EGRU

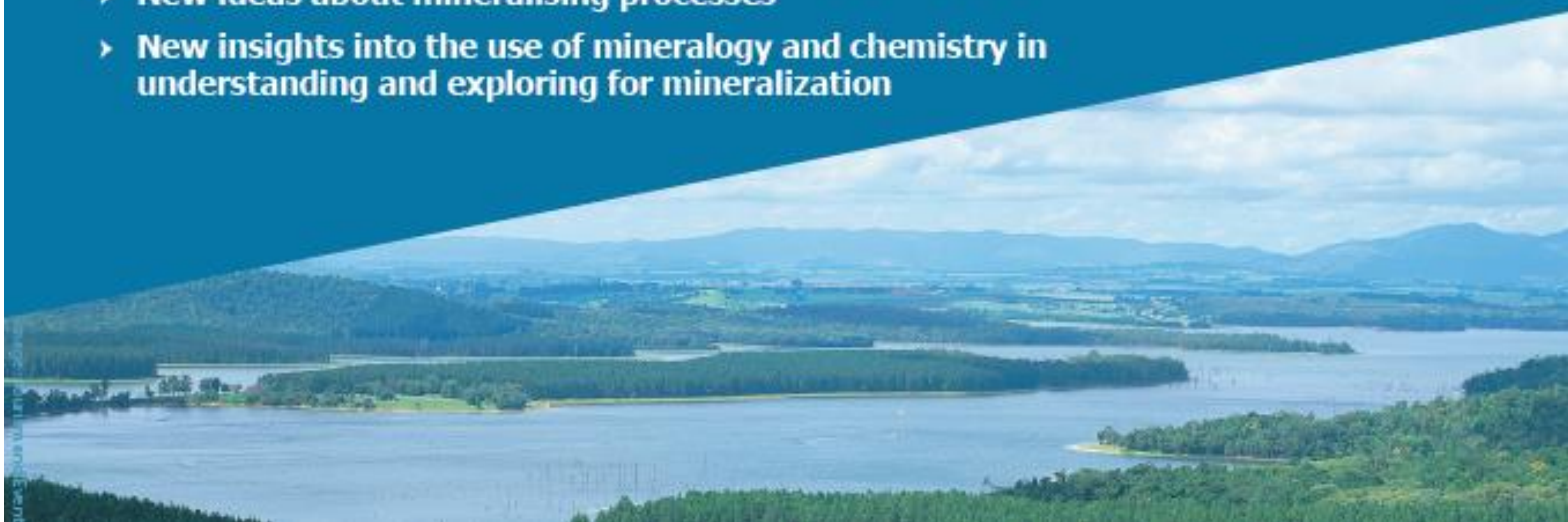
presents an international geological conference on

Sn-W-Critical Metals & Associated Magmatic Systems

24th - 28th June 2019

Tinaroo Lake Resort, Atherton Tablelands, Queensland, Australia

- **Technical Sessions & Field Trips**
- **New results and concepts about deposits and mineralisation in North America, China, Europe, Africa, and Australia**
- **New ideas about mineralising processes**
- **New insights into the use of mineralogy and chemistry in understanding and exploring for mineralization**



GSQ Technical Workshop “Data and Research Innovations for Exploration”

Preliminary Results on the Magma Fertility Related to Cu-Au and U-REE Mineralisation in the Mary Kathleen Domain, Mt Isa Inlier

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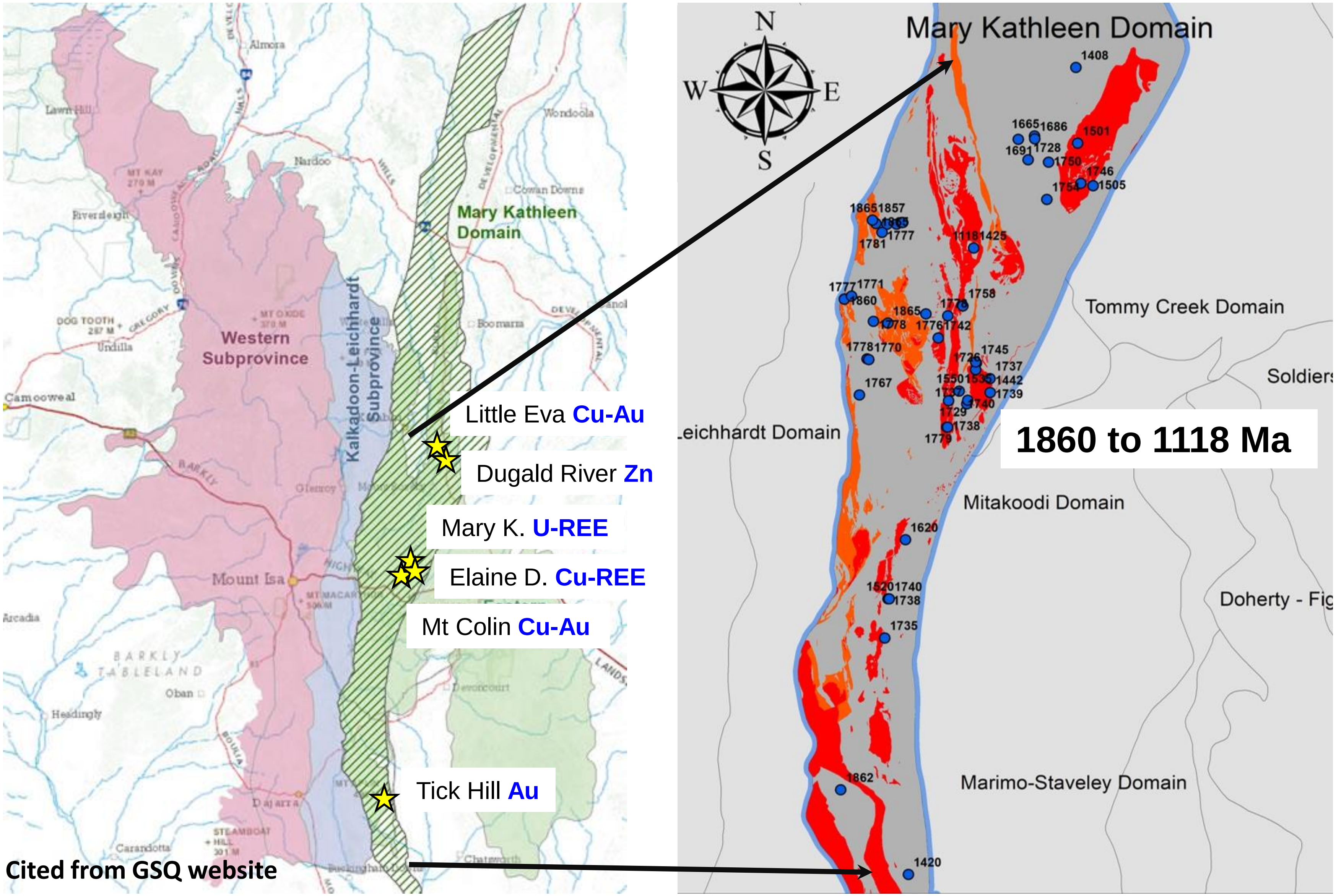
Economic Geology Research Centre, James Cook University

5 June 2019

Townsville, Queensland, Australia

Research background



Research aims

- ❑ Establish the **extent, character and timing** of the dominant magmatic activities in the Mary Kathleen Domain of the Mt Isa Inlier
- ❑ Develop an understanding of the **tectono-magmatic history** of the Mary Kathleen Domain and **its links to metallogenesis**
- ❑ Explore the applicability of **magma fertility concepts** as a tool for exploration for a variety of deposit types

Provide an updated geological framework of Mary Kathleen Domain in collaboration with **GSQ team** (David Purdy, Bob Bultitude, Dominic Brown, Derek Hoy, etc.)

