I1: Western Succession 3D basin architecture & ore systems

George Gibson

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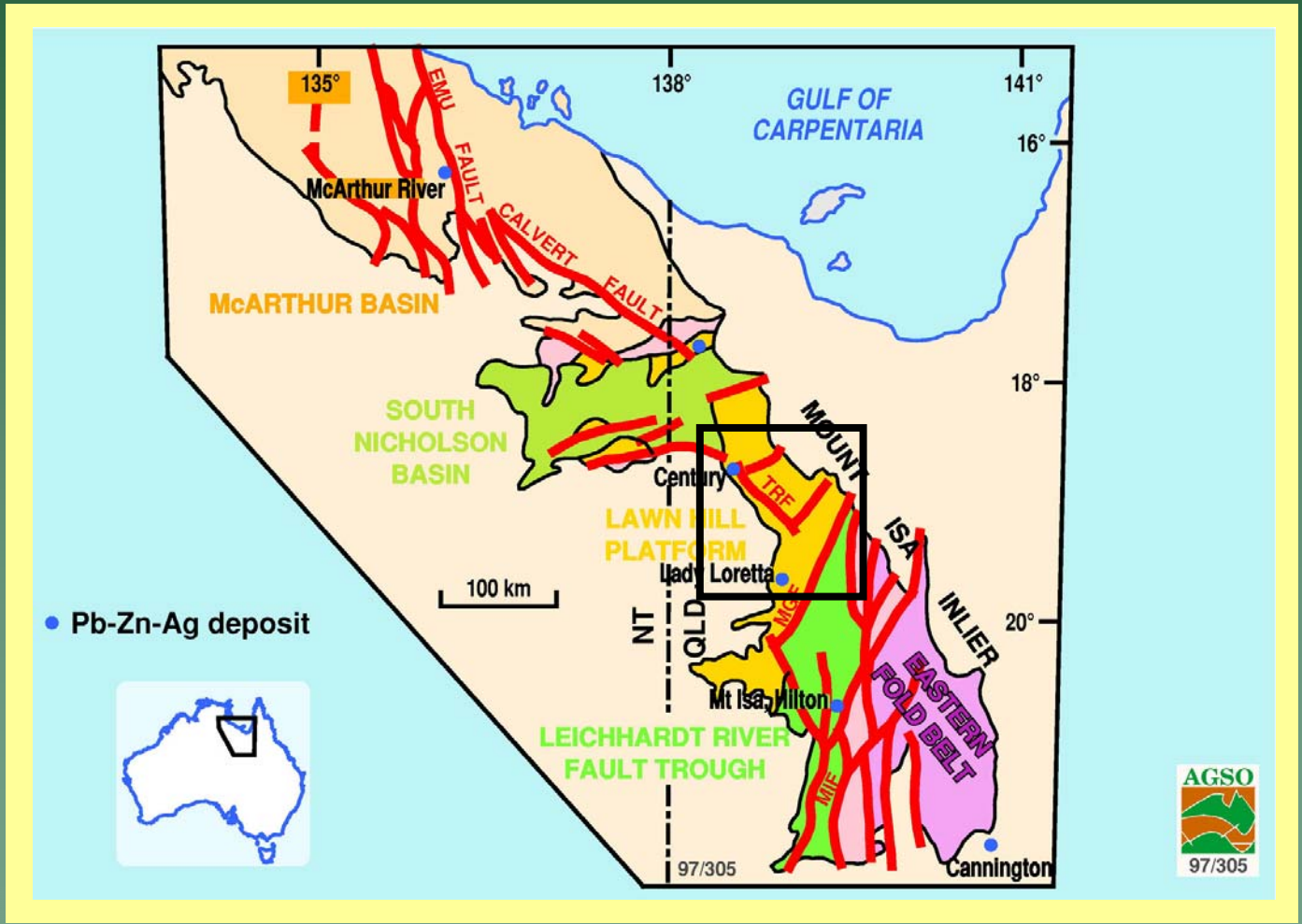
Mount Isa Pb-Zn-Ag Mineral Province



Project organisation

Four modules:

1. 3D basin architecture & fault geometries (GOCAD)
2. Sedimentary facies analysis (sequence stratigraphy & 3D fence diagram)
3. 2D metamorphic & alteration map (hyperspectral imagery)
4. Revised tectonic history & time-space plot

PhD study Century (Leo Feltrin)

Module 1: Building the 3D Map

Integrating:

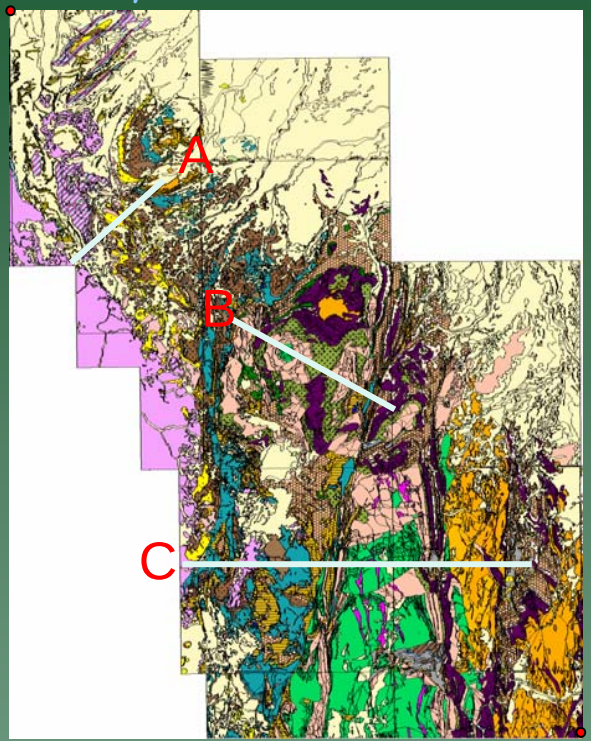
- Chronostratigraphic (sequence) boundaries & unconformities
- Thickness variation in sedimentary packages
- Geometry of bounding structures & faults
- Basin topography (erosion v. non-deposition)
- Potential field data

Deconstructing:

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

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

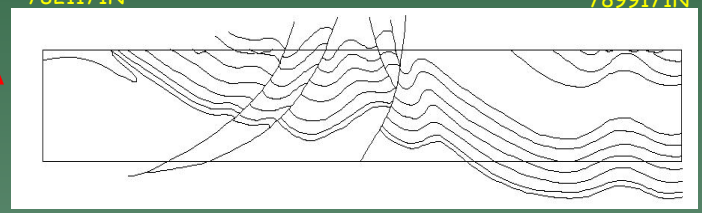
138°30, 18°22



278122E
7821171N

251122E
7899171N

A



297222E
7882371N

3424422E
7858971N

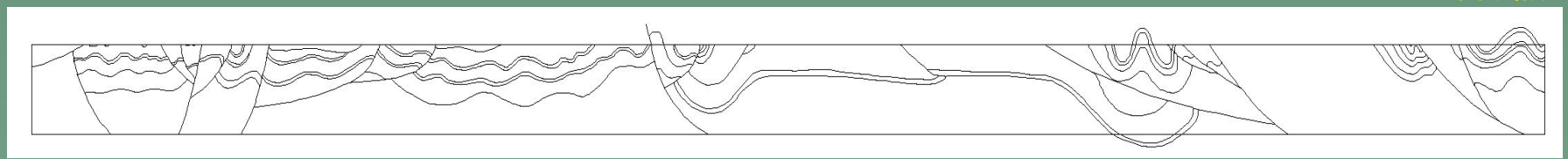
B

284122E
7816171N

140°, 20°10

380122.7E7
816171.8N

C



predictive mineral discovery

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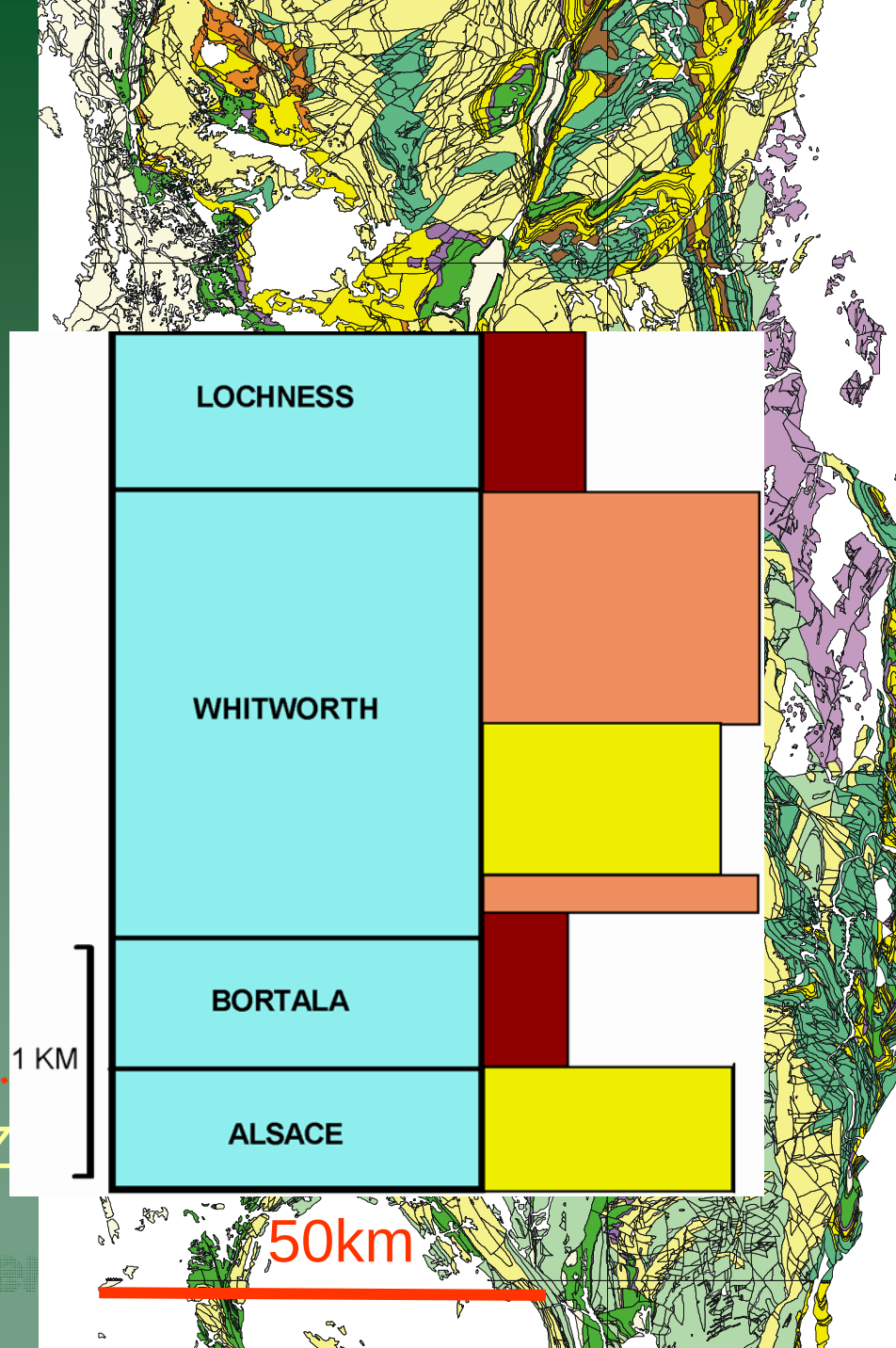
Leichhardt River Fault Trough: original basin architecture

