# 6 BURSTALL SUITE

## 6.1 Timing

1740 Ma

## 6.2 Individual Ages

**Primary Ages:**

| | |
|---|---|
| 1. Burstall Granite[1,2] | 1745 ± 16 Ma, U-Pb |
| 2. Lunch Creek Gabbro [1,2] | 1740 ± 24 Ma, U-Pb |
| 3. Burstall Rhyolite dykes [1,2] | 1737 ± 15 Ma, U-Pb |
| 4. Burstall Granite [1,2] | 1726 ± 8 Ma, U-Pb |

Other chronologically similar volcanics that are stratigraphically post-Argylla Formation:

| | |
|---|---|
| 1. Unnamed Volcanics, Tommy Creek Block [3] | 1762 ± 5 Ma, SHRIMP |
| 2. Unnamed Volcanics, Tommy Creek Block [3] | 1758 ± 4 Ma, SHRIMP |
| 3. Mitakoodi Quartzite [3] | 1756 ± 3 Ma, SHRIMP |
| 4. Ballara Quartzite [3] | 1755 ± 3 Ma, SHRIMP |
| 5. Corella Volcanics at Mount Roseby [1,4,5] | 1750 ± 7 Ma, SHRIMP |
| 6. Corella Volcanics at Mount Fort Constantine [1,4,5] | 1742 ± 6 Ma, SHRIMP |
| 7. Corella Volcanics at Mount Fort Constantine [1,4,5] | 1746 ± 9 Ma, SHRIMP |
| 8. Double Crossing Metamorphics [1,4,5] | 1740 ±6 Ma, SHRIMP |
| 9. Doherty Formation [1,4,5] | 1725 ± 3 Ma, SHRIMP |
| 10. Doherty Formation [1,4,5,6] | 1720 ± 7 Ma, U-Pb |

Sources: [1] OZCHRON, [2] Page (1983a), [3] Page *et al*. (1997), [4] Page and Sun (1996), [5] Page and Sun (*in press*), [6] Page (1983b). Note: all of the ages of the intrusives are based on conventional U-Pb analyses.

## 6.3 Regional Setting

This linear north-trending suite was emplaced as small circular to elliptical intrusions into the Eastern Fold Belt at around 1740 Ma. The suite is characterised by a common association with coeval gabbros (Blake 1981). On the basis of structural data, Pearson *et al.* (1992) contend that the granites of the Burstall Suite were emplaced into the upper plate during an extensional episode. The whole suite has been affected by regional metamorphism and some units have been metamorphosed to upper amphibolite facies. Primary magmatic alteration has been documented (Aslund 1994; Aslund *et al.* 1995) but this is difficult to distinguish from syn-intrusion alteration and later alteration associated with the regional metamorphism and deformation at ~1500 Ma and 1100 Ma (Oliver 1995, Oliver *et al.* 1994). The Burstall Suite has a progression from more mafic plutons in the northern and southernmost parts of the Mary Kathleen Zone to more felsic, fractionated plutons in the central part (Overlander and Burstall Granites). The granites of this suite intrude the Corella Formation, and felsic volcanics which are in the Corella Formation are more likely to be comagmatic with this suite than with the Wonga Suite.

## 6.4 Summary

The Burstall Suite is classified as an Hiltaba type as it shows evidence of fractionation and concentration of elements during crystallisation. Fluorite is more common in the more fractionated components. It has a noted spatial association with small but rich Cu-Au-Ag deposits, although many authors would argue for a much younger, post-intrusive origin for some of these deposits (*e.g.,* Oliver 1995). If the deposits do have a magmatic origin, one limitation is that as plutons of the Burstall Suite are relatively small, any associated deposits are likely to have a low tonnage, although they could have high grades. The oxidation plots of this granite are interesting. Most of the felsic plutons are oxidised and most of the associated deposits are Cu-rich. In contrast, all of the unaltered samples of the Saint Mungo Granite are reduced. This granite is the closest granite to the Au-dominated Tick Hill deposit and may thus have unrecognised metallogenic significance.

## 6.5 Potential

The Burstall Suite has potential for further Cu-Au deposits, and although these are likely to be of low tonnage, they have the potential to be of high grade. New geochronological information (Page and Sun 1996, *in press;* Page *et al.* 1997) suggest that coeval with this intrusive suite is a series of felsic volcanics which are interbedded with the Ballara Quartzite, Mitakoodi Quartzite and Corella Formation (and may also include volcanics of the Tommy Creek Block). Although speculative, it is possible that epithermal and/or Carlin-style Au deposits may be found within these sediments, related to the fractionating magmatism of the Burstall Suite (particularly as some of these sediments contain graphitic schist).

| | |
|---|---|
| **Cu:** | **Moderate** |
| **Au:** | **Moderate** |
| **Pb/Zn:** | **None** |
| **Sn:** | **Low** |
| **Mo/W:** | **Low** |
| **Confidence level:** | **322** |

## 6.6 Descriptive Data

***Location:*** Along the eastern margin of the Mary Kathleen Zone in the central part of the Mount Isa Inlier.

***Dimensions and area:*** A series of narrow plutons in a northerly trending belt 150 km long and 6 km wide. Total area covered by the suite is 160 $km^2$.

## 6.7 Intrusives

***Component plutons:*** Mount Godkin Granite, Burstall Granite, Overlander Granite, Mount Erle Igneous Complex, Revenue Granite, Saint Mungo Granite and possibly the Myubee Igneous Complex.

***Form:*** Most plutons form elongate elliptical or circular bodies that are no more than 30 $km^2$.

***Metamorphism and Deformation:*** All members of the suite have been metamorphosed and deformed to some extent. *Specifically*: Burstall Granite - foliated; Mount Erle Igneous Complex - generally foliated and recrystallised, regionally metamorphosed to amphibolite facies: some prehnite also recorded; Myubee Igneous Complex - regionally metamorphosed to amphibolite facies; Overlander Granite - massive to foliated; Revenue Granite - crenulated gneissic granite in places. Aslund (1994) and Aslund *et al.* (1995) argued that the it was affected by two phases of deformation prior to the Isan Orogeny; Saint Mungo Granite - slightly to intensely foliated and recrystallised.

***Dominant intrusive rock types:*** Leucogranite, porphyritic hornblende-biotite granite, minor tonalite, microgranite. *Specifically*: Burstall Granite - fine to medium-grained, leucocratic, even-grained to porphyritic hornblende-biotite granite; minor tonalite and diorite (in net-veined complexes); aplite, pegmatite, microgranite, porphyritic rhyolite dykes; Mount Erle Igneous Complex - leucocratic medium to fine-grained granite which is locally porphyritic, metadolerite, gabbro, diorite, and a net-veined complex of granite, dolerite, and dioritic hybridised rocks; Myubee Igneous Complex - leucocratic granite (contains inclusions of coarse granite), gabbro, minor diorite; Overlander Granite, Revenue Granite - massive to foliated, leucocratic medium to coarse-grained, even-grained to slightly porphyritic granite; Saint Mungo Granite - medium to coarse-grained granite with microcline phenocrysts up to 3 cm across, minor foliated porphyritic granite; Burstall Granite - fairly homogenous leucocratic, coarse even-grained to porphyritic granite; Mount Godkin Granite - microgranite, fine to medium-grained granite.

***Colour:*** Pink to grey. *Specifically:* Burstall Granite - pink to grey; Overlander Granite, Revenue Granite - pink.

***Veins, Pegmatites, Aplites, Greisens:*** Aplite and pegmatite are common. *Specifically:* Burstall Granite - numerous late-stage rhyolite dykes emanate from the intrusion, aplite and microgranite dykes common, as well as some fluorite veins which are subeconomic; Mount Erle Igneous Complex - minor aplite, feldspar porphyry and pegmatite; Myubee Igneous

Complex - aplite and pegmatite recorded; Overlander Granite - swarms of tourmaline-bearing pegmatite dykes and veins, as well as being cut by veins of fluorite, tourmaline, amethyst; Saint Mungo Granite - aplite, pegmatite.

***Distinctive mineralogical characteristics:*** Hornblende, biotite, titanite, apatite, zircon, allanite, fluorite. *Specifically:* Burstall Granite - K-feldspar, plagioclase, quartz, hornblende, biotite, chlorite, with accessory fluorite (abundant), zircon and apatite: titanite rims opaques or occurs as aggregates; Mount Erle Igneous Complex - K-feldspar, hornblende, biotite, plagioclase with accessory allanite, apatite, opaque minerals, titanite and zircon; Myubee Igneous Complex - hornblende biotite granite; Overlander Granite, Revenue Granite - hornblende, biotite; Saint Mungo Granite - quartz, microcline, plagioclase, biotite, hornblende, accessory apatite, fluorite, calcite, chlorite, scapolite, titanite, allanite; Mount Godkin Granite - quartz, K-feldspar, albite, biotite, zircon and opaques.

***Breccias:*** None noted.

***Alteration in the granite:*** Some alteration recorded - it is difficult to discern whether alteration is related to magmatism or metamorphism. Aslund (1994) and Aslund *et al.* (1995) argued that the fluids altering the Revenue Granite were high temperature (~700° C), highly saline (up to 50 wt.% NaCl) and that the metasomatic fluids had an igneous stable isotope signature. *Specifically:* Mount Godkin Granite - highly altered and albitised; Mount Erle Igneous Complex - scapolite, calcite, epidote, sericite/muscovite, chlorite, prehnite recorded: these are more likely to be related to later metamorphism; Revenue Granite - intensely scapolitised and albitised (Aslund 1994).

## 6.8 Extrusives

Felsic volcanics outcrop in the vicinity of the granites, but the chemistry and age relationships are yet to be determined. Many of the felsic volcanics within the Ballara and Mitakoodi Quartzites and the Corella Formation are likely to be comagmatic with the Burstall Suite.

## 6.9 Country Rock

***Contact metamorphism:*** Narrow hornfelses have been recorded adjacent to some intrusions. It is generally difficult to discern the exact extent due to overprinting by the later regional metamorphism. *Specifically*: Mount Erle Igneous Complex - intrudes Corella Formation and thermal effects are restricted to within one metre of the contact; and Overlander Granite - converts Corella Formation to skarn adjacent to intrusion.

***Reaction with country rock:*** Some endoskarn assemblages are developed where granites intrude calc-silicate rocks. Net-veined complexes are commonly recorded adjacent to coeval gabbros. Extensive alteration is associated with the intrusion of some of the granites of the Burstall Suite and garnet and pyroxene exoskarns are extensive in their contact aureoles (Aslund 1994; Aslund *et al.* 1995; Derrick 1977; Cruickshank *et al.* 1977; Oliver 1995; Oliver *et al.* 1986). *Specifically:* Mount Erle Igneous Complex - net-veined complexes formed with coeval dolerite

***Units the granite intrudes:*** Corella Formation, Mary Kathleen Group, Plum Mountain Gneiss. Net-veined complexes have been recorded.

***Dominant rock types:*** Calc-silicate rocks, hornblende and biotite schists, dolerites.

***Potential hosts:*** Due to metamorphic overprinting it is difficult to identify potential hosts.

## 6.10 Mineralisation

There is a clear spatial association of members of the Bustall Suite with a series of small but rich Cu/Au deposits, including Duchess (Cu-Au-Ag), Trekelano (Cu-Au-Ag) and Revenue (Cu-Au). All three are hosted by hornblende-biotite schist, biotite schist and calc-silicate granofels, and at Duchess, the mine is also hosted by granite. The Mary Kathleen uranium deposit is among rhyolite dykes emanating from the Burstall Granite.

Despite the clear spatial association, a direct genetic relationship between any of these deposits and intrusives of the Burstall Suite is unproven. The Mary Kathleen U deposit has been considered to be related to the Burstall Granite (*e.g.,* Derrick 1977, 1978; Abeysinghe *et al.* 1984a, 1984b; Abeysinghe 1985; Cruickshank *et al.* 1977) but it is more probable that U in this deposit was remobilised during later metamorphism (e.g., Oliver 1995; Oliver *et al.* 1986, Maas *et al.* 1988, Page 1983a). Oliver (1995) also attributes the calcite-hosted Cu deposits in the vicinity of the Burstall Suite (including Trekelano) to his Phase 2 Hydrothermal Activity at ~1550 Ma, but does argue for some Au mobilisation during his Phase 1 hydrothermal activity at 1750-1730 Ma. The Tick Hill Gold deposit lies within 5 km of the Saint Mungo Granite, although very few theories for its genesis ever invoke a granite (e.g., Crookes 1993).

This project argues that the plutons of the Burstall Suite were capable of concentrating economic amounts of Cu, Au and possibly U during fractionation, although some remobilisation could have occurred during the major $D_2$ activity at ~1550 Ma. The source of the Au which preferentially partitions along the upper plate/lower plate boundary during the 1750-1730 Ma episode (Oliver 1995), could well be plutons of the Burstall Suite. Due to the small size of the individual plutons, any deposits formed as a result of fractionation processes in the Burstall Suite are likely to be small, but have the potential to be of high grade.

## 6.11 Geochemical Data

***Data source:*** The data come from five sources: (1) Geoff Derrick's Ph.D (Derrick 1978); (2) regional mapping programs carried out by AGSO and GSQ (Bultitude *et al*. 1982; Blake *et al*. 1982; Derrick *et al.* 1971, 1977; Wilson *et al.* 1979); (3) specialised granite sampling by Wyborn in 1978 as part of a survey of Mount Isa granites; (4) samples collected by Page for age determinations using Rb-Sr and U-Pb zircon techniques (Page 1983a); (5) samples collected as part of a regional study of the Mary Kathleen U-deposit (Cruickshank *et al.* 1977).

***Data quality:*** Good. All samples were analysed within the one laboratory at AGSO.

***Are the data representative?*** The collections are not biased towards any particular granite type.

***Are the data adequate?*** Barely, more specialised sampling needs to be done.

***$SiO_2$ range (Fig. 6.1):*** The silica range of the felsic magmas of the Burstall suite is relatively limited and very high, being predominantly > 68 wt.% $SiO_2$. Rocks above 68 wt.% $SiO_2$ have a

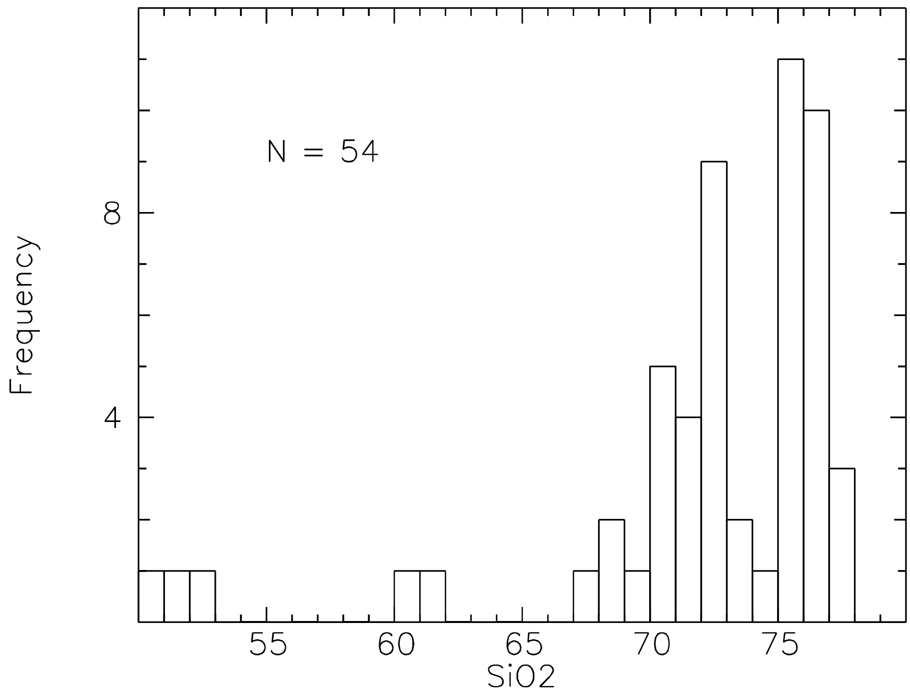


Figure 6.1. Frequency histogram for $SiO_2$ values for the Burstall Suite

bimodal distribution reflecting the contrast between the normal granites and late-stage aplites and rhyolite/micogranite dykes. There are coeval gabbros intimately associated with at least four of the plutons (Myubee and Mount Erle Igneous Complexes, and the Revenue and Burstall Granites) whilst the rocks that plot at around 60 wt.% $SiO_2$ are likely to be hybrids.

***Alteration (Fig. 6.2):***

- ***$SiO_2$:*** One sample with > 80 wt.% is an aplite; silicification is absent.
- ***$K_2O/Na_2O$:*** Both potassic and sodic alteration occur in this suite. There is a gradual change in compositions to more K-rich alteration, whereas the sodic samples are distinctly separate and probably formed due to contamination with the local Corella Formation. The evidence of alteration in this suite contrasts with that of the Wonga Suite, which intrudes unreactive felsic volcanics of the Argylla Formation. Studies by Aslund (1994) suggest that this alteration is related to magmatic processes.
- ***Th/U:*** The Th/U values are somewhat high, and extreme in some altered samples, particularly those of the Burstall Granite.
- ***$Fe_2O_3/(FeO+Fe_2O_3)$:*** This plot shows oxidation of some samples (in particular the Overlander and Burstall Granites), whilst the more mafic samples are relatively reduced.

 

***Fractionation Plots (Fig. 6.3):***

- ***Rb:*** Rb appears to first increase and then decrease with increasing $SiO_2$.
- ***U:*** Samples show increasing U with increasing $SiO_2$.
- ***Y:*** Samples show strongly increasing Y with increasing $SiO_2$.
- ***$P_2O_5$:*** Samples show decreasing $P_2O_5$ with increasing $SiO_2$.
- ***Th:*** Samples show increasing Th with increasing $SiO_2$ (except the Burstall Granite).
- ***K/Rb:*** Plot too scattered to determine a consistent trend.
- ***Rb-Ba-Sr:*** Some samples (particularly those of the Overlander Granite) plot in the strongly differentiated granite field.
- ***Sr:*** Values of Sr are very low (below 150 ppm).
- ***Rb/Sr:*** Samples show a strongly exponentially increasing trend in Rb/Sr with increasing $SiO_2$.
- ***Ba:*** Values of Ba are moderate (up to 1500 ppm).
- ***F:*** Insufficient data to determine. Six of the seven samples have low values, and lower than those for the Wonga and Argylla Suites.

***Metals (Fig. 6.4):***

- ***Cu:*** With the exception of the Overlander Granite and Mount Erle Igneous Complex, Cu decreases with increasing $SiO_2$.
- ***Pb:*** Values are low.
- ***Zn:*** Values are low and decrease with increasing $SiO_2$.
- ***Sn:*** Values increase weakly with increasing $SiO_2$, particularly for the Saint Mungo Granite.

***High field strength elements (Fig. 6.5):***

- ***Zr:*** Samples showmoderate values for Zr, with two samples of the Mount Erle Igneous Complex being anomalously high.
- ***Nb:*** Samples show moderate values for Nb which increases up to 60 ppm with increasing $SiO_2$.
- ***Ce:*** Samples show moderate values for Ce, and individual plutons show decreases with increasing $SiO_2$.

***Classification (Fig. 6.6):***

- ***The $CaO/Na_2O/K_2O$ plot of White, quoted in Sheraton and Simons (1992):*** The granites plot in the monzogranite to granite field reflecting the high $SiO_2$ range of this suite. Some samples plot in the trondhjemite field reflecting albitisation.
- ***Zr/Y vs Sr/Sr*:*** All samples plot below 1 reflecting the Sr-depleted, Y-non-depleted nature of this suite.
- ***Spidergram:*** The spidergrams for this suite are Sr-depleted, Y-non-depleted and show strong fractionation of B, Sr and Ti with increasing $SiO_2$.
- ***Oxidation plot of Champion and Heinemann (1994):*** The felsic samples are oxidised, with four of the Overlander Granite samples being strongly oxidised. In contrast, most samples of the Myubee Igneous Complex and the Saint Mungo Granite, from the southern part of the area, are reduced.
- ***ASI:*** The majority of samples have an ASI index of <1.1 and are metaluminous to weakly peraluminous.
- ***A-type plot of Eby (1990):*** The Wonga suite straddles the A-type/normal granite fields for Palaeozoic granites.

***Granite type (Chappell and White 1974; Chappell and Stephens 1988):*** I-(granodiorite) type, non-restite.

***Australian Proterozoic granite type:*** Hiltaba type.

## 6.12 Geophysical Signature

***Radiometrics (Fig. 6.7):*** Most samples plot well above the Proterozoic median values for $K_2O$, Th and U and hence would appear white in an RGB image.

***Gravity:*** The AGSO regional gravity data are too coarse and the plutons too small for a meaningful assessment to be made.

***Magnetics:*** The magnetics appear extremely variable and are probably dependent on the degree of alteration and the $SiO_2$ content of the individual granite phases. No systematic measurements are available.

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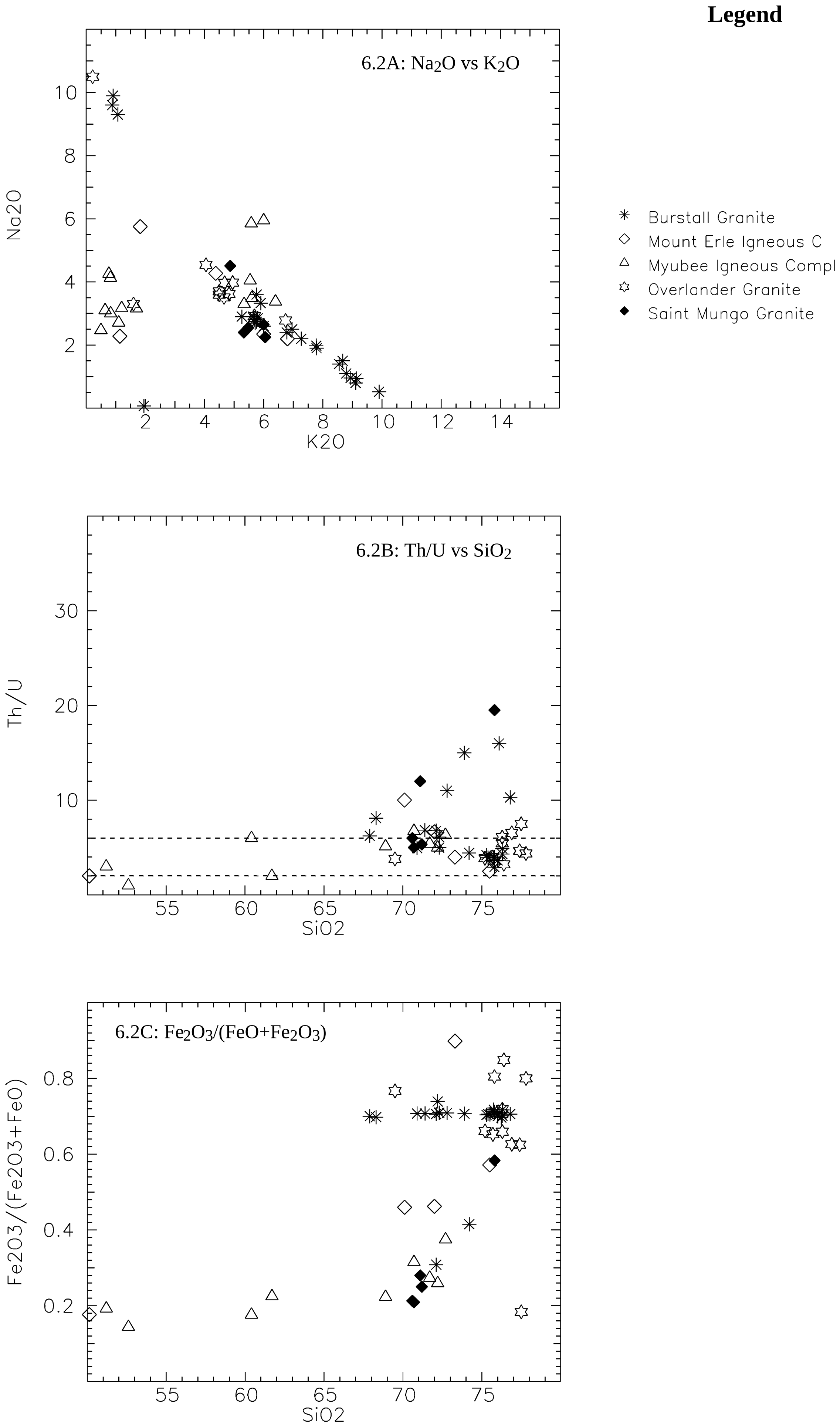
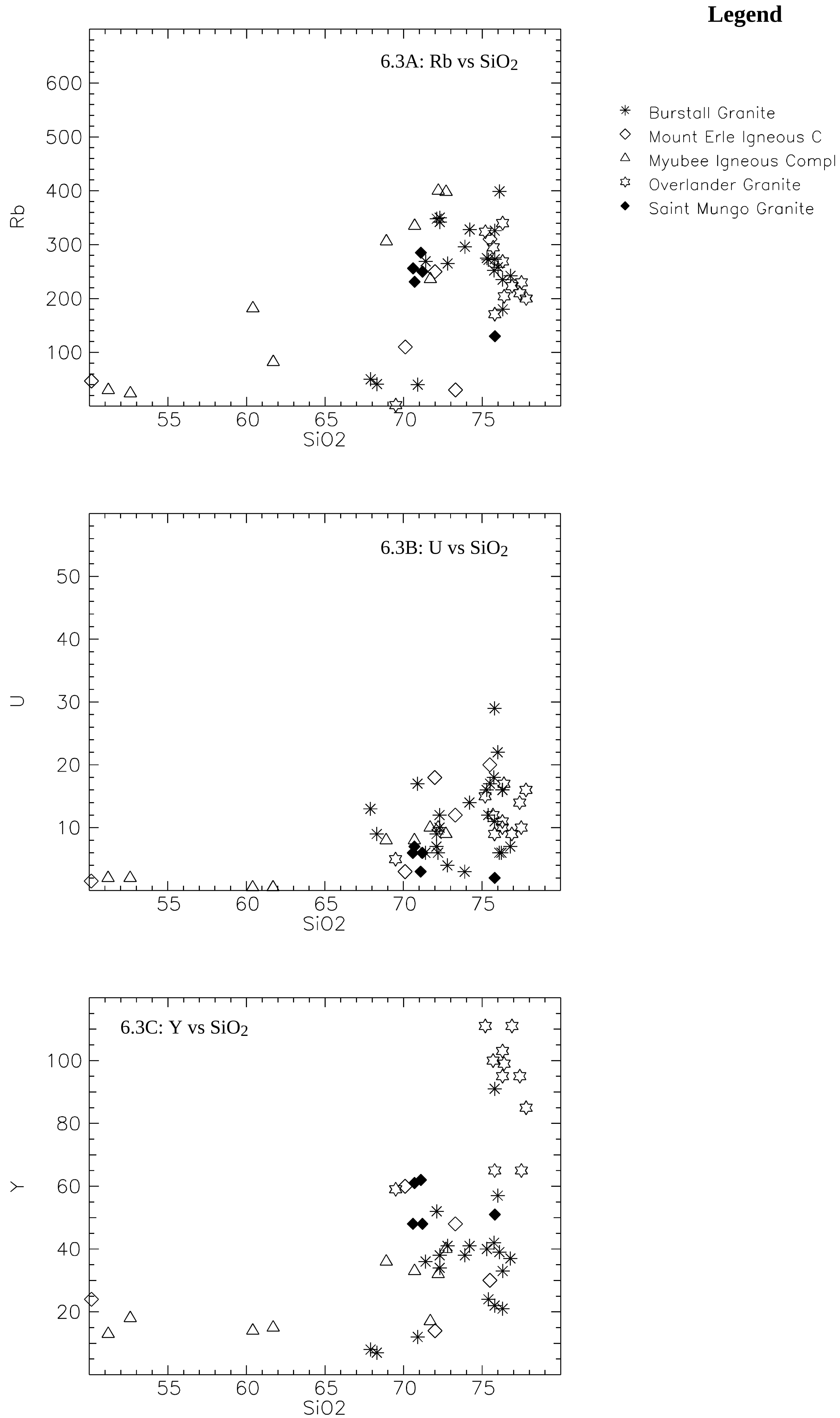

Legend
6.2A: Na2O vs K2O
Na2O
K2O
6.2B: Th/U vs SiO2
Th/U
SiO2
6.2C: Fe2O3/(FeO+Fe2O3)
Fe2O3/(Fe2O3+FeO)
SiO2
Burstall Granite
Mount Erle Igneous C
Myubee Igneous Compl
Overlander Granite
Saint Mungo Granite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Burstall Granite
Mount Erle Igneous C
Myubee Igneous Compl
Overlander Granite
Saint Mungo Granite
6.3A: Rb vs SiO2
Rb
600
500
400
300
200
100
55
60
65
70
75
SiO2
6.3B: U vs SiO2
U
50
40
30
20
10
55
60
65
70
75
SiO2
6.3C: Y vs SiO2
Y
100
80
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40
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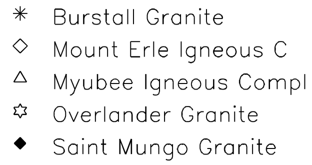
60
65
70
75
SiO2