Completed work (up to date)

- **Literature review and data compilation**

- **Field investigation**

1) July 2018: granitoids, felsic dykes, pegmatite, mafic dykes, gabbro, sediments and metasomatic rocks in the Mary Kathleen Syncline, and Mary Kathleen, Elaine Dorothy, Mt Colin deposits
2) October 2018: granitoids, pegmatite, diorite, mafic dykes and gabbro of the MGK, BST, LC & WG complexes, north of Highway

- **Sample collection and preparation**

1) 61 samples collected from the north of highway
2) Rock cutting, observation, photographing, zircon separation, mounting…

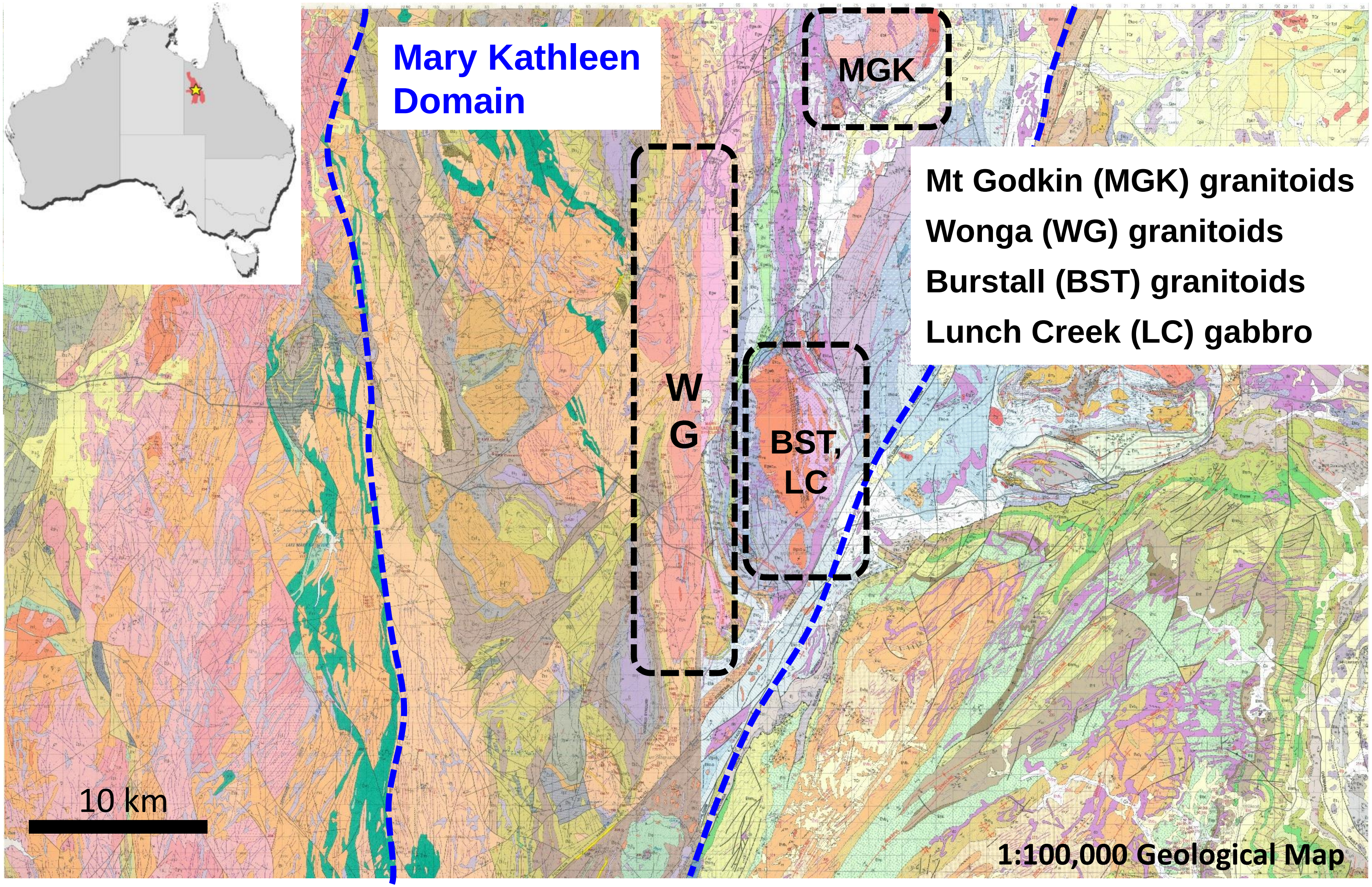
Completed work (up to date)

- **In-house analyses & data reduction**
  - 1) Whole rock geochemistry (Bureau Veritas, Canada): 51 samples
  - 2) LA-ICPMS zircon U-Pb dating (AAC, JCU): 10 samples, 186 analyses
  - 3) LA-MC-ICPMS zircon Hf isotope (AAC, JCU): 4 samples, 88 analyses

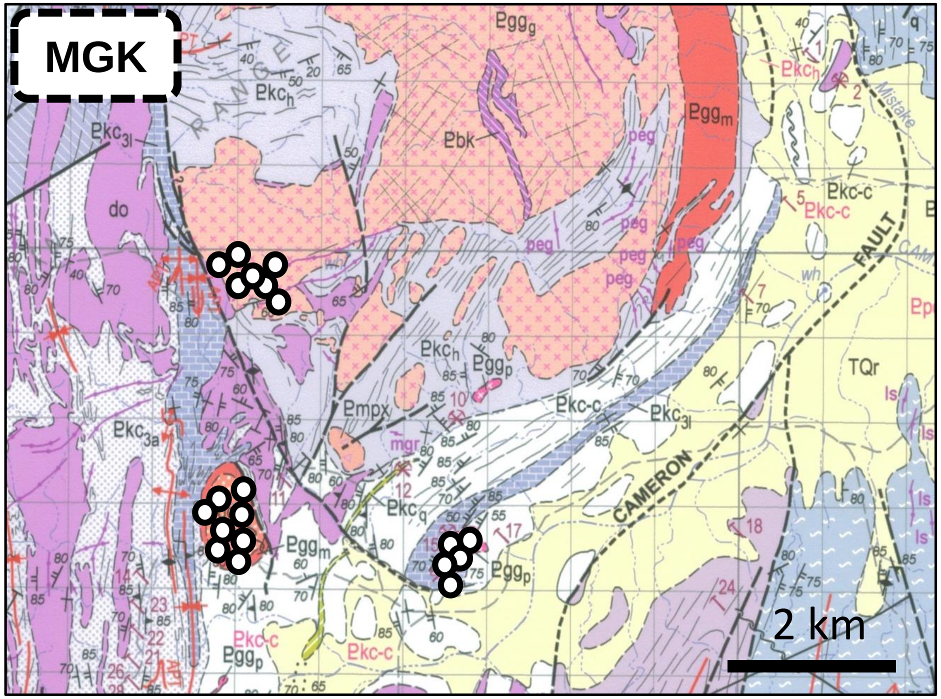
- **New data**
  - 102 zircon CL images (10 samples)
  - WR geochemistry (51 suites)
  - U-Pb ages (9 ages)
  - Hf isotopes (2 samples)