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



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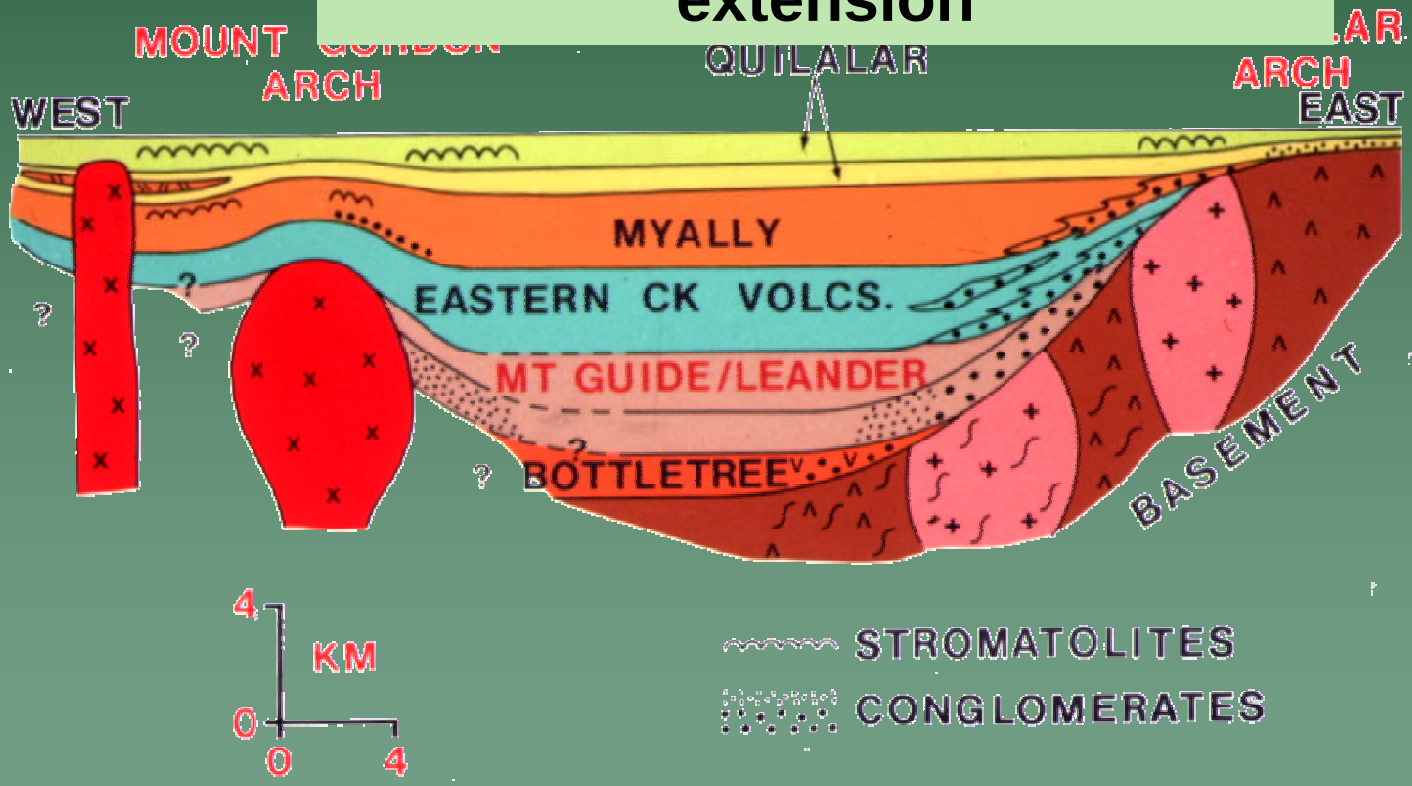
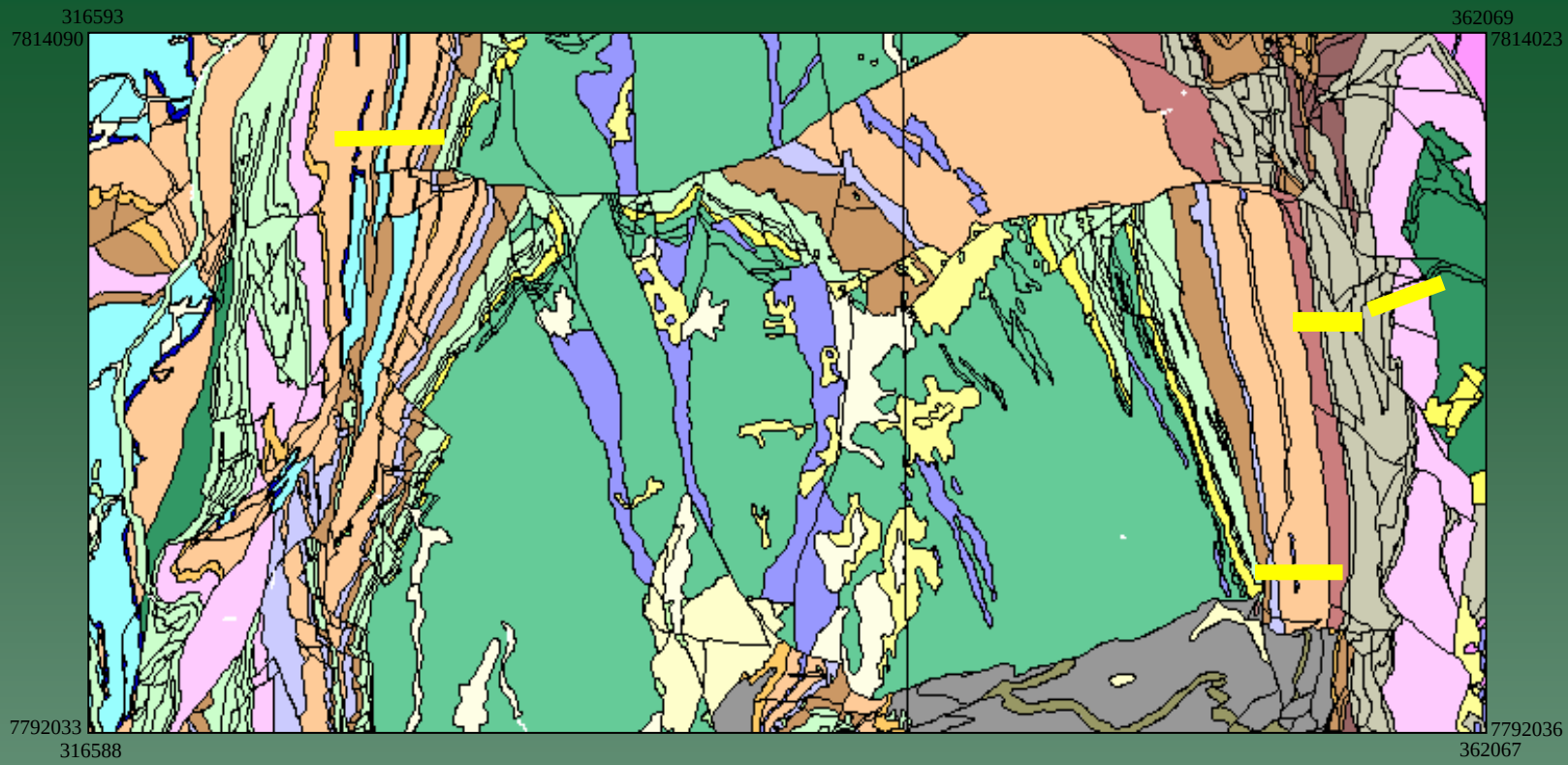
North-south trending rift - eastward-thickening wedge?

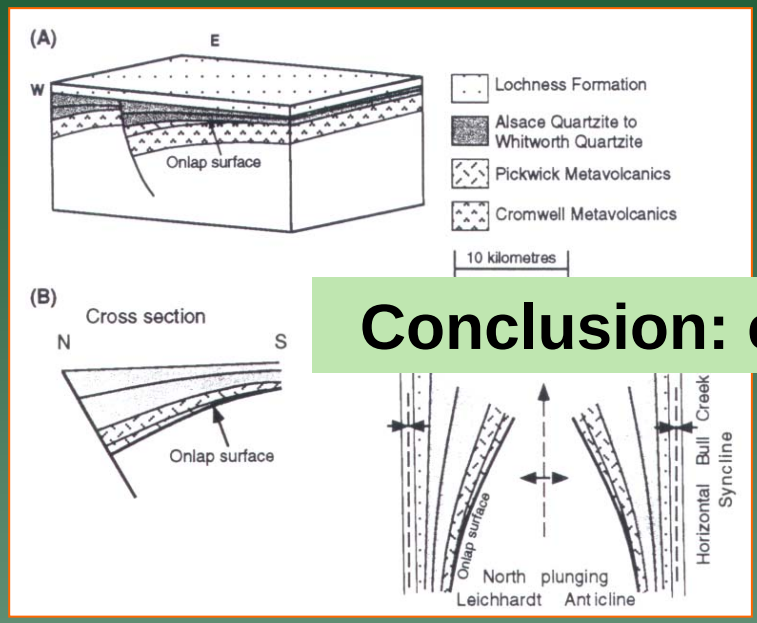
Conclusion: Early west-east extension



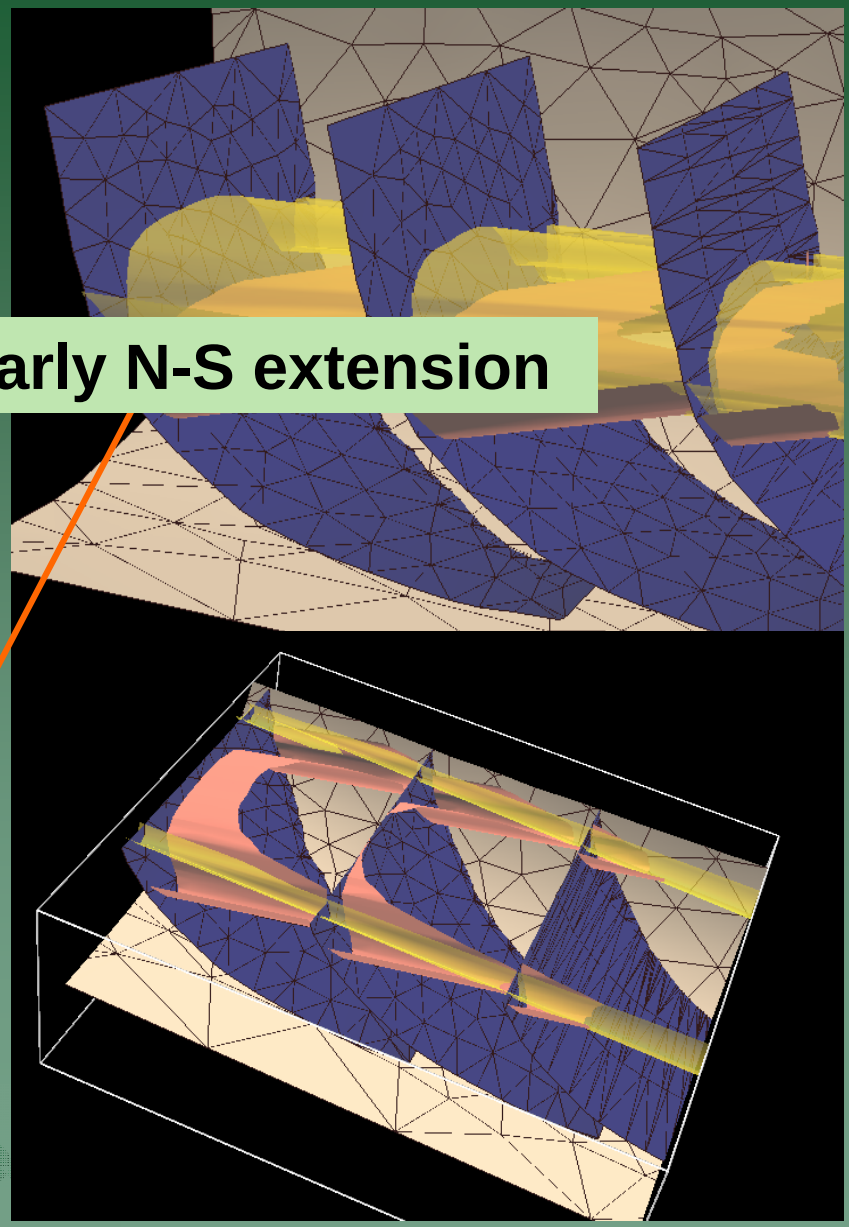
(Derrick et al., 1982)



- 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?