**Legend**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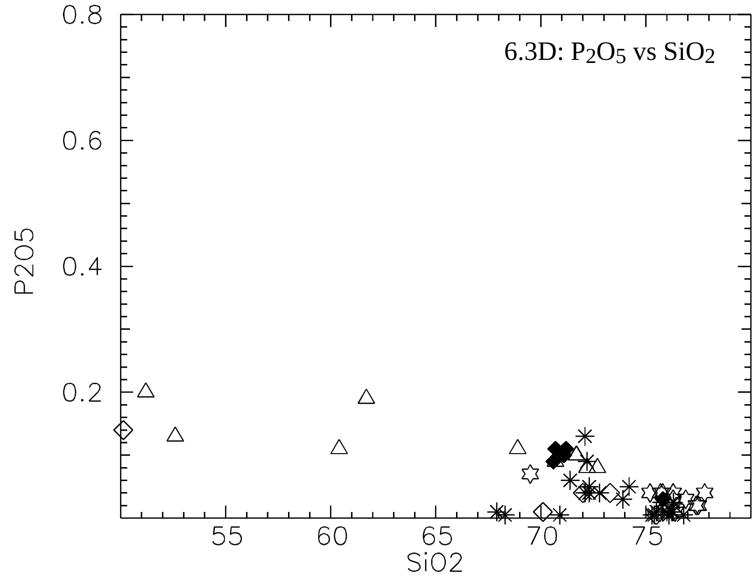
Saint Mungo Granite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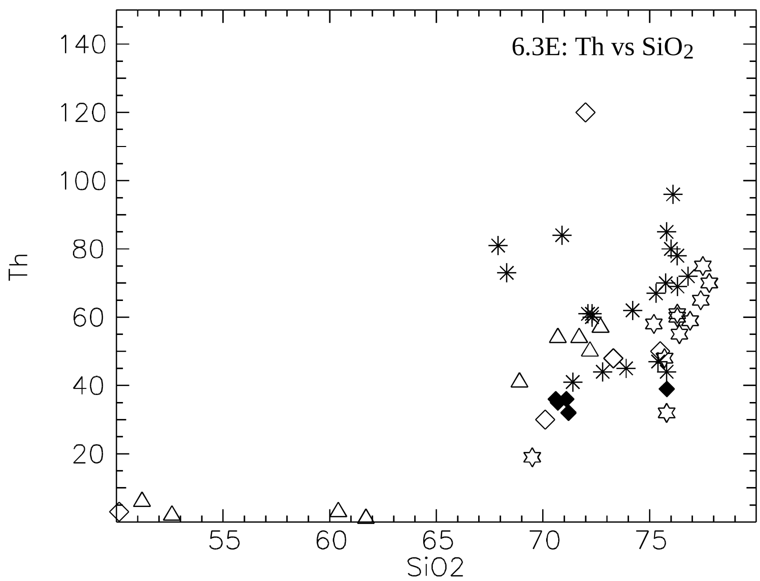
P2O5
SiO2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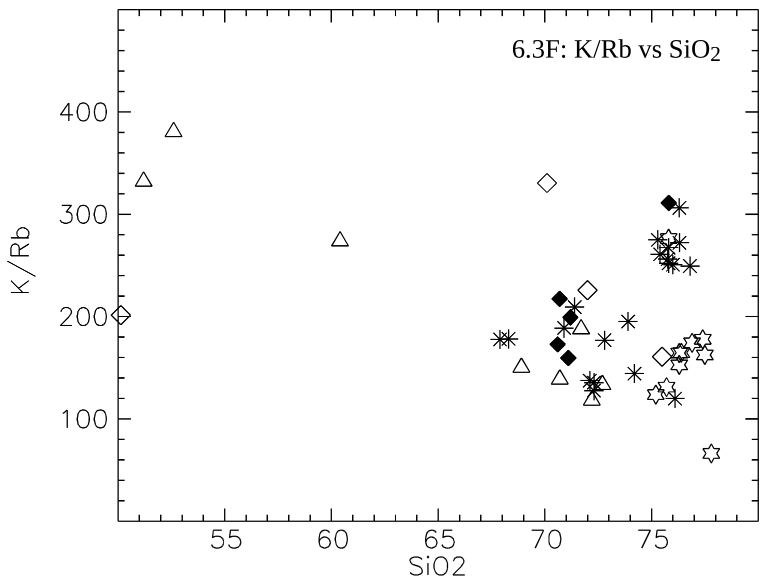
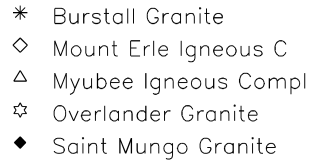
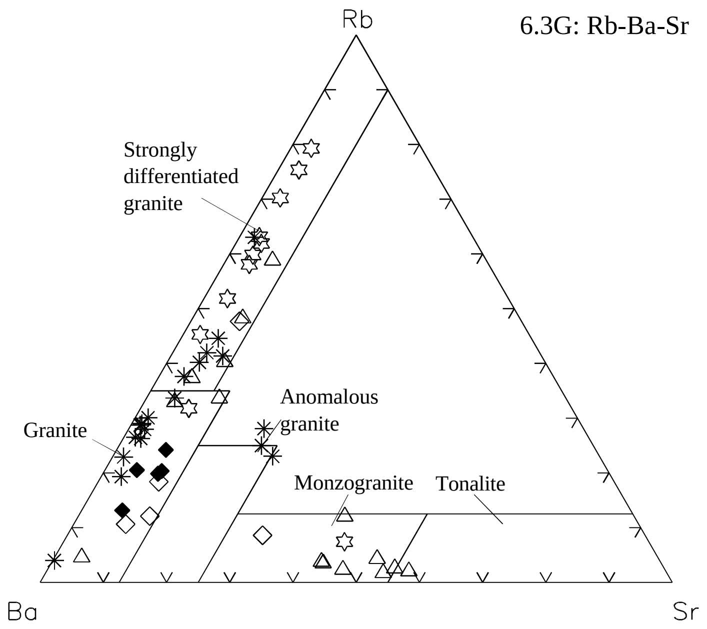
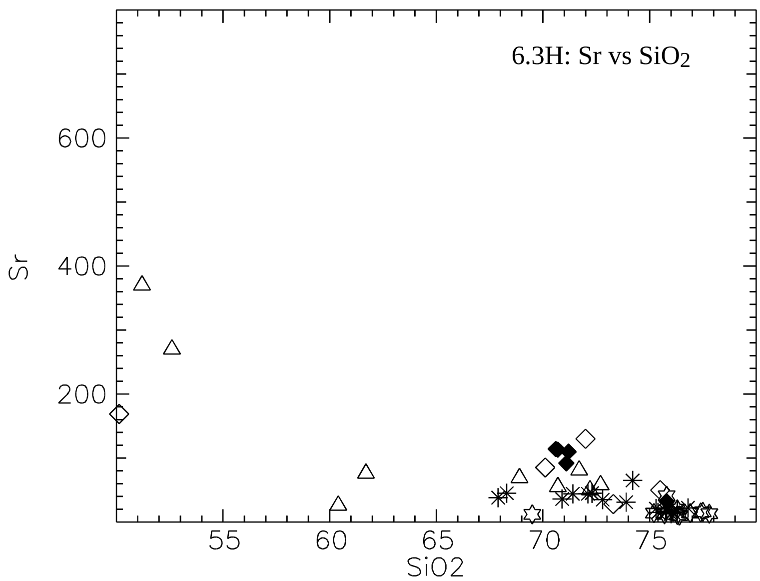
Th
SiO2

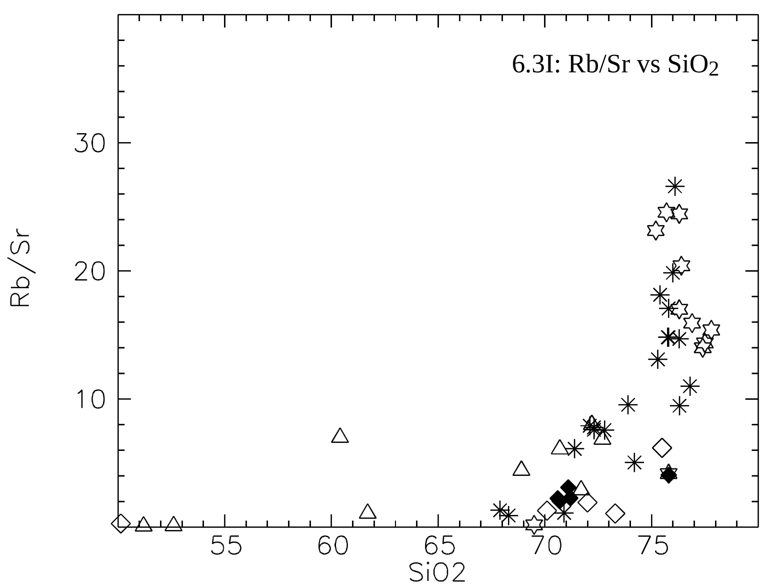

6.3F: K/Rb vs SiO2
K/Rb
SiO2

**Legend**

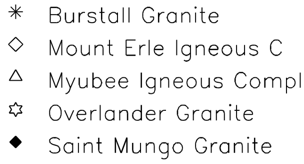

Burstall Granite
Mount Erle Igneous C
Myubee Igneous Compl
Overlander Granite
Saint Mungo Granite


Rb
6.3G: Rb-Ba-Sr
Strongly
differentiated
granite
Anomalous
granite
Granite
Monzogranite
Tonalite
Ba
Sr

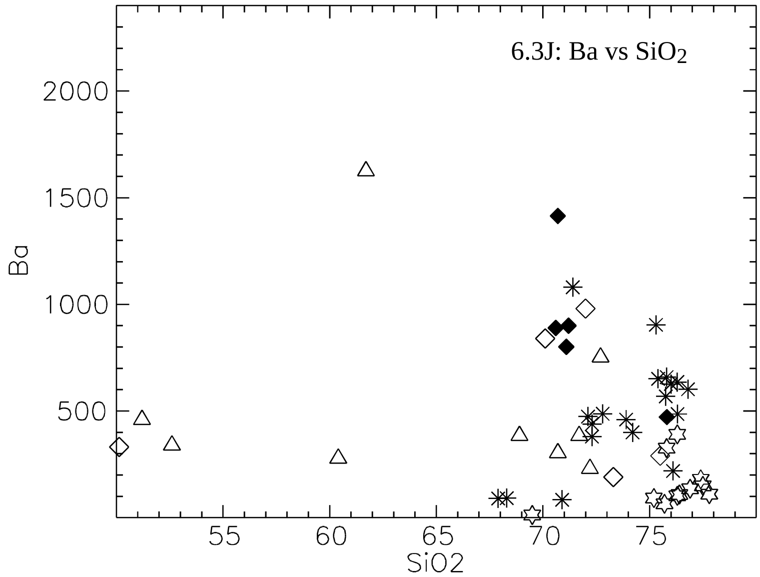

6.3H: Sr vs SiO2
Sr
600
400
200
55
60
65
70
75
SiO2


6.3I: Rb/Sr vs SiO2
Rb/Sr
30
20
10
55
60
65
70
75
SiO2

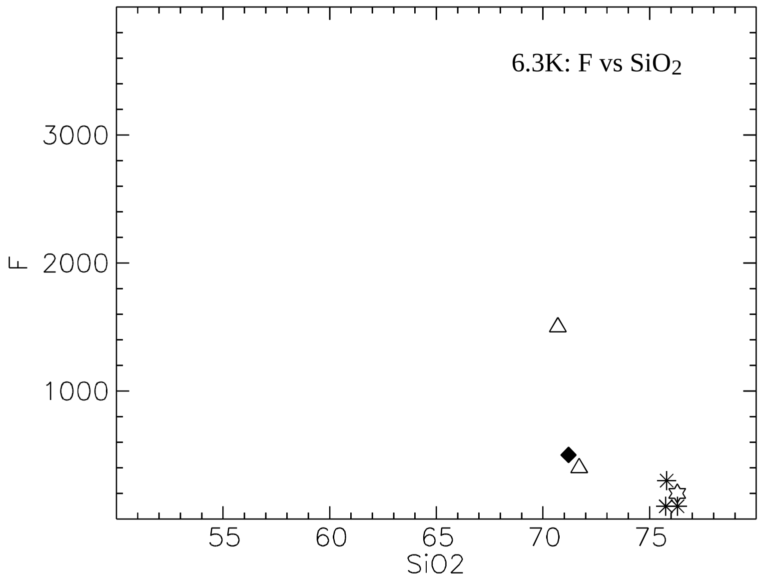
**Legend**



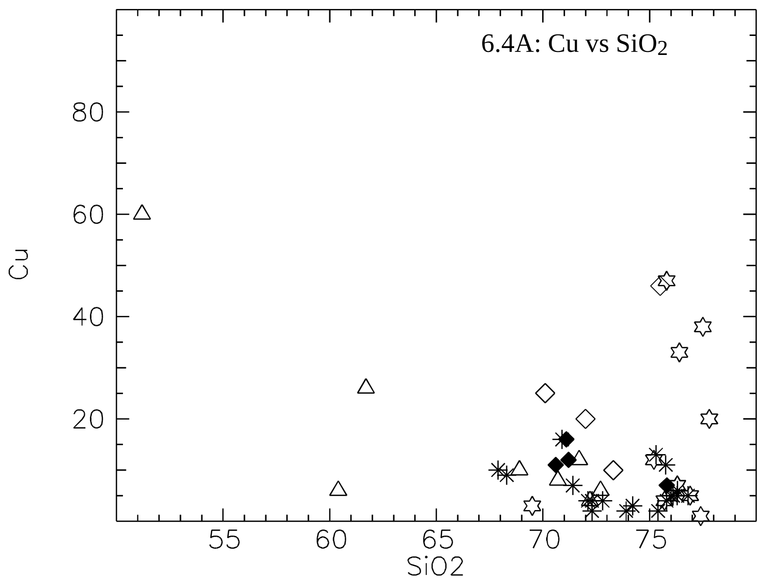
Burstall Granite
Mount Erle Igneous C
Myubee Igneous Compl
Overlander Granite
Saint Mungo Granite

6.3J: Ba vs SiO2
Ba
2000
1500
1000
500
55
60
65
70
75
SiO2

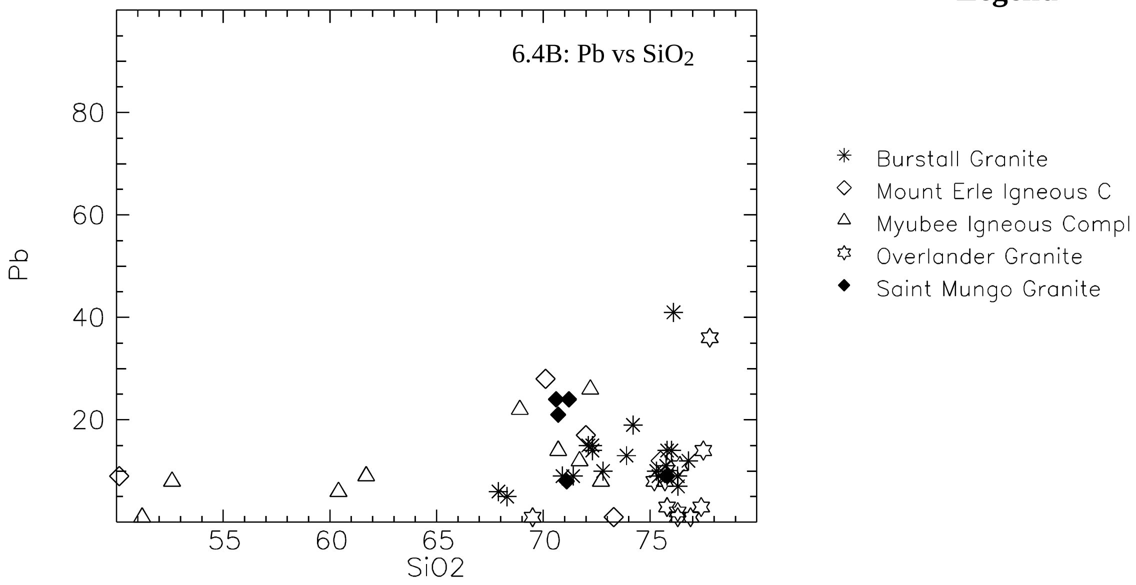



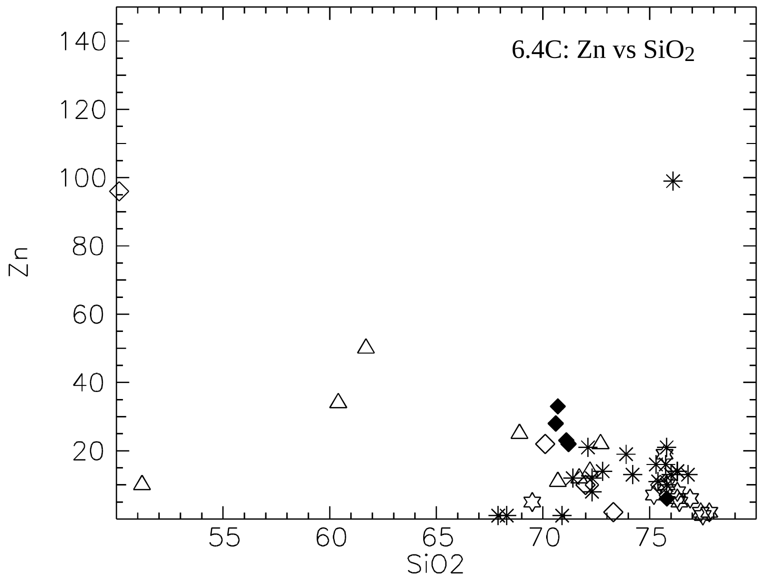
6.3K: F vs SiO2
F
3000
2000
1000
55
60
65
70
75
SiO2

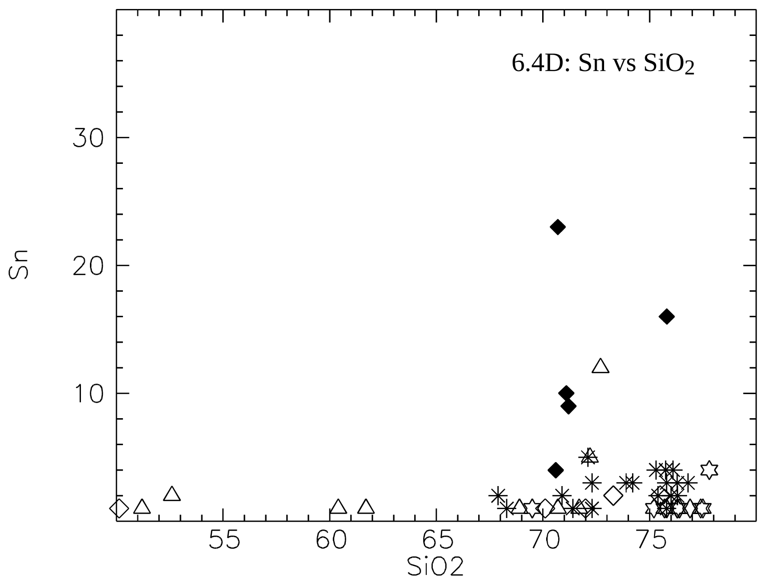



6.4A: Cu vs SiO2
Cu
80
60
40
20
55
60
65
70
75
SiO2

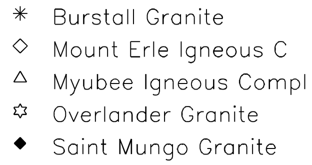
**Legend**

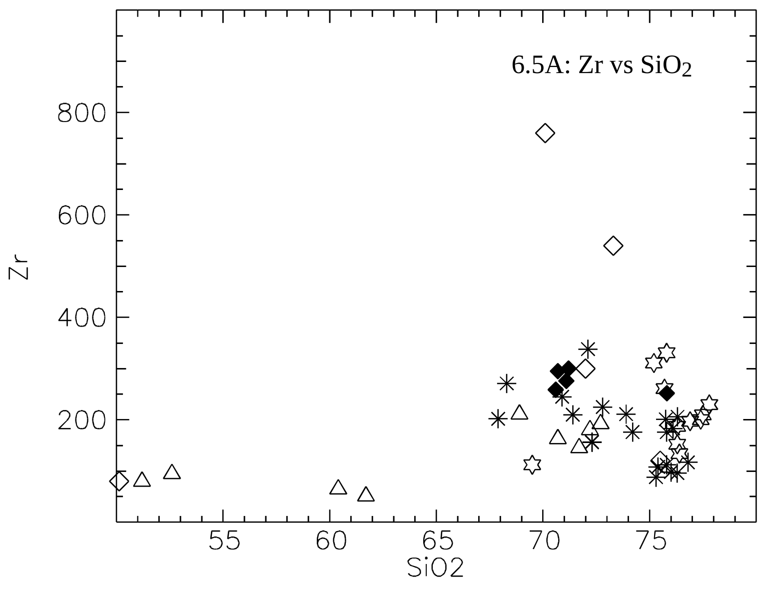

6.4B: Pb vs SiO2
Pb
80
60
40
20
55
60
65
70
75
SiO2
Burstall Granite
Mount Erle Igneous C
Myubee Igneous Compl
Overlander Granite
Saint Mungo Granite

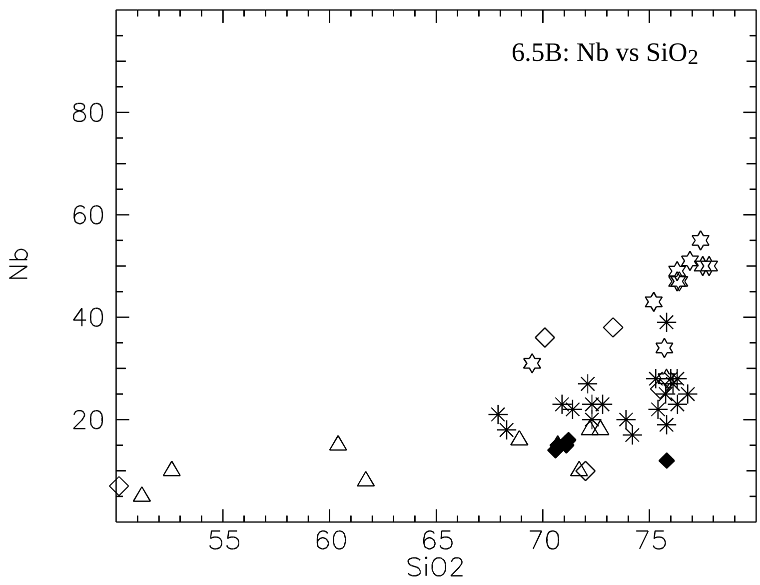

6.4C: Zn vs SiO2
Zn
140
120
100
80
60
40
20
55
60
65
70
75
SiO2

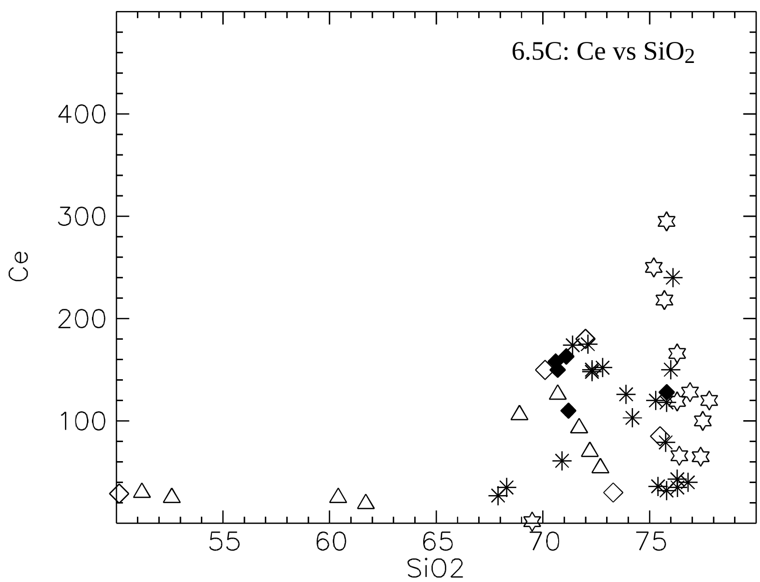

6.4D: Sn vs SiO2
Sn
30
20
10
55
60
65
70
75
SiO2

**Legend**

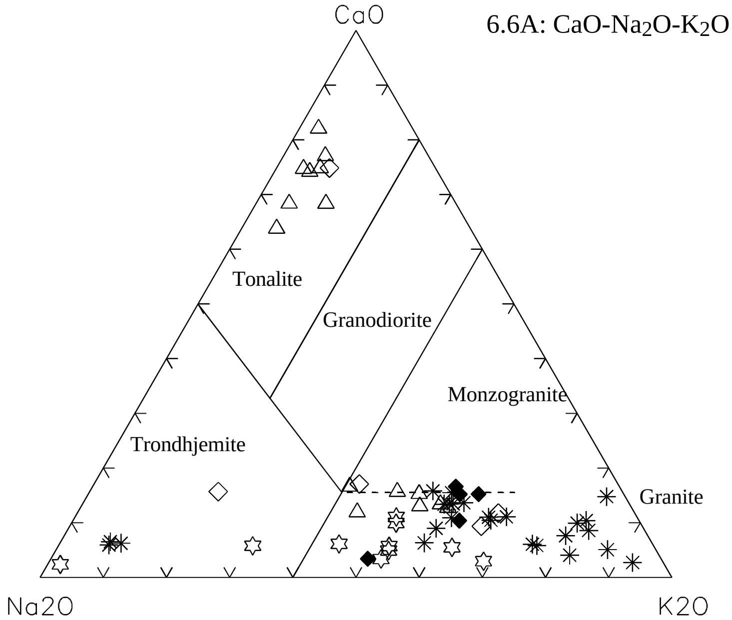

Burstall Granite
Mount Erle Igneous C
Myubee Igneous Compl
Overlander Granite
Saint Mungo Granite