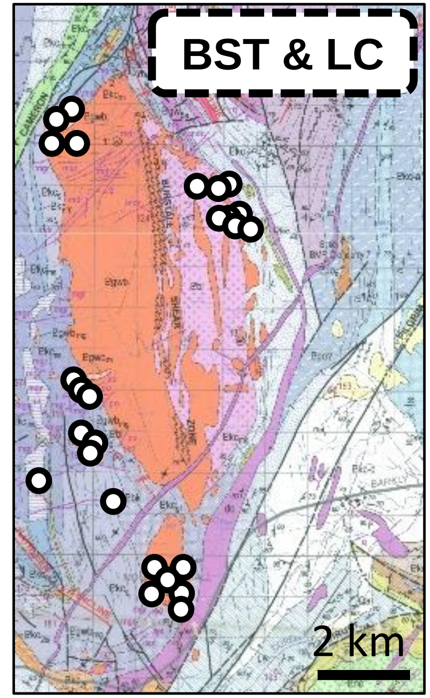
- **Presentations, reports and journal papers**

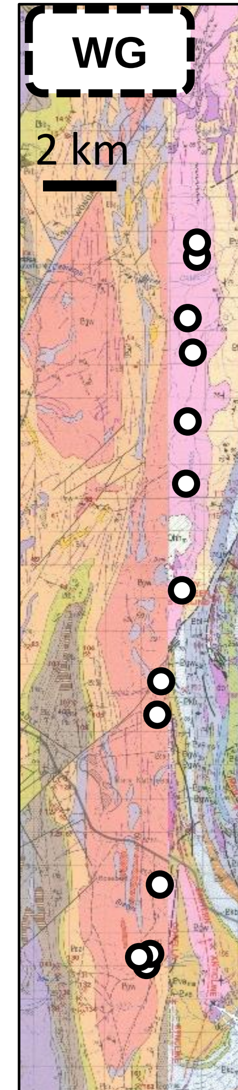
Sample locations



Sample locations







Mt Godkin (MGK) granitoids: 20 samples

Burstal (BST) granitoids: 13 samples

Burstal mafic / felsic dykes: 6 samples

Lunch Creek (LC) gabbro: 8 samples

Wonga (WG) granitoids: 12 samples

Geology and Petrology

Mt Godkin Granitoids

plus monzonite and pegmatite phases…

Geology and Petrology

Wonga granitoids

Wonga granitoids

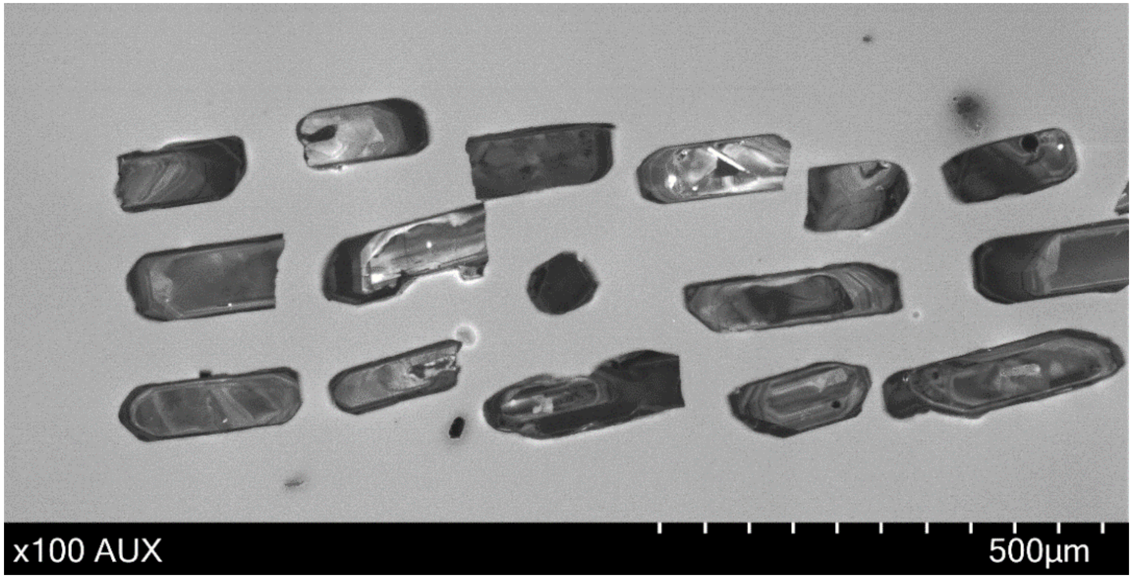
Lunch Creek gabbro

Gabbro, diorite, monzonite, granite (foliated, altered, and fresh) and, pegmatite!

Zircon CL Images

(10 samples, 102 images)