Conclusion: early N-S extension



Yellow = Base of Loch Ness Fm.

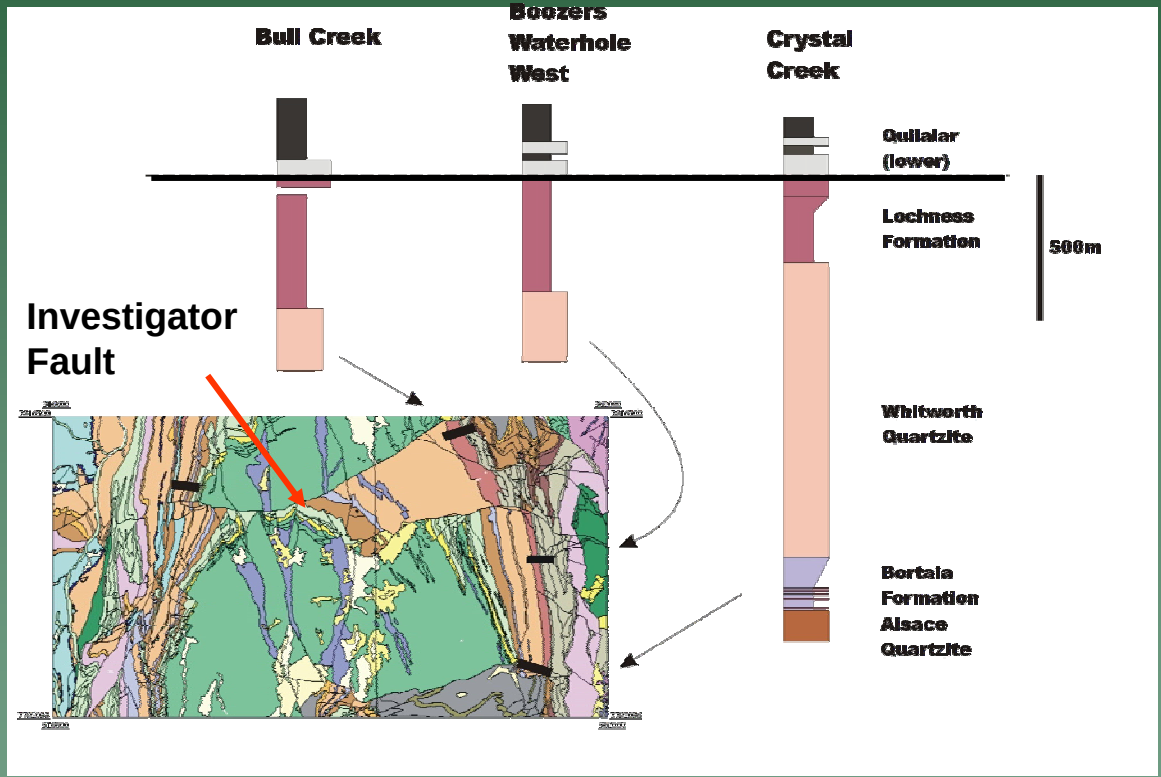
Pink = Top of ECV

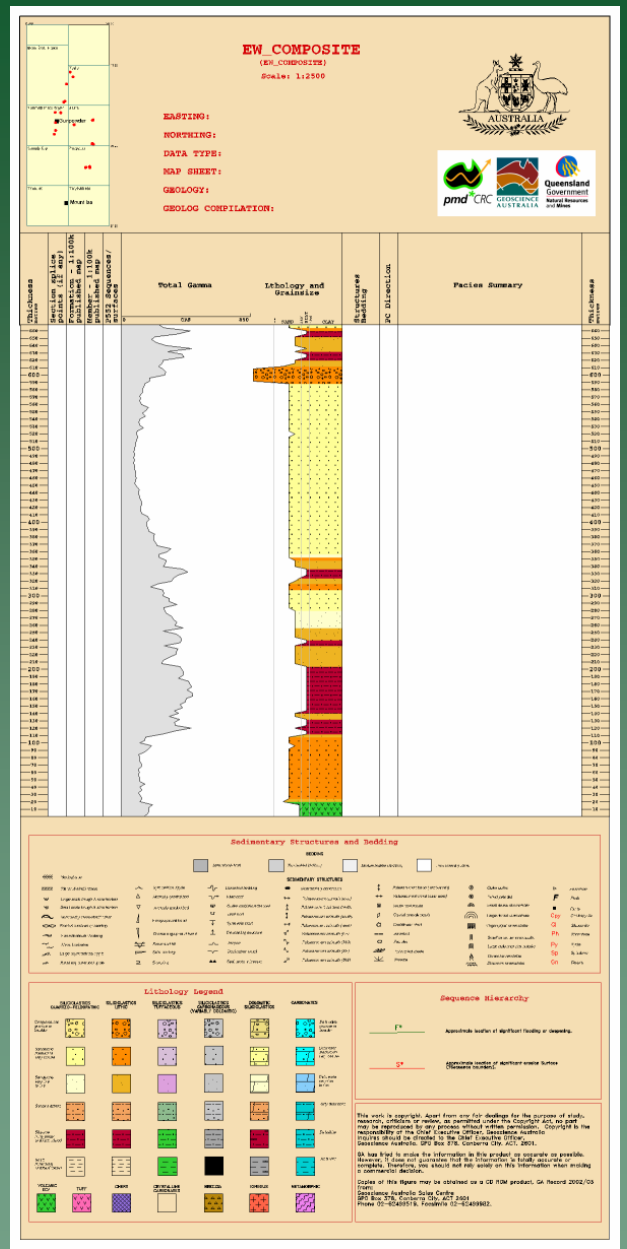
Blue = growth fault

(after O'Dea 1997)

Whitworth & Alsace qzites

Sequence Stratigraphy: Myally Subgroup





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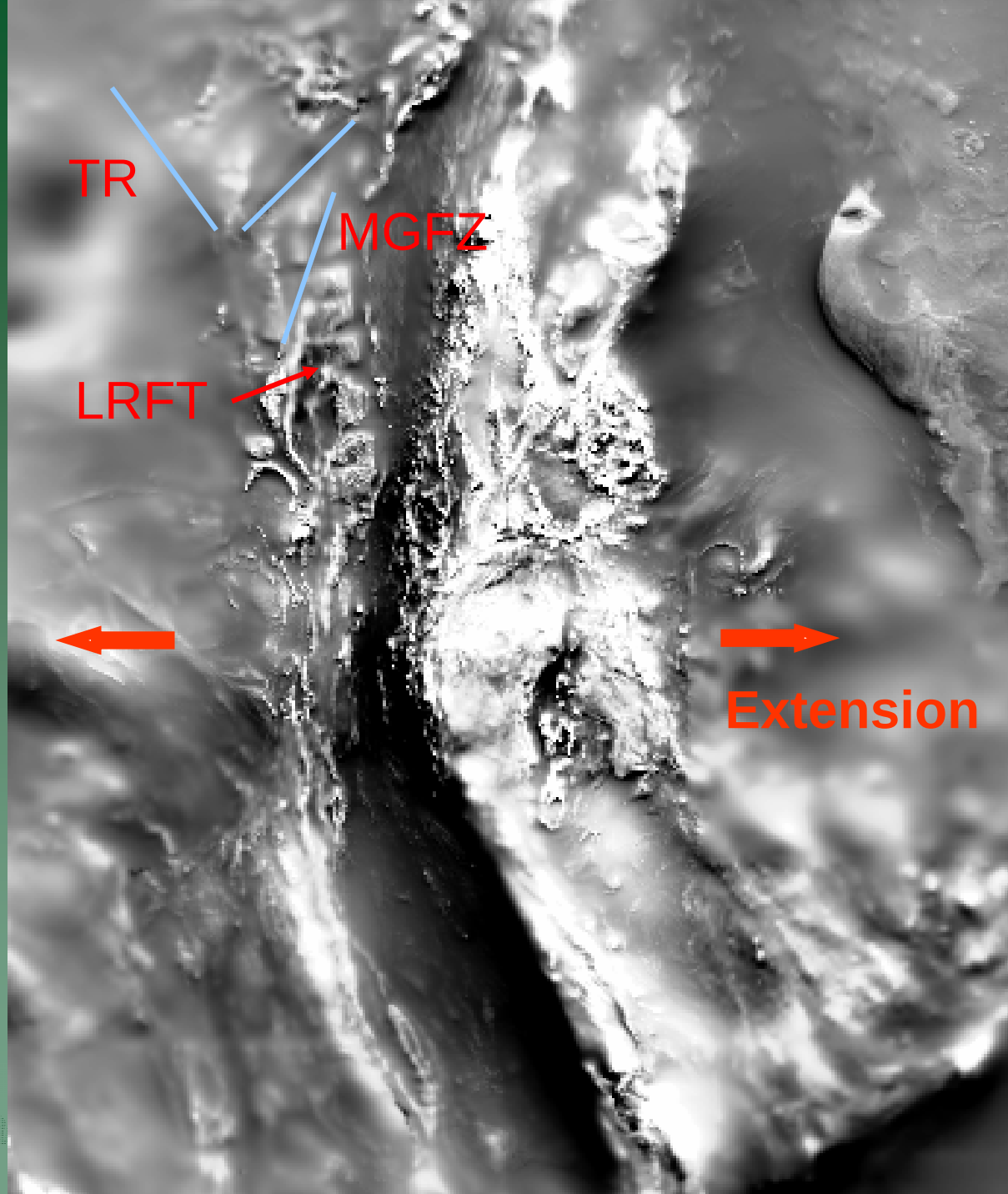
Regional structure: Aeromag 1VD

- Dominant N-S trend
- Early W-E extension
- N-S Dyking (= ECV?)
- Sedimentary facies
- Post-rift shortening