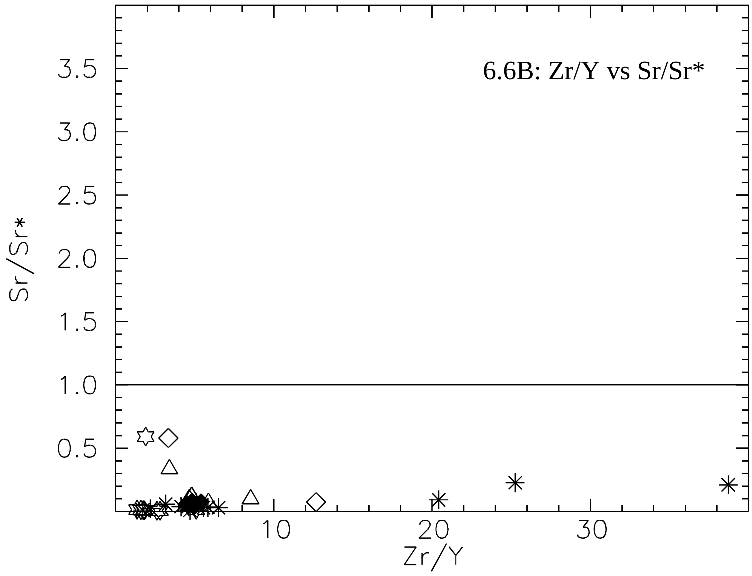

6.5A: Zr vs $SiO_2$
Zr
800
600
400
200
55
60
65
70
75
SiO2

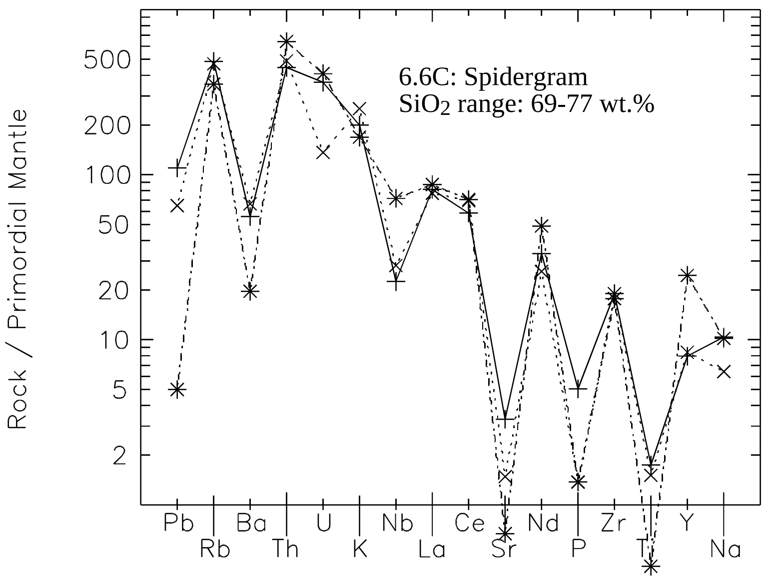

6.5B: Nb vs $SiO_2$
Nb
80
60
40
20
55
60
65
70
75
SiO2


6.5C: Ce vs $SiO_2$
Ce
400
300
200
100
55
60
65
70
75
SiO2

**Legend**

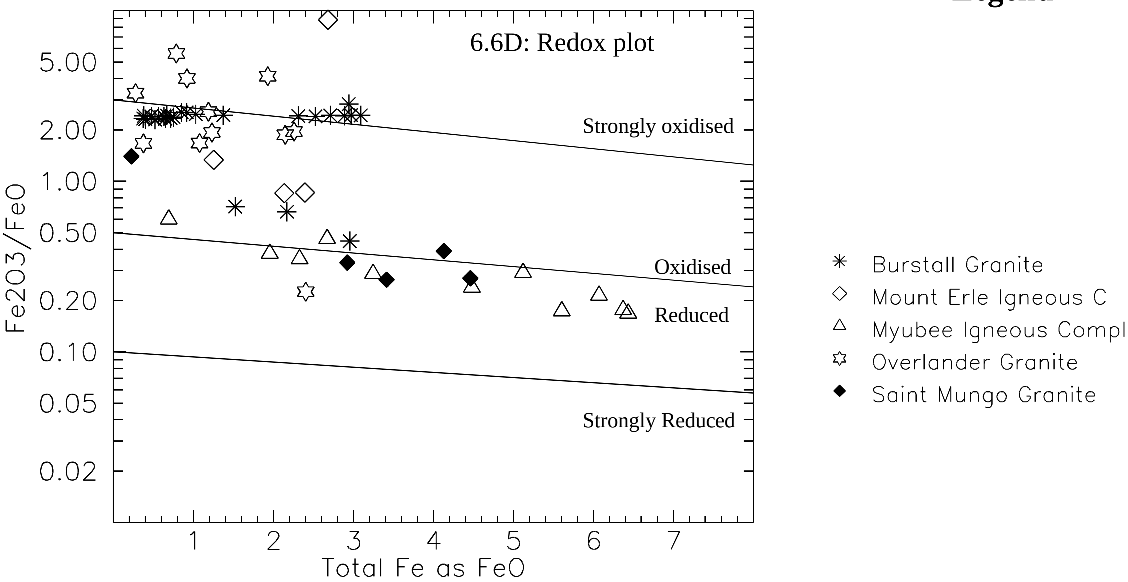


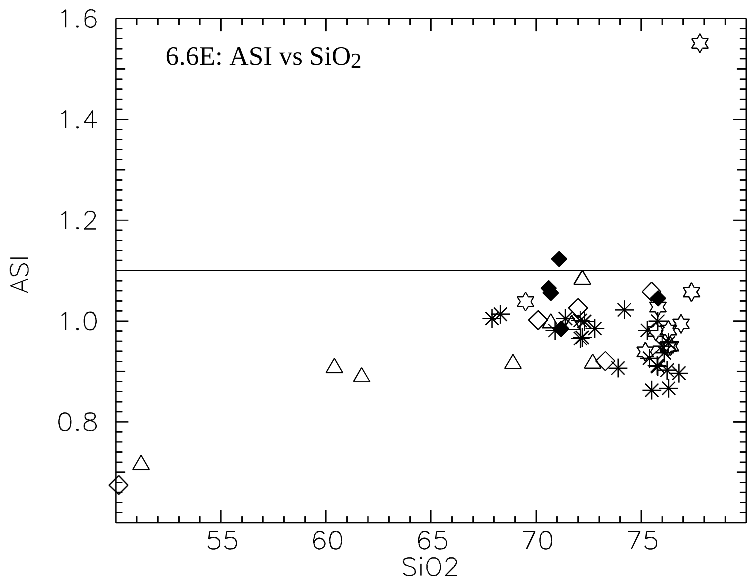



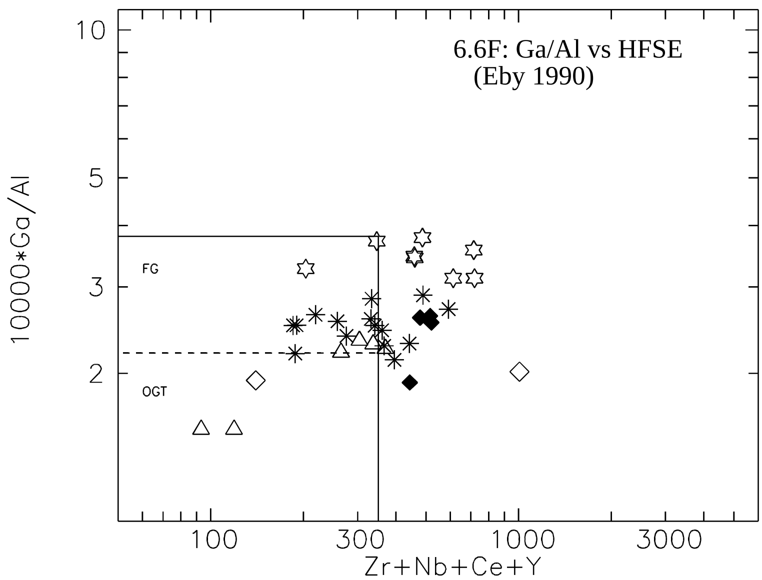



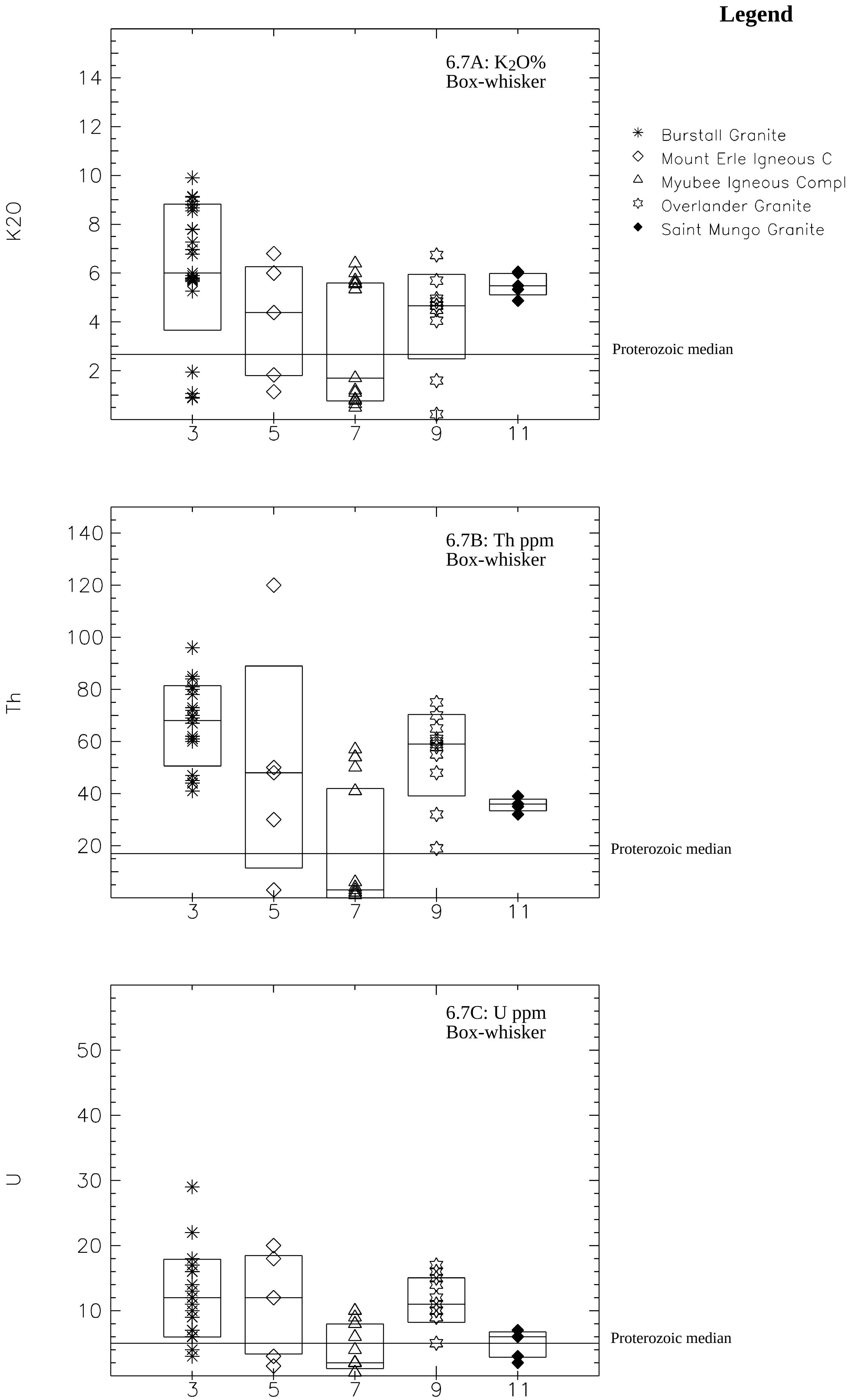

- ✳ Burstall Granite
- ◇ Mount Erle Igneous C
- △ Myubee Igneous Compl
- ✡ Overlander Granite
- ◆ Saint Mungo Granite

**Legend**


6.6D: Redox plot
Strongly oxidised
Oxidised
Reduced
Strongly Reduced
Fe2O3/FeO
Total Fe as FeO
Burstall Granite
Mount Erle Igneous C
Myubee Igneous Compl
Overlander Granite
Saint Mungo Granite


6.6E: ASI vs SiO2
ASI
SiO2


6.6F: Ga/Al vs HFSE
(Eby 1990)
FG
OGT
10000*Ga/Al
Zr+Nb+Ce+Y


Legend
Burstall Granite
Mount Erle Igneous C
Myubee Igneous Compl
Overlander Granite
Saint Mungo Granite
6.7A: K2O%
Box-whisker
K2O
Proterozoic median
6.7B: Th ppm
Box-whisker
Th
Proterozoic median
6.7C: U ppm
Box-whisker
U
Proterozoic median

## Burstall Granite

### MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 74.23 | 75.3 | 3.21 | 67.9 | 83.9 | 25 |
| TiO2 | 0.23 | 0.21 | 0.11 | 0.08 | 0.41 | 25 |
| Al2O3 | 12.81 | 12.42 | 2.35 | 6.55 | 18.3 | 25 |
| Fe2O3 | 1.01 | 0.66 | 0.75 | 0.28 | 2.36 | 25 |
| FeO | 0.55 | 0.28 | 0.49 | 0.12 | 2.11 | 25 |
| MnO | 0.05 | 0.04 | 0.05 | 0.01 | 0.23 | 25 |
| MgO | 0.28 | 0.16 | 0.43 | 01 | 2.15 | 25 |
| CaO | 0.93 | 0.93 | 0.37 | 0.29 | 1.54 | 25 |
| Na2O | 2.94 | 2.5 | 2.67 | 0.07 | 9.9 | 25 |
| K2O | 6.24 | 6 | 2.64 | 0.88 | 9.9 | 25 |
| P2O5 | 0.03 | 0.01 | 0.04 | 05 | 0.17 | 25 |
| H2O+ | 0.45 | 0.37 | 0.31 | 0.18 | 1.61 | 24 |
| H2O- | 0.12 | 0.08 | 0.13 | 0.03 | 0.39 | 7 |
| CO2 | 0.11 | 0.13 | 0.06 | 05 | 0.15 | 4 |
| LOI | 1.14 | 1.14 | - | 1.14 | 1.14 | 1 |
| Ba | 857.95 | 486.5 | 1658.07 | 84 | 7820 | 20 |
| Li | 16.5 | 16.5 | 14.85 | 6 | 27 | 2 |
| Rb | 252.05 | 270.5 | 102.45 | 40 | 399 | 20 |
| Sr | 30.2 | 26.5 | 14.59 | 13 | 65 | 20 |
| Pb | 12.55 | 10.5 | 7.54 | 5 | 41 | 20 |
| Th | 66 | 68 | 15.82 | 41 | 96 | 20 |
| U | 11.92 | 12 | 6.09 | 3 | 29 | 25 |
| Zr | 178.8 | 179.5 | 64.93 | 88 | 338 | 20 |
| Nb | 23.9 | 23 | 4.9 | 17 | 39 | 20 |
| Y | 35.65 | 37.5 | 18.66 | 7 | 91 | 20 |
| La | 38.33 | 38 | 30.91 |  | 91 | 20 |
| Ce | 102.2 | 110.5 | 62.13 | 27 | 240 | 20 |
| Pr | 15 | 15 | - | 15 | 15 | 1 |
| Nd | 25.73 | 35 | 18.87 |  | 60 | 15 |
| Sc | 1.8 |  | 1.26 |  | 5 | 15 |
| V | 7.2 | 5 | 5.83 |  | 18 | 20 |
| Cr | 41.38 |  | 79.75 |  | 161 | 4 |
| Mn | 297 | 297 | - | 297 | 297 | 1 |
| Co | 4.87 | 4 | 3.38 |  | 10 | 15 |
| Ni | 3.65 | 4 | 1.58 |  | 6 | 17 |
| Cu | 37.25 | 5 | 139.1 | 2 | 628 | 20 |
| Zn | 16.45 | 13 | 20.28 |  | 99 | 20 |
| Sn | 2.58 | 3 | 1.17 |  | 5 | 19 |
| W | 5.5 | 4 | 3.08 | 3 | 13 | 14 |
| Mo | 2.86 |  | 5.54 |  | 25 | 18 |
| Ga | 17.93 | 17 | 3.59 | 14 | 25 | 15 |
| As | 2.94 | 3 | 2.23 |  | 8 | 18 |
| S | 995 | 65 | 1870.23 | d | 3800 | 4 |
| F | 166.67 | 100 | 115.47 | 100 | 300 | 3 |
| Cl | 266.67 | 200 | 115.47 | 200 | 400 | 3 |
| Be | 5 | 5 | - | 5 | 5 | 1 |
| Ag | 1 | 1 | - | 1 | 1 | 1 |
| Bi | 1 |  | - |  |  | 1 |
| Hf | 7 | 7 | - | 7 | 7 | 1 |
| Ta | 1 |  | - |  |  | 1 |
| Cs | 1.5 |  | - |  |  | 1 |
| Ge | 5 | 5 | - | 5 | 5 | 1 |
| Se | 0.5 |  | - |  |  | 1 |

## Mount Erle Igneous Complex

## MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 68.21 | 72 | 10.29 | 50.13 | 75.5 | 5 |
| TiO2 | 0.41 | 0.31 | 0.26 | 0.13 | 0.83 | 5 |
| Al2O3 | 13.88 | 13.4 | 1.35 | 12.6 | 15.62 | 5 |
| Fe2O3 | 1.48 | 1.16 | 0.76 | 0.76 | 2.65 | 5 |
| FeO | 2.36 | 1.21 | 3.38 | 0.3 | 8.36 | 5 |
| MnO | 0.07 | 0.05 | 0.06 | 0.02 | 0.17 | 5 |
| MgO | 1.82 | 0.44 | 3.21 | 0.1 | 7.55 | 5 |
| CaO | 3.09 | 1.41 | 3.98 | 0.86 | 10.18 | 5 |
| Na2O | 3.37 | 2.35 | 1.59 | 2.2 | 5.75 | 5 |
| K2O | 4.03 | 4.38 | 2.49 | 1.14 | 6.8 | 5 |
| P2O5 | 0.05 | 0.04 | 0.05 | 01 | 0.14 | 5 |
| H2O+ | 0.42 | 0.48 | 0.19 | 0.15 | 0.56 | 4 |
| H2O- | 0.14 | 0.15 | 0.05 | 0.08 | 0.19 | 4 |
| CO2 | 0.29 | 0.09 | 0.42 | 0.04 | 0.92 | 4 |
| LOI | 1.12 | 1.12 | - | 1.12 | 1.12 | 1 |
| Ba | 526.2 | 331 | 357.54 | 190 | 980 | 5 |
| Li | 18 | 18 | - | 18 | 18 | 1 |
| Rb | 149.4 | 110 | 124.71 | 30 | 310 | 5 |
| Sr | 92.4 | 85 | 57.62 | 28 | 169 | 5 |
| Pb | 13.4 | 12 | 10.01 | | 28 | 5 |
| Th | 50.2 | 48 | 43.34 | 3 | 120 | 5 |
| U | 10.9 | 12 | 8.44 | 1.5 | 20 | 5 |
| Zr | 360 | 300 | 288.1 | 80 | 760 | 5 |
| Nb | 23.4 | 26 | 14.38 | 7 | 38 | 5 |
| Y | 35.2 | 30 | 18.58 | 14 | 60 | 5 |
| La | 55.2 | 30 | 50.05 | 16 | 140 | 5 |
| Ce | 94.8 | 85 | 68.79 | 29 | 180 | 5 |
| Pr | 1.5 | | - | | | 1 |
| Nd | 26 | 26 | 14.14 | 16 | 36 | 2 |
| Sc | 19 | 19 | 24.04 | 2 | 36 | 2 |
| V | 64 | 20 | 95.4 | | 232 | 5 |
| Cr | 81 | 81 | 104.65 | 7 | 155 | 2 |
| Mn | - | - | - | - | - | - |
| Co | - | - | - | - | - | - |
| Ni | 83 | 83 | 111.72 | 4 | 162 | 2 |
| Cu | 46.8 | 25 | 49.95 | 10 | 133 | 5 |
| Zn | 28 | 10 | 38.68 | 2 | 96 | 5 |
| Sn | 1.4 | | 0.55 | | 2 | 5 |
| W | - | - | - | - | - | - |
| Mo | 3.25 | 3.25 | 2.47 | | 5 | 2 |
| Ga | 16 | 16 | - | 16 | 16 | 2 |
| As | 0.75 | 0.75 | 0.35 | 0.5 | 1 | 2 |
| S | - | - | - | - | - | - |
| F | - | - | - | - | - | - |
| Cl | - | - | - | - | - | - |
| Be | 0.5 | | - | | | 1 |
| Ag | - | - | - | - | - | - |
| Bi | 0.5 | | - | | | 1 |
| Hf | - | - | - | - | - | - |
| Ta | - | - | - | - | - | - |
| Cs | 6 | 6 | - | 6 | 6 | 1 |
| Ge | - | - | - | - | - | - |
| Se | - | - | - | - | - | - |

## Myubee Igneous Complex

## MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 58.23 | 52.6 | 10.42 | 46.3 | 72.7 | 15 |
| TiO2 | 0.66 | 0.47 | 0.55 | 0.22 | 2.12 | 15 |
| Al2O3 | 16.86 | 17.2 | 2.57 | 13.7 | 21.2 | 15 |
| Fe2O3 | 1.09 | 0.94 | 0.71 | 0.27 | 3.38 | 15 |
| FeO | 4.83 | 4.85 | 3.04 | 0.45 | 10.69 | 15 |
| MnO | 0.09 | 0.1 | 0.05 | 0.02 | 0.17 | 15 |
| MgO | 3.11 | 3.77 | 2.77 | 0.35 | 8.28 | 15 |
| CaO | 6.86 | 8.86 | 5.19 | 1.25 | 13.6 | 15 |
| Na2O | 3.66 | 3.3 | 1.04 | 2.47 | 5.95 | 15 |
| K2O | 3.18 | 1.7 | 2.5 | 0.5 | 6.4 | 15 |
| P2O5 | 0.19 | 0.12 | 0.24 | 0.08 | 1.03 | 15 |
| H2O+ | 0.86 | 0.66 | 0.62 | 0.31 | 2.57 | 14 |
| H2O- | 0.12 | 0.11 | 0.05 | 0.07 | 0.24 | 14 |
| CO2 | 0.21 | 0.25 | 0.15 | 0.04 | 0.47 | 14 |
| LOI | 0.73 | 0.73 | - | 0.73 | 0.73 | 1 |
| Ba | 454 | 380 | 349.7 | 220 | 1625 | 15 |
| Li | 9 | 9.5 | 5.73 | 2 | 18 | 6 |
| Rb | 145.67 | 82 | 149.96 | 11 | 400 | 15 |
| Sr | 221.67 | 270 | 166.33 | 26 | 500 | 15 |
| Pb | 14.4 | 8 | 23.49 | | 95 | 15 |
| Th | 18.8 | 3 | 23.97 | | 57 | 15 |
| U | 4.53 | | 3.56 | | 10 | 15 |
| Zr | 94.73 | 75 | 65.68 | 22 | 211 | 15 |
| Nb | 9.27 | 8 | 5.73 | | 18 | 15 |
| Y | 18.4 | 15 | 11.27 | 5 | 40 | 15 |
| La | 25 | 13 | 22.6 | | 70 | 15 |
| Ce | 48.2 | 35 | 35.67 | 10 | 126 | 15 |
| Pr | - | - | - | - | - | - |
| Nd | 30.5 | 29.5 | 14.96 | 15 | 49 | 6 |
| Sc | 3.4 | 4 | 1.52 | | 5 | 5 |
| V | 19.5 | 17 | 12.35 | | 40 | 8 |
| Cr | 5 | 4.5 | 3.16 | | 9 | 6 |
| Mn | - | - | - | - | - | - |
| Co | 2 | 2 | - | 2 | 2 | 1 |
| Ni | 3.67 | 3.5 | 0.82 | 3 | 5 | 6 |
| Cu | 16.5 | 9 | 18.88 | 4 | 60 | 8 |
| Zn | 22.25 | 18 | 13.97 | 10 | 50 | 8 |
| Sn | 2.47 | | 2.83 | | 12 | 15 |
| W | 5 | 5 | - | 5 | 5 | 1 |
| Mo | 4 | 4 | - | 4 | 4 | 1 |
| Ga | 15.83 | 16.5 | 1.47 | 14 | 17 | 6 |
| As | 1 | 1 | 0.32 | | 1.5 | 6 |
| S | - | - | - | - | - | - |
| F | 950 | 950 | 777.82 | 400 | 1500 | 2 |
| Cl | - | - | - | - | - | - |
| Be | 5 | 5 | - | 5 | 5 | 1 |
| Ag | - | - | - | - | - | - |
| Bi | 1 | | - | | | 1 |
| Hf | - | - | - | - | - | - |
| Ta | - | - | - | - | - | - |
| Cs | - | - | - | - | - | - |
| Ge | - | - | - | - | - | - |
| Se | - | - | - | - | - | - |

## Overlander Granite

## MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 75.89 | 76.3 | 2.27 | 69.5 | 77.8 | 11 |
| TiO2 | 0.1 | 0.08 | 0.05 | 0.06 | 0.19 | 11 |
| Al2O3 | 12.66 | 12.1 | 1.94 | 11.8 | 18.5 | 11 |
| Fe2O3 | 0.89 | 0.8 | 0.51 | 0.23 | 1.69 | 11 |
| FeO | 0.53 | 0.41 | 0.55 | 0.07 | 2 | 11 |
| MnO | 0.39 | 0.02 | 1.2 | 0.01 | 4 | 11 |
| MgO | 0.45 | 0.12 | 1.18 | 0.02 | 4 | 11 |
| CaO | 0.51 | 0.48 | 0.27 | 0.26 | 1.05 | 10 |
| Na2O | 4.22 | 3.62 | 2.14 | 2.78 | 10.5 | 11 |
| K2O | 4.22 | 4.66 | 1.81 | 0.22 | 6.74 | 11 |
| P2O5 | 0.03 | 0.04 | 0.02 | 02 | 0.07 | 11 |
| H2O+ | 0.26 | 0.27 | 0.11 | 0.1 | 0.45 | 11 |
| H2O- | 0.13 | 0.11 | 0.05 | 0.06 | 0.2 | 11 |
| CO2 | 0.09 | 0.06 | 0.09 | 05 | 0.3 | 11 |
| LOI | - | - | - | - | - | - |
| Ba | 152.27 | 110 | 111.78 | 13 | 391 | 11 |
| Li | 1.5 | 1.5 | 0.53 | 1 | 2 | 8 |
| Rb | 224.36 | 223 | 91.55 | 2 | 340 | 11 |
| Sr | 16.18 | 14 | 8.67 | 10 | 41 | 11 |
| Pb | 8 | 3 | 10.31 | | 36 | 11 |
| Th | 54.73 | 59 | 16.38 | 19 | 75 | 11 |
| U | 11.64 | 11 | 3.59 | 5 | 17 | 11 |
| Zr | 211.36 | 200 | 68.82 | 112 | 331 | 11 |
| Nb | 44.09 | 47 | 9.01 | 28 | 55 | 11 |
| Y | 89.82 | 95 | 18.76 | 59 | 111 | 11 |
| La | 81 | 61 | 50.37 | | 180 | 11 |
| Ce | 138.95 | 120 | 87.03 | | 295 | 11 |
| Pr | - | - | - | - | - | - |
| Nd | 72.56 | 74 | 40 | | 123 | 8 |
| Sc | 1 | | - | | | 8 |
| V | 4.73 | | 6.21 | | 20 | 11 |
| Cr | 18.88 | 9 | 24.66 | 7 | 79 | 8 |
| Mn | - | - | - | - | - | - |
| Co | - | - | - | - | - | - |
| Ni | 3.69 | 1.5 | 5.93 | | 18 | 8 |
| Cu | 16.09 | 7 | 16.08 | | 47 | 11 |
| Zn | 6.45 | 6 | 4.97 | | 19 | 11 |
| Sn | 1.27 | | 0.9 | | 4 | 11 |
| W | - | - | - | - | - | - |
| Mo | - | - | - | - | - | - |
| Ga | 23.38 | 22.5 | 3.81 | 20 | 32 | 8 |
| As | 0.75 | 0.75 | 0.27 | | 1 | 8 |
| S | - | - | - | - | - | - |
| F | 200 | 200 | - | 200 | 200 | 1 |
| Cl | - | - | - | - | - | - |
| Be | - | - | - | - | - | - |
| Ag | - | - | - | - | - | - |
| Bi | - | - | - | - | - | - |
| Hf | - | - | - | - | - | - |
| Ta | - | - | - | - | - | - |
| Cs | - | - | - | - | - | - |
| Ge | - | - | - | - | - | - |
| Se | - | - | - | - | - | - |

## Saint Mungo Granite

### MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 71.88 | 71.1 | 2.21 | 70.6 | 75.81 | 5 |
| TiO2 | 0.43 | 0.43 | 0.03 | 0.38 | 0.46 | 5 |
| Al2O3 | 13.3 | 13.2 | 0.32 | 13 | 13.81 | 5 |
| Fe2O3 | 0.76 | 0.75 | 0.39 | 0.14 | 1.19 | 5 |
| FeO | 2.35 | 2.76 | 1.35 | 0.1 | 3.59 | 5 |
| MnO | 0.03 | 0.03 | 0.01 | 0.02 | 0.04 | 5 |
| MgO | 0.45 | 0.54 | 0.22 | 0.06 | 0.56 | 5 |
| CaO | 1.17 | 1.49 | 0.54 | 0.33 | 1.55 | 5 |
| Na2O | 2.87 | 2.55 | 0.93 | 2.25 | 4.51 | 5 |
| K2O | 5.55 | 5.48 | 0.49 | 4.87 | 6.05 | 5 |
| P2O5 | 0.09 | 0.1 | 0.03 | 0.03 | 0.11 | 5 |
| H2O+ | 0.62 | 0.68 | 0.32 | 0.12 | 0.89 | 5 |
| H2O- | 0.25 | 0.24 | 0.12 | 0.11 | 0.38 | 5 |
| CO2 | 0.07 | 0.07 | 0.04 | 01 | 0.11 | 5 |
| LOI | - | - | - | - | - | - |
| Ba | 895.2 | 889 | 338.08 | 472 | 1414 | 5 |
| Li | 18.5 | 22 | 11.36 | 2 | 28 | 4 |
| Rb | 230.4 | 250 | 59.37 | 130 | 285 | 5 |
| Sr | 92.2 | 110 | 34.82 | 32 | 114 | 5 |
| Pb | 17.2 | 21 | 8.04 | 8 | 24 | 5 |
| Th | 35.6 | 36 | 2.51 | 32 | 39 | 5 |
| U | 4.8 | 6 | 2.17 | 2 | 7 | 5 |
| Zr | 276.4 | 276 | 21.22 | 252 | 300 | 5 |
| Nb | 14.4 | 15 | 1.52 | 12 | 16 | 5 |
| Y | 54 | 51 | 6.96 | 48 | 62 | 5 |
| La | 72.8 | 85 | 29.14 | 21 | 90 | 5 |
| Ce | 141.8 | 150 | 22.25 | 110 | 163 | 5 |
| Pr | - | - | - | - | - | - |
| Nd | 57.5 | 68.5 | 24.47 | 21 | 72 | 4 |
| Sc | 7.25 | 6.5 | 2.87 | 5 | 11 | 4 |
| V | 13.8 | 13 | 3.56 | 11 | 20 | 5 |
| Cr | 8.75 | 9 | 2.87 | 5 | 12 | 4 |
| Mn | - | - | - | - | - | - |
| Co | 6 | 5 | 2.71 | 4 | 10 | 4 |
| Ni | 3 | 3 | 1.63 | | 5 | 4 |
| Cu | 31.4 | 12 | 44.61 | 7 | 111 | 5 |
| Zn | 22.4 | 23 | 10.16 | 6 | 33 | 5 |
| Sn | 12.4 | 10 | 7.3 | 4 | 23 | 5 |
| W | 6 | 6 | - | 6 | 6 | 1 |
| Mo | 1.5 | | - | | | 1 |
| Ga | 17 | 18 | 2 | 14 | 18 | 4 |
| As | 2.75 | 3 | 0.5 | 2 | 3 | 4 |
| S | - | - | - | - | - | - |
| F | 500 | 500 | - | 500 | 500 | 1 |
| Cl | - | - | - | - | - | - |
| Be | - | - | - | - | - | - |
| Ag | - | - | - | - | - | - |
| Bi | - | - | - | - | - | - |
| Hf | - | - | - | - | - | - |
| Ta | - | - | - | - | - | - |
| Cs | - | - | - | - | - | - |
| Ge | - | - | - | - | - | - |
| Se | - | - | - | - | - | - |

# 7 FIERY SUPERSUITE

## 7.1 Timing

1710 Ma

## 7.2 Individual Ages

Primary Ages:

| | |
|---|---|
| 1. Peters Creek Volcanics | 1724 ± 2 Ma, SHRIMP |
| 2. Peters Creek Volcanics | 1726 ± 2 Ma, SHRIMP |
| 3. Fiery Creek Volcanics | 1709 ± 3 Ma, SHRIMP |
| 4. Weberra Granite | 1698 ± 24 Ma, U-Pb |

Source: OZCHRON

## 7.3 Regional Setting

Note: In this project we have chosen to separate the Carters Bore Rhyolite from the Fiery Creek Volcanics due to the similarity of the former with the ~1670 Ma Sybella Suite intrusions and the latter with the 1678 Ma Weberra Granite. Although the Peters Creek Volcanics probably represent a separate, older event, due to the general similarity in both composition and alteration overprint we are including both these volcanic units, along with the Weberra Granite, in the Fiery Supersuite. This is predominantly an extrusive suite, with the only significant intrusive, the Weberra Granite, being relatively small and emplaced at fairly shallow crustal levels.