Wonga Granite



Clear oscillatory zoning under CL

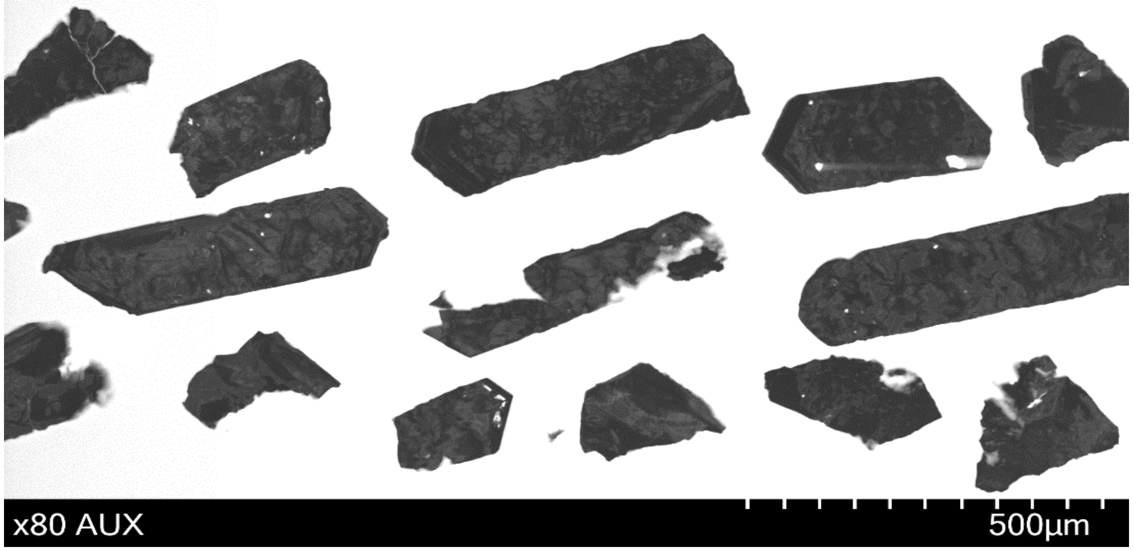
↓

Magmatic zircon

↓

Facilitate age determination

Mt Godkin Pegmatite



High U content

↓

Radiation damage

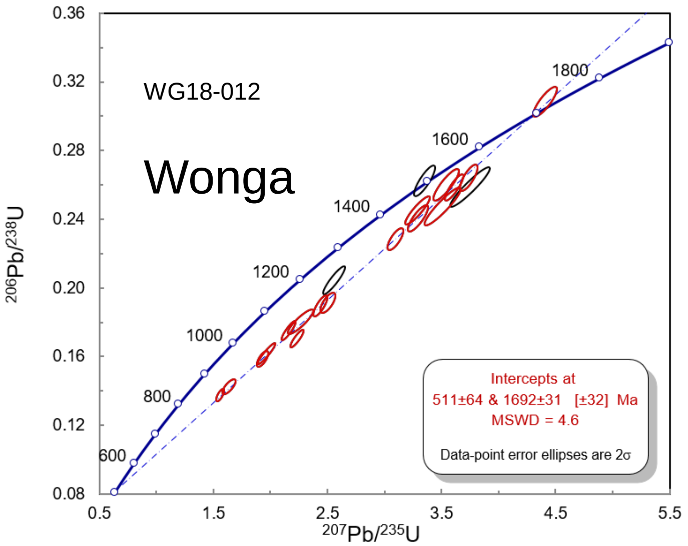
↓

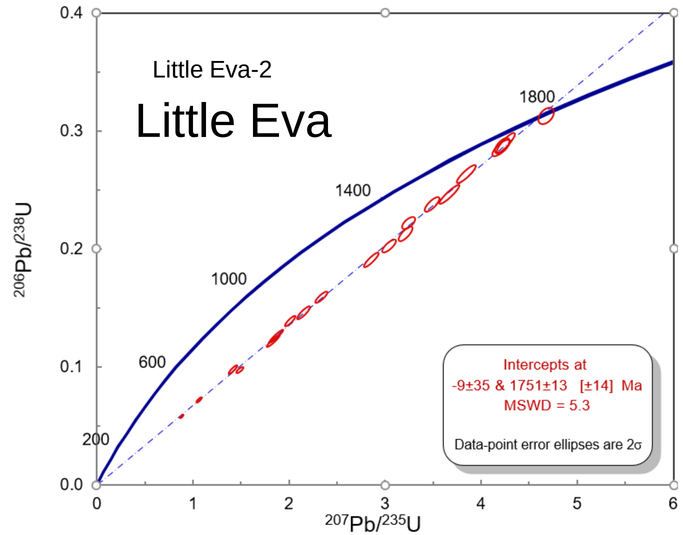
Pb loss

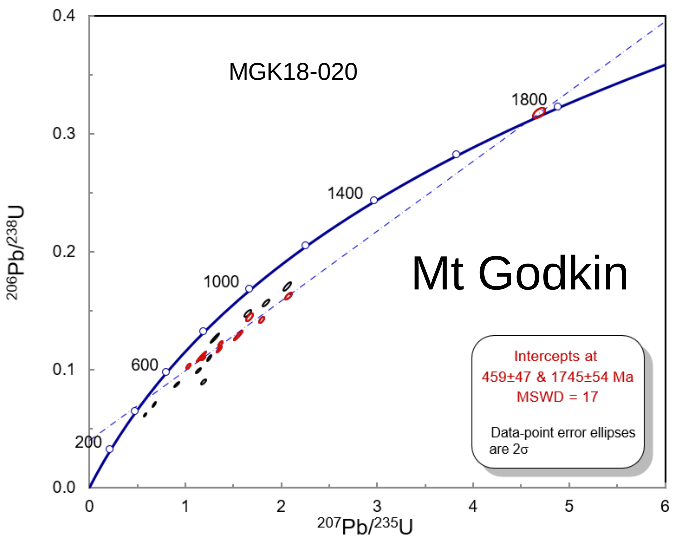
↓

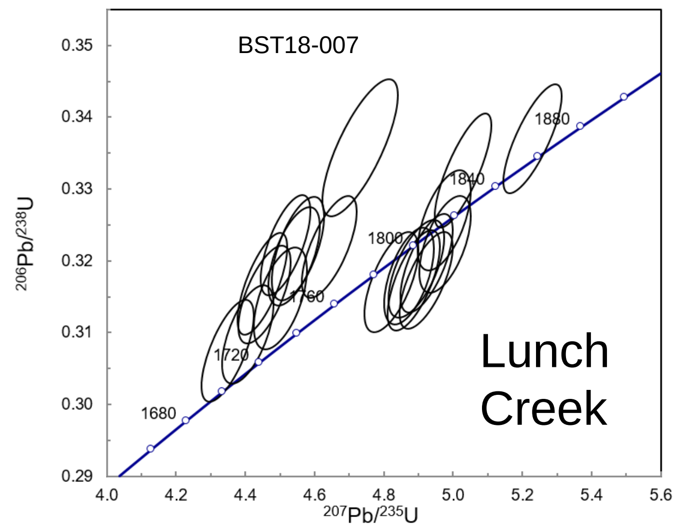
Complicate age determination

Geochronology









Preliminary results

Mt Godkin granitoids: 1745 ± 54 Ma

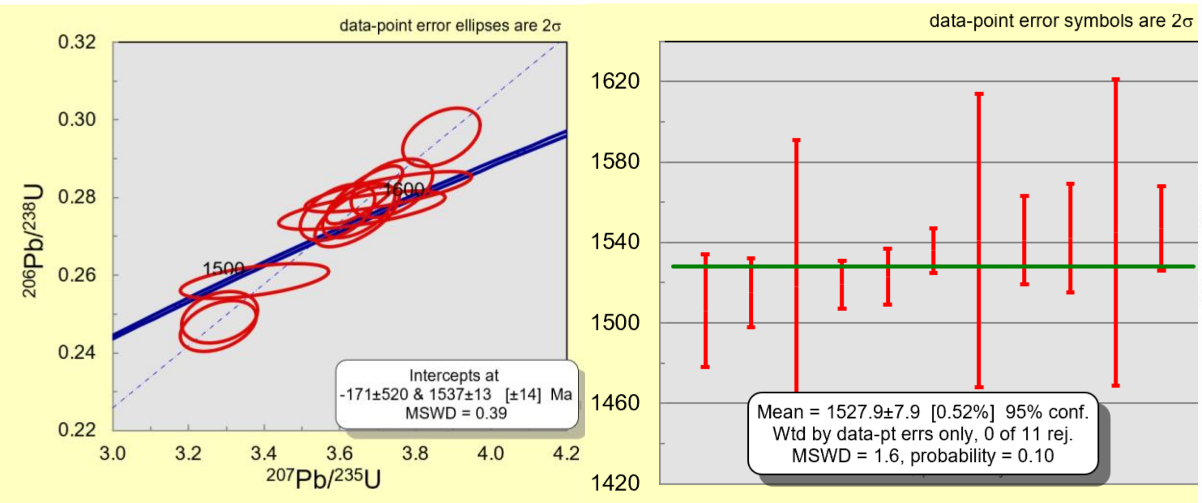
Little Eva granitoids: 1751 ± 13 Ma

Wonga granitoids: 1692 ± 31 Ma

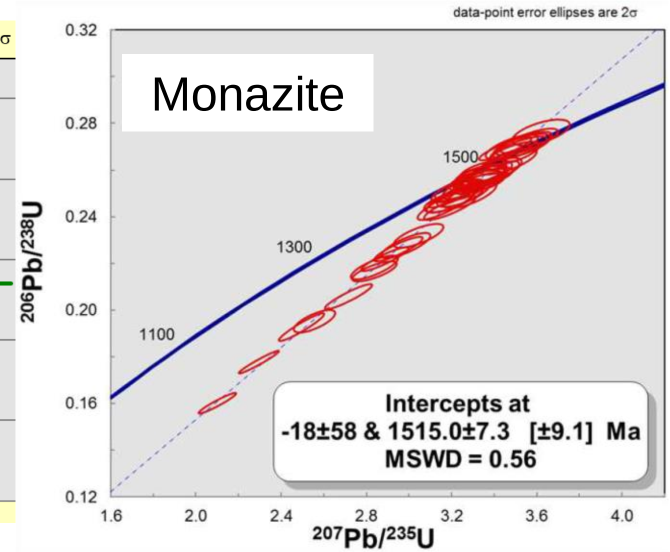
Lunch Creek gabbro: ?

Not the final ages!

