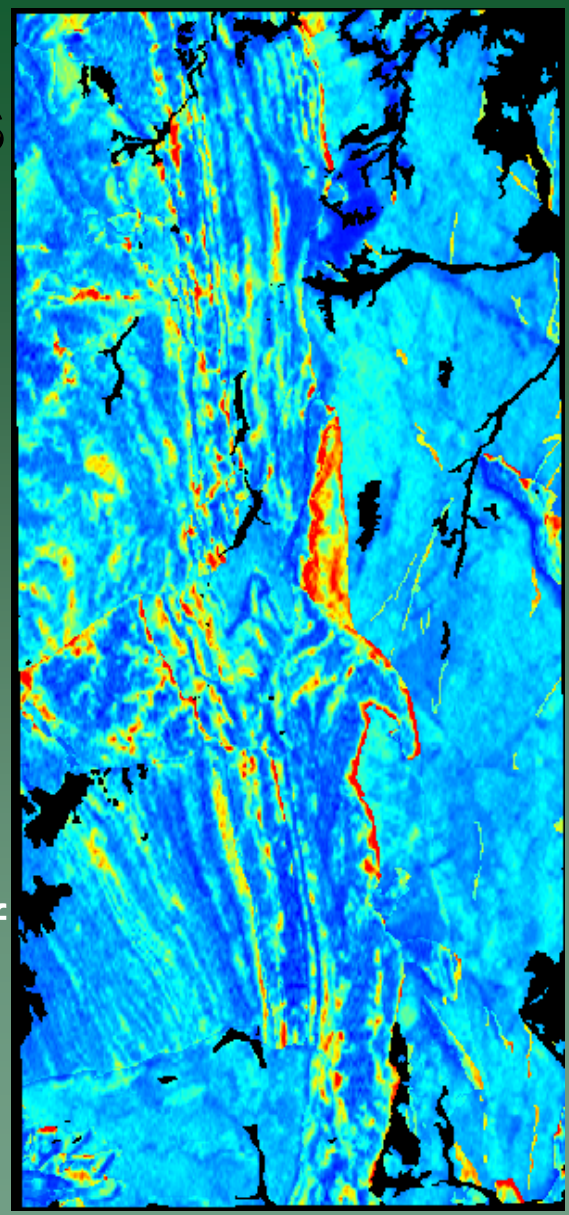


- Lochness Formation
- Potassic alteration in veins and in layer-parallel fabrics
- Could be related to deformation