The Supersuite is bimodal, with both mafic and felsic rock types represented, suggesting that the tectonic setting operating at the time was extensional. An alteration overprint is very pervasive throughout this supersuite, and the primary igneous geochemistry is difficult to ascertain with confidence.

## 7.4 Summary

Even allowing for the extensive alteration, the members of this supersuite do not appear to have undergone any significant magmatic fractionation which would allow for the concentration of significant amounts of Au or base metals. The significance of this supersuite to metallogenesis is the ubiquitous hematitic alteration overprint. McGoldrick *et al.* (1996) have suggested that because of the low Au tenor of the HYC, Mount Isa and Lady Loretta deposits, the mineralising fluids associated with these deposits are likely to have been oxidising and near-neutral to alkaline. The alteration assemblages within the units of the Fiery Supersuite suggest that these units may possibly have seen a fluid similar to that which carried the Pb and Zn associated with these giant sediment-hosted base metal deposits. Hence mapping the extent of these alteration assemblages may provide clues to fluid pathways associated with these Zn-Pb-Ag deposits.

## 7.5 Potential

The supersuite is not considered to have any potential for granite-related hydrothermal mineralisation. It is of limited spatial extent.

| | |
|---|---|
| **Cu:** | **None** |
| **Au:** | **None** |
| **Pb/Zn:** | **None** |
| **Sn:** | **None** |
| **Mo/W:** | **None** |
| **Confidence level:** | **321** |

## 7.6 Descriptive Data

***Location:*** Northern Mount Isa Inlier, mainly on the Lawn Hill Platform between the Murphy Inlier and the Mount Gordon Fault.

***Dimensions and area:*** Members of the Fiery Creek Supersuite crop out sporadically over a region 315 km by 120 km. Total area of outcrop is about 200 $km^2$.

## 7.7 Intrusives

***Component plutons:*** Weberra Granite and several rhyolite, trachyte, granophyre and dolerite dykes.

***Form:*** A approximately circular intrusion with several major dyke systems emanating from it.

***Metamorphism and Deformation:*** None.

***Dominant intrusive rock types:*** Even-grained medium to coarse-grained syenogranite to alkali-feldspar granite, slightly more biotite towards the perimeter, minor granophyre.

***Colour:*** Grey to pink.

***Veins, Pegmatites, Aplites, Greisens:*** Some aplite and minor pegmatite noted.

***Distinctive mineralogical characteristics:*** Quartz, K-feldspar, plagioclase, interstitial biotite, accessory zircon, titanite and hematite. Rare garnet has been noted.

***Breccias:*** None recorded.

***Alteration in the granite:*** Albitised in places but generally potassically altered although a high primary $K_2O$ content is probable. Chlorite and calcite noted as alteration products.

## 7.8 Extrusives

Flow-banded rhyolite, rhyolitic agglomerate, rhyolitic ignimbrite interbedded with altered reddish vesicular basalt and trachybasalt, red arkosic sandstone, and conglomerate; quartz-feldspar porphyry in domes and dykes. Mafic volcanics are much more widespread than the felsic volcanics. The Fiery Creek Volcanics contain altered basalt with secondary K-feldspar and hematite, possibly produced by saline fluids under oxidizing conditions. Felsic volcanics of the Peters Creek Volcanics comprise quartz-feldspar porphyry, ashstone, rhyolite, rhyodacite: some are highly altered with assemblages of hematite and K-feldspar.

## 7.9 Country Rock

***Contact metamorphism:*** The country rocks are contact metamorphosed up to hornblende hornfels facies in a contact aureole up to 4 km from the outcropping edge of the pluton (although the granite may occur at shallow depths beneath this area).

***Reaction with country rock:*** None noted.

***Units the granite intrudes:*** Intrudes a dome of Myally Subgroup and Quilalar Formation.

***Dominant rock types:*** Quartzite, red mudstone, siltstone, dolomite.

***Potential hosts:*** Reactions could occur with the dolomites.

## 7.10 Mineralisation

There are several small Cu mines in the vicinity of some of the outcrops of the Fiery Creek Volcanics: these are mainly hosted by Whitworth Quartzite, and primary magmatic activity is not considered to have played a role in their formation. The extremely oxidised nature of these volcanics and the dominance of hematite and K-feldspar is of metallogenic significance as it implies that the volcanics have re-equilibrated with an oxidised neutral to alkaline fluid. Such a fluid has been invoked as being the mineralising fluid associated with the formation of major Zn-Pb-Ag deposits such as Mount Isa, HYC and Lady Loretta (McGoldrick *et al.* 1996). There are noticeable differences in the composition of the Peters Creek and Fiery Creek Volcanics in that the Peters Creek Volcanics are higher in Ba and U. These changes probably reflect subtle differences in the physicochemical properties of the alteration fluid.

## 7.11 Geochemical Data

***Data source:*** AGSO's OZCHEM data base.

***Data quality:*** The data quality is good.

***Are the data representative?*** There is insufficient sampling of the various rock types.

***Are the data adequate?*** No way.

***$SiO_2$ range (Fig. 7.1):*** The $SiO_2$ range is from 50 to 77 wt.% reflecting the bimodal character of this suite. There is a gap at around 60 wt.%.

***Alteration (Fig. 7.2):***

- ***$SiO_2$:*** There is some evidence of silicification in the altered samples.

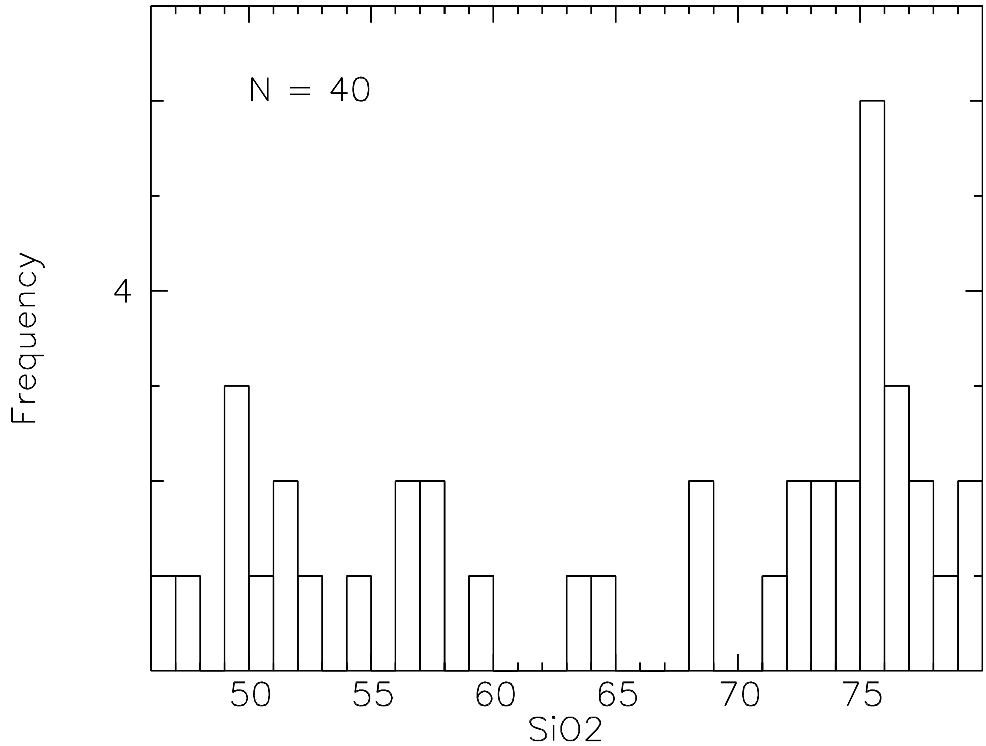



Figure 7.1. Histogram of values for the Fiery Creek Supersuite.

- ***$K_2O/Na_2O$*:** All samples are extremely altered with unrealistically high values of $K_2O$ and low values for $Na_2O$ for a primary igneous rock.
- ***Th/U:*** During alteration there has been loss of U in most of the Weberra Granite and Fiery Creek samples with > 70 wt.% $SiO_2$.
- ***$Fe_2O_3/(FeO+Fe_2O_3)$*:** Both suites of volcanics have been extensively oxidised during alteration.

***Fractionation Plots (Fig. 7.3):***

- ***Rb:*** There is no increase in Rb with increasing $SiO_2$.
- ***U:*** There is no increase in U with increasing $SiO_2$.
- ***Y:*** Some samples show a very weak increase in Y with increasing $SiO_2$.
- ***$P_2O_5$*:** There is no increase or decrease in $P_2O_5$ with increasing $SiO_2$.
- ***Th:*** There is a weak increase in Th with increasing $SiO_2$.
- ***K/Rb:*** The K/Rb ratios have been drastically affected by alteration and are unrealistically high for primary igneous rocks.
- ***Rb-Ba-Sr:*** These samples are too altered for this plot to be meaningful.
- ***Sr:*** All values are extremely low for primary igneous rocks.
- ***Rb/Sr:*** Very weak increase with increasing $SiO_2$: this plot is likely to have been affected by the ubiquitous alteration.
- ***Ba:*** Ba values are higher for the Peters Creek Volcanics than the Fiery Creek Volcanics, suggesting that the alteration fluid in this area may have been of different composition.
- ***F:*** Values are within the range noted by Eby (1990) for Palaeozoic A-type granites.

***Metals (Fig. 7.4):***

- ***Cu:*** Some moderate values, which may reflect alteration.
- ***Pb:*** Values are mostly low, presumably because of the destruction of primary K-Feldspar.
- ***Zn:*** Values are low, no change with increasing $SiO_2$.
- ***Sn:*** Values are low, no change with increasing $SiO_2$.

***High field strength elements (Fig.7.5):***

- ***Zr:*** Values are moderate, no change with increasing $SiO_2$.
- ***Nb:*** Values are low to moderate, no change with increasing $SiO_2$.
- ***Ce:*** Values are generally low, no change with increasing $SiO_2$.

***Classification (Fig. 7.6):***

- ***The CaO/$Na_2O$/$K_2O$ plot of White, quoted in Sheraton and Simons (1992):*** Most samples plot in the granite field (including the mafic samples) because of the high $K_2O$.
- ***Zr/Y vs Sr/Sr*:*** All samples plot below 1 indicating that the primary magma was Sr-depleted, Y-undepleted.
- ***Spidergram:*** The samples plotted have a typical Sr-depleted, Y-undepleted pattern with strong fractionation of Sr, P and Ti.
- ***Oxidation plot of Champion and Heinemann (1994):*** Due to the alteration, most samples plot in the strongly oxidised to oxidised field.
- ***ASI:*** All samples are peraluminous, but this could be because of the removal of $Na_2O$ and CaO during alteration.
- ***A-type plot of Eby (1990):*** Most samples plot within the A-type field defined for Palaeozoic A-type granites.

***Granite type (Chappell and White 1974; Chappell and Stephens 1988):*** I-(granodiorite) type.

***Australian Proterozoic granite type:*** Sybella.

## 7.12 Geophysical Signature

***Radiometrics (Fig. 7.7):*** All samples plot well above the Proterozoic median for $K_2O$; are close to the median values for Th and U for the Peters Creek Volcanics; and close to median for Th in the Fiery Creek Volcanics. In a RGB plot, most would plot as white, with a tendency to red for the Fiery Creek Volcanics.

***Gravity:*** Density measurements have been carried out on the Weberra Granite and the Fiery Creek Volcanics by Hone *et al.* (1987). The wet densities ranged from 2.53 to 2.59 gm/cm$^3$ and were the lowest values recorded for any felsic igneous rocks in the Mount Isa Inlier. Given the narrow size of the outcrops, the AGSO regional data are too coarse for any significant correlations to be made.

***Magnetics:*** The Peters Creek Volcanics have a distinctive high magnetic signature (Martin *et al.* 1997) which suggests that a high proportion of the subsurface members of this unit are mafic volcanics. The felsic volcanics and the Weberra Granite have low measured susceptibilities (Wyborn, unpublished data; Hone *et al.* 1987).

## 7.13 References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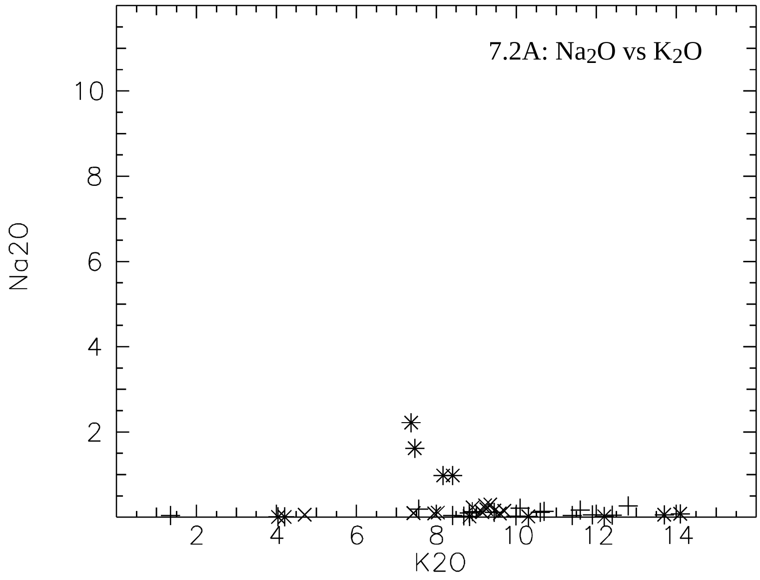
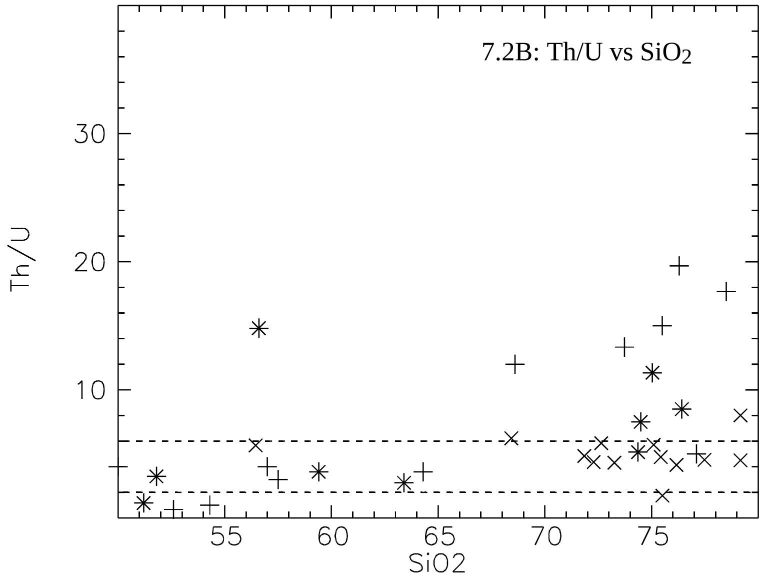
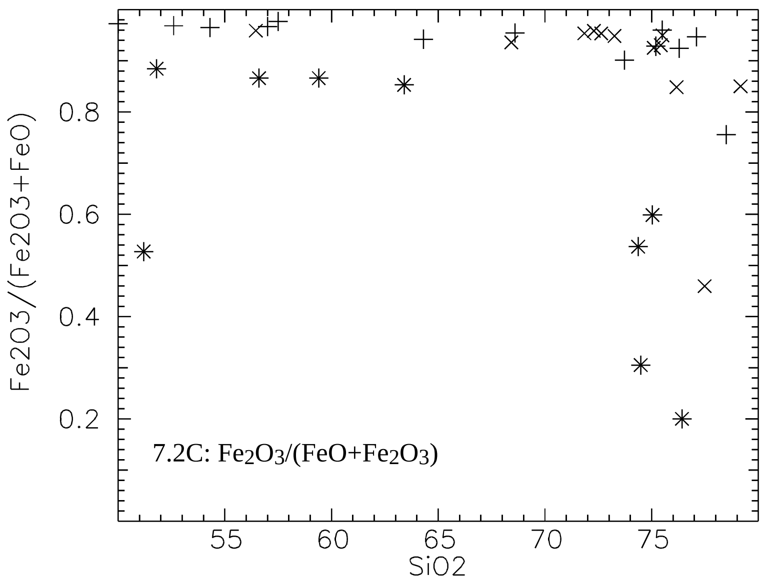
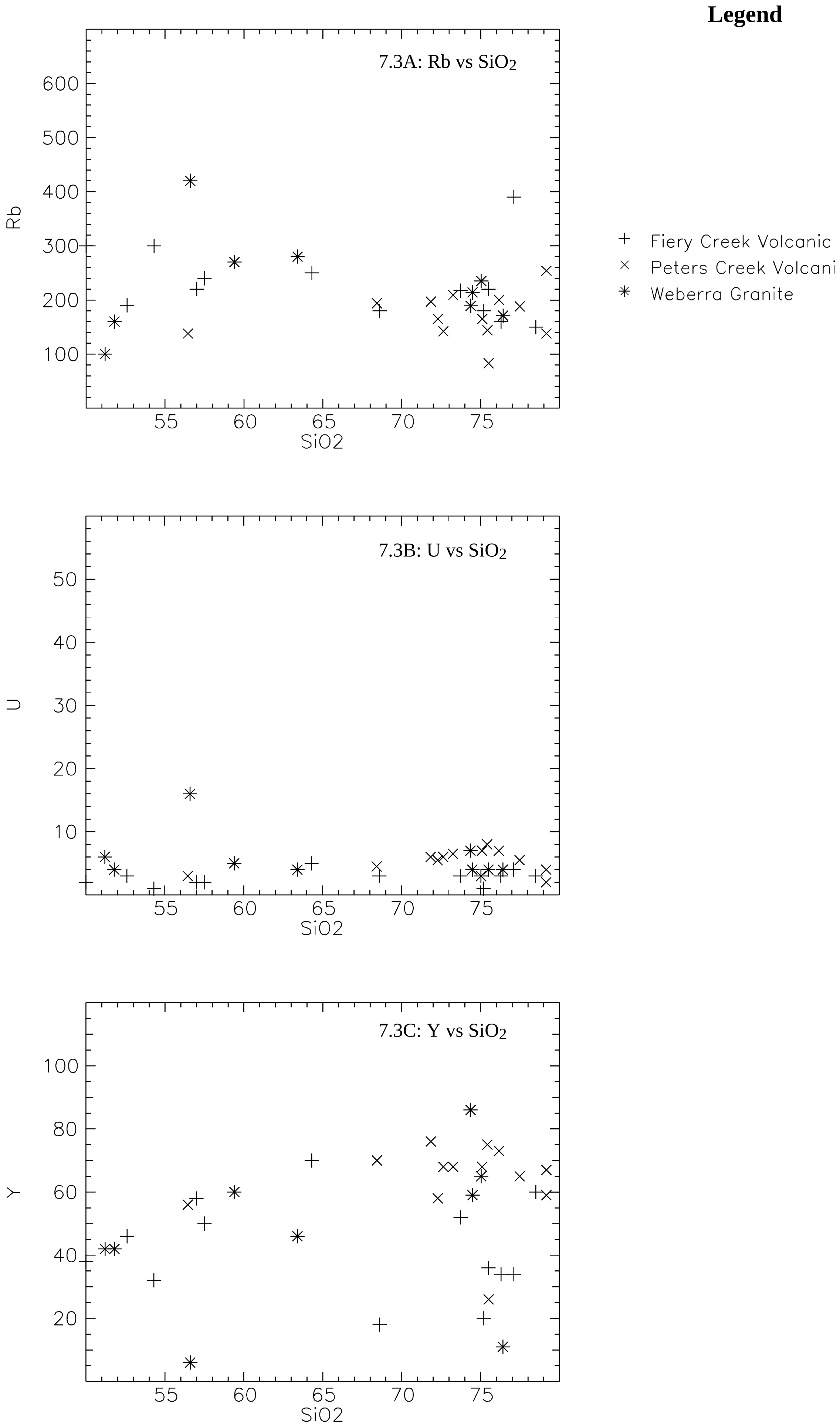



+ Fiery Creek Volcanic
× Peters Creek Volcani
* Weberra Granite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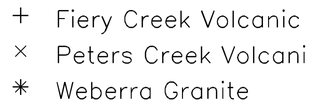
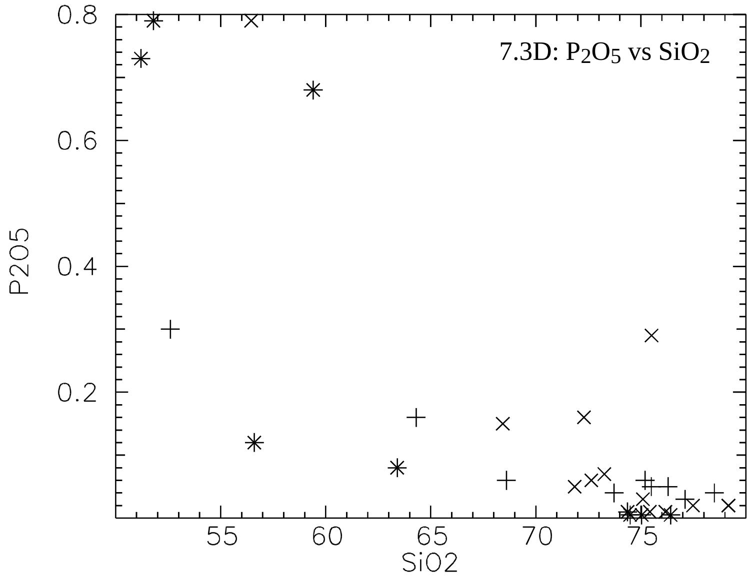
7.3A: Rb vs SiO2
Rb
SiO2
7.3B: U vs SiO2
U
SiO2
7.3C: Y vs SiO2
Y
SiO2
Fiery Creek Volcanic
Peters Creek Volcani
Weberra Granite

**Legend**


Fiery Creek Volcanic
Peters Creek Volcani
Weberra Granite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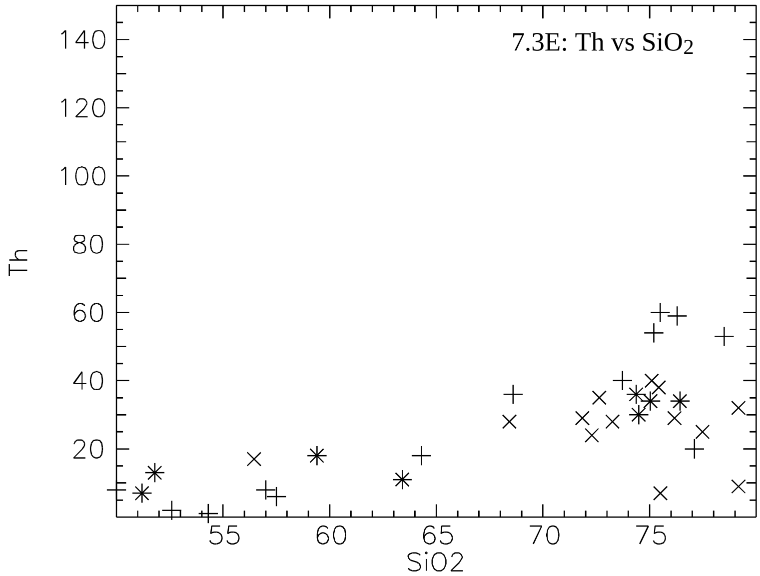
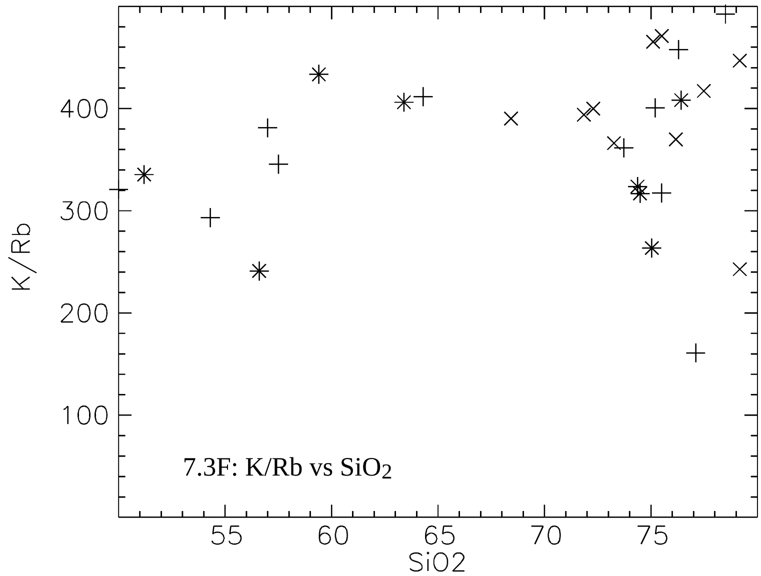
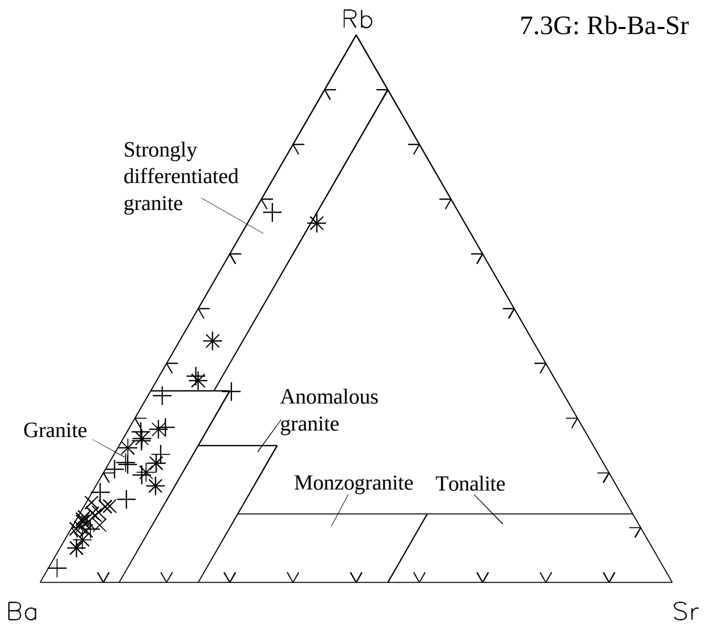
SiO2
0.8
0.6
0.4
0.2
55
60
65
70
75

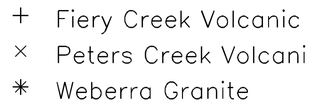

7.3E: Th vs SiO2
Th
SiO2
140
120
100
80
60
40
20
55
60
65
70
75

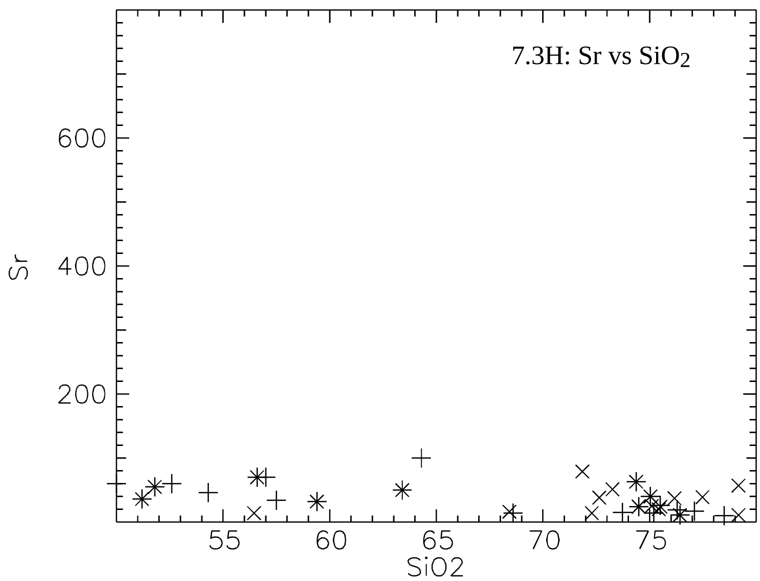

7.3F: K/Rb vs SiO2
K/Rb
SiO2
400
300
200
100
55
60
65
70
75

**Legend**


Rb
7.3G: Rb-Ba-Sr
Strongly differentiated granite
Anomalous granite
Granite
Monzogranite
Tonalite
Ba
Sr