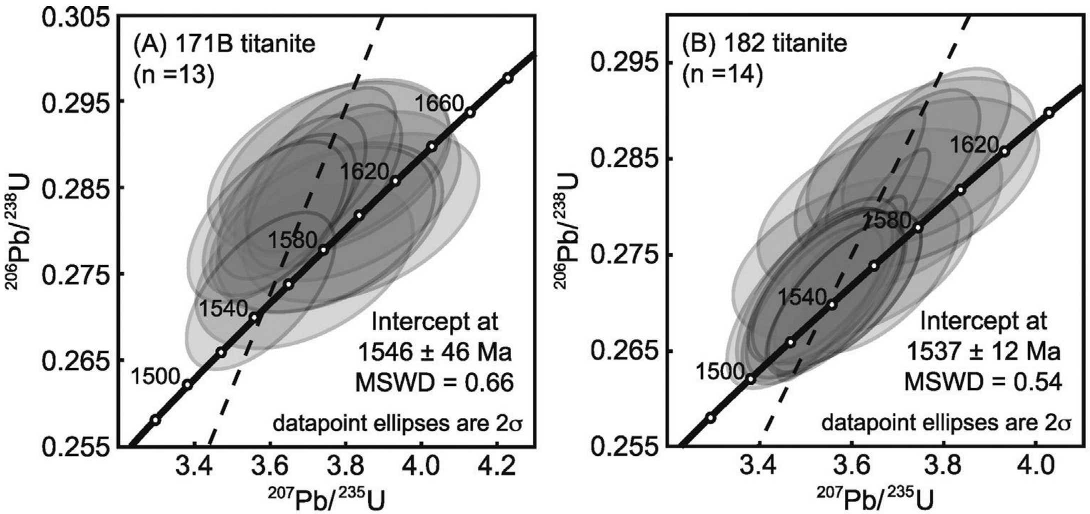
Geochronology



Tick Hill Au deposit, Truong Le et al., unpublished data



Mary Kathleen Syncline, Alex Edgar et al., unpublished data

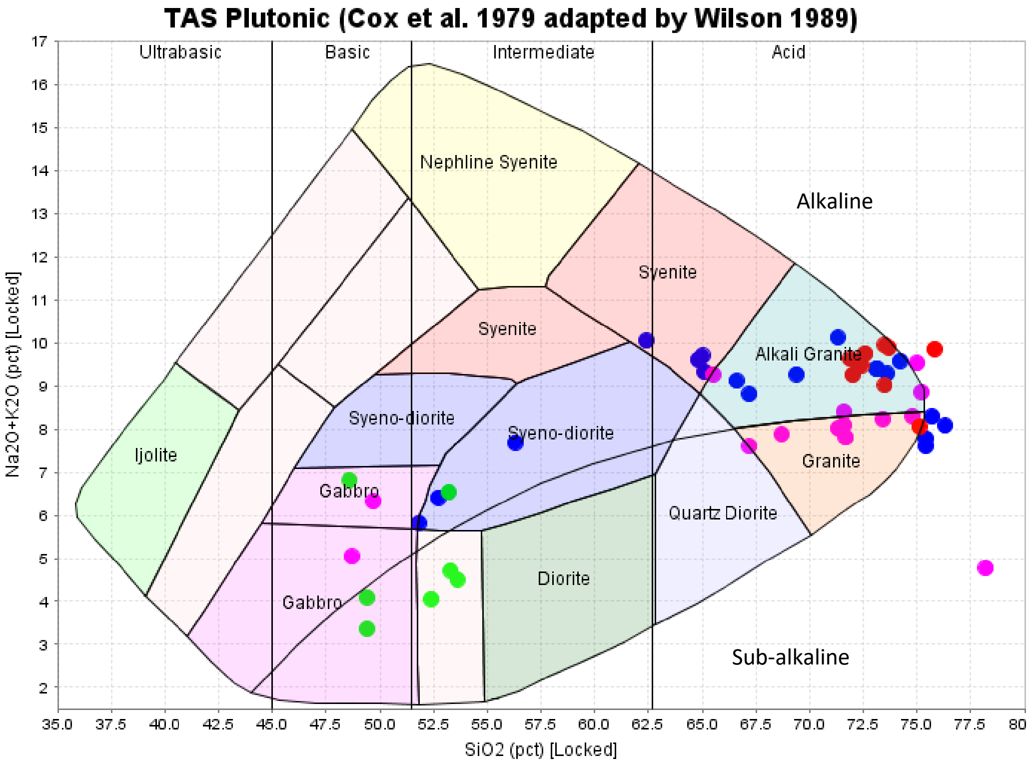


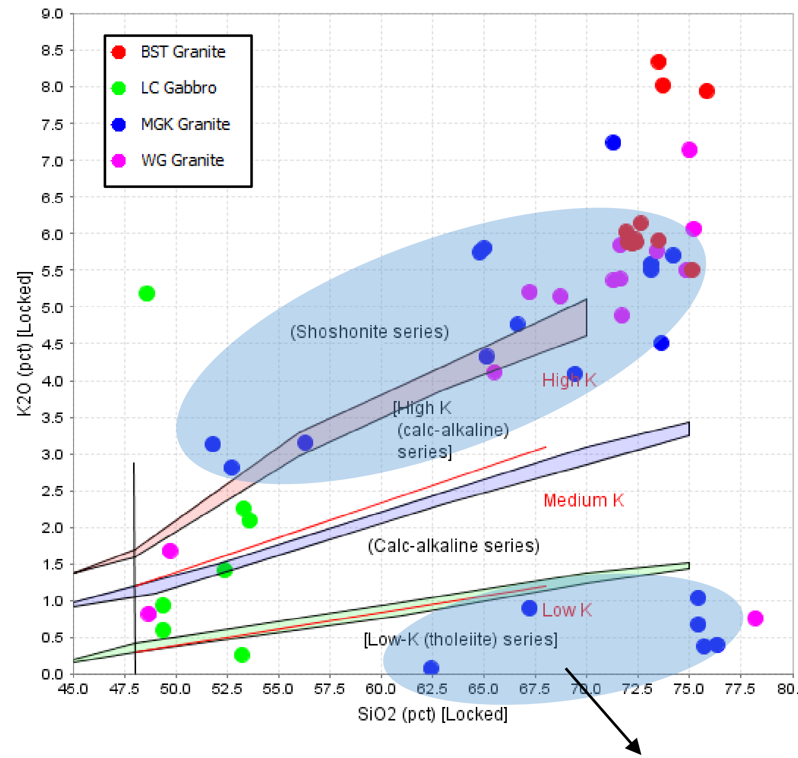
Elaine Dorothy Cu-REE Prospect:

- **1515 – 1546 Ma** by titanite U/Pb (Spandler et al., 2016)
- **1529 ± 6 Ma** by biotite ^{40}Ar-^{39}Ar (Sha, 2012)