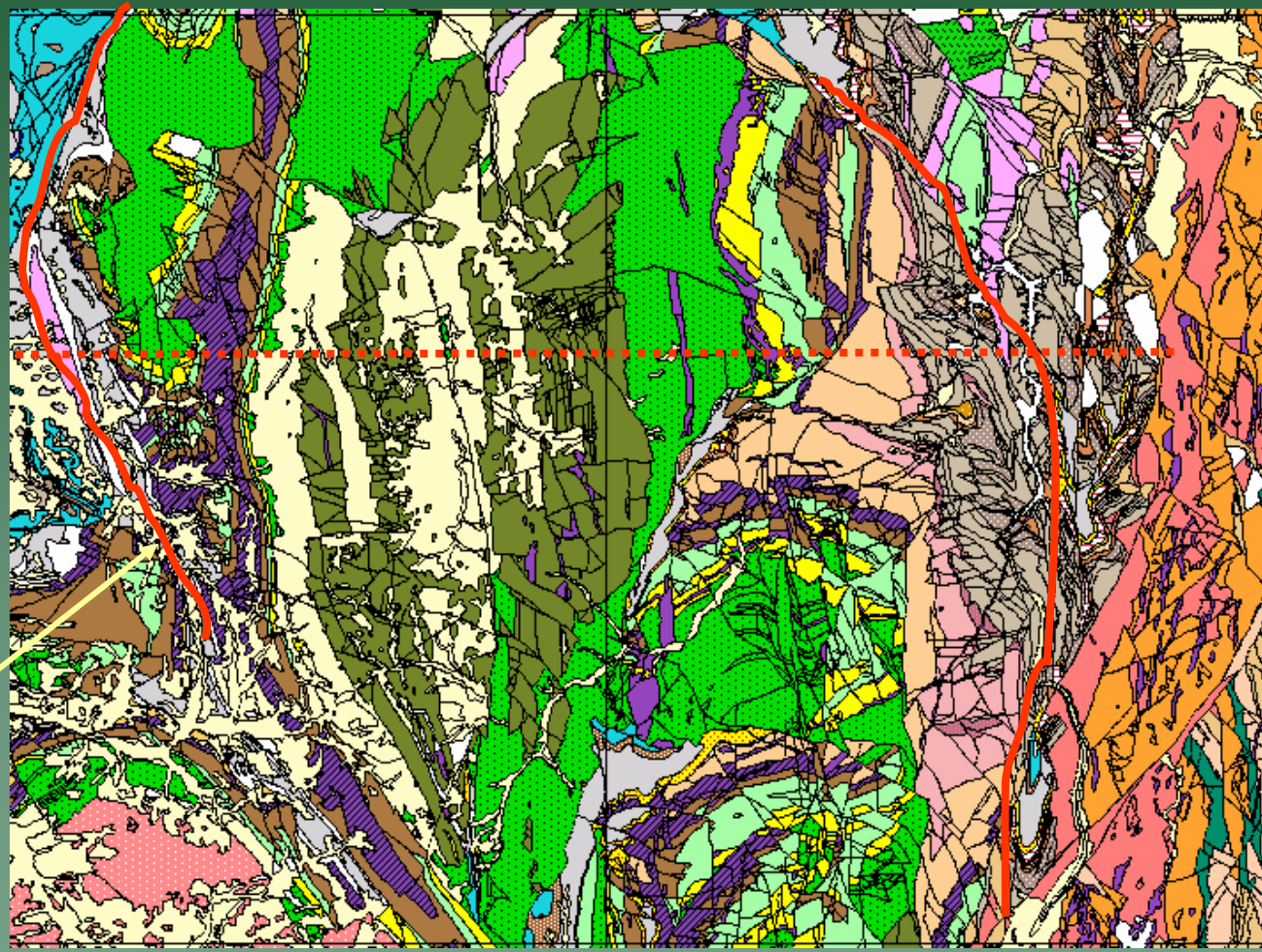
South Leichhardt River Fault Trough

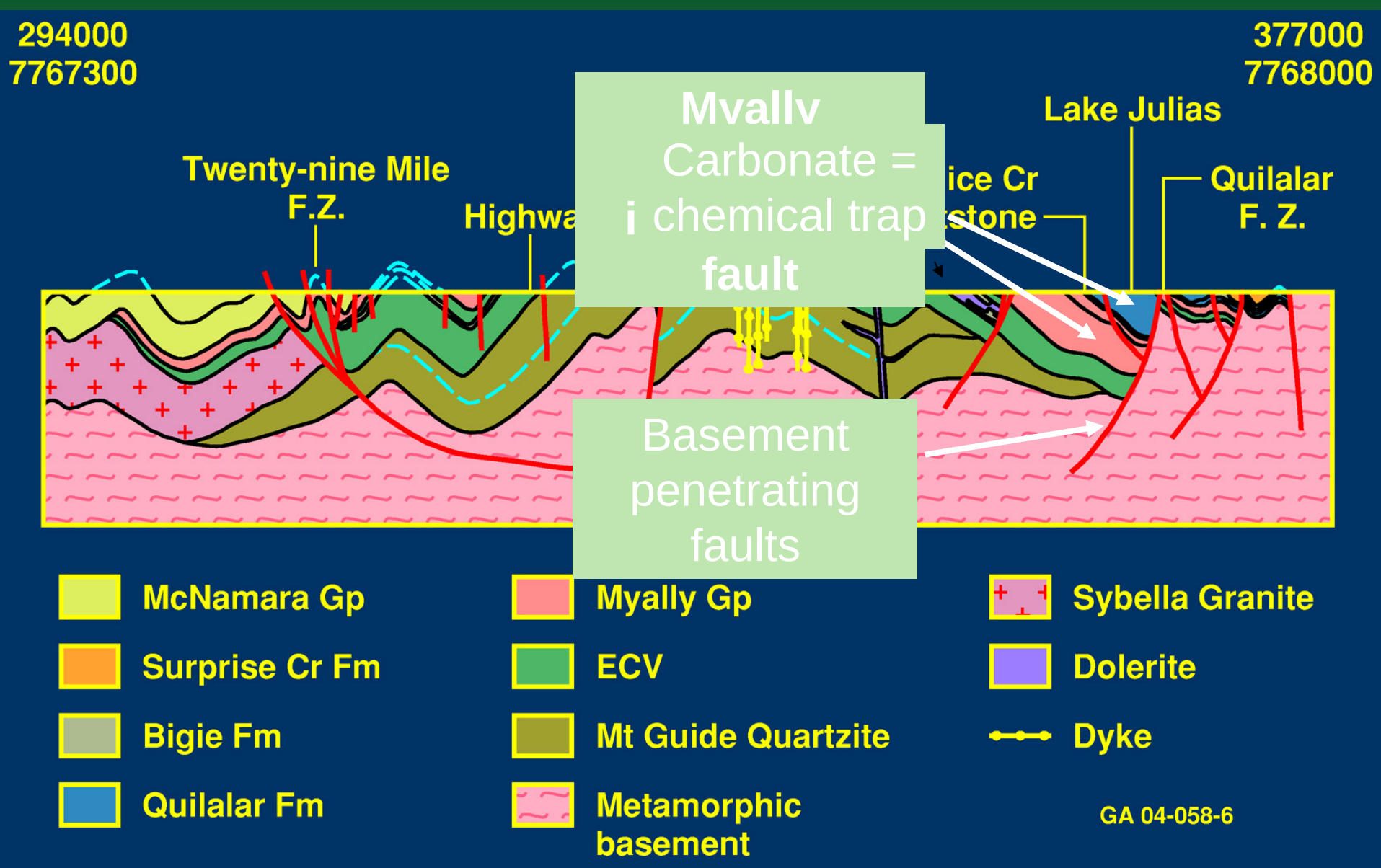
Eastward-thickening wedge

Normal fault geometry in east

Thrust boundary in west

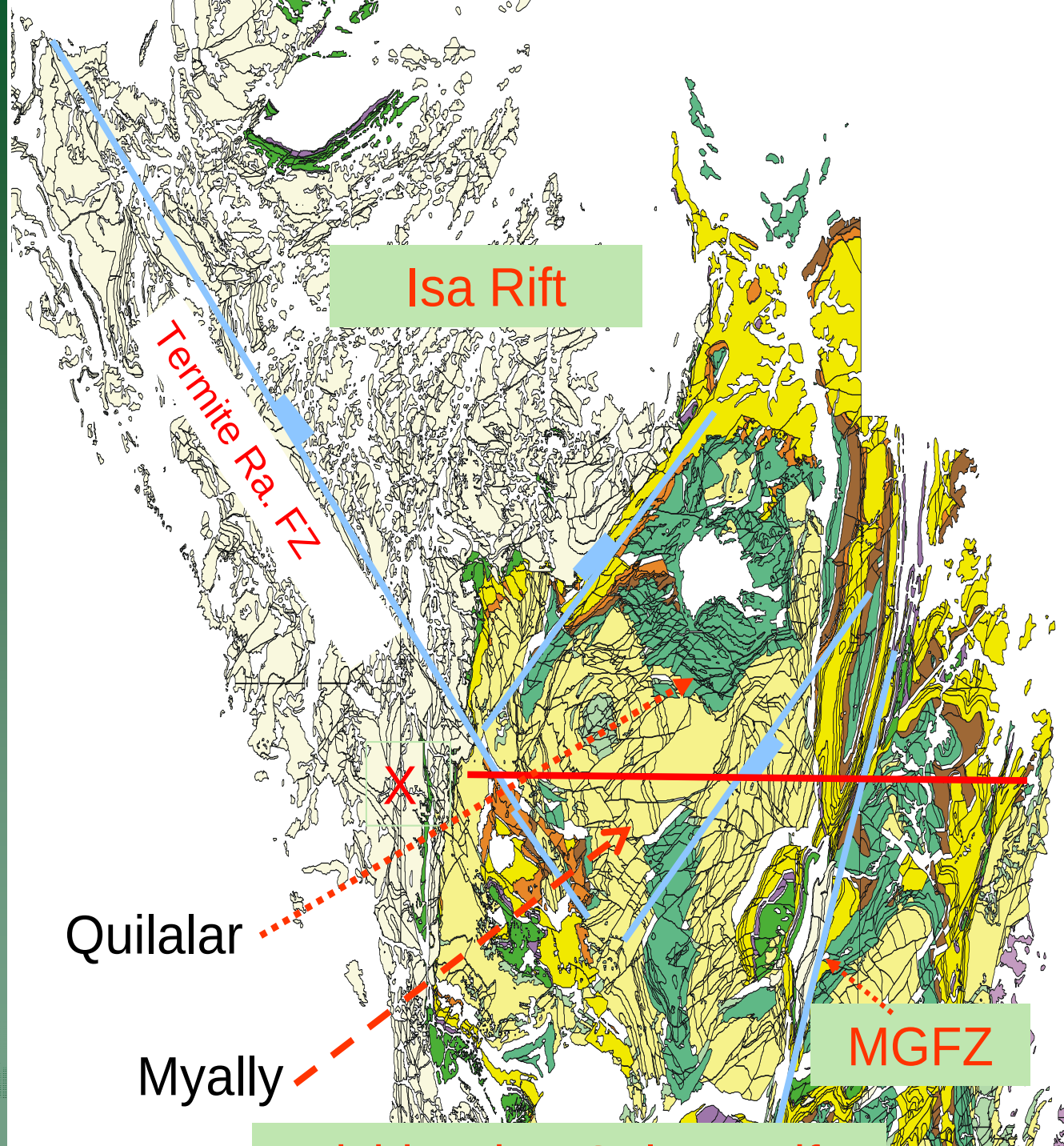
Twenty-nine Mile FZ

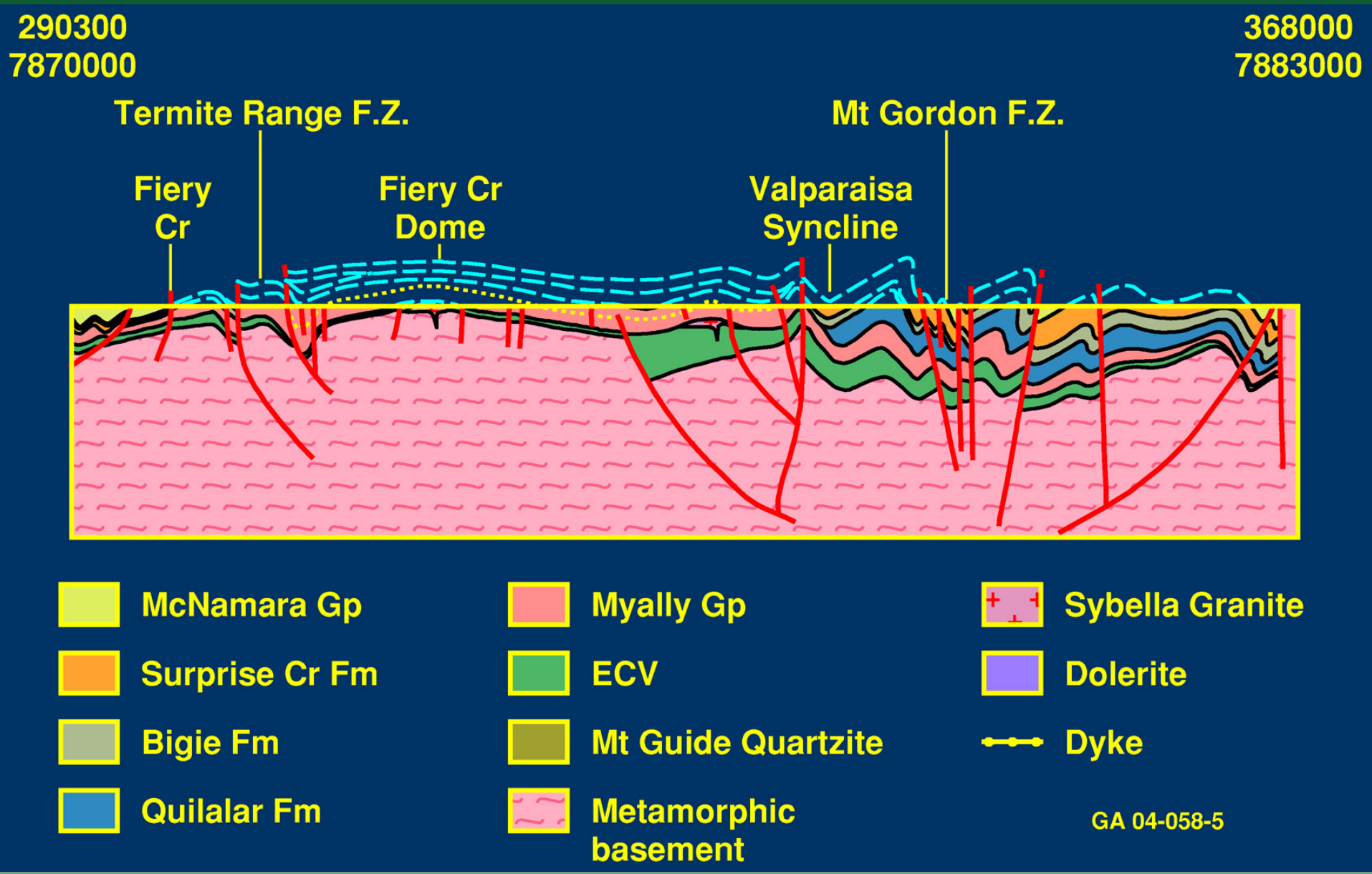



294000
7767300
377000
7768000
Twenty-nine Mile
F.Z.
Highwa
ice Cr
stone
Lake Julias
Quilalar
F. Z.
Mvallv
Carbonate =
i chemical trap
fault
Basement
penetrating
faults
McNamara Gp
Surprise Cr Fm
Bigie Fm
Quilalar Fm
Myally Gp
ECV
Mt Guide Quartzite
Metamorphic
basement
Sybella Granite
Dolerite
Dyke
GA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