Fiery Creek Volcanic
Peters Creek Volcani
Weberra Granite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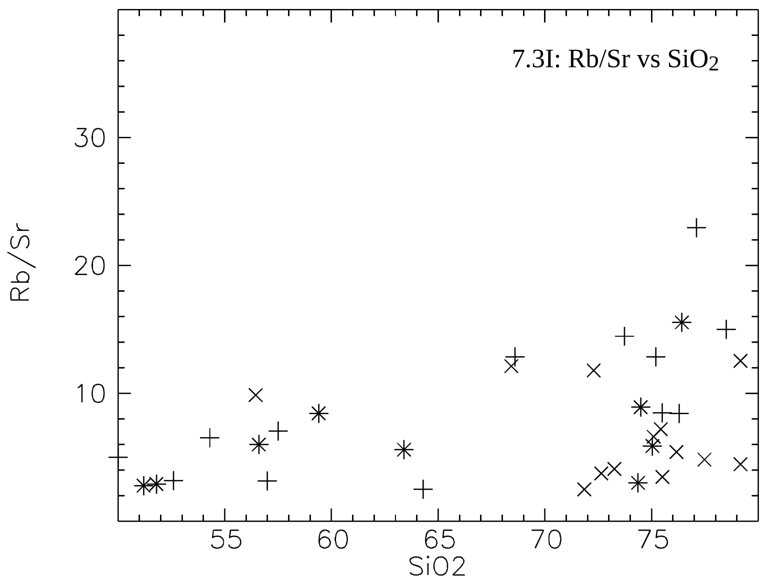
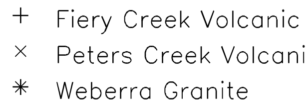
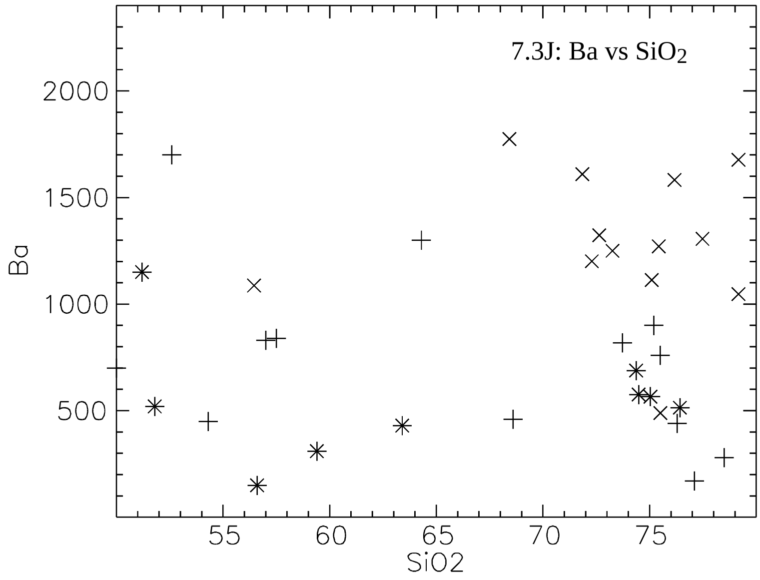
Sr
600
400
200
55
60
65
70
75
SiO2


7.3I: Rb/Sr vs SiO2
Rb/Sr
30
20
10
55
60
65
70
75
SiO2

**Legend**


Fiery Creek Volcanic
Peters Creek Volcani
Weberra Granite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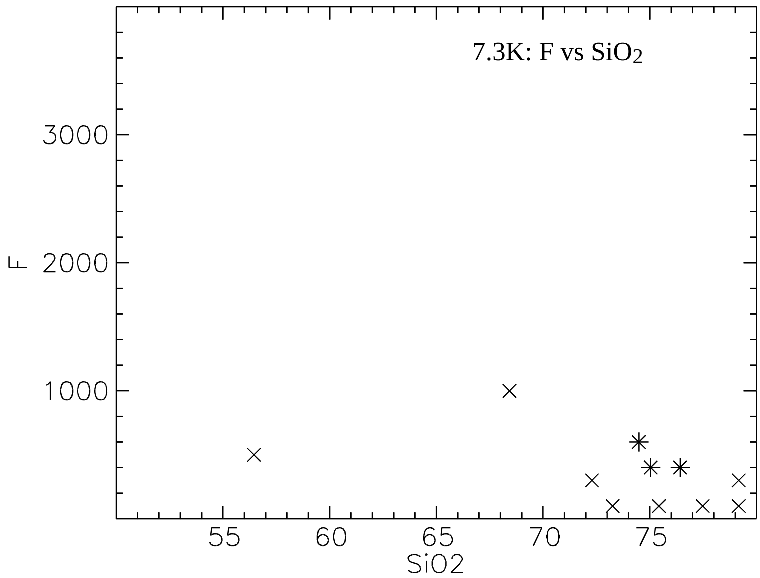
SiO2
2000
1500
1000
500
55
60
65
70
75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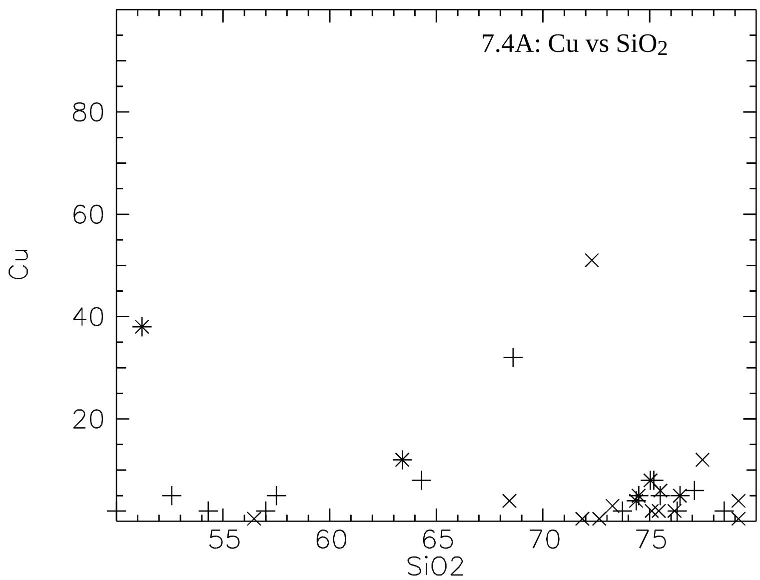
F
SiO2
3000
2000
1000
55
60
65
70
75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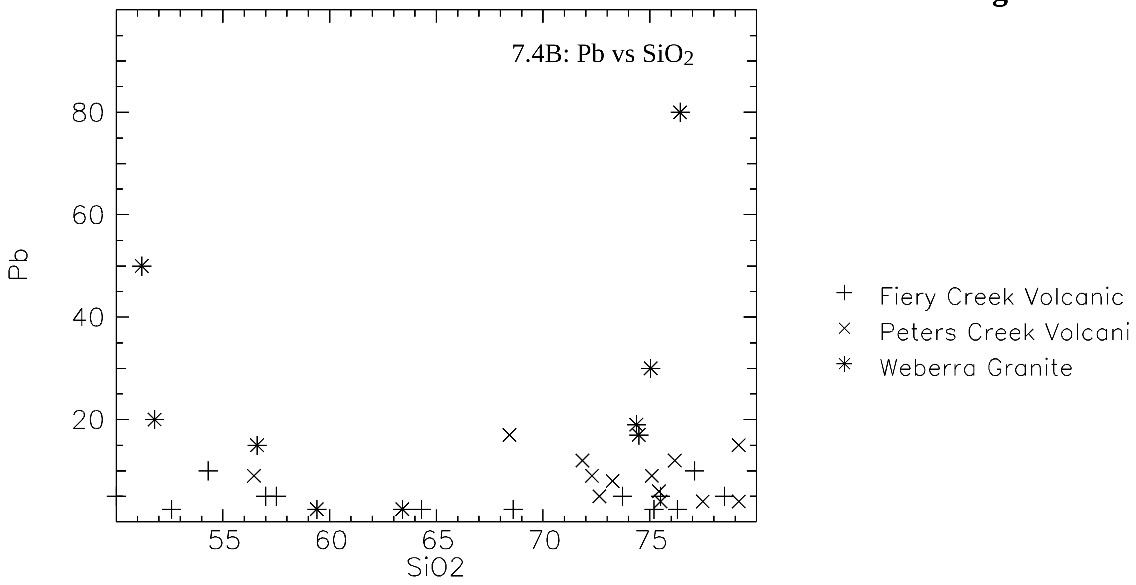
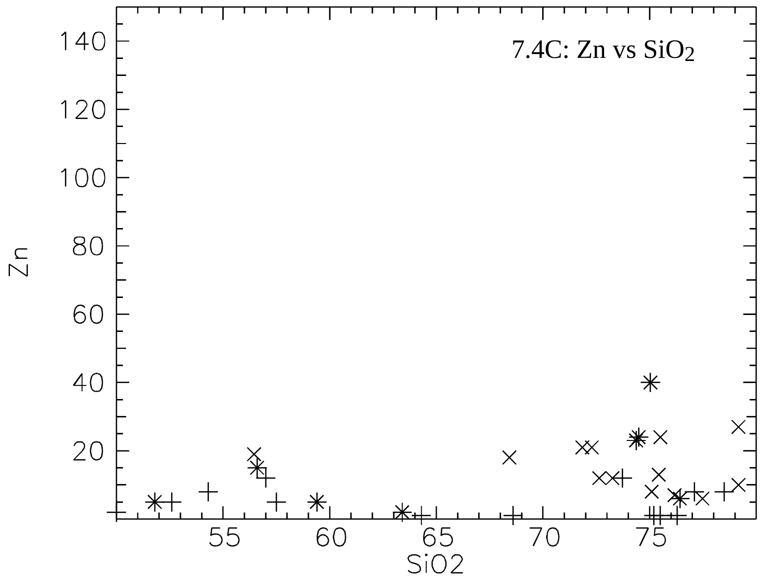
Cu
SiO2
80
60
40
20
55
60
65
70
75

**Legend**


7.4B: Pb vs SiO2
Pb
80
60
40
20
55
60
65
70
75
SiO2
Fiery Creek Volcanic
Peters Creek Volcani
Weberra Granite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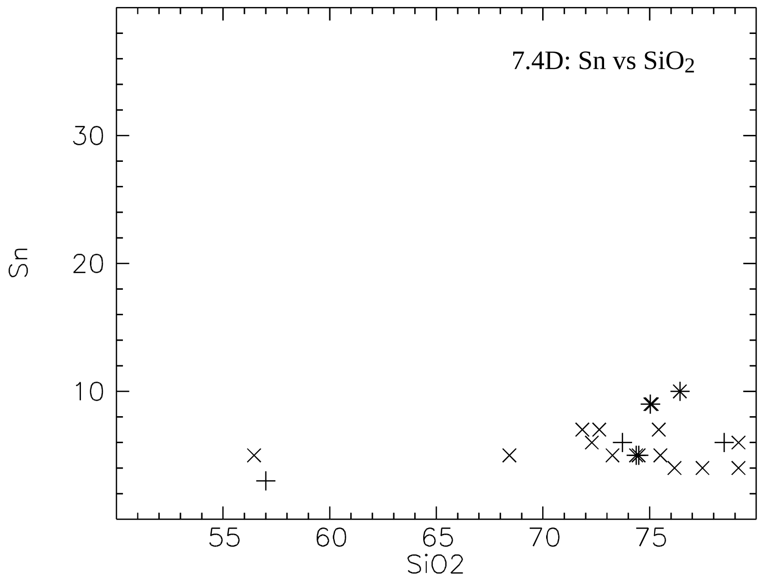
Zn
140
120
100
80
60
40
20
55
60
65
70
75
SiO2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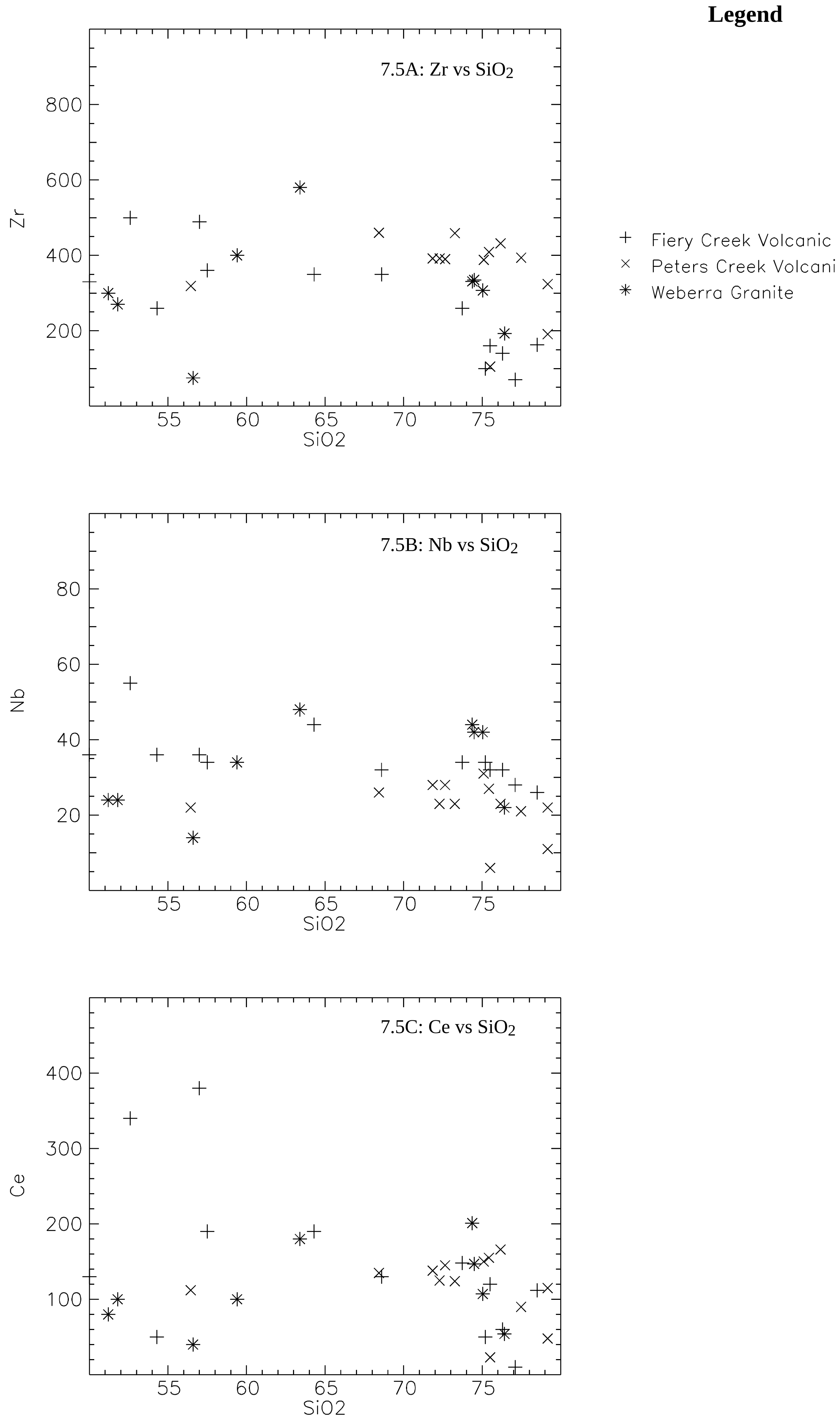
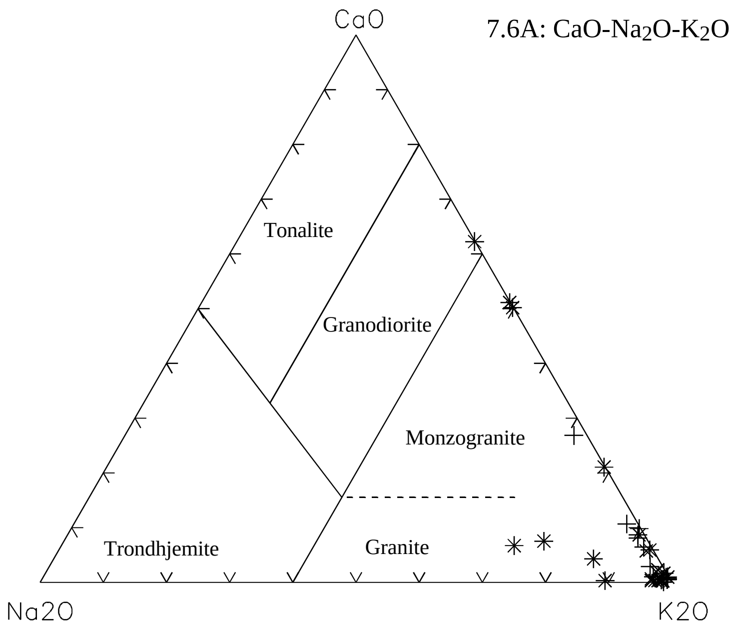
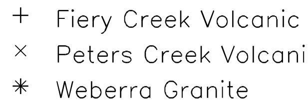
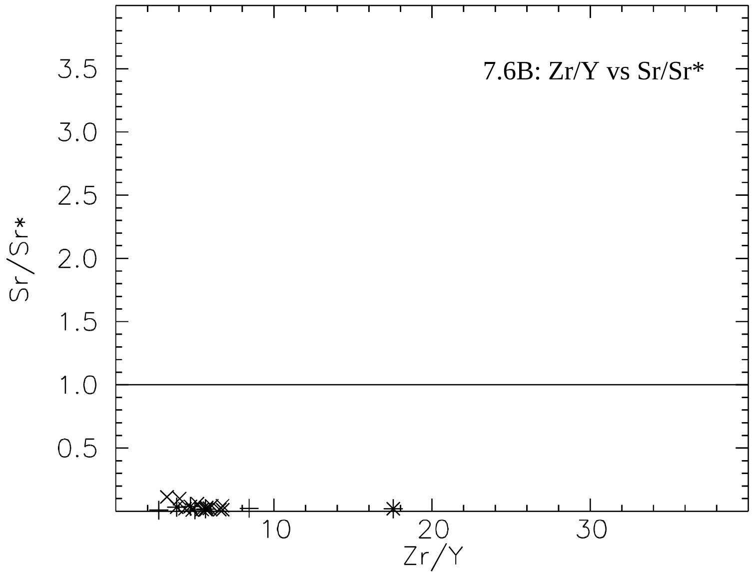
Sn
30
20
10
55
60
65
70
75
SiO2

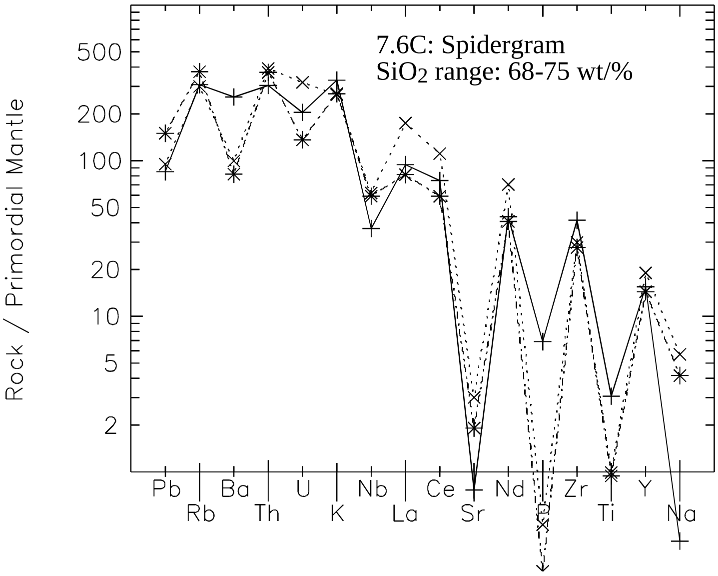

Legend
7.5A: Zr vs SiO2
800
600
400
200
Zr
55
60
65
70
75
SiO2
Fiery Creek Volcanic
Peters Creek Volcani
Weberra Granite
7.5B: Nb vs SiO2
80
60
40
20
Nb
55
60
65
70
75
SiO2
7.5C: Ce vs SiO2
400
300
200
100
Ce
55
60
65
70
75
SiO2

**Legend**


7.6A: CaO-Na2O-K2O
CaO
Tonalite
Granodiorite
Monzogranite
Trondhjemite
Granite
Na2O
K2O

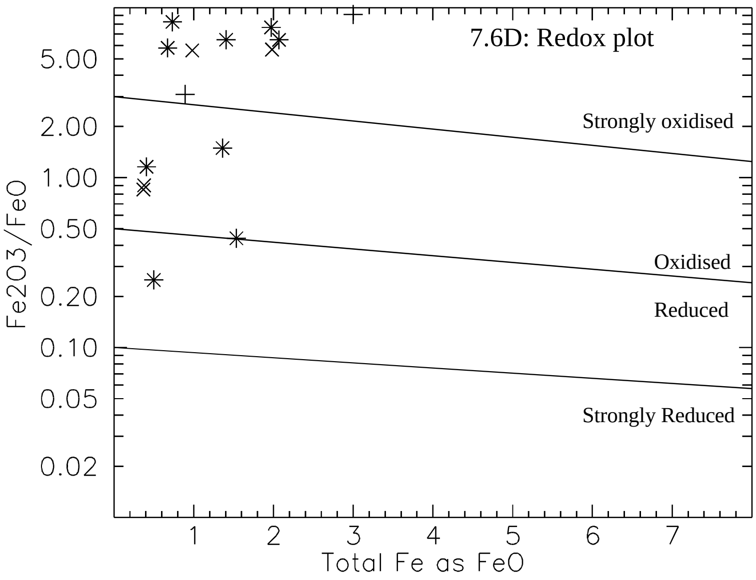

Fiery Creek Volcanic
Peters Creek Volcani
Weberra Granite

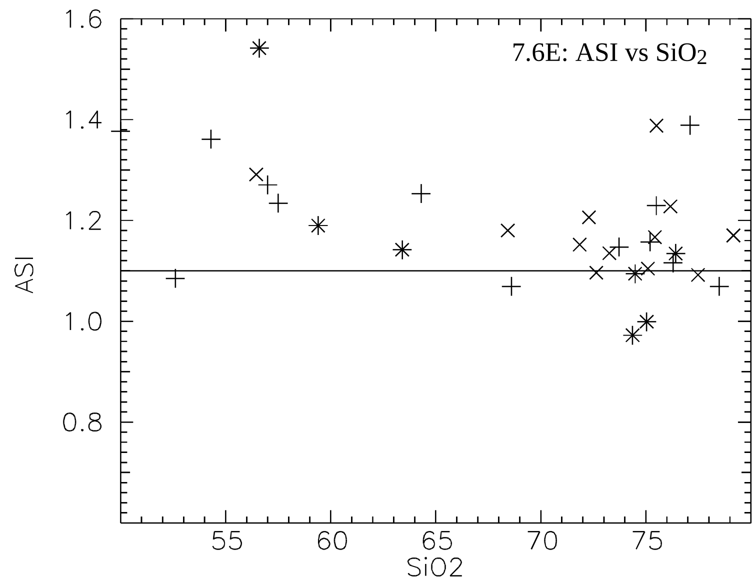

7.6B: Zr/Y vs Sr/Sr*
Sr/Sr*
3.5
3.0
2.5
2.0
1.5
1.0
0.5
10
20
30
Zr/Y

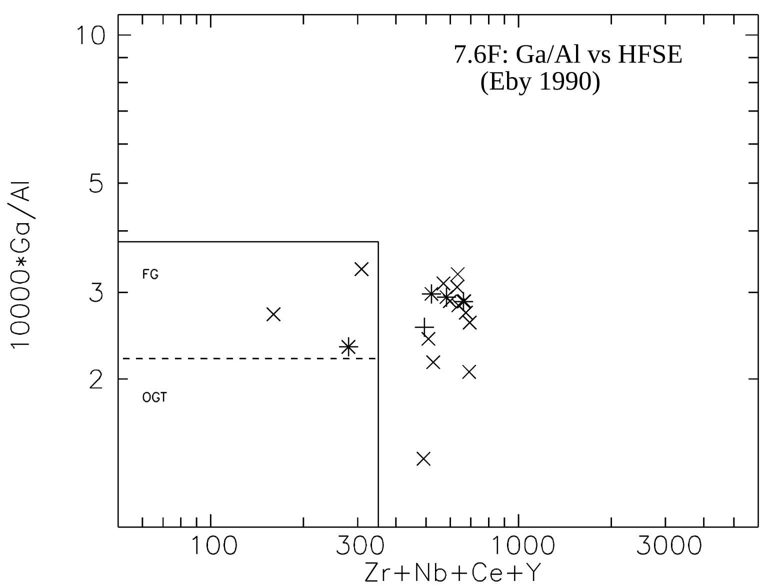

7.6C: Spidergram
SiO2 range: 68-75 wt/%
Rock / Primordial Mantle
500
200
100
50
20
10
5
2
Pb Rb Ba Th U K Nb La Ce Sr Nd P Zr Ti Y Na

**Legend**

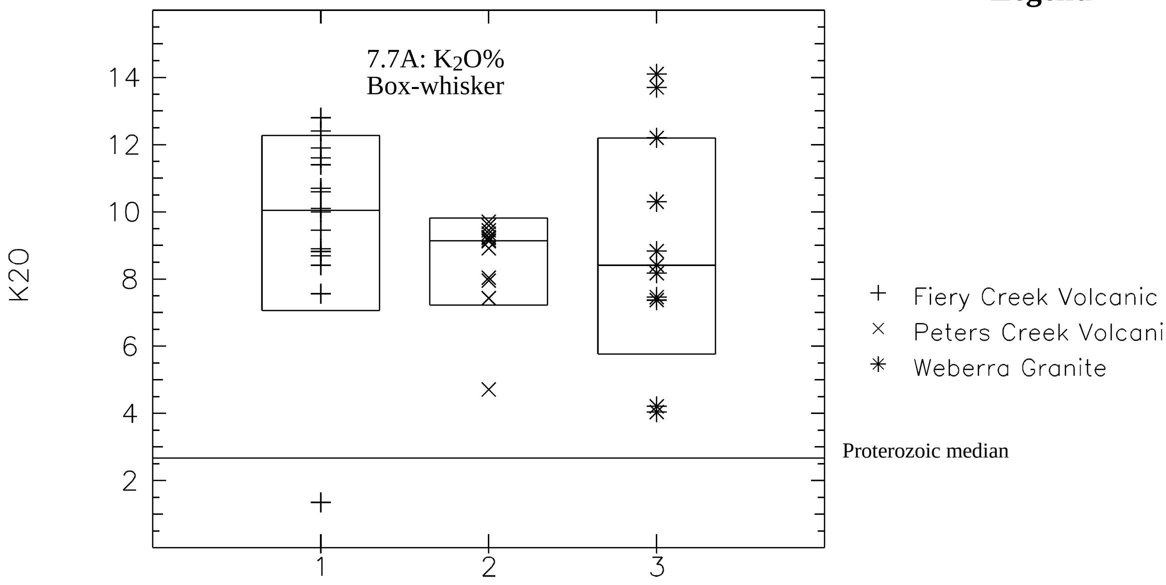
+ Fiery Creek Volcanic
× Peters Creek Volcani
* Weberra Granite

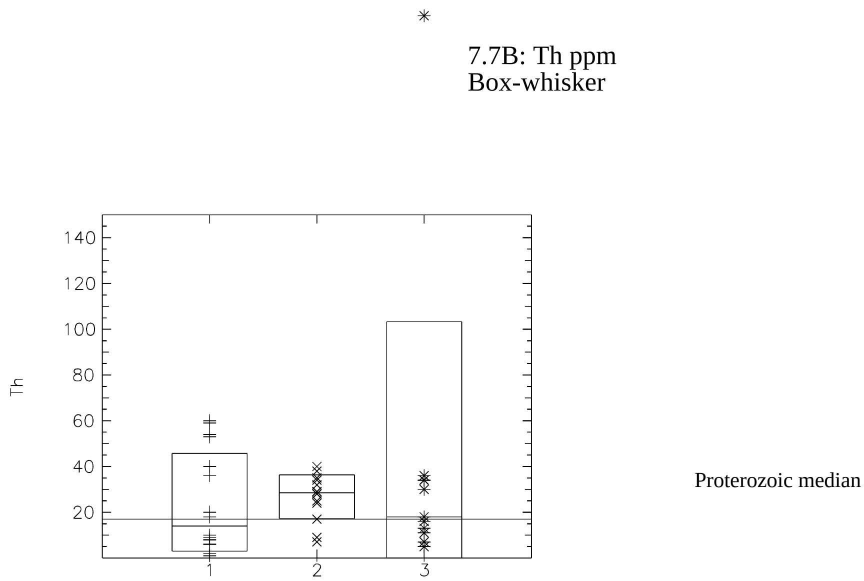


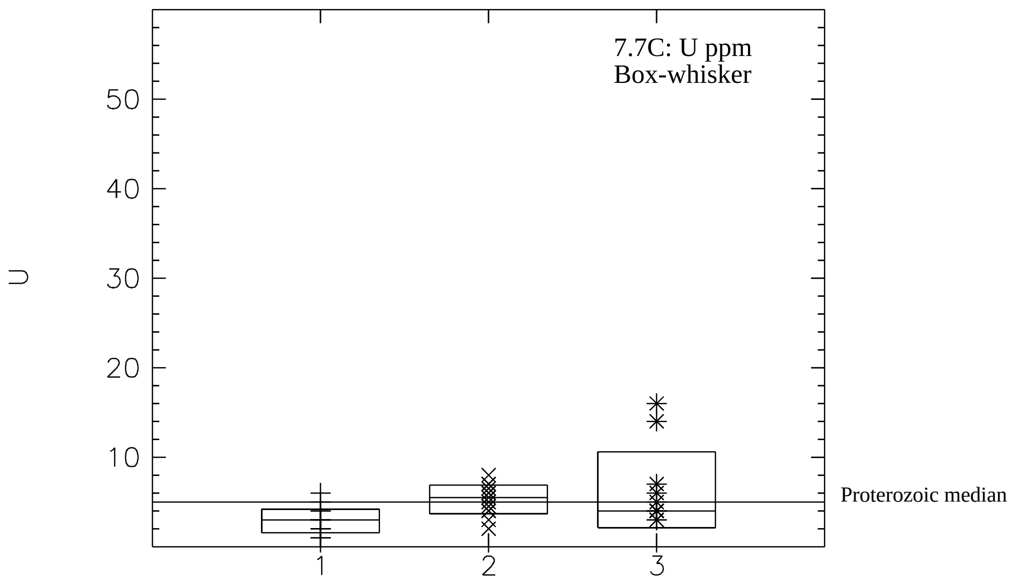



**Legend**


7.7A: $K_2O$%
Box-whisker
K2O
14
12
10
8
6
4
2
1
2
3
Fiery Creek Volcanic
Peters Creek Volcani
Weberra Granite
Proterozoic median