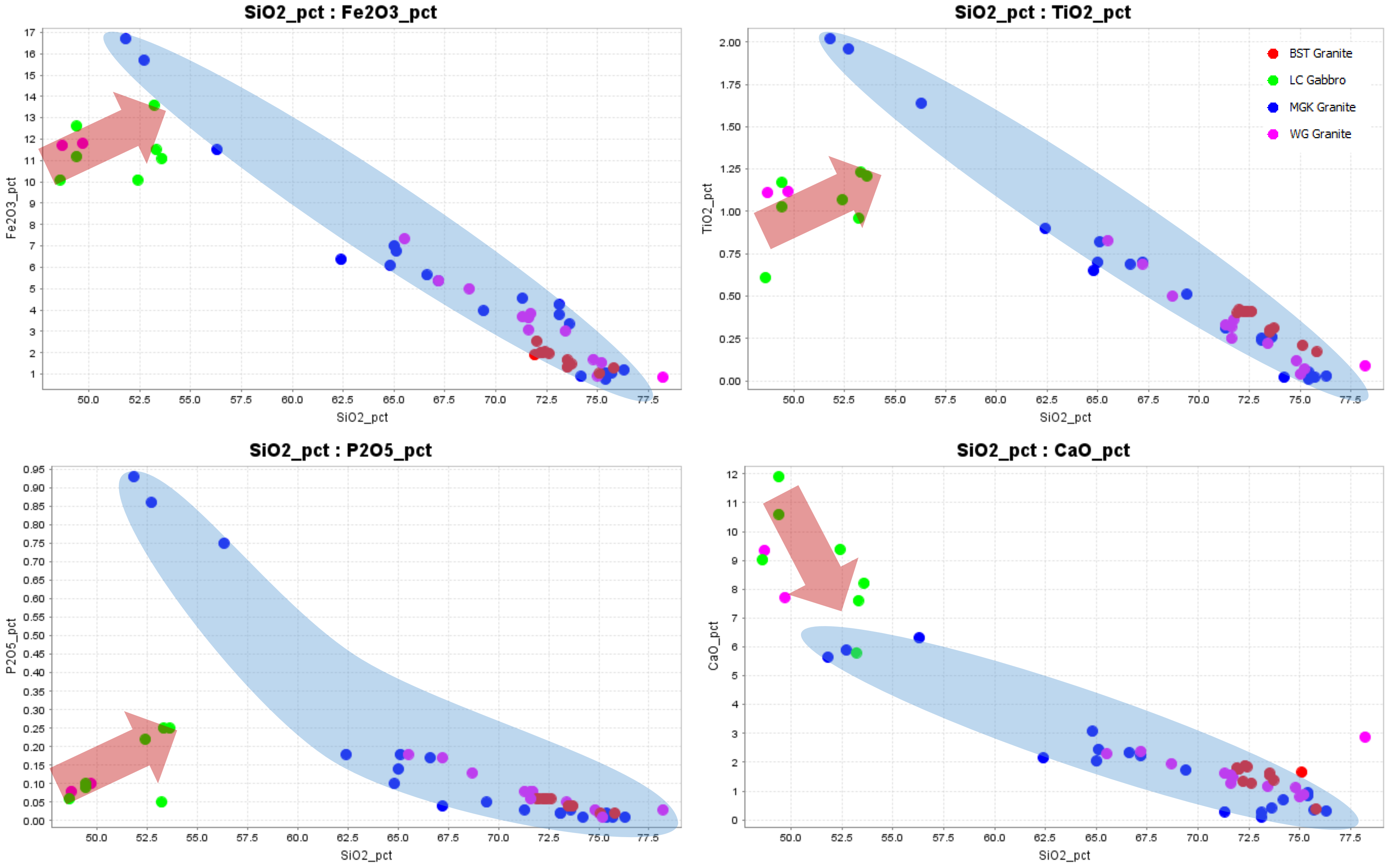
Favourable mineralisation age!

Geochemical characteristics



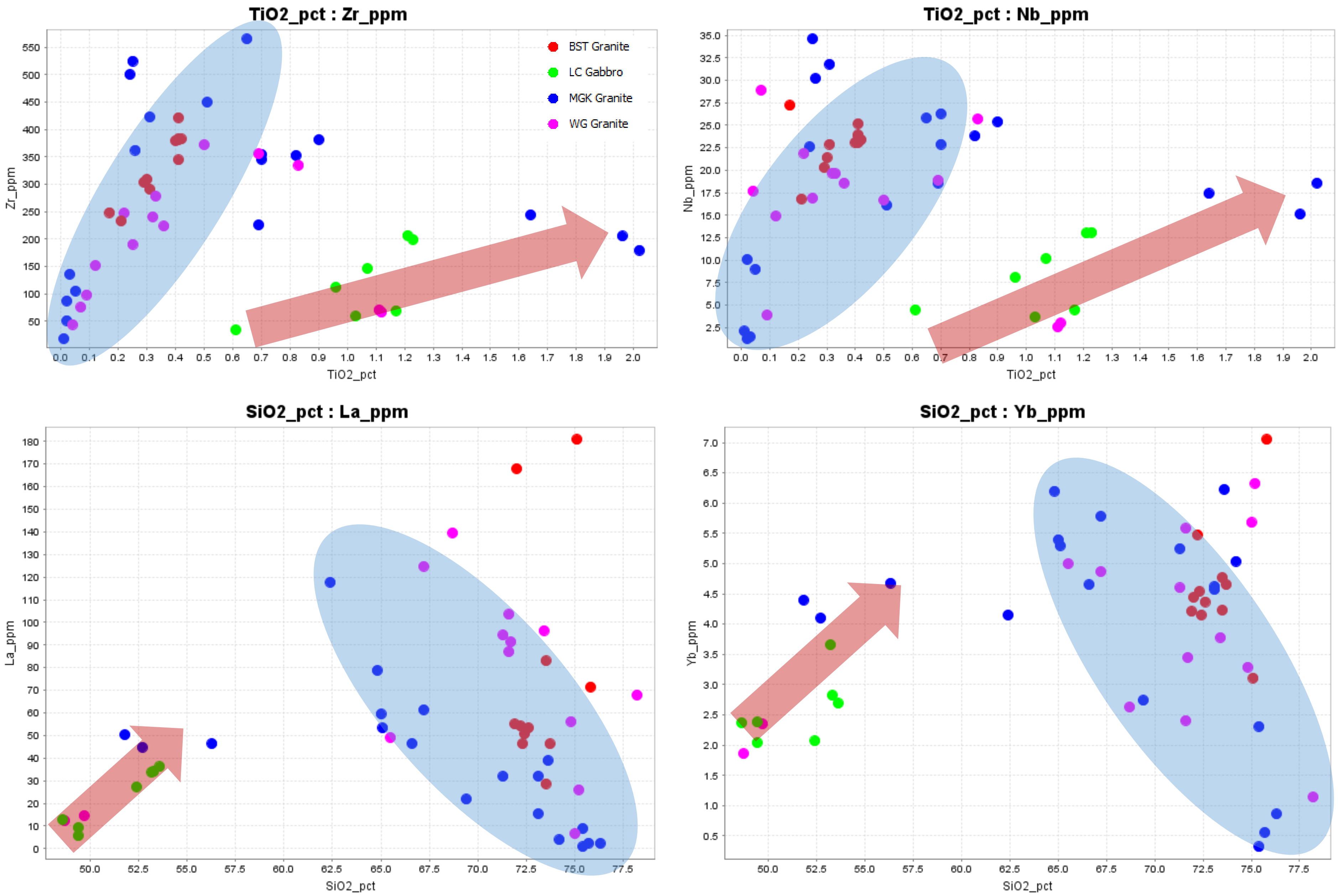


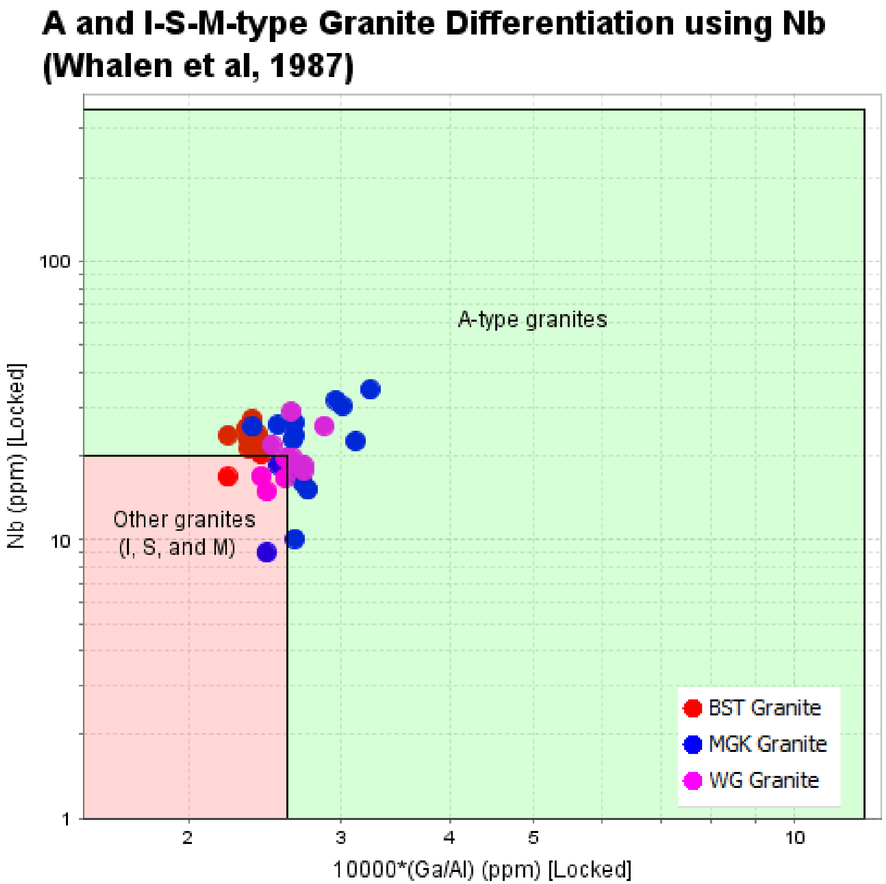
- Wide compositional range: mafic ➡ intermediate ➡ felsic pegmatite
- High alkali content, especially high in K_2O concentration
- Mt Godkin granitoids: bimodal K_2O concentrations, shoshonite series vs. low-K series