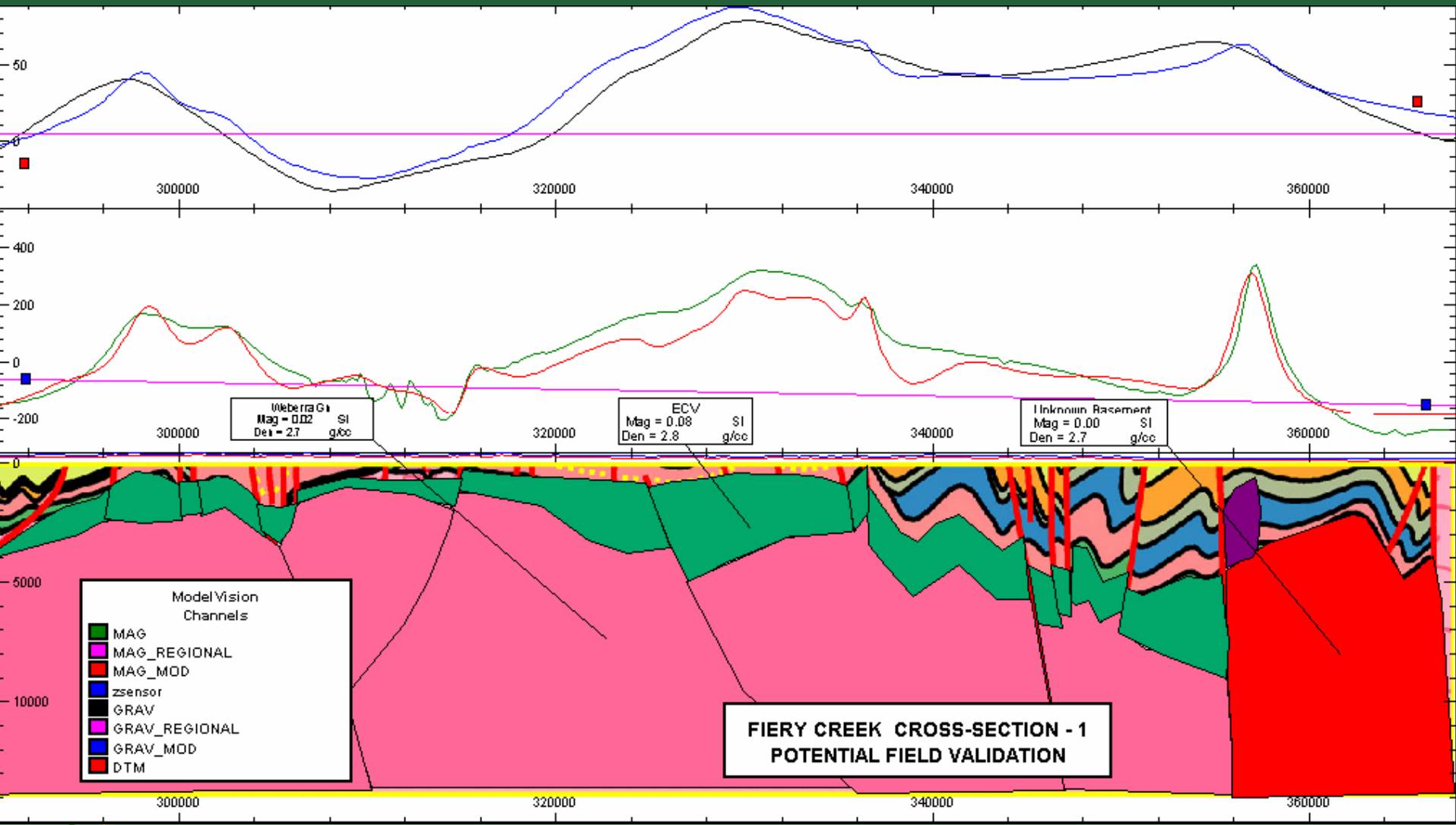
Fiery Creek Dome

- 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?

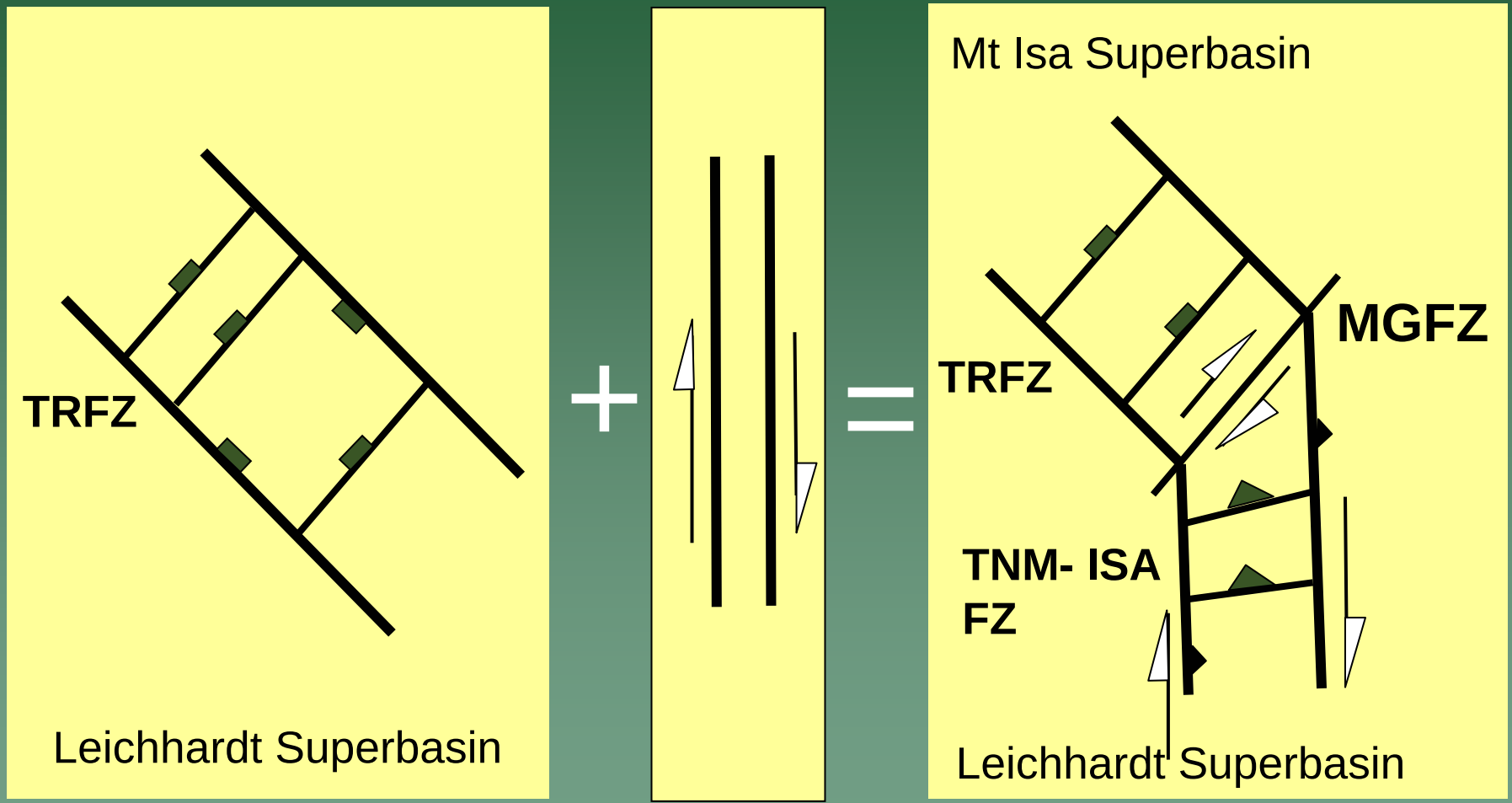



290300
7870000
368000
7883000
Termite Range F.Z.
Mt Gordon F.Z.
Fiery Cr
Fiery Cr Dome
Valparaisa Syncline
McNamara Gp
Surprise Cr Fm
Bigie Fm
Quilalar Fm
Myally Gp
ECV
Mt Guide Quartzite
Metamorphic basement
Sybella Granite
Dolerite
Dyke
GA 04-058-5

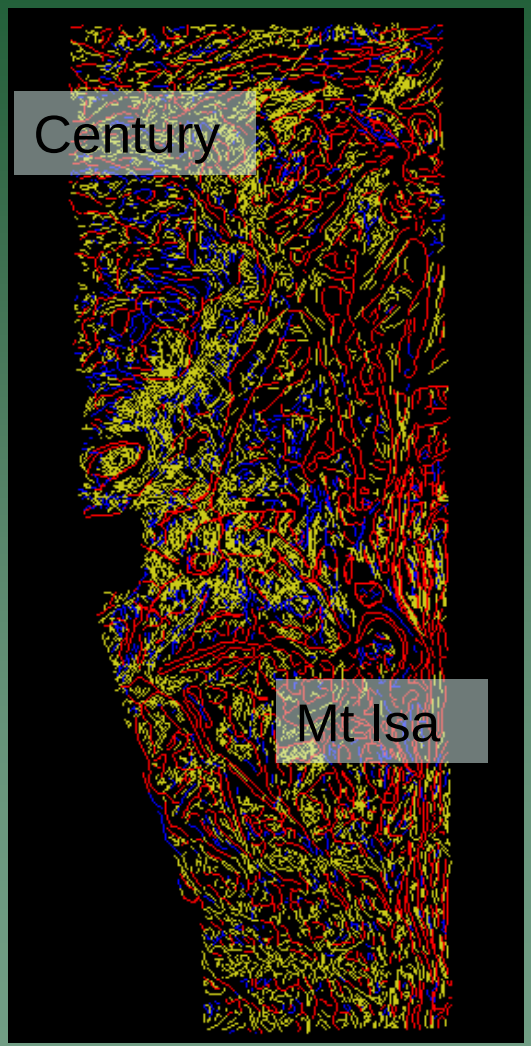
Potential Field Modelling (ModelVision)