7.7B: Th ppm
Box-whisker
Th
140
120
100
80
60
40
20
1
2
3
Proterozoic median


7.7C: U ppm
Box-whisker
U
50
40
30
20
10
1
2
3
Proterozoic median

# Fiery Creek Volcanics

## MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 62.88 | 60.9 | 11.91 | 46.6 | 78.5 | 16 |
| TiO2 | 1.38 | 1.88 | 1.15 | 01 | 2.89 | 16 |
| Al2O3 | 13.72 | 13.85 | 2.32 | 10.5 | 17.5 | 16 |
| Fe2O3 | 7.28 | 3.7 | 6.09 | 0.68 | 17 | 16 |
| FeO | 0.67 | 0.3 | 1.59 | 0.04 | 6.61 | 16 |
| MnO | 0.01 | 0.01 | 0.01 | 01 | 0.05 | 16 |
| MgO | 1.37 | 0.17 | 4.41 | 0.02 | 17.9 | 16 |
| CaO | 0.41 | 0.09 | 0.46 | 0.01 | 1.23 | 16 |
| Na2O | 0.11 | 0.11 | 0.07 | 0.03 | 0.27 | 16 |
| K2O | 9.67 | 10.05 | 2.69 | 1.35 | 12.8 | 16 |
| P2O5 | 0.38 | 0.22 | 0.37 | 0.03 | 0.93 | 16 |
| H2O+ | 1.36 | 0.95 | 1.9 | 0.2 | 8.06 | 15 |
| H2O- | 0.19 | 0.15 | 0.12 | 0.08 | 0.54 | 15 |
| CO2 | 0.11 | 0.1 | 0.06 | 05 | 0.27 | 14 |
| LOI | 0.75 | 0.75 | - | 0.75 | 0.75 | 1 |
| Ba | 1068.31 | 780 | 1531.4 | 45 | 6600 | 16 |
| Li | 4 | 4 | - | 4 | 4 | 1 |
| Rb | 217.31 | 218.5 | 79.87 | 30 | 390 | 16 |
| Sr | 42.25 | 30 | 31.86 | 10 | 100 | 16 |
| Pb | 6.72 | 5 | 7.89 | | 35 | 16 |
| Th | 24.38 | 14 | 22.07 | | 60 | 16 |
| U | 2.88 | 3 | 1.36 | 1 | 6 | 16 |
| Zr | 292.63 | 275 | 160.02 | 70 | 660 | 16 |
| Nb | 36.38 | 34 | 12.88 | 20 | 75 | 16 |
| Y | 44.88 | 45 | 16.76 | 18 | 80 | 16 |
| La | 71.06 | 65 | 44.94 | | 160 | 16 |
| Ce | 151.88 | 125 | 106.05 | | 380 | 16 |
| Pr | 16 | 16 | - | 16 | 16 | 1 |
| Nd | 77.33 | 60 | 36.25 | 53 | 119 | 3 |
| Sc | 2 | 2 | - | 2 | 2 | 1 |
| V | 10 | 10 | - | 10 | 10 | 1 |
| Cr | 10.93 | | 10.08 | | 40 | 15 |
| Mn | 88 | 88 | - | 88 | 88 | 1 |
| Co | 10.18 | 5 | 13.43 | | 55 | 14 |
| Ni | 3 | 3 | - | 3 | 3 | 1 |
| Cu | 6 | 5 | 7.32 | 2 | 32 | 16 |
| Zn | 7.94 | 5 | 13.13 | | 55 | 16 |
| Sn | 5 | 6 | 1.73 | 3 | 6 | 3 |
| Mo | 1 | | - | | | 1 |
| Ga | 16 | 16 | - | 16 | 16 | 1 |
| As | 2.5 | 2.5 | - | 2.5 | 2.5 | 1 |
| S | 130 | 130 | - | 130 | 130 | 1 |
| C | - | - | - | - | - | - |
| F | - | - | - | - | - | - |
| Cl | - | - | - | - | - | - |
| Be | 3 | 3 | - | 3 | 3 | 1 |
| Ag | 2 | 2 | - | 2 | 2 | 1 |
| Bi | 1 | | - | | | 1 |
| Hf | 5 | 5 | - | 5 | 5 | 1 |
| Ta | 1 | | - | | | 1 |
| Cs | 1.5 | | - | | | 1 |
| Ge | 1.5 | 1.5 | - | 1.5 | 1.5 | 1 |
| Se | 0.5 | | - | | | 1 |

## Peters Creek Volcanics

## MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 73.81 | 75.26 | 5.99 | 56.45 | 80.46 | 14 |
| TiO2 | 0.6 | 0.39 | 0.63 | 0.25 | 2.57 | 14 |
| Al2O3 | 11.01 | 11.58 | 1.61 | 6.98 | 13.31 | 14 |
| Fe2O3 | 3.86 | 3.08 | 3.37 | 0.17 | 11.64 | 14 |
| FeO | 0.27 | 0.2 | 0.12 | 0.15 | 0.5 | 14 |
| MnO | 0.01 | 0.01 | 0.01 | 0.01 | 0.03 | 14 |
| MgO | 0.22 | 0.12 | 0.25 | 0.01 | 0.83 | 14 |
| CaO | 0.14 | 0.03 | 0.24 | 0.02 | 0.92 | 14 |
| Na2O | 0.15 | 0.13 | 0.07 | 0.06 | 0.3 | 14 |
| K2O | 8.52 | 9.14 | 1.34 | 4.71 | 9.7 | 14 |
| P2O5 | 0.12 | 0.04 | 0.21 | 0.01 | 0.79 | 14 |
| H2O+ | 0.71 | 0.72 | 0.46 | 0.22 | 1.82 | 14 |
| H2O- | 0.24 | 0.09 | 0.29 | 0.04 | 1.07 | 14 |
| CO2 | 0.04 | 0.04 | 0.01 | 0.03 | 0.05 | 4 |
| LOI | 0.05 | 0.01 | 0.04 | 13 | 0.1 | 4 |
| Ba | 1252.64 | 1260.5 | 347.5 | 489 | 1774 | 14 |
| Li | 5.86 | 5.5 | 3.21 | 3 | 15 | 14 |
| Rb | 168.29 | 165 | 42.2 | 83 | 254 | 14 |
| Sr | 30.93 | 24.5 | 20.51 | 8 | 79 | 14 |
| Pb | 8.5 | 8.5 | 4.22 | 4 | 17 | 14 |
| Th | 26.79 | 28.5 | 9.9 | 7 | 40 | 14 |
| U | 5.29 | 5.5 | 1.66 | 2 | 8 | 14 |
| Zr | 357.14 | 391 | 99.59 | 105 | 460 | 14 |
| Nb | 22.36 | 23 | 6.64 | 6 | 31 | 14 |
| Y | 64.86 | 68 | 13.08 | 26 | 79 | 14 |
| La | 56.36 | 61 | 23.62 | 16 | 85 | 14 |
| Ce | 112.21 | 124.5 | 44.56 | 23 | 166 | 14 |
| Pr | 12.93 | 14.5 | 4.84 | 3 | 20 | 14 |
| Nd | 51.57 | 57.5 | 18.69 | 14 | 79 | 14 |
| Sc | 8.86 | 5 | 8.1 | 3 | 27 | 14 |
| V | 47.5 | 12.5 | 80.65 | 4 | 281 | 14 |
| Cr | 9.57 | 4 | 15.79 | 1 | 58 | 14 |
| Mn | 72.75 | 57.5 | 51.66 | 29 | 147 | 4 |
| Co | - | - | - | - | - | - |
| Ni | 1.18 | 0.75 | 1.08 |  | 4 | 14 |
| Cu | 6.5 | 2.5 | 13.16 |  | 51 | 14 |
| Zn | 14.29 | 12.5 | 7.47 | 2 | 27 | 14 |
| Sn | 5.64 | 5 | 1.45 | 4 | 9 | 14 |
| Mo | 2.64 | 2 | 1.6 |  | 6 | 14 |
| Ga | 15.64 | 17 | 3.93 | 7 | 21 | 14 |
| As | 1.61 | 1.75 | 0.63 | 0.5 | 2.5 | 14 |
| S | 39.54 | 44 | 17.23 |  | 64 | 14 |
| C | 100 | Â | - | Â | Â | 1 |
| F | 288.89 | Â | 301.85 | Â | 1000 | 9 |
| Cl | 225.5 | 161 | 137.94 | 104 | 503 | 10 |
| Be | 1.71 | 1.5 | 0.83 | 1 | 3 | 14 |
| Ag | 1 | 1 | - | 1 | 1 | 4 |
| Bi | 0.86 |  | 0.23 |  | 1 | 14 |
| Hf | 10 | 11 | 3.26 | 3 | 13 | 14 |
| Ta | 1.57 |  | 0.76 |  | 3 | 14 |
| Cs | 5.54 | 4.75 | 3.89 |  | 11 | 12 |
| Ge | 1.79 | 1.5 | 1.27 | 0.5 | 4 | 14 |
| Se | 0.38 | 50 | 0.13 |  | 0.5 | 14 |

## Weberra Granite

### MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 61.74 | 59.4 | 11.52 | 47.3 | 76.42 | 11 |
| TiO2 | 1.53 | 1.23 | 1.29 | 0.2 | 3.12 | 11 |
| Al2O3 | 14.15 | 12.5 | 3.01 | 11.55 | 20.3 | 11 |
| Fe2O3 | 2.16 | 0.82 | 2.97 | 0.1 | 8.16 | 11 |
| FeO | 1.54 | 0.28 | 2.68 | 0.08 | 7.32 | 11 |
| MnO | 0.08 | 0.02 | 0.1 | 0.01 | 0.24 | 11 |
| MgO | 1.18 | 0.34 | 1.73 | 0.15 | 4.77 | 11 |
| CaO | 3.08 | 0.74 | 4.97 | 0.03 | 14.6 | 11 |
| Na2O | 0.55 | 0.06 | 0.79 | 0.01 | 2.22 | 11 |
| K2O | 8.98 | 8.41 | 3.37 | 4.04 | 14.1 | 11 |
| P2O5 | 0.3 | 0.12 | 0.34 | 01 | 0.79 | 11 |
| H2O+ | 1.51 | 0.74 | 1.59 | 0.45 | 4.96 | 11 |
| H2O- | 0.24 | 0.25 | 0.11 | 0.12 | 0.45 | 11 |
| CO2 | 2.21 | 0.18 | 3.93 | 0.06 | 11.7 | 11 |
| LOI | - | - | - | - | - | - |
| Ba | 644 | 566 | 402.54 | 150 | 1600 | 11 |
| Li | 3.5 | 3.5 | 0.58 | 3 | 4 | 4 |
| Rb | 208.09 | 189 | 92.01 | 100 | 420 | 11 |
| Sr | 45.64 | 46 | 19.6 | 11 | 75 | 11 |
| Pb | 31 | 20 | 26.54 | | 80 | 11 |
| Th | 40.09 | 18 | 66.29 | 5 | 237 | 11 |
| U | 6.36 | 4 | 4.46 | 3 | 16 | 11 |
| Zr | 288.73 | 300 | 139.4 | 75 | 580 | 11 |
| Nb | 29.82 | 24 | 12.54 | 14 | 48 | 11 |
| Y | 43.18 | 42 | 23.92 | 6 | 86 | 11 |
| La | 52.91 | 43 | 30.97 | 20 | 122 | 11 |
| Ce | 106.27 | 100 | 51.13 | 40 | 201 | 11 |
| Pr | - | - | - | - | - | - |
| Nd | 61.25 | 60 | 26.89 | 30 | 95 | 4 |
| Sc | 1 | | - | | | 4 |
| V | 1.75 | 1.5 | 0.96 | | 3 | 4 |
| Cr | 10.91 | 10 | 9.87 | | 30 | 11 |
| Mn | - | - | - | - | - | - |
| Co | 54.68 | 5 | 93.41 | | 310 | 11 |
| Ni | 3.5 | 3 | 1.73 | 2 | 6 | 4 |
| Cu | 2302 | 38 | 5574.33 | 4 | 18000 | 11 |
| Zn | 61.64 | 18 | 116.69 | 2 | 390 | 11 |
| Sn | 7.25 | 7 | 2.63 | 5 | 10 | 4 |
| Mo | - | - | - | - | - | - |
| Ga | 18 | 19 | 2 | 15 | 19 | 4 |
| As | 1 | 1 | - | 1 | 1 | 4 |
| S | - | - | - | - | - | - |
| C | - | - | - | - | - | - |
| F | 466.67 | 400 | 115.47 | 400 | 600 | 3 |
| Cl | - | - | - | - | - | - |
| Be | - | - | - | - | - | - |
| Ag | - | - | - | - | - | - |
| Bi | - | - | - | - | - | - |
| Hf | - | - | - | - | - | - |
| Ta | - | - | - | - | - | - |
| Cs | - | - | - | - | - | - |
| Ge | - | - | - | - | - | - |
| Se | - | - | - | - | - | - |

# 8 SYBELLA SUITE

## 8.1 Timing

1670 Ma

## 8.2 Individual Ages

**Primary Ages:**

| | |
|---|---|
| 1. Kitty Plain microgranite [1,2] | 1780 ± 20 or 1670 Ma with inheritance of 1900 Ma U-Pb |
| 2. Carters Bore Rhyolite [1,2] | 1678 ± 1 Ma, U-Pb |
| 3. Carters Bore Rhyolite [1] | 1678 ± 2 Ma, SHRIMP |
| 4. Keithys Granite [1,2] | 1671 ± 8 Ma, U- Pb |
| 5. Keithys Granite [1,2] | 1668 ± 23 Ma, U- Pb |
| 6. Queen Elizabeth Granite [1,3] | 1660 ± 5 Ma, SHRIMP |
| 7. Queen Elizabeth Granite [1,3] | 1655 ± 4 Ma, SHRIMP |

Sources: [1] OZCHRON, [2] Page and Bell (1986), [3] Connors and Page (1995). Note that the dated sample of the Kitty Plain microgranite is atypical of the bulk of this pluton and is possibly from a small localised patch of S-type granite.

## 8.3 Regional Setting

The Sybella Suite is a major body of fluorine-enriched, hornblende-bearing I-(granodiorite) types which were emplaced into the Western Fold Belt at ~ 1670 Ma. The suite is fairly felsic and most samples have > 68 wt.% $SiO_2$. Most of the Suite is intrusive, but we are placing the Carters Bore Rhyolite within this suite. Although highly altered, the Carters Bore Rhyolite occurs only adjacent to the Sybella Suite, and does have some chemical similarities. Coeval with these granites are a suite of tholeiitic dolerite intrusions (Ellis and Wyborn 1984) which form extensive net-veined complexes (Blake 1981). The suite predates the formation of the Mount Isa Group (Wyborn *et al.* 1988; Connors and Page 1995) and also appears to be coeval with minor 'felsic volcanics' in Gandry Dam gneiss of the Maronan Supergroup in the far eastern part of the Mount Isa Inlier. Within the vicinity of the suite are some small biotite-rich S-types and older I-types which will not be considered further as they are volumetrically insignificant and are obviously not comagmatic.

The whole Sybella Suite has been affected by the major $D_2$ regional metamorphic event, and the metamorphic grade in the Mount Isa 1:100 000 sheet area ranges from lower greenschist in the northwest to uppermost amphibolite in the southeast. Near Mica Creek, the granite is locally migmatised and pegmatitic segregations developed parallel to the main $D_2$ foliation.

## 8.4 Summary

Although chemically the granite clearly shows evidence of fractionation, and it could be loosely classed as an oxidised fractionated metaluminous granite, there are several factors which downgrade its mineral potential. These are:

1) high F content, and high Zr, Nb, La, and Ce throughout all phases;
2) limited silica range over which the granite has crystallised; and
3) lack of suitable host rocks.

Fluorite-rich granites of this type are not noted for mineralisation, and there is very little mineralisation which can unequivocally be assigned to magmatic processes associated with this suite. The best economic potential is in their high U, which was remobilised during metamorphism. The pegmatitic segregations which were probably generated during the $D_2$ metamorphism are anomalous in Be, Th and Sn.

Due to the high content of heat-producing elements (U, Th, K) in this suite, there is also a possibility of the resultant high heat production causing secondary low-T fluid circulation. This process has been considered by Solomon and Heinrich (1992) to be an ingredient in forming the nearby Mount Isa Pb-Zn deposit. However, it is only required if it is assumed that the ore fluids carrying the Pb and Zn are reduced. Granites similar to this type are associated with Mo deposits such as Climax. If the interpretation of the emplacement of the members of this suite as sheets at considerable depth is correct, then this may also downgrade the potential for this style of mineralisation as the plutons are too small to generate sufficient late-stage fluids, and the depth of emplacement also significantly reduces the ability to exsolve a late fluid phase.

## 8.5 Potential

The Sybella Suite is not considered to have any significant potential for mineralisation. Some small Sn and Be pegmatites that occur adjacent to the Queen Elizabeth Granite could be magmatic, however, it is more probable that they were generated during the ~1530 Ma metamorphic event, particularly as these pegmatites are parallel to the main $D_2$ foliation and also occur within the envelope of highest metamorphic grade.

| | |
|---|---|
| **Cu:** | **None** |
| **Au:** | **None** |
| **Pb/Zn:** | **None** |
| **Sn:** | **Low** |
| **Mo/W:** | **Low** |
| **Confidence level:** | **321** |

## 8.6 Descriptive Data

***Location:*** Western part of the Mount Isa Inlier.

***Dimensions and area:*** Elongate, northerly trending belt 195 km by 36 km. Total outcrop area is 1200 $km^2$.

## 8.7 Intrusives

***Component plutons:*** The Sybella Suite includes: the Annable Granite, Briar Granite, Dingo Granite, Easter Egg Granite, Garden Creek Porphyry, Gidya Granite, Guns Knob Granite, Hay Mill Granite, Kahko Granodiorite, Keithys Granite, most of the Kitty Plain microgranite, Queen Elizabeth Granite, Steeles Granite, Widgewarra Granite and Wonomo Granite. The Kahko Granodiorite comprises grey, foliated to gneissic, medium- to coarse-grained biotite-hornblende granodiorite and minor diorite, contains xenoliths of granodiorite, amphibolite and quartzite and may not all be part of the Sybella Suite. Joplin and Walker (1961) suggested that parts the Sybella Suite in this area have more affinities with the Kalkadoon Granodiorite in the central Mount Isa Inlier. There is insufficient age data to validate this hypothesis, however, some samples from the Kahko pluton plot on a distinctly different geochemical trend.

***Form:*** The suite consists of a series of elongate plutons, some of which are narrow and ‘dyke-like’ (especially the Annable Granite and Garden Creek Porphyry). In the third dimension some intrusions are relatively thin, e.g., the Queen Elizabeth pluton has been modelled to be <2 km thick (Leaman *pers comm*. 1995), suggesting that it may have been emplaced as sheets at deeper crustal levels. This thin shape has recently been verified by the Mount Isa seismic survey (Goleby *et al.* 1996). In contrast, the Kitty Plain microgranite west of Kitty Plains in the far northeast of the Sybella Suite may be substantially thicker (Leaman *pers comm.* 1995).

***Metamorphism and Deformation:*** The Sybella Suite is mostly foliated, and has been metamorphosed to upper amphibolite facies; the eastern edge of the Queen Elizabeth pluton has become a granite 'migmatite'. Pegmatites in the Mica Creek area (Mount Isa 1:100 000 Sheet area) are believed to be formed by metamorphism. *Specifically:* Briar Granite, Dingo Granite - foliated especially near the margins; Garden Creek Porphyry - massive to locally sheared; Guns Knob Granite - strongly foliated and fine-grained within 1-2 km of the contact, and more massive and coarser toward its centre; Kahko Granodiorite - two foliations are preserved, one parallel to the regional foliation (N-S), and one defined by quartz dykes (NE); Kitty Plain microgranite - massive to weakly foliated; Queen Elizabeth Granite - strongly foliated throughout and metamorphosed to upper amphibolite facies: mylonitised at the contact with Mount Guide Quartzite in the northwest.

***Dominant intrusive rock types:*** The suite is characterised by four main mineralogical types: 1) megacrystic K-feldspar granite and leucogranite which are characterised by strong joint patterns; 2) K-feldspar-bearing granite which is characterised by *ß*-quartz phenocrysts; 3) aplite; and 4) pegmatite. The dominant intrusive rock types are porphyritic biotite granite, biotite leucogranite, biotite-muscovite leucogranite, muscovite leucogranite, gneissic biotite-hornblende granodiorite, gneissic biotite-granite and rare quartz diorite. *Specifically:* Briar Granite - leucocratic (biotite-) muscovite granite, porphyritic biotite granite; Dingo Granite - porphyritic biotite granite; Easter Egg Granite - medium to coarse-grained ocellar quartz diorite, diorite, granodiorite and granite; Garden Creek Porphyry - porphyritic microgranite; Guns Knob Granite - variably porphyritic medium to coarse-grained biotite granite; Hay Mill Granite - variably porphyritic medium to coarse-grained biotite granite; Kahko Granodiorite - foliated to gneissic medium- to coarse-grained biotite-hornblende granodiorite and minor diorite, extensively intruded by porphyritic biotite granite, leucogranite, and tourmaline-bearing pegmatite; Keithys Granite - medium- to coarse-grained, slightly porphyritic biotite granite which grades into microgranite at its margins; Kitty Plain microgranite - slightly porphyritic, fine to medium-grained alkali-feldspar granite to granodiorite; Queen Elizabeth Granite - mostly variably porphyritic medium to coarse-grained biotite granite. The northeastern margin consists of a distinctive highly leucocratic phase and there are also minor magnetite-rich phases of granite and gneiss in contact with Eastern Creek Volcanics in the north; Steeles Granite - composite pluton containing a younger phase of porphyritic biotite granite intruding an older strongly foliated and gneissic granodiorite to diorite phase; Wonomo Granite - composite pluton with a strongly foliated to gneissic older phase in the south and younger biotite granite in the north.

***Colour:*** Grey to pink to red. *Specifically*: Briar Granite - pink or grey; Dingo Granite - pink or grey; Garden Creek Porphyry - pink to grey; Guns Knob Granite - grey to pink; Hay Mill Granite - pink; Kahko Granodiorite - grey; Keithys Granite - pink to grey; Kitty Plain microgranite - mainly pink; Queen Elizabeth Granite - pink to red.

***Veins, Pegmatites, Aplites, Greisens:*** Ubiquitous cross-cutting aplite veins and pegmatitic segregations occur throughout the Sybella Suite, and tend to be concentrated in the more felsic phases. Be and Sn-bearing pegmatites in the Mica Creek area are probably developed as a result of metamorphism. Paterson and Poole (1981) noted that the Sn-bearing pegmatites concentrate near the northeastern margin of the Queen Elizabeth pluton. In this area the local granite melted during the main $D_2$ metamorphism and produced major pegmatitic segregations. *Specifically:* Briar Granite - the leucocratic muscovite granite phase is intruded by a tourmaline-bearing muscovite pegmatite, and pegmatitic segregations are common; Garden Creek Porphyry - quartz-veined; Keithys Granite - intruded by aplite and pegmatite; Kitty Plain microgranite - intruded by several small dykes of sodic aplite, albitite, quartz-tourmaline rock and pegmatite; Queen Elizabeth Granite - intruded by the Mica Creek pegmatites on the northern end of the pluton which contain microcline, quartz, albite, muscovite, and minor beryl, tourmaline, garnet, tantalite-columbite minerals, cassiterite, monazite, and fluorite; Widgewarra Granite - beryl occurs in pegmatite at the Big River prospect in the south of the pluton and also on the northern margin.

***Distinctive mineralogical characteristics:*** The suite has been extensively metamorphosed and heavily recrystallised making determination of the original minerals very difficult in some plutons. Rapakivi textures are common (i.e., albite rims around K-feldspars), and fluorite is ubiquitous throughout. Appears to be dominantly a megacrystic K-feldspar, plagioclase, biotite ± hornblende suite. Titanite, zircon, allanite, apatite and opaque oxide occur as accessories. Tourmaline is locally abundant in aplite and pegmatite. *Specifically:* Briar Granite - rapakivi textures are locally common, and feldspar phenocrysts common, some up to 15 cm, hornblende is usually present, although there may be some muscovite: accessories include titanite, fluorite, zircon, allanite, apatite and opaque oxide; Dingo Granite - contains sparse to abundant feldspar phenocrysts up to 8 cm long, rapakivi textures are locally common, accessory minerals include titanite, allanite, fluorite, apatite, zircon, opaque oxide; Easter Egg Granite - quartz ocelli and rapakivi textures present; Garden Creek Porphyry - pink microcline phenocrysts, accessory biotite, apatite, opaques and zircon; Keithys Granite - phenocrysts of K-feldspar and rounded ß-quartz, abundant fluorite, well developed rapakivi textures; Kitty Plain microgranite - hornblende-poor, contains more K-feldspar and less ferromagnesian minerals than most Sybella Suite phases, granophyric intergrowths common; Queen Elizabeth Granite - main phase has hornblende, biotite, K-feldspar megacrysts, plagioclase, quartz: fluorite is ubiquitous throughout. Rapakivi textures are common; Steeles Granite - pale pink feldspar phenocrysts up to 8 cm long, accessory minerals include biotite, hornblende, titanite, allanite, zircon, apatite, opaque oxides rimmed by titanite. Rapakivi textures are locally common.

***Xenoliths:*** Xenoliths of mafic inclusions have been noted, but these appear to be associated with net-veined complexes. *Specifically:* Kahko Granodiorite - contains xenoliths of granodiorite, amphibolite and quartzite; Kitty Plain microgranite - locally abundant metasedimentary and mafic xenoliths, as well as mafic 'pillows'/enclaves.

***Breccias:*** Not noted in the literature.

***Alteration in the granite:*** Some alteration is locally pervasive but may be a result of subsequent metamorphism.

## 8.8 Extrusives

The Carters Bore Rhyolite is believed to be a comagmatic extrusive. Although previously correlated with the Fiery Creek Volcanics, recent dating confirms that the two are separate events in agreement with the original concept of Wilson *et al.* (1979) that the Carters Bore Rhyolite is comagmatic with the Sybella Suite. The Carters Bore Rhyolite consists of porphyritic rhyolite, rhyolitic tuff and ignimbrite; with minor schistose quartz porphyry dykes, amygdaloidal andesite, and altered basalt. It is strongly foliated and commonly silicified. It contains accessory hematite, zircon, apatite, rutile and tourmaline.

## 8.9 Country Rock

***Contact metamorphism:*** Contact aureole generally less than 5 m wide, but difficult to tell as the whole suite has been affected by later high-grade regional metamorphism.

***Reaction with country rock:*** Adjacent country rock is extensively intruded by tourmaline - muscovite - pink feldspar pegmatite veins. Tourmaline in sediments adjacent to granite contacts is due to boron metasomatism. However whether this is a magmatic or metamorphic effect is difficult to tell. *Specifically*: Kitty Plain microgranite - net-veined complexes in Kittys Plain area between Kittys Plain Microgranite, Kittys Plain Dolerite and Eastern Creek Volcanics are partially due to hybridization but may also involve magma mixing. The contact zone is magnetic and contains mafic xenoliths. The country rocks on the NE margin are greisenised and large dykes of mica pegmatite cut the granite in this area.

***Units the granite intrudes:*** Intrudes Myally Subgroup, Eastern Creek Volcanics, Mount Guide Quartzite, Jayah Creek Metabasalt, Oroopo Metabasalt, Saint Ronans Metamorphics, Kallala Quartzite, and Sulieman Gneiss.

***Dominant rock types:*** Basalt, quartzite, some feldspathic sediments and shales.

***Potential hosts:*** There are no abundant strong reductants in the hosts, and no evidence of an older metasomatic alteration which could have produced favourable magnetite-rich host rocks.

## 8.10 Mineralisation

There are minor Sn, Be and U deposits near this granite system which are more likely to be related to later regional metamorphism rather than to magmatic processes, particularly as they occur in the area of highest metamorphic grade. Paterson and Poole (1981) and Wyborn (1987) suggested that the U in these deposits has been mobilised from the granite by later deformation and metamorphism. In the northwest, small Au deposits occur in the May Downs Gold Field, concentrated along the May Downs Fault. Most are hosted by sediments of the McNamara Group and as field evidence (Hill *et al.* 1975; Wilson *et al.* 1979) and recent dating (Connors and Page 1995) suggest that the Sybella Suite predates this group, they are not considered to be related to the granite.

## 8.11 Geochemical Data

***Data source:*** The samples come from three sources:
1) age determination samples collected by Page (1978), Page and Bell (1986) and Connors and Page (1995). As most of these samples were collected for Rb-Sr dating, the samples are heavily biased towards more felsic end members or aplite. Most of these samples are strongly deformed and/or very altered;
2) collections made by Mock (1978) and Bultitude (1982) as part of 1:100 000 scale geological mapping; and
3) collections made by Wyborn from 1983-1984 (Wyborn *et al.* 1988). Unfortunately these samples are biased heavily towards the Queen Elizabeth pluton.