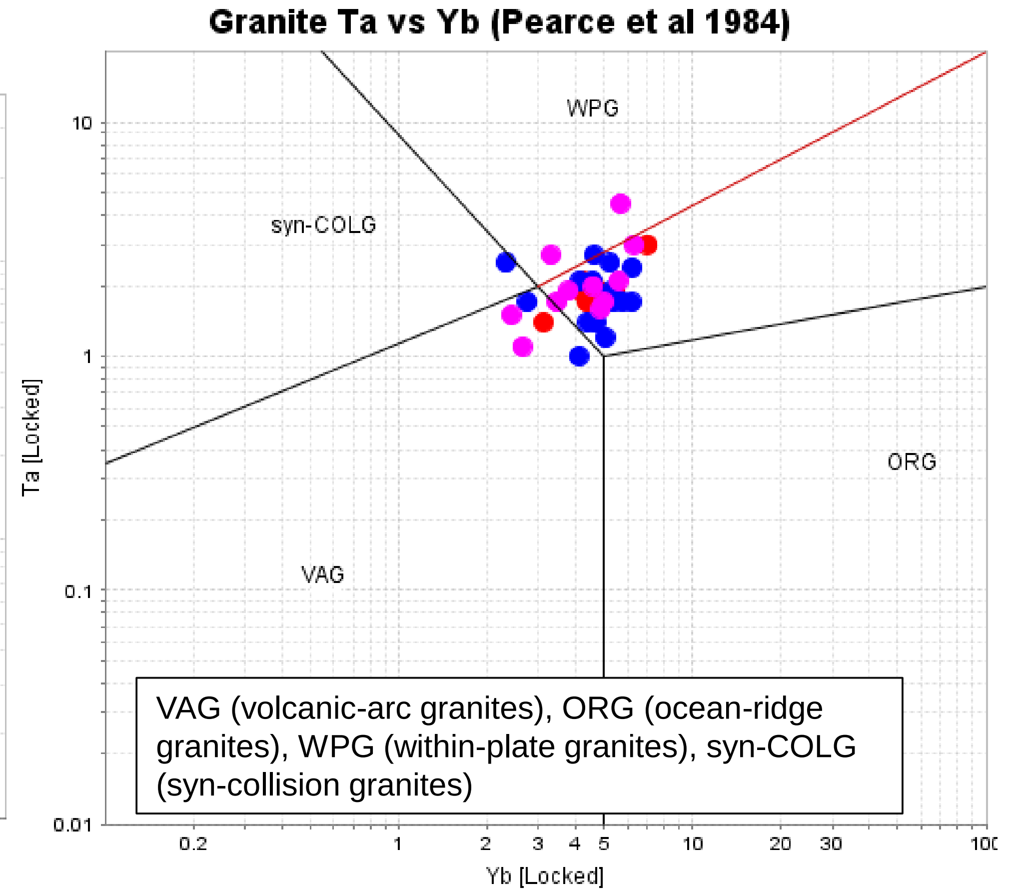


- Magnetite / titanite / rutile, plagioclase / K-feldspar, and apatite may have fractionated and precipitated during the granitic magma evolution
- Gabbro vs. granitoids: different evolution trends ➡ no direct genetic connection?