Late Dextral Wrench Faulting



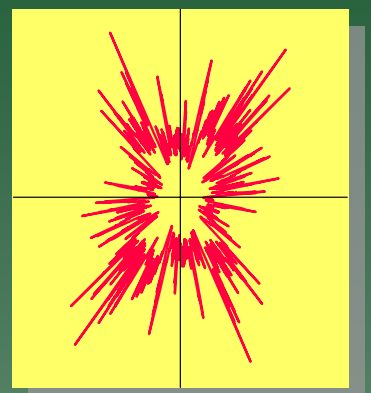
Statistical Analysis of (Aeromag) Worms

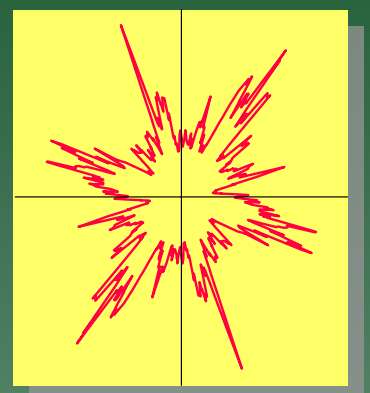


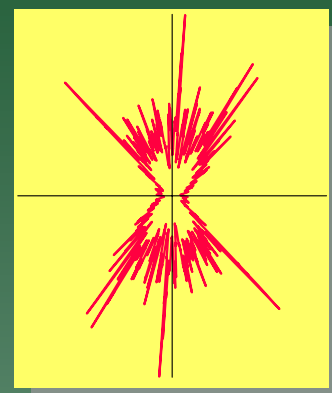
Sheet 1 (north)

Sheet 2 (south)

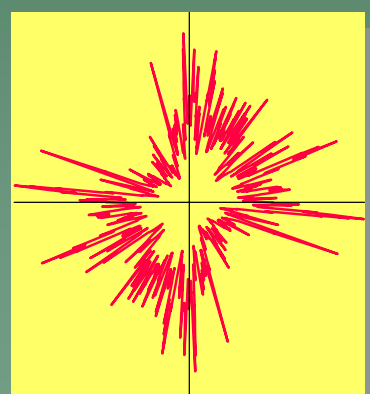
Northern sheet

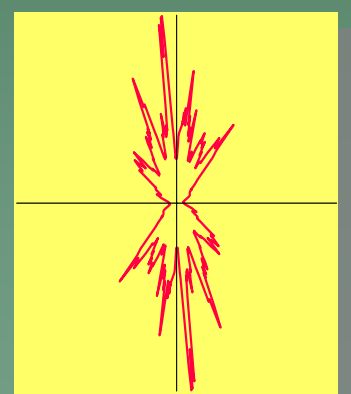


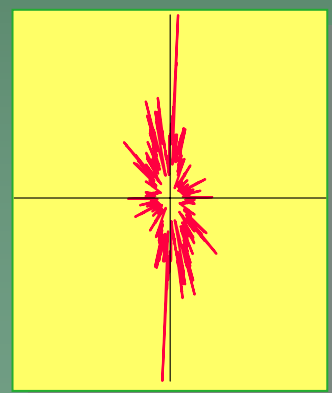




Southern sheet

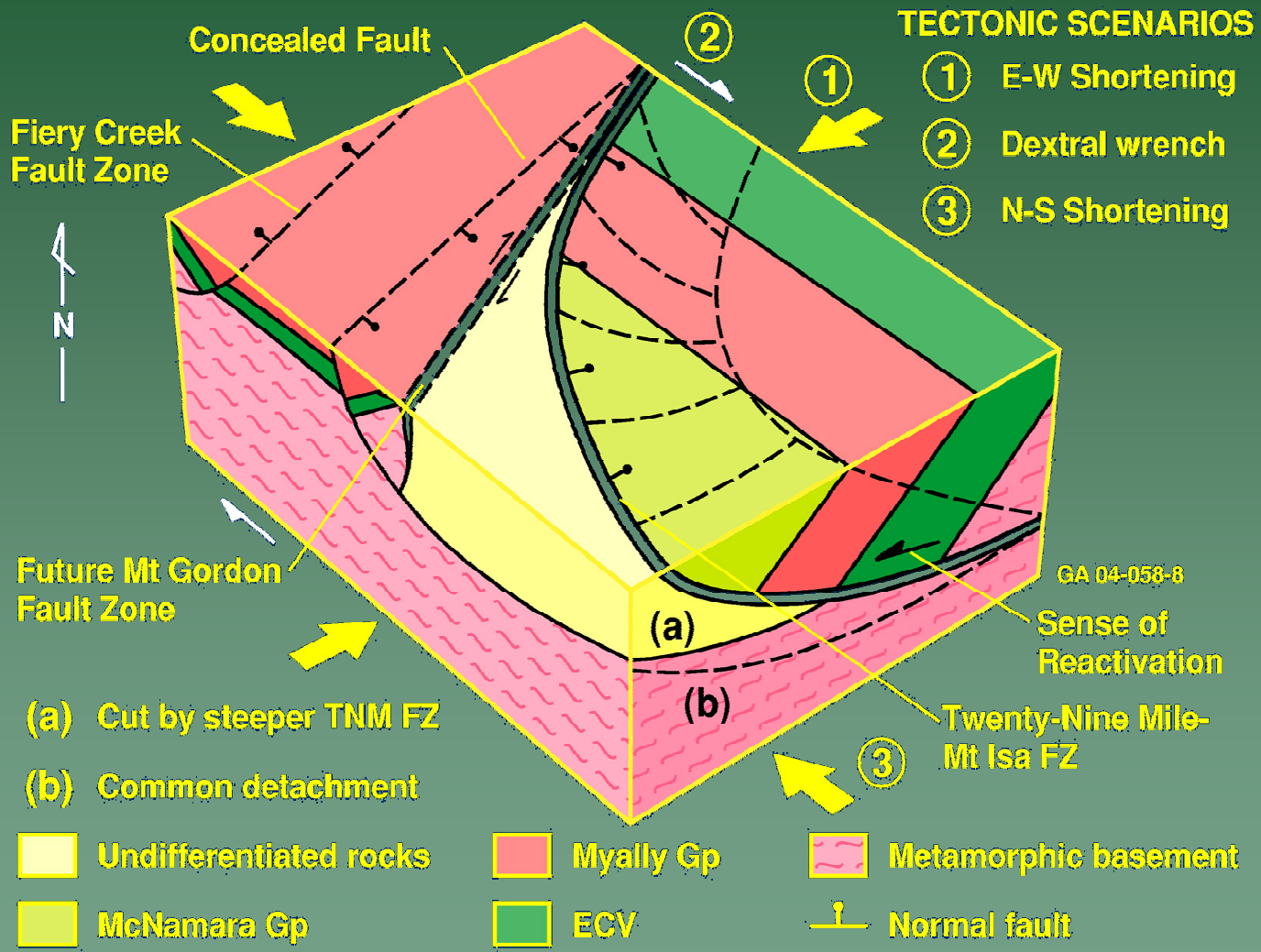






Numerical modelling: regional scale

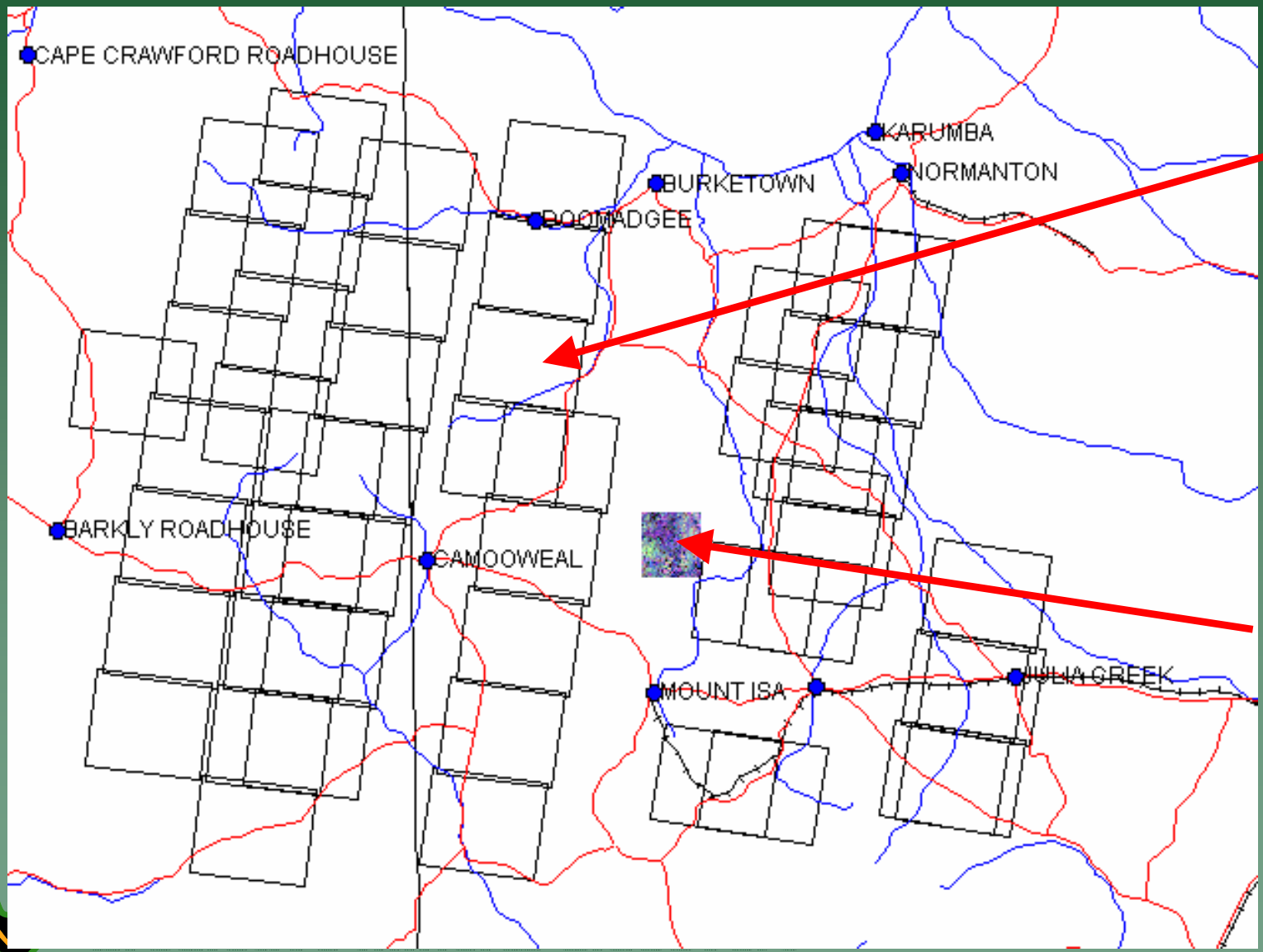
- Fluid conduits & trajectories
- Outboard normal fault
- Reactivated structures important in mineralisation?
- Isa FZ = Termite Range FZ