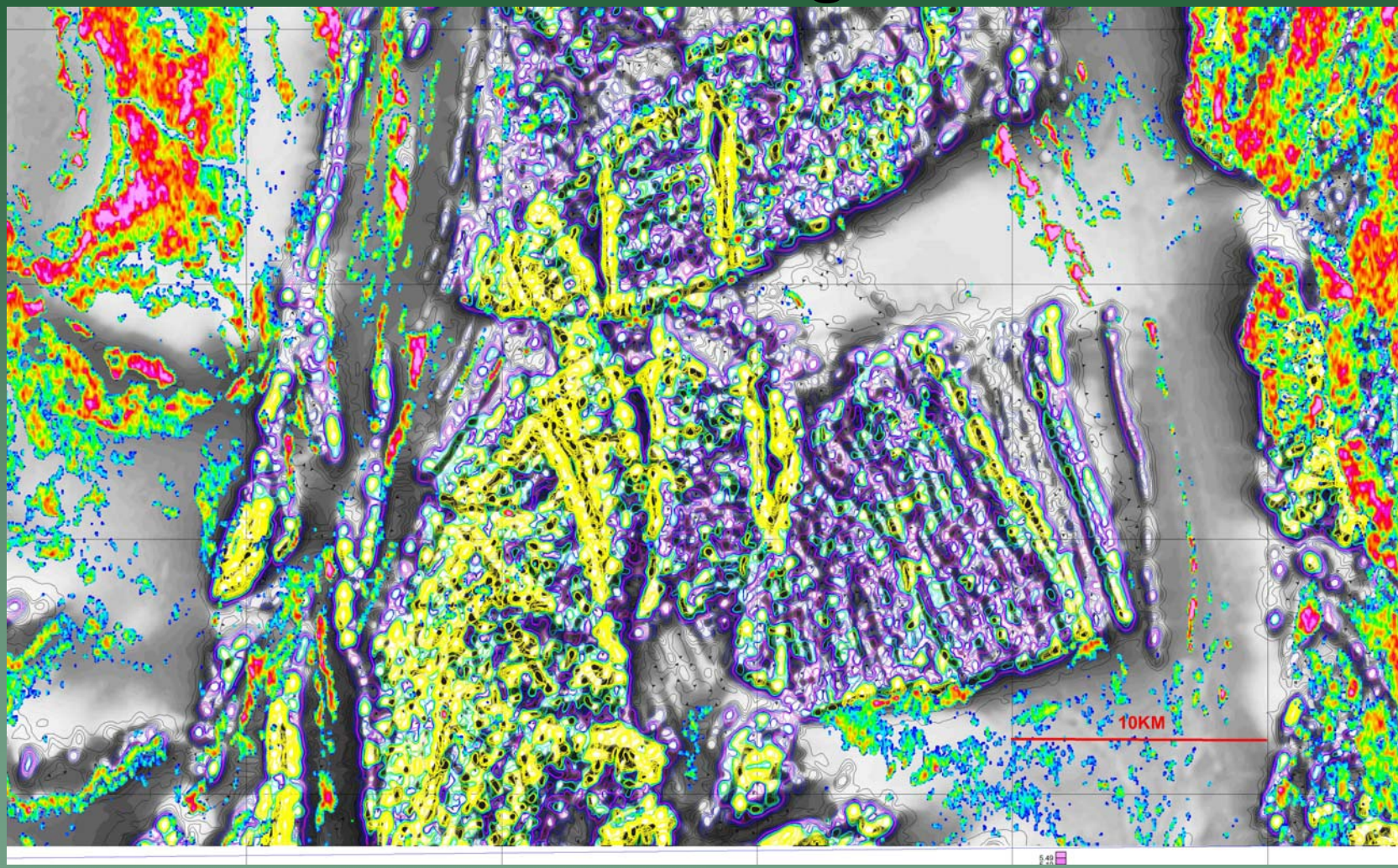
Radiometrics

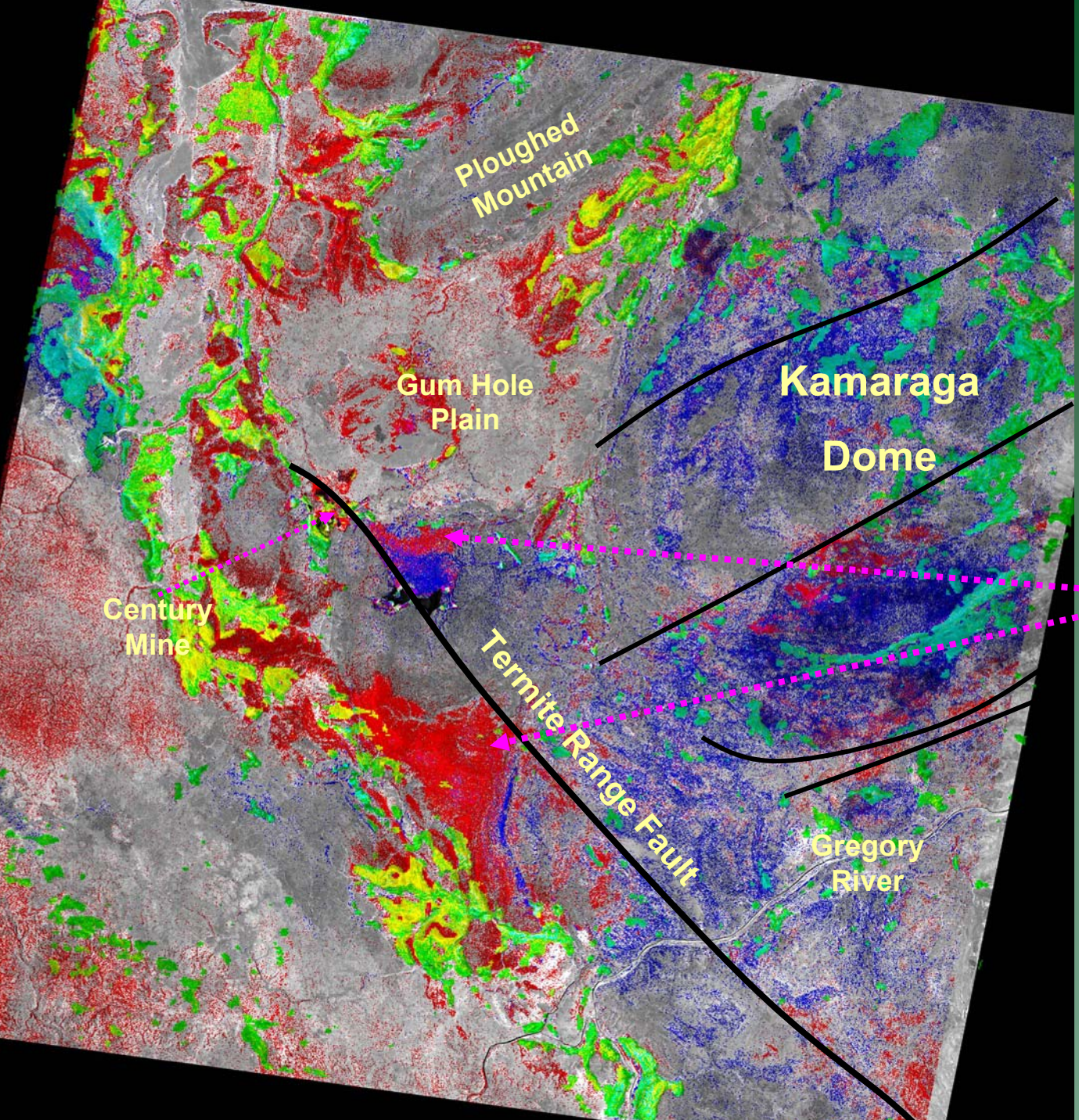
Potassium band, Western Alsace 100k sheet



Normalised potassium (K/median of each lithological unit)

%K on 1VD Aeromagnetics





ASTER

Century & Termite Ra. Fault

Alteration zone?

Red: Phengite
Green: Carbonate
Blue: Kaolinite

Conclusions

- Rift & fault geometry established early
- Strong link between alteration and growth faults = fluid conduits
- Size of hydrothermal footprints mappable by satellite imagery
- Eastern margin of Leichhardt River Fault Trough & Quilalar Group rocks under explored; past emphasis on McNamara/Isa Groups

3D Model

Movie Time