***Data quality:*** Good. All of the samples were analysed within the one laboratory at AGSO.

***Are the data representative?*** Not really. Too much of the collection is biased towards more felsic end members as it was collected for Rb-Sr dating.

***Are the data adequate?*** Barely. It is possible to classify this granite, but not to fully understand the controls on all of the chemical variations.

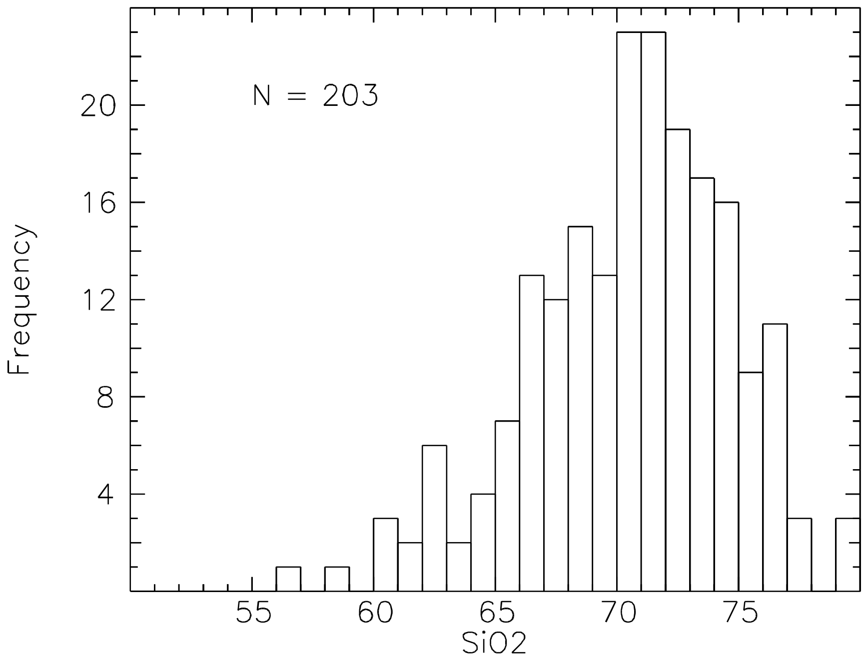



Figure 8.1. Frequency histogram of $SiO_2$ values for the Sybella Suite

***$SiO_2$ range (Fig.8.1):*** The range is relatively restricted and most samples are more felsic than 68%. This is reflected in the dominance of compositions from monzogranite to granite.

***Alteration (Fig. 8.2):***

- ***$SiO_2$:*** High values may reflect silicification, although some samples with >80 wt.% are aplites.
- ***$K_2O/Na_2O$:*** The most extreme examples in this plot are the Carters Bore Rhyolite and the aplite dykes. These samples can have either extremely high $K_2O$ and no $Na_2O$ (all samples of the Carters Bore Rhyolite and some aplites), whilst others have high $Na_2O$ and low $K_2O$ (some aplites and pegmatites and some granites).
- ***Th/U:*** The Th/U values are somewhat high, and extreme in some altered samples. This suggests loss of U during metamorphism, and the small U deposits on the northeastern corner of the Mount Isa 1:100 000 Sheet area may be related to this mobilisation (Paterson and Poole 1981; Wyborn 1987).
- ***$Fe_2O_3/(FeO+Fe_2O_3)$:*** This plot shows extensive oxidation of some samples (especially the Carters Bore Rhyolite), whilst a few, mostly from the Keithys Granite and the Steeles Granite, are relatively reduced.

***Fractionation Plots (Fig. 8.3):***

- ***Rb:*** Samples show exponentially increasing Rb with increasing $SiO_2$. The Na-enriched aplites are depleted in Rb.
- ***U:*** Samples show exponentially increasing U with increasing $SiO_2$: the late aplites have the highest values.
- ***Y:*** Some plutons show increasing Y with increasing $SiO_2$. Samples of the main phase of the highly metamorphosed Queen Elizabeth Granite and the Keithys Granite are high throughout, whilst some samples of the Kahko Granodiorite are anomalously low.
- ***$P_2O_5$:*** Samples show decreasing $P_2O_5$ with increasing $SiO_2$. Samples of the main phase of the highly metamorphosed Queen Elizabeth Granite plot on a much lower trend.
- ***Th:*** Samples show exponentially increasing Th with increasing $SiO_2$.
- ***K/Rb:*** Samples show a general decrease in K/Rb with increasing $SiO_2$.
- ***Rb-Ba-Sr:*** The samples range from normal granite to strongly differentiated granite, with a considerable number plotting in the strongly differentiated field.
- ***Sr:*** Values of Sr are low (all but one below 300 ppm) and decrease with increasing $SiO_2$. Some samples of the Kahko Granodiorite are anomalously high and are similar to values of the Kalkadoon Supersuite. This potential correlation was predicted from petrographic observations made in 1961 (Joplin and Walker 1961).
- ***Rb/Sr:*** Samples show exponentially increasing Rb/Sr with increasing $SiO_2$.

- ***Ba:*** Values of Ba are high (>2000 ppm) and decrease with increasing $SiO_2$. Samples of the main phase of the highly metamorphosed Queen Elizabeth Granite and the Keithys Granite appear to plot on a separate and higher trend from the other plutons.
- ***F:*** F is high throughout most of the five granites analysed and shows increasing values with increasing $SiO_2$, with values up to 1.1 wt.% in a pegmatite (off graph scale).

***Metals (Fig. 8.4):***

- ***Cu:*** Most values are low, <30 ppm.
- ***Pb:*** Values are moderate. The Carters Bore Rhyolite samples are anomalously low and may reflect alteration.
- ***Zn:*** Values decrease with increasing $SiO_2$. Samples of the main phase of the highly metamorphosed Queen Elizabeth Granite and the Keithys Granite appear to plot on a separate and higher trend from the other plutons.
- ***Sn:*** Most values are in the low range for Sn.

***High field strength elements (Fig. 8.5):***

- ***Zr:*** Values are high and up to 800 ppm, with the highest values being in the main phase of the highly metamorphosed Queen Elizabeth Granite.
- ***Nb:*** Values are high and up to 80 ppm: highest values are in both phases of the Queen Elizabeth Granite, the Keithys Granite, pegmatite and aplite.
- ***Ce:*** Most values are very high for Proterozoic granites and range up to 600 ppm: highest values are in the main phase of the Queen Elizabeth Granite, the Gidya Granite and aplite.

***Classification (Fig. 8.6):***

- ***The $CaO/Na_2O/K_2O$ plot of White, quoted in Sheraton and Simons (1992):*** Most granites plot in the monzogranite to granite field reflecting the high $SiO_2$ range of this suite. The sodic-altered samples plot in the trondhjemite field.
- ***Zr/Y vs Sr/Sr*:*** All samples plot below 1 signifying that all samples are Sr-depleted, Y-non depleted.
- ***Spidergram:*** The selected spidergrams for this suite are Sr-depleted, Y-non depleted.
- ***Oxidation plot of Champion and Heinemann (1994):*** Most samples are oxidised with some samples of the altered Carters Bore Rhyolite and some of the aplite samples being strongly oxidised. Some samples of the Steeles and Keithys Granites are reduced.
- ***ASI:*** The majority of samples have an ASI of <1.1 and are metaluminous to weakly peraluminous. A group of aplites has an interesting, separate trend.
- ***A-type plot of Eby (1990):*** The Sybella Suite plots clearly in the A-type field as defined for Palaeozoic granites.

***Granite type (Chappell and White 1974; Chappell and Stephens 1988):*** I-granodiorite, non-restite.

***Australian Proterozoic granite type:*** Type example of the Sybella type.

## 8.12 Geophysical Signature

***Radiometrics (Fig. 8.7):*** The majority of samples plot above the Proterozoic median for K and Th. Some plutons, particularly those that have been metamorphosed to upper amphibolite facies (the main more mafic phase of the Queen Elizabeth Granite and the Widgewarra Granite) appear to have lost U. These regions would appear yellowish on a RGB image.

***Gravity:*** Most of the plutons are coincident with regional gravity lows.

***Magnetics:*** Most of the plutons are coincident with regional magnetic lows.

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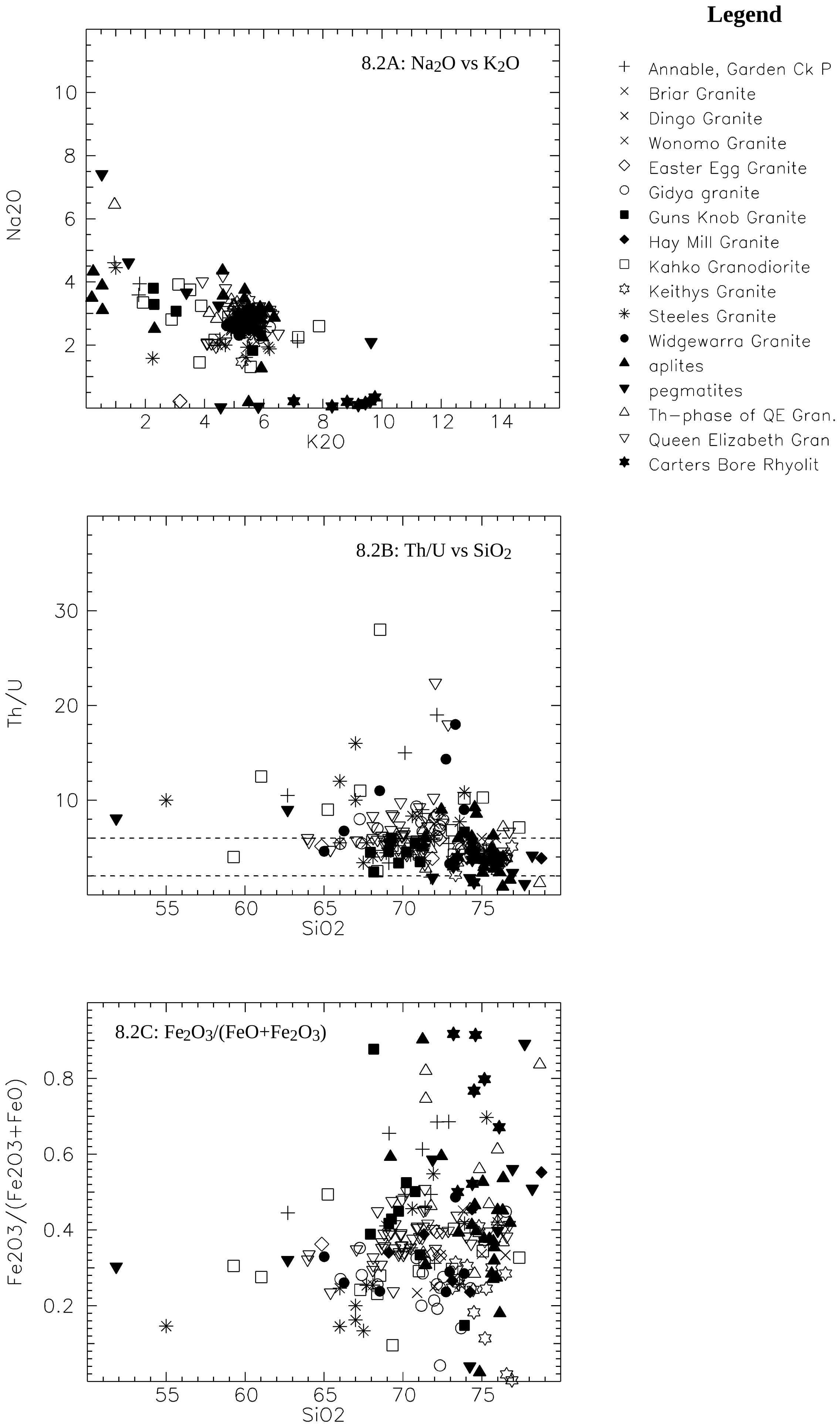
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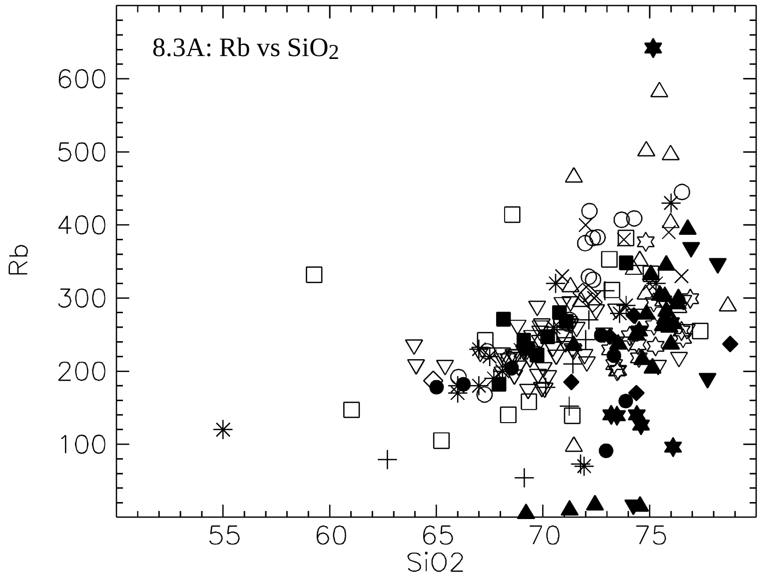
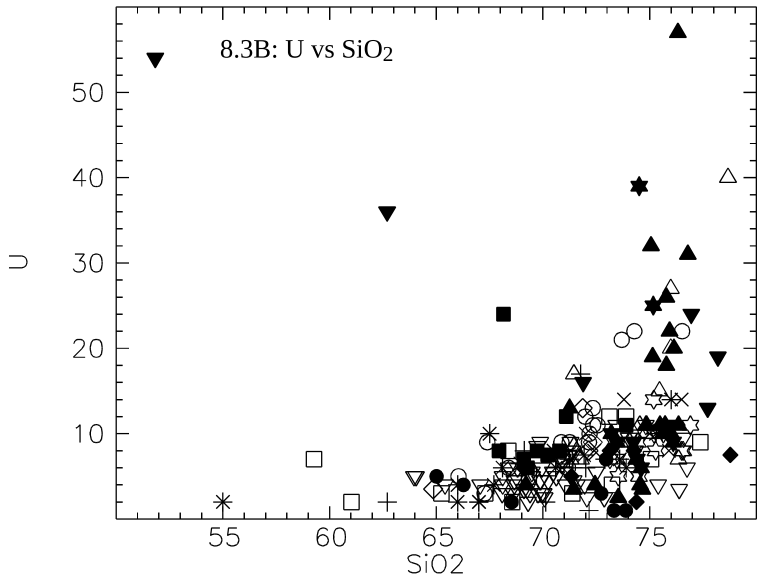
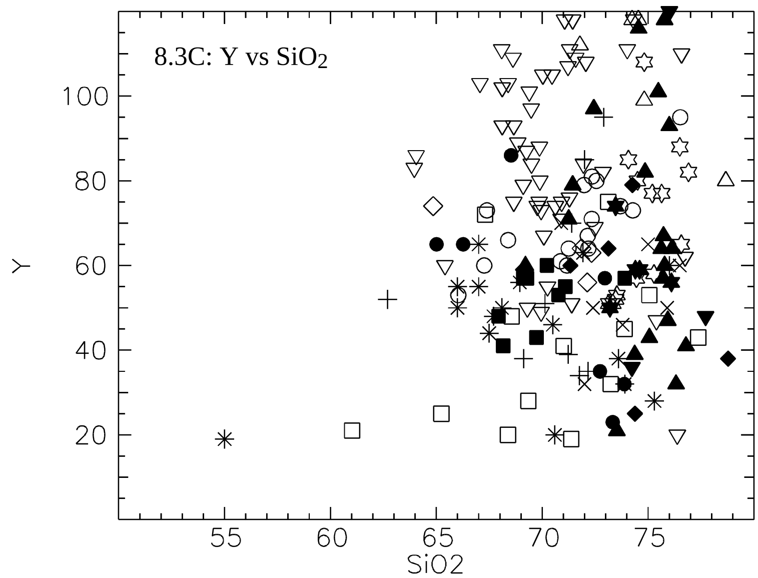
× Briar Granite
× Dingo Granite
× Wonomo Granite
◇ Easter Egg Granite
○ Gidya granite
■ Guns Knob Granite
◆ Hay Mill Granite
□ Kahko Granodiorite
Keithys Granite
Steeles Granite
● Widgewarra Granite
▲ aplites
▼ pegmatites
△ Th−phase of QE Gran.
▽ Queen Elizabeth Gran
Carters Bore Rhyolit
8.2A: $Na_2O$ vs $K_2O$
Na2O
K2O
2
4
6
8
10
12
14
8.2B: Th/U vs $SiO_2$
Th/U
SiO2
10
20
30
55
60
65
70
75
8.2C: $Fe_2O_3/(FeO+Fe_2O_3)$
Fe2O3/(Fe2O3+FeO)
0.2
0.4
0.6
0.8

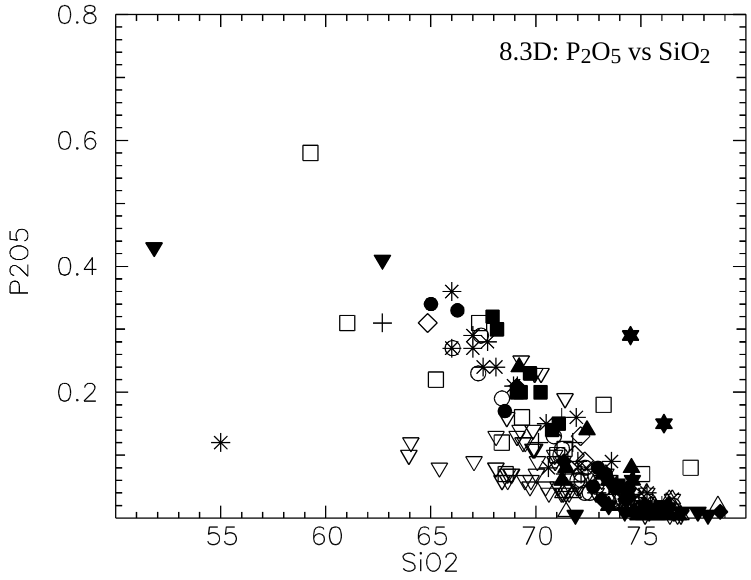



**Legend**

- + Annable, Garden Ck P
- × Briar Granite
- × Dingo Granite
- × Wonomo Granite
- ◇ Easter Egg Granite
- ○ Gidya granite
- ■ Guns Knob Granite
- ◆ Hay Mill Granite
- □ Kahko Granodiorite
- ✡ Keithys Granite
- ✳ Steeles Granite
- ● Widgewarra Granite
- ▲ aplites
- ▼ pegmatites
- △ Th−phase of QE Gran.
- ▽ Queen Elizabeth Gran
- ✶ Carters Bore Rhyolit



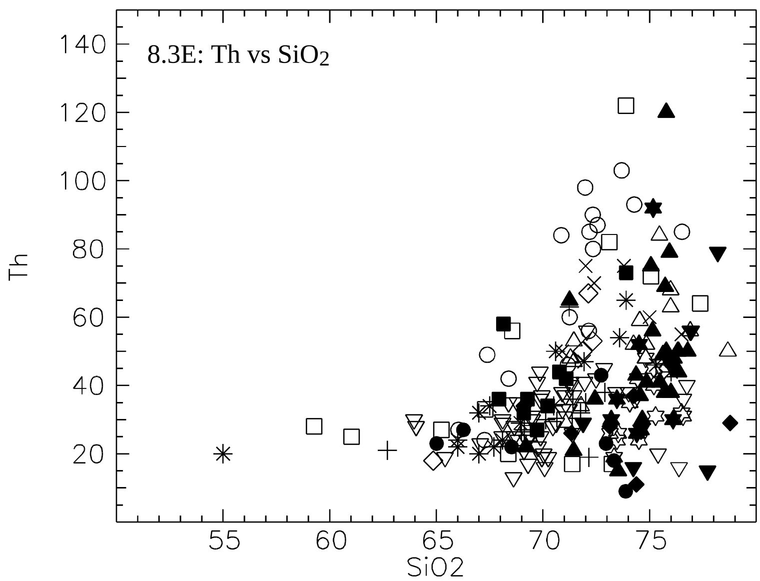





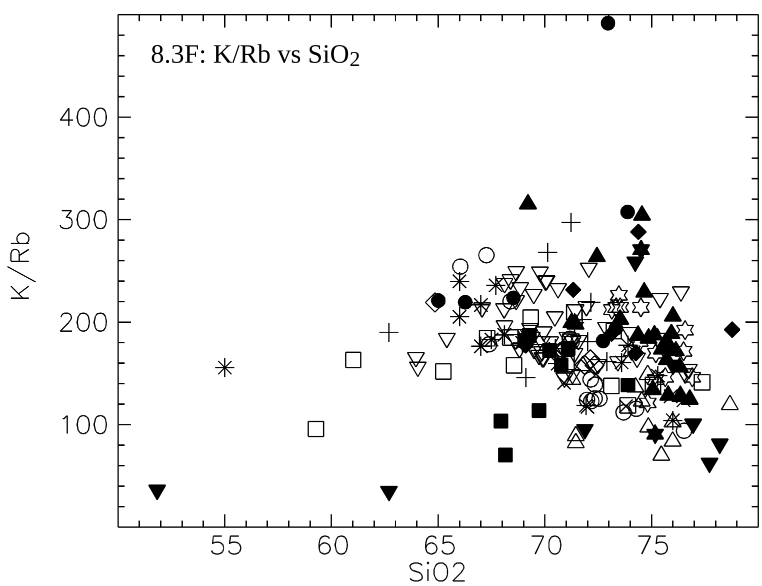

8.3D: $P_2O_5$ vs $SiO_2$

**Legend**

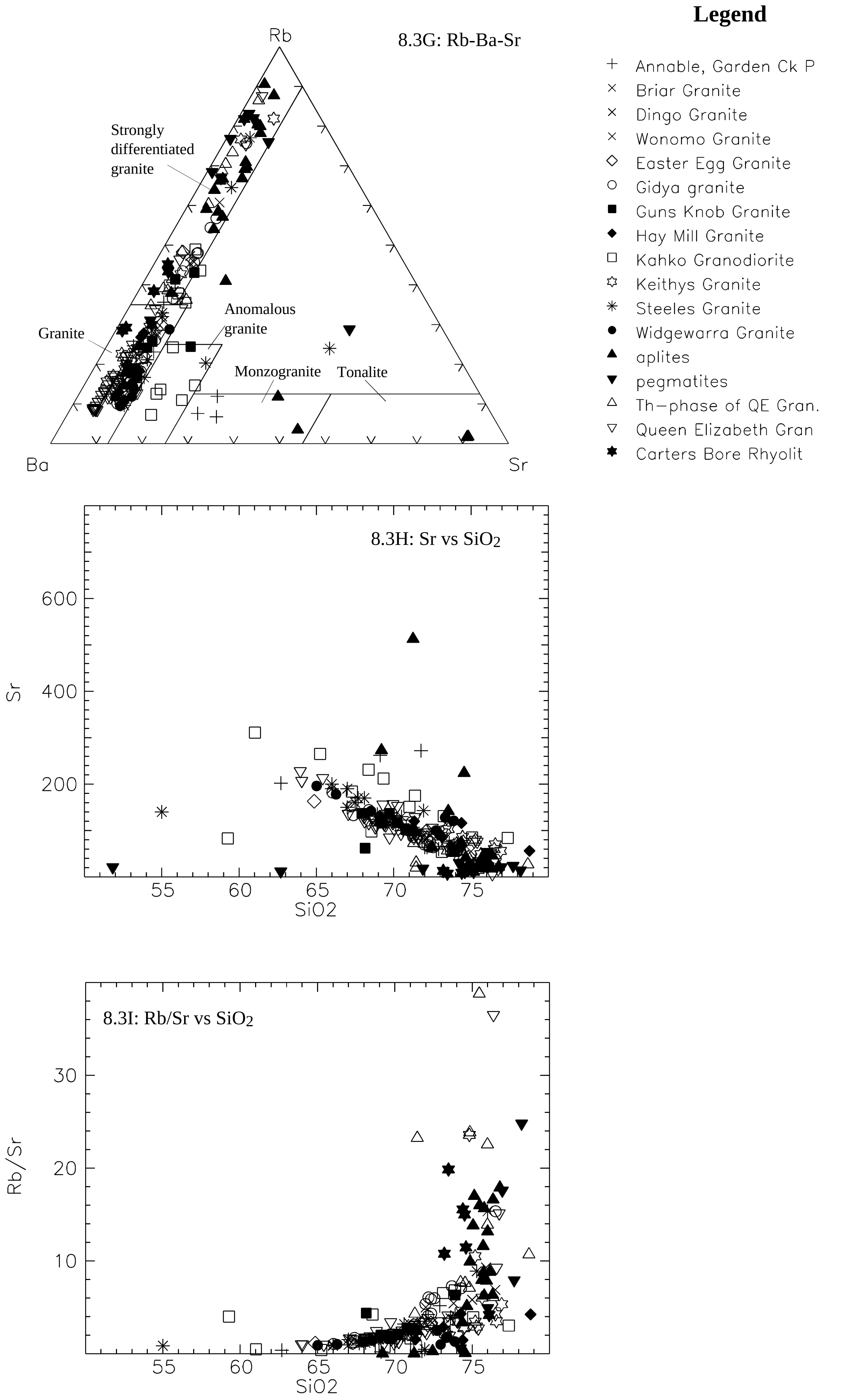
- \+ Annable, Garden Ck P
- × Briar Granite
- × Dingo Granite
- × Wonomo Granite
- ◇ Easter Egg Granite
- ○ Gidya granite
- ■ Guns Knob Granite
- ◆ Hay Mill Granite
- □ Kahko Granodiorite
- ✡ Keithys Granite
- ✳ Steeles Granite
- ● Widgewarra Granite
- ▲ aplites
- ▼ pegmatites
- △ Th−phase of QE Gran.
- ▽ Queen Elizabeth Gran
- ✶ Carters Bore Rhyolit



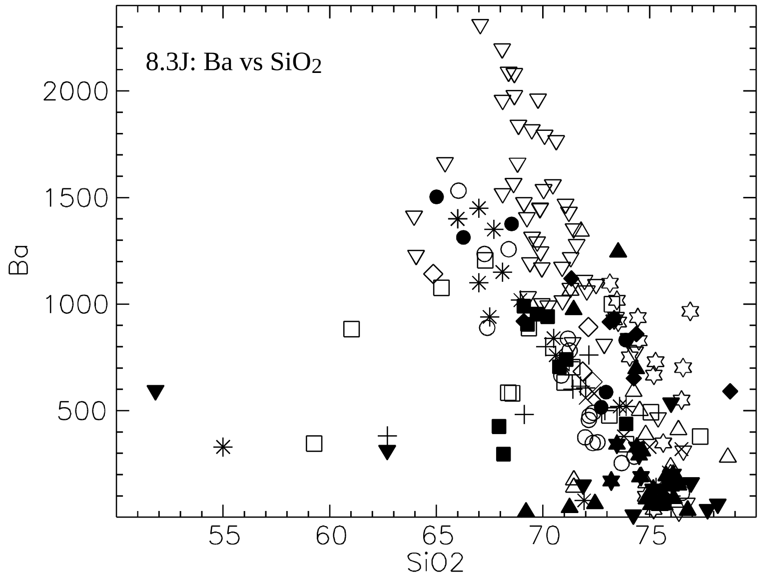

8.3E: Th vs $SiO_2$



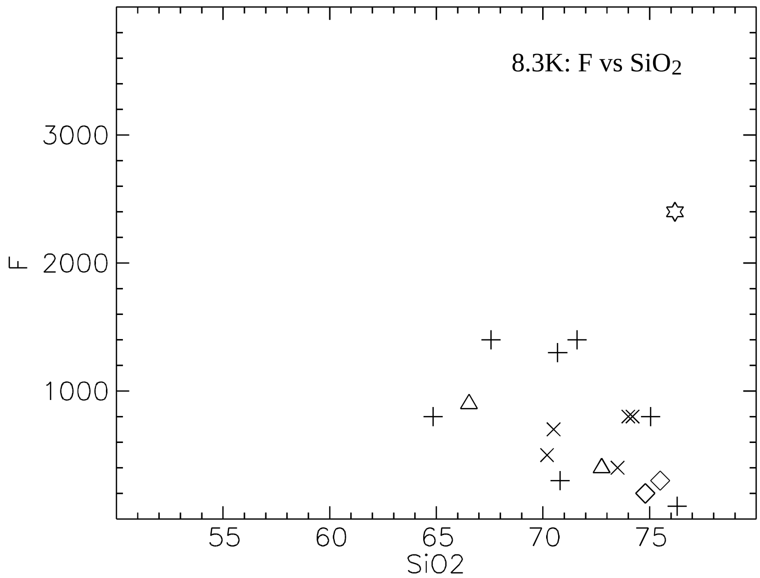

8.3F: K/Rb vs $SiO_2$

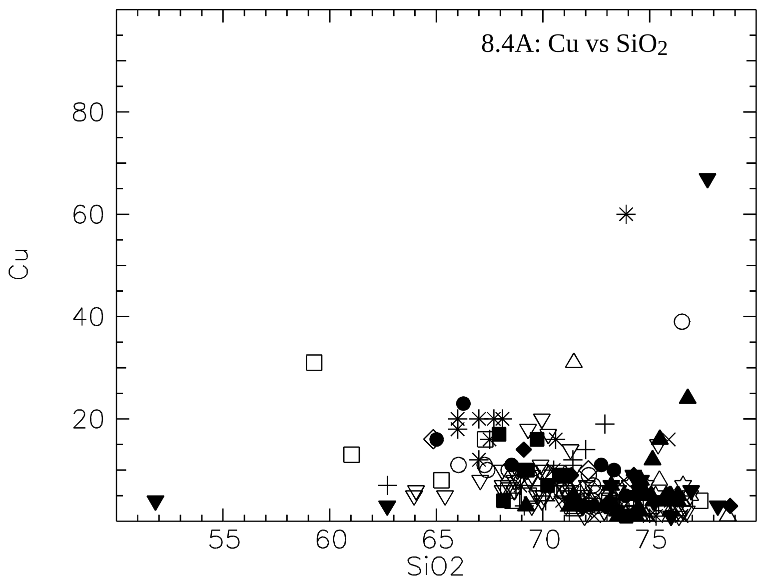

Legend
+ Annable, Garden Ck P
× Briar Granite
× Dingo Granite
× Wonomo Granite
◇ Easter Egg Granite
○ Gidya granite
■ Guns Knob Granite
◆ Hay Mill Granite
□ Kahko Granodiorite
✡ Keithys Granite
✳ Steeles Granite
● Widgewarra Granite
▲ aplites
▼ pegmatites
△ Th−phase of QE Gran.
▽ Queen Elizabeth Gran
✶ Carters Bore Rhyolit
8.3G: Rb-Ba-Sr
Rb
Ba
Sr
Strongly differentiated granite
Granite
Anomalous granite
Monzogranite
Tonalite
8.3H: Sr vs SiO2
Sr
600
400
200
55
60
65
70
75
SiO2
8.3I: Rb/Sr vs SiO2
Rb/Sr
30
20
10
55
60
65
70
75
SiO2