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

SATELLITE IMAGE SOURCES – ASTER L1B



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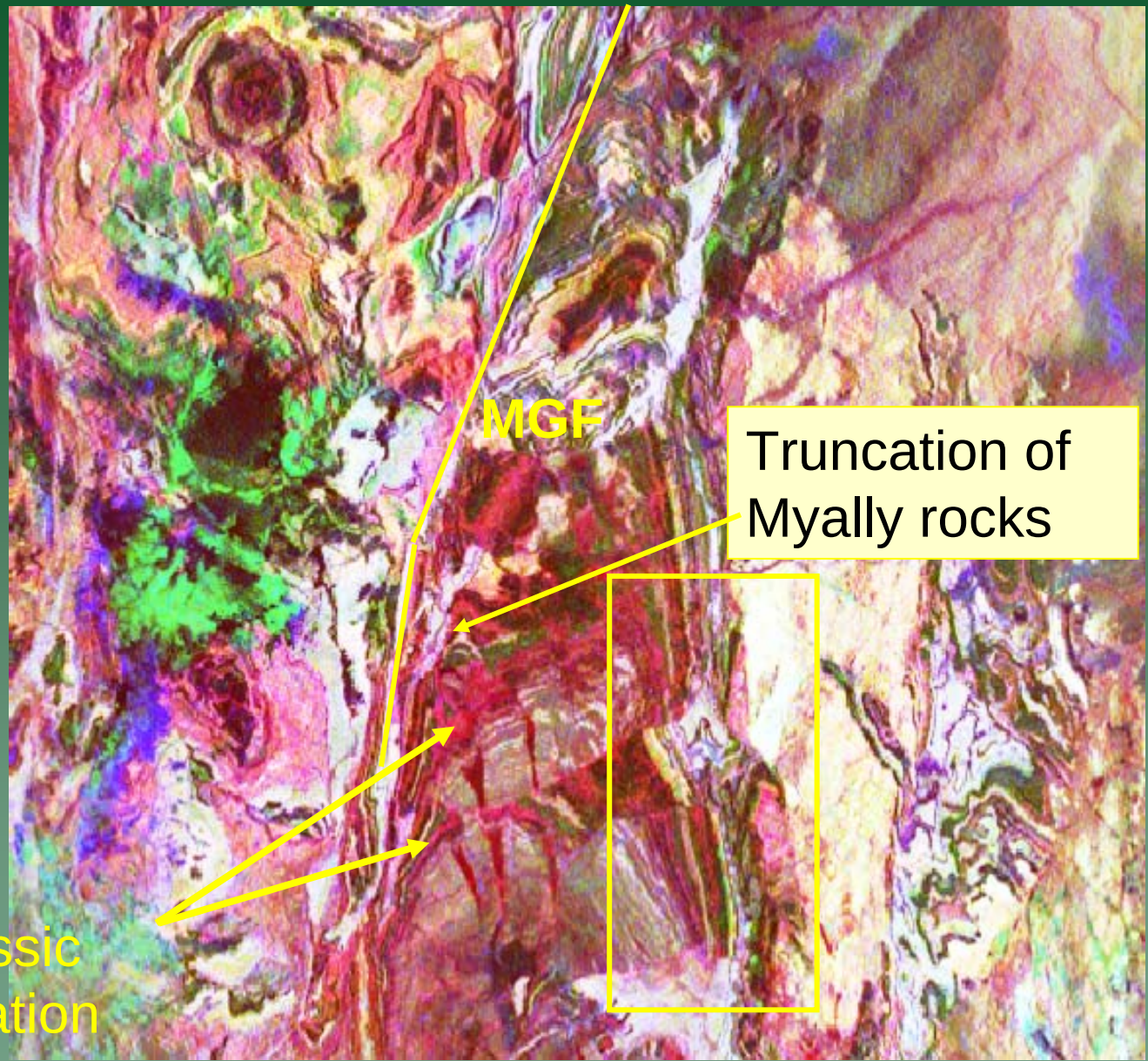
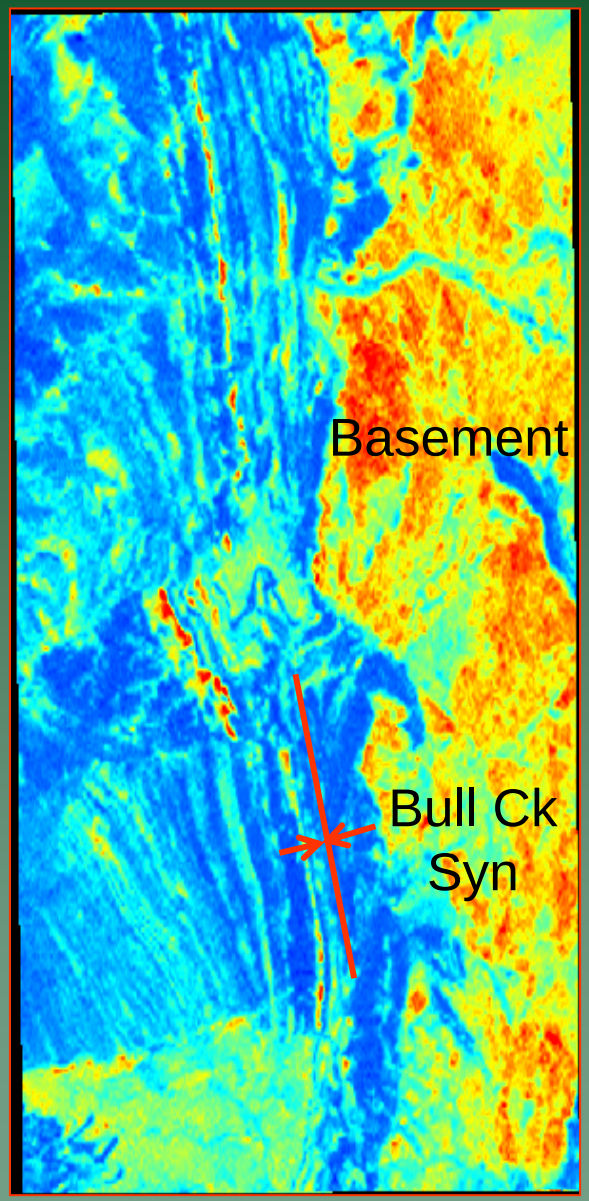
Module 3: Radiometrics

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

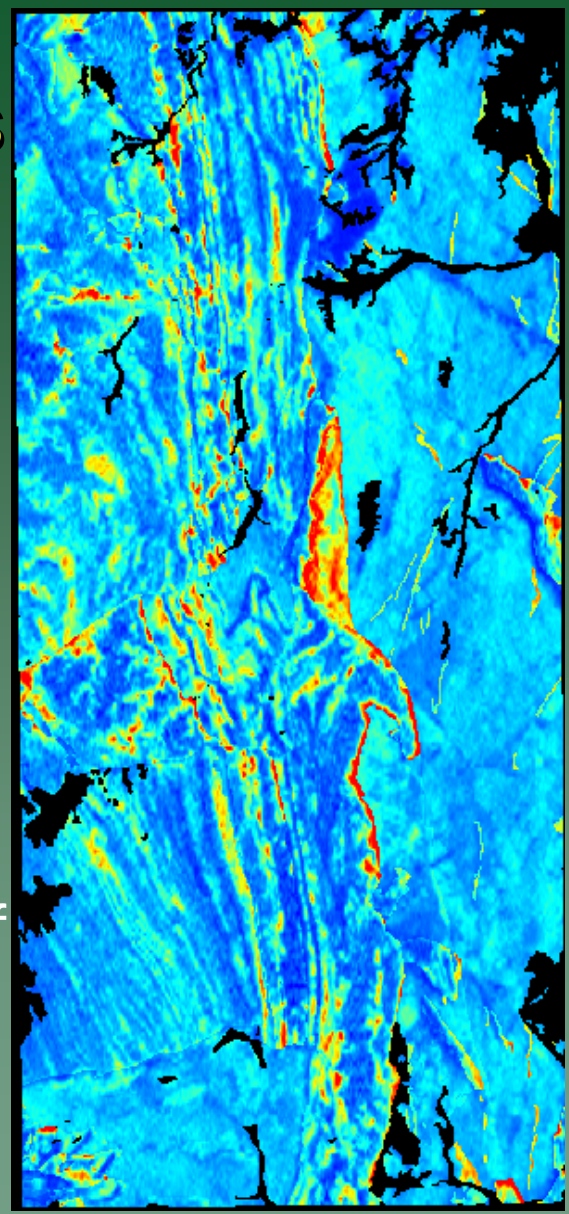


- Lochness Formation
- Potassic alteration in veins and in layer-parallel fabrics
- Could be related to deformation

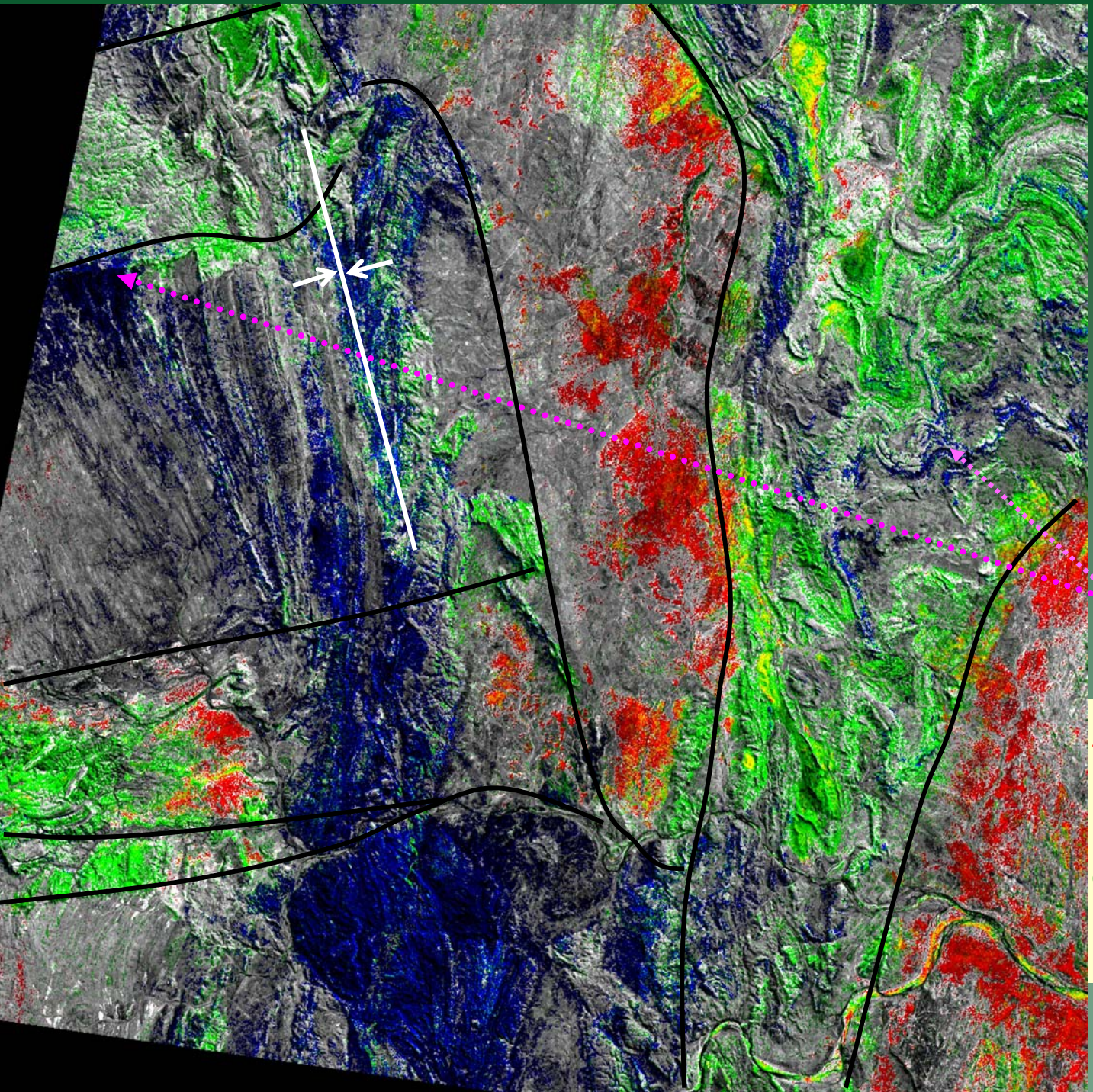


Radiometrics

Potassium band, Western Alsace 100k sheet



Normalised potassium (K/median of each lithological unit)