Mafic vs. felsic: two different evolutional pathways, separated magma systems

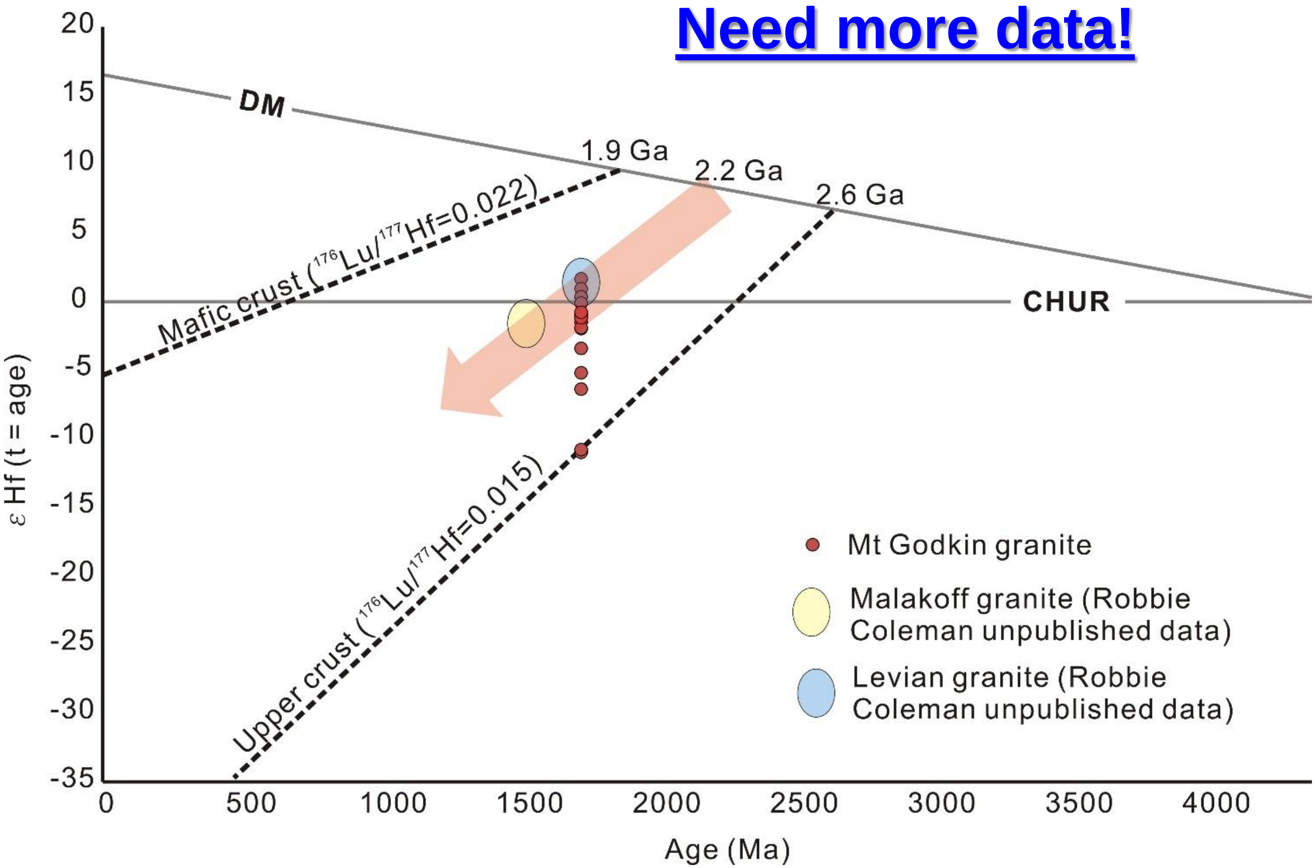


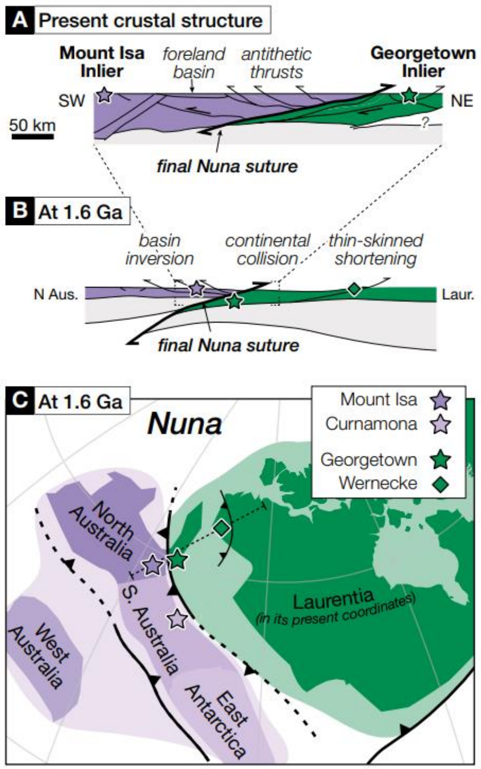




A-type (alkaline, anorogenic and anhydrous) granitoids formed under intraplate extensional geodynamic environment?

Magma source and crust evolution





Pourteau et al., 2018

Preliminary thoughts:

1) Recycling of ancient crustal materials by mafic component under-plating; or
2) Partial melting of enriched mantle, then differentiation

Data from Lunch Creek gabbro will be critical to resolve this problem

Magma fertility: the concept

There are huge amount of magmatic bodies in nature, but only a very limited portion of them are capable to cause mineralization. Any special difference between the “normal magma” and the “fertile magma”?

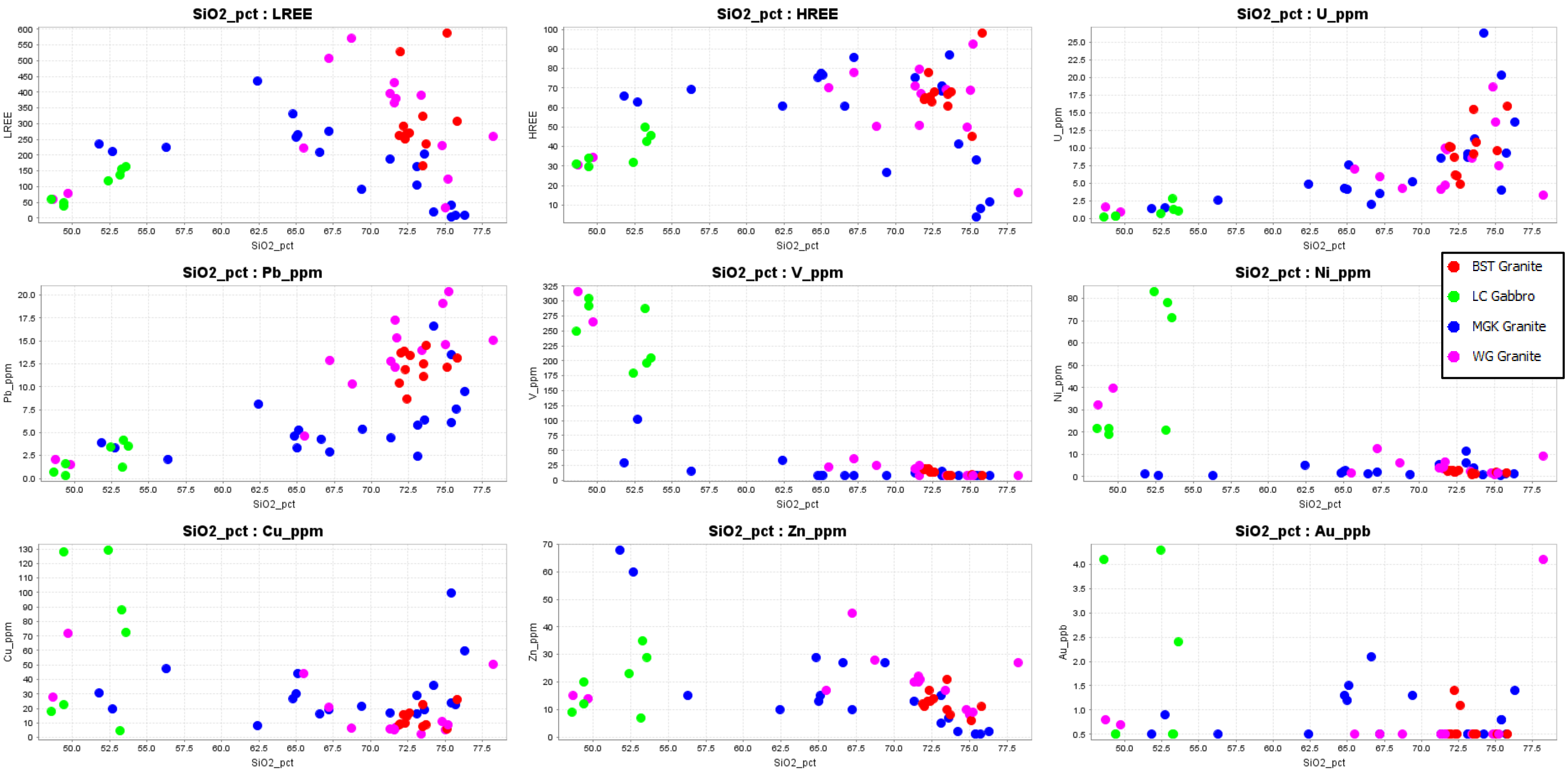
Metal endowment: Production of high grade ore requires **high metal content** of cratons, terranes, districts, and intrusions

Factors that appear to be important include (Cooke et al., 2009):

- ✓ **Geodynamic settings and local crustal architecture**
- ✓ **Oxidation state of magmas, hydrothermal fluids and wallrocks**
- ✓ **Magmatic volatile components, and efficiency of volatile exsolution**
- ✓ **Interactions between magmas, fluids and/or wallrocks**

Fertilisation of a magma also involves **water content and evolution of the causative intrusions** (Cheng et al., unpublished data)

Magma fertility: metal endowment



Burstall and Wonga granites contain the highest REE and U concentrations

Lunch Creek gabbro contains higher Cu and Au content than granite samples

Future Considerations

What was the role of MAGMATIC activities for the formation of ore deposits in Mary Kathleen Domain?

1) **The relation between regional metasomatism and metal enrichment: establish the link between regional magmatic activities, metasomatism and mineralization**

2) **Regional Cu-Au vs U-REE vs Zn-Pb-Ag mineralisation in the Mary Kathleen Domain: are they one integrated giant mineral system, or multiple separated systems?**

3) **Regional fertility: Why is Mt Isa Inlier more fertile for multiple commodities?** *Although the Georgetown block and Mt Isa Inlier have similar age spectra, however, their metal endowment is likely different*

4) **1.9-1.5 Ga Columbia (Nuna) supercontinent breakup and amalgamation**

Magma Fertility: Assessing the Mineral Potential Under Cover…