ASTER

Bull Creek Syncline & Faults

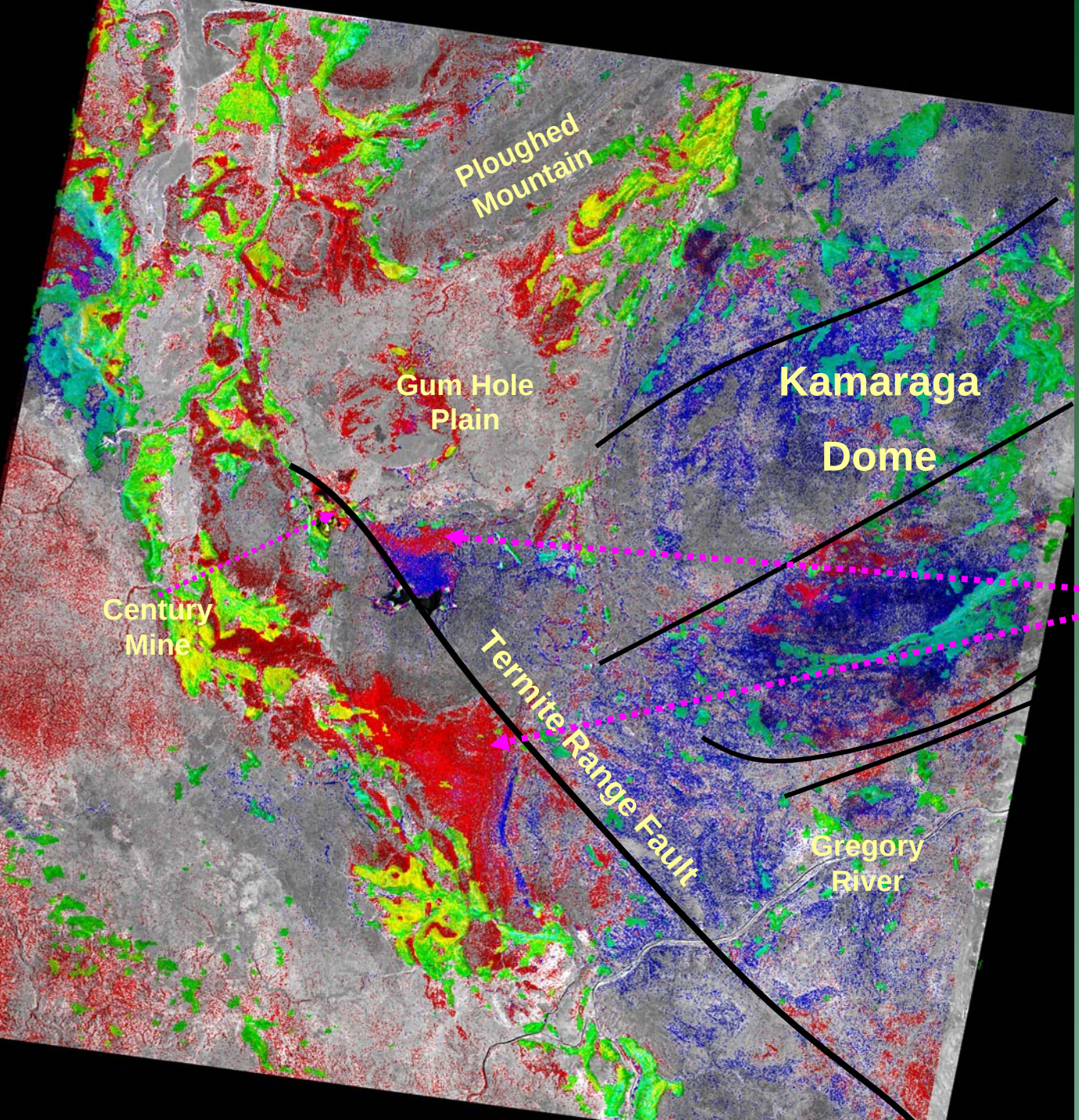
Alteration zone?

AlOH Minerals:

Red - Alunite

Green - Muscovite

Blue - Phengite



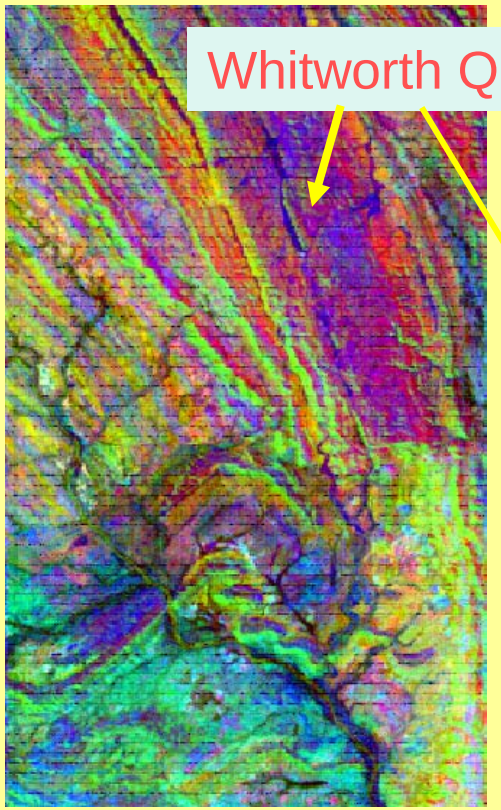
ASTER

Century & Termite Ra. Fault

Alteration zone?

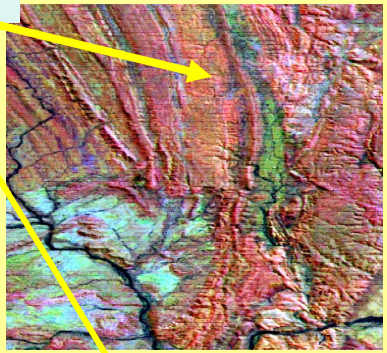
Red: Phengite
Green: Carbonate
Blue: Kaolinite

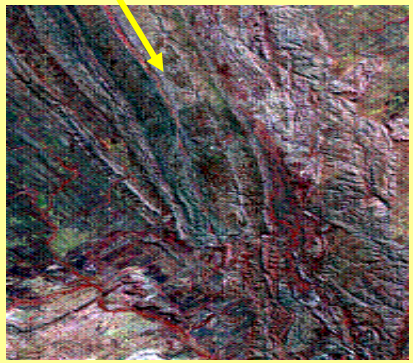
Ground-truthing Hyperspectral Imagery with PIMA



Whitworth Q.

Landsat

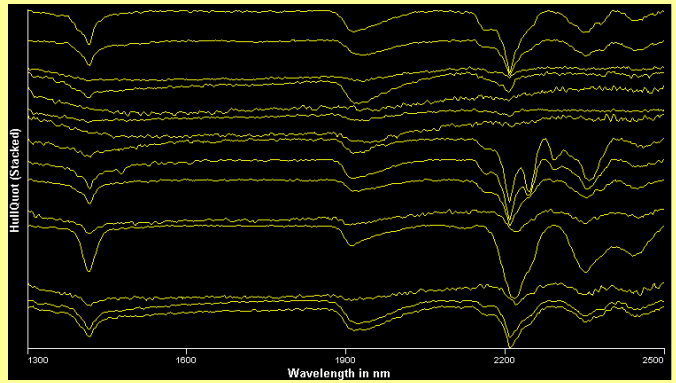


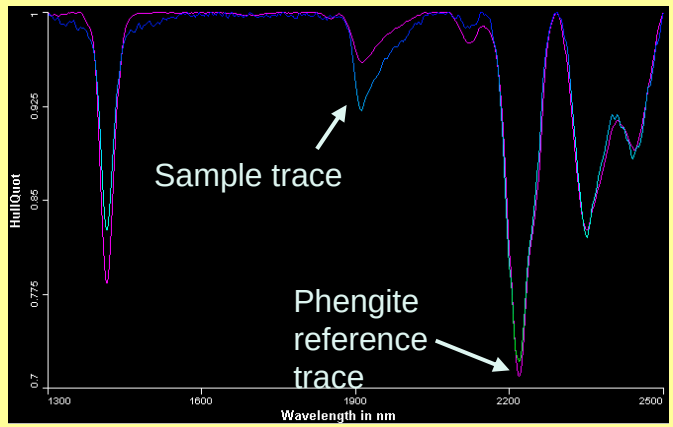


Hyperion

ASTER

PIMA – analysis of Whitworth Quartzite





predictive mineral discovery

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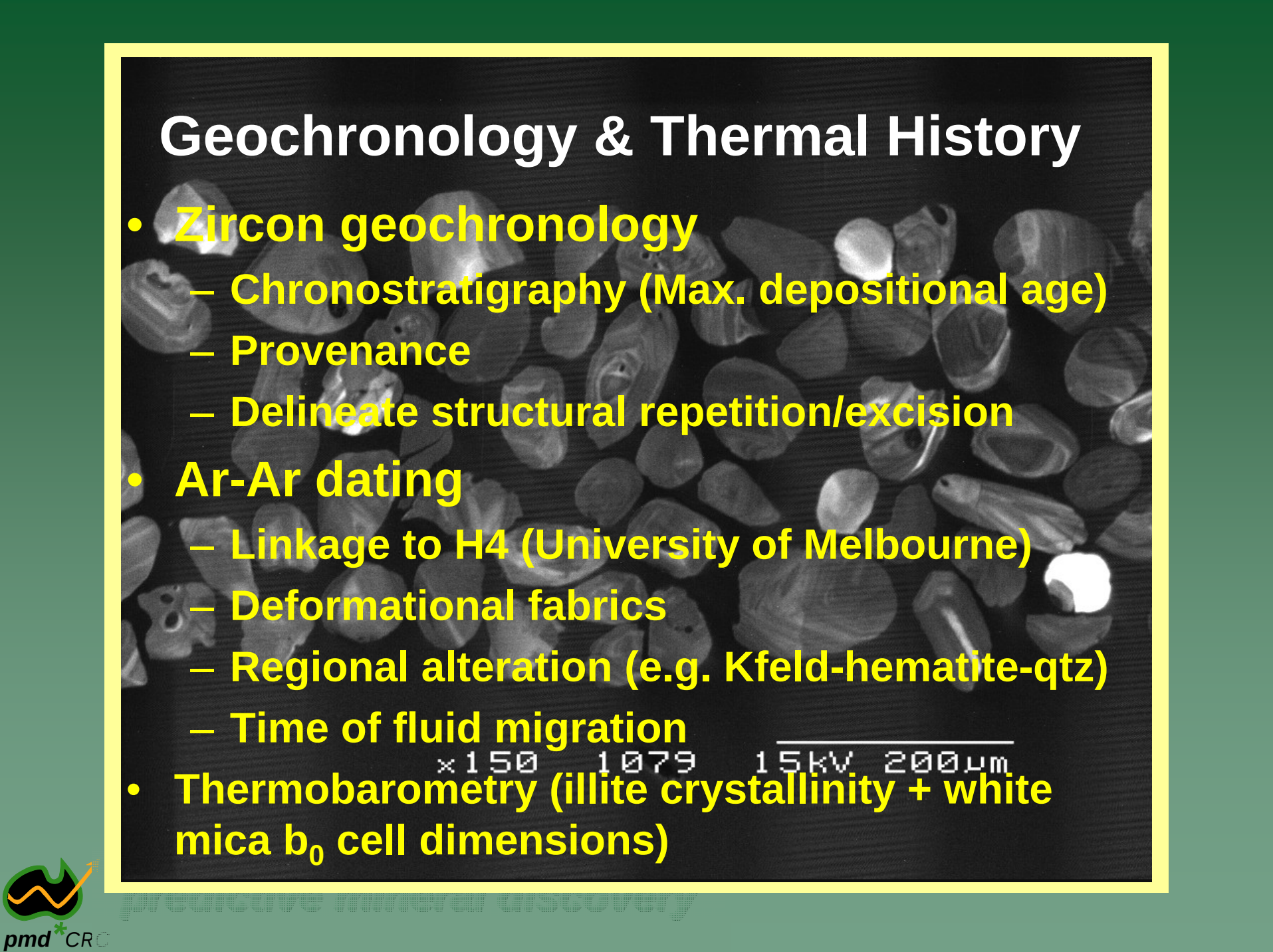
Geochronology & Thermal History

- **Zircon geochronology**
  - Chronostratigraphy (Max. depositional age)
  - Provenance
  - Delineate structural repetition/excision
- **Ar-Ar dating**
  - Linkage to H4 (University of Melbourne)
  - Deformational fabrics
  - Regional alteration (e.g. Kfeld-hematite-qtz)
  - Time of fluid migration
- **Thermobarometry (illite crystallinity + white mica b_0 cell dimensions)**



Module 2: 3D Sedimentary Fence Diagram

- Regional-scale depocentres
  - Mapped thickness variation
  - Measured sections
- Sedimentary facies distribution
- Vector to syn-depositional (growth) faults
- Myally Gp; Quilalar Fm; Bigie Fm; Surprise Creek

3D Model

Movie Time