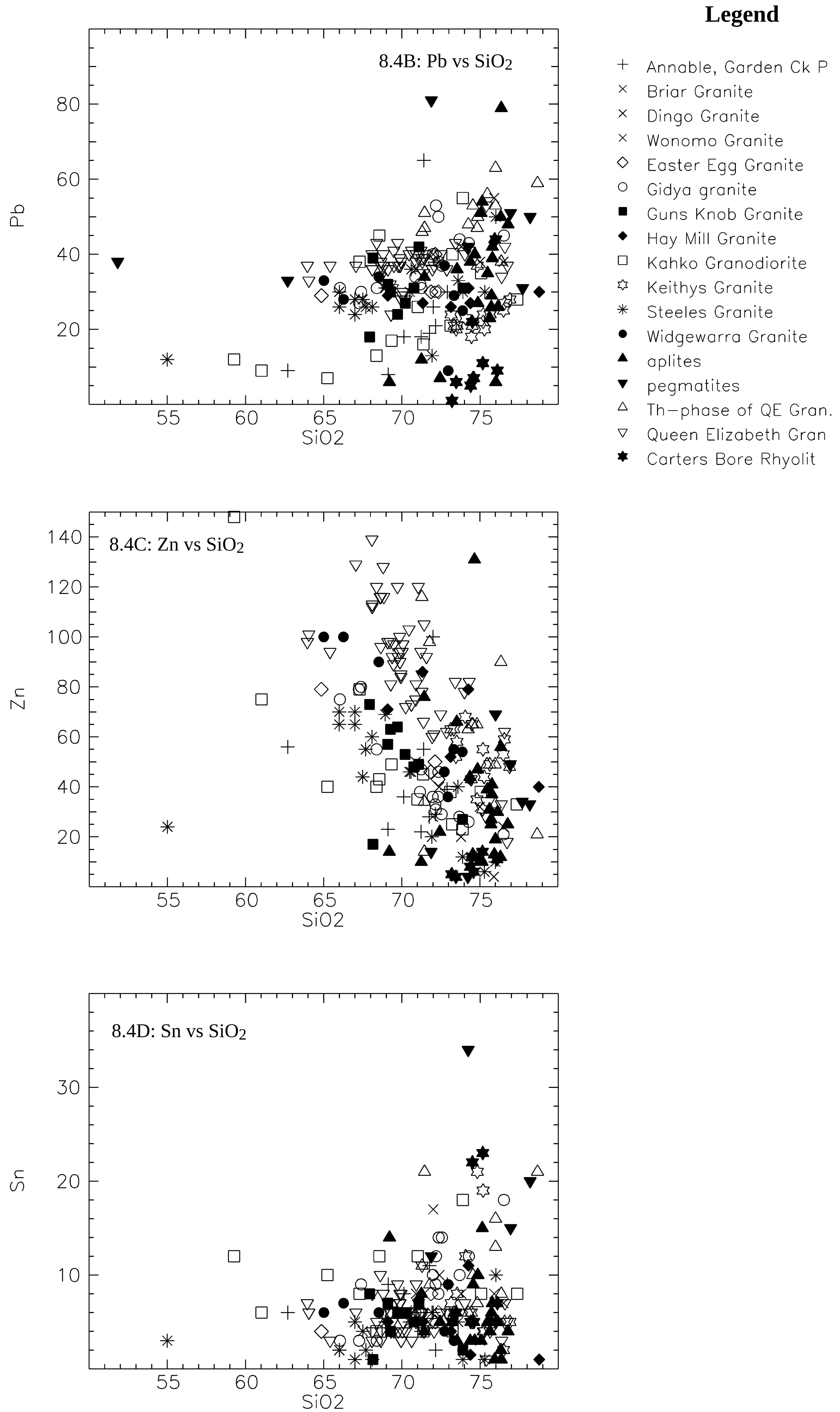
**Legend**

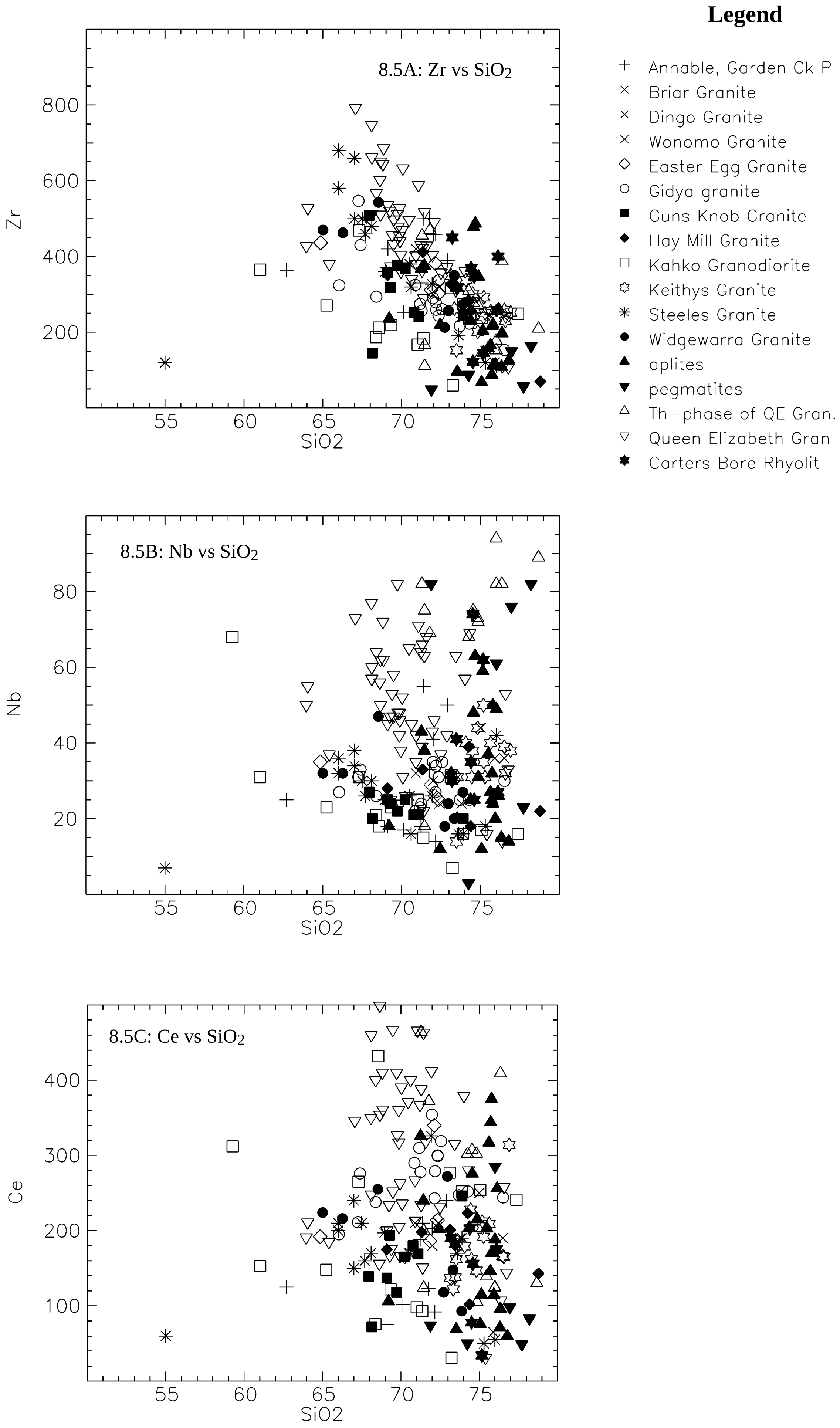

8.3J: Ba vs SiO2
Ba
SiO2
2000
1500
1000
500
55
60
65
70
75

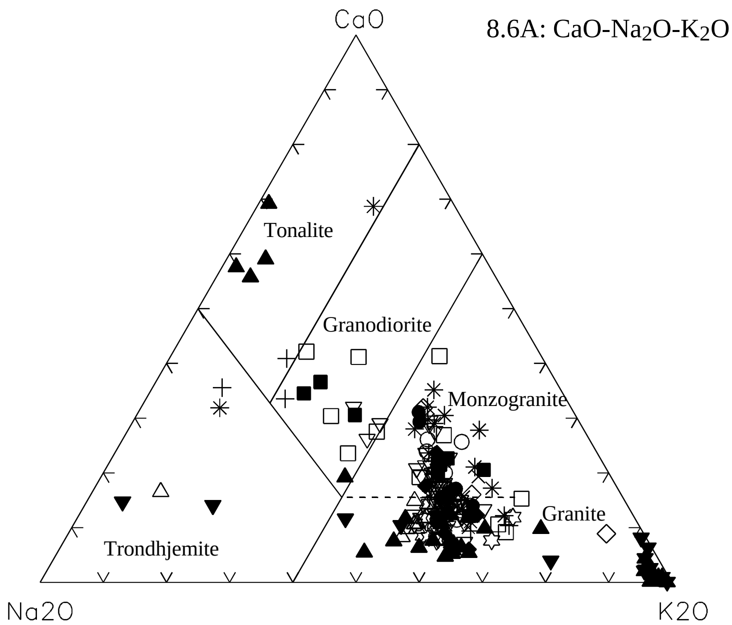

+ Annable, Garden Ck P
× Briar Granite
× Dingo Granite
× Wonomo Granite
◇ Easter Egg Granite
○ Gidya granite
■ Guns Knob Granite
◆ Hay Mill Granite
□ Kahko Granodiorite
✡ Keithys Granite
✳ Steeles Granite
● Widgewarra Granite
▲ aplites
▼ pegmatites
△ Th-phase of QE Gran.
▽ Queen Elizabeth Gran
✶ Carters Bore Rhyolit


8.3K: F vs SiO2
F
SiO2
3000
2000
1000
55
60
65
70
75


8.4A: Cu vs SiO2
Cu
SiO2
80
60
40
20
55
60
65
70
75

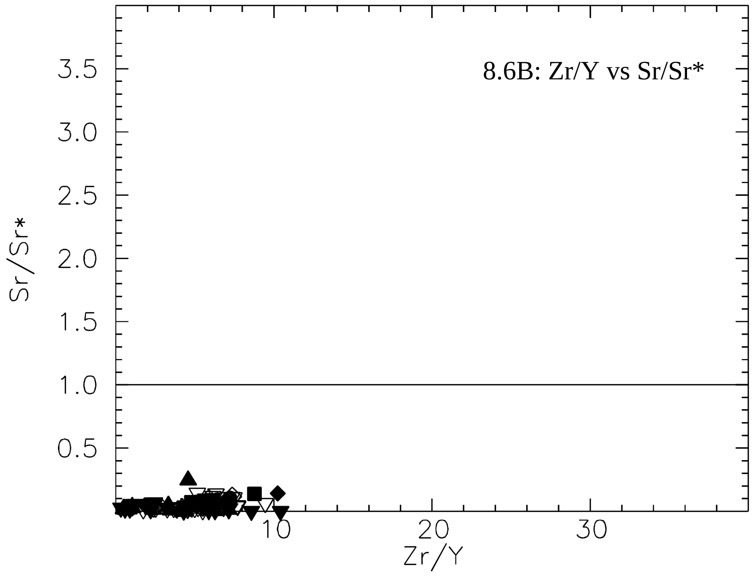

Legend
Annable, Garden Ck P
Briar Granite
Dingo Granite
Wonomo Granite
Easter Egg Granite
Gidya granite
Guns Knob Granite
Hay Mill Granite
Kahko Granodiorite
Keithys Granite
Steeles Granite
Widgewarra Granite
aplites
pegmatites
Th−phase of QE Gran.
Queen Elizabeth Gran
Carters Bore Rhyolit
8.4B: Pb vs SiO2
Pb
SiO2
8.4C: Zn vs SiO2
Zn
SiO2
8.4D: Sn vs SiO2
Sn
SiO2

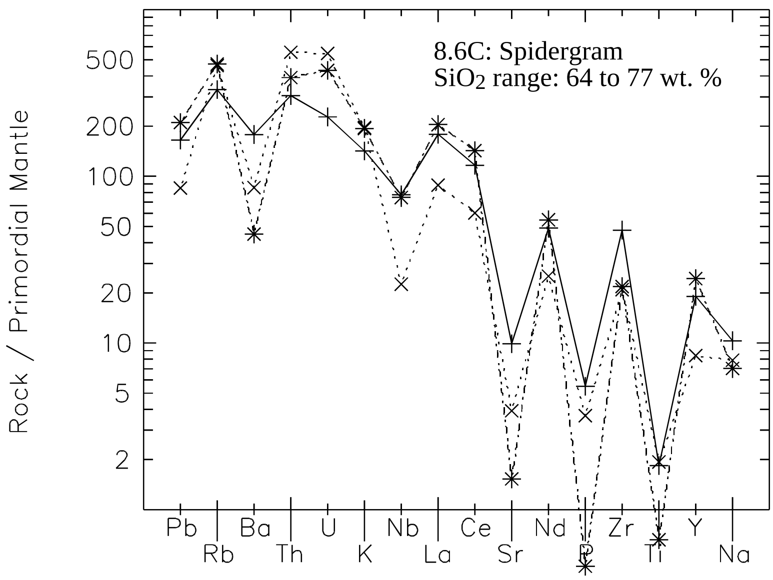

Legend
Annable, Garden Ck P
Briar Granite
Dingo Granite
Wonomo Granite
Easter Egg Granite
Gidya granite
Guns Knob Granite
Hay Mill Granite
Kahko Granodiorite
Keithys Granite
Steeles Granite
Widgewarra Granite
aplites
pegmatites
Th−phase of QE Gran.
Queen Elizabeth Gran
Carters Bore Rhyolit
8.5A: Zr vs SiO2
Zr
800
600
400
200
55
60
65
70
75
SiO2
8.5B: Nb vs SiO2
Nb
80
60
40
20
55
60
65
70
75
SiO2
8.5C: Ce vs SiO2
Ce
400
300
200
100
55
60
65
70
75
SiO2

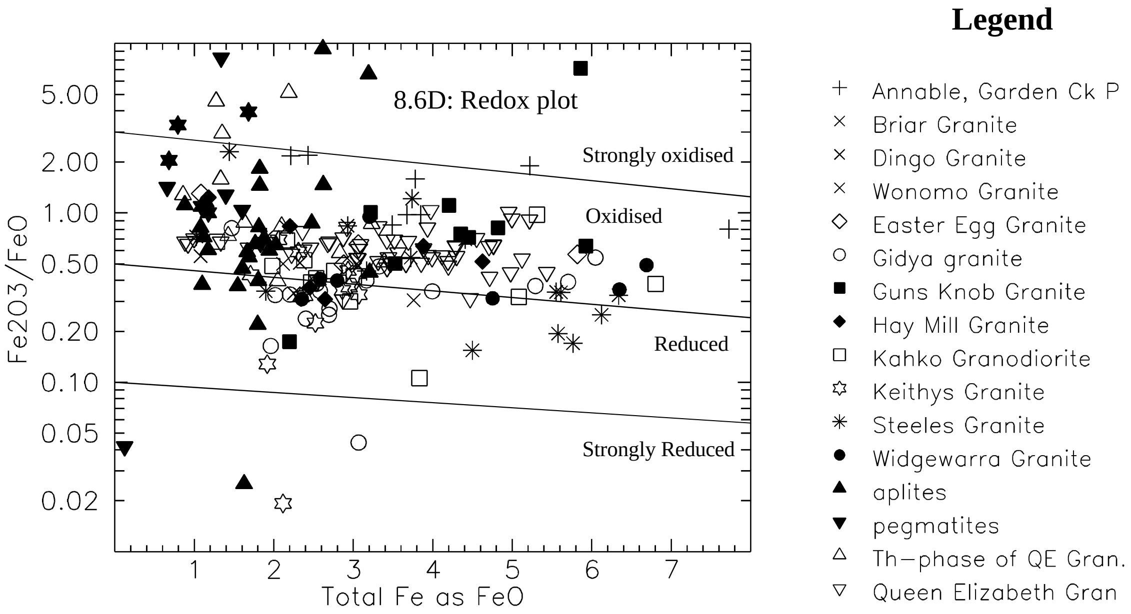

8.6A: CaO-Na2O-K2O
CaO
Na2O
K2O
Tonalite
Granodiorite
Monzogranite
Granite
Trondhjemite

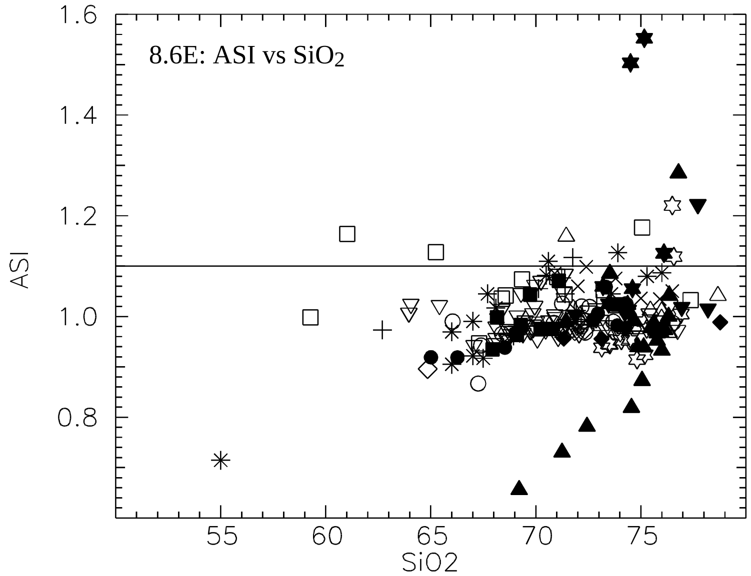
**Legend**

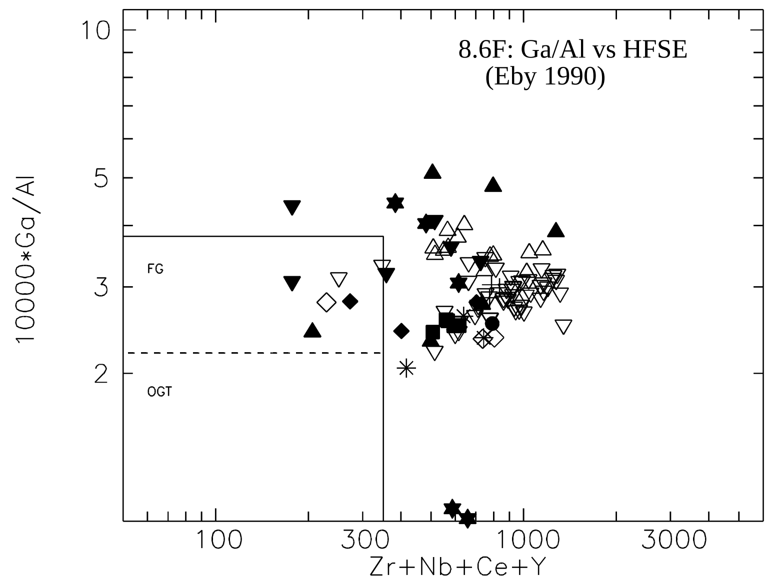

Annable, Garden Ck P
Briar Granite
Dingo Granite
Wonomo Granite
Easter Egg Granite
Gidya granite
Guns Knob Granite
Hay Mill Granite
Kahko Granodiorite
Keithys Granite
Steeles Granite
Widgewarra Granite
aplites
pegmatites
Th−phase of QE Gran.
Queen Elizabeth Gran
Carters Bore Rhyolit

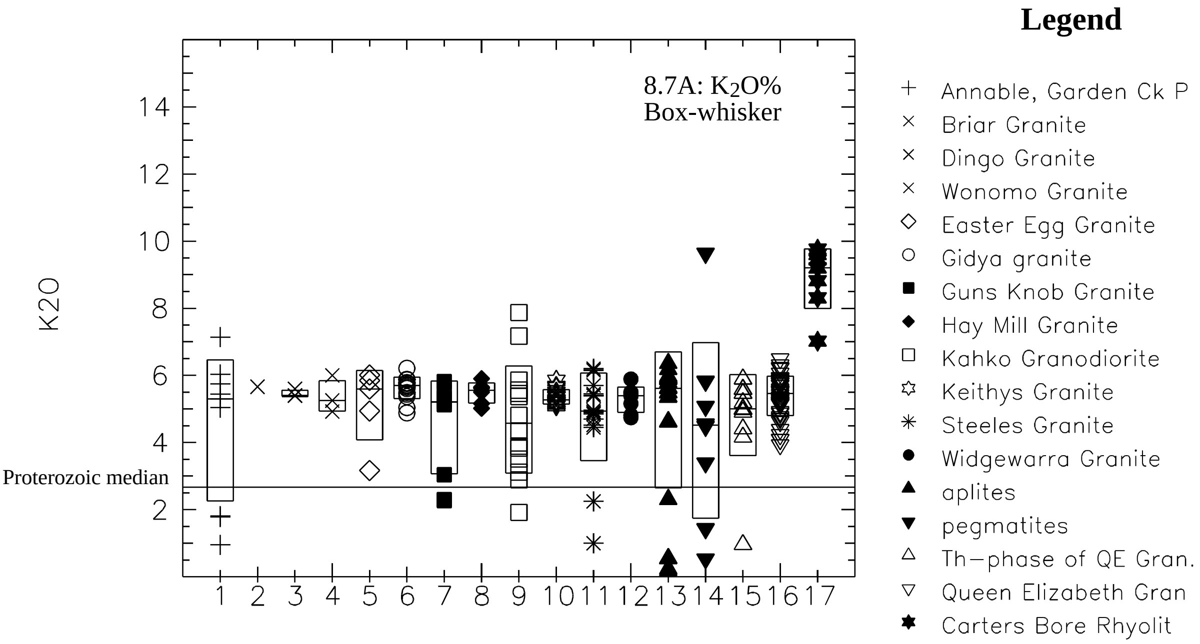

8.6B: Zr/Y vs Sr/Sr*
Sr/Sr*
Zr/Y
3.5
3.0
2.5
2.0
1.5
1.0
0.5
10
20
30

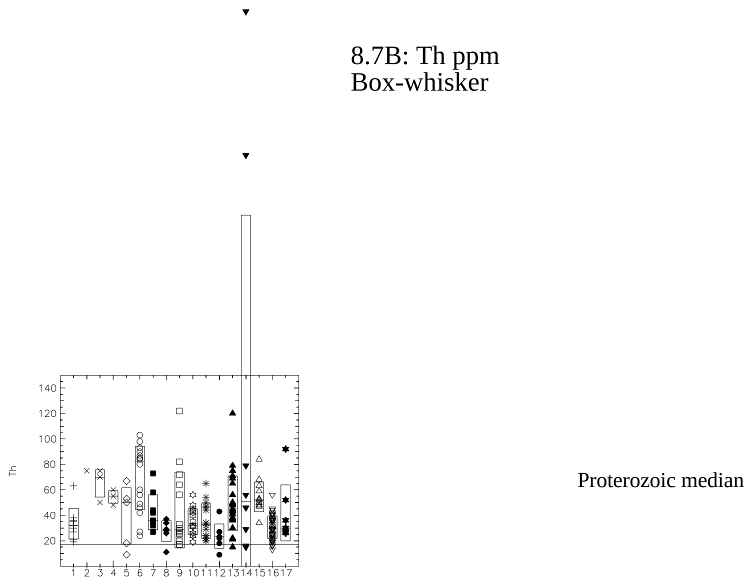

8.6C: Spidergram
SiO2 range: 64 to 77 wt. %
Rock / Primordial Mantle
500
200
100
50
20
10
5
2
Pb
Rb
Ba
Th
U
K
Nb
La
Ce
Sr
Nd
P
Zr
Ti
Y
Na

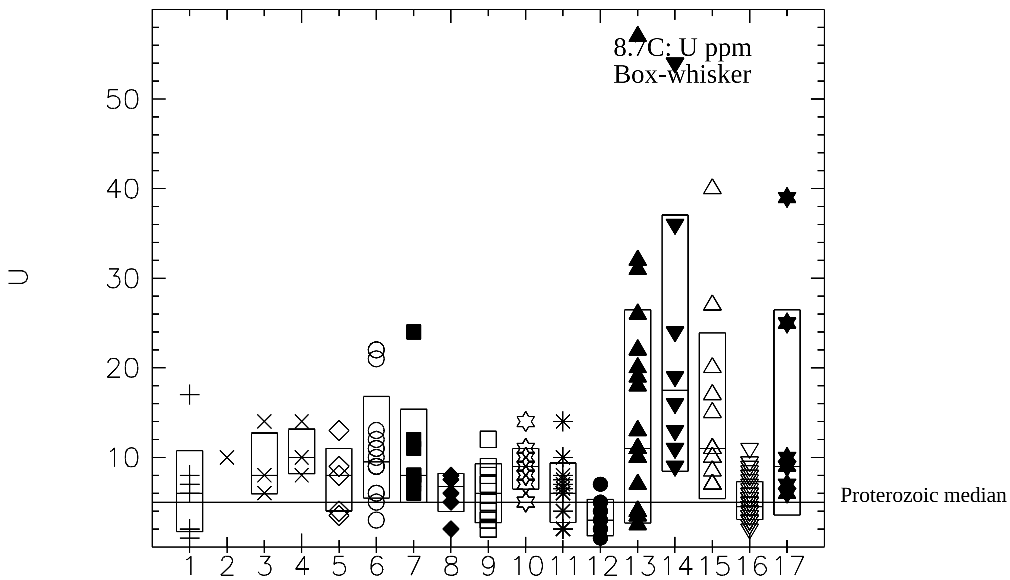

Legend
Annable, Garden Ck P
Briar Granite
Dingo Granite
Wonomo Granite
Easter Egg Granite
Gidya granite
Guns Knob Granite
Hay Mill Granite
Kahko Granodiorite
Keithys Granite
Steeles Granite
Widgewarra Granite
aplites
pegmatites
Th-phase of QE Gran.
Queen Elizabeth Gran
Carters Bore Rhyolit
8.6D: Redox plot
Strongly oxidised
Oxidised
Reduced
Strongly Reduced
Fe2O3/FeO
5.00
2.00
1.00
0.50
0.20
0.10
0.05
0.02
1
2
3
4
5
6
7
Total Fe as FeO


8.6E: ASI vs SiO2
ASI
1.6
1.4
1.2
1.0
0.8
55
60
65
70
75
SiO2


8.6F: Ga/Al vs HFSE
(Eby 1990)
10000*Ga/Al
10
5
3
2
FG
OGT
100
300
1000
3000
Zr+Nb+Ce+Y


Legend
8.7A: K2O%
Box-whisker
K2O
Proterozoic median
14
12
10
8
6
4
2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Annable, Garden Ck P
Briar Granite
Dingo Granite
Wonomo Granite
Easter Egg Granite
Gidya granite
Guns Knob Granite
Hay Mill Granite
Kahko Granodiorite
Keithys Granite
Steeles Granite
Widgewarra Granite
aplites
pegmatites
Th–phase of QE Gran.
Queen Elizabeth Gran
Carters Bore Rhyolit


8.7B: Th ppm
Box-whisker
Proterozoic median


8.7C: U ppm
Box-whisker
U
50
40
30
20
10
Proterozoic median
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

## Annable and Garden Creek Porphyries

### MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 70.38 | 71.4 | 3.09 | 62.7 | 72.9 | 9 |
| TiO2 | 0.59 | 0.55 | 0.3 | 0.23 | 1.26 | 9 |
| Al2O3 | 13.35 | 13.3 | 0.59 | 12.6 | 14.53 | 9 |
| Fe2O3 | 2.2 | 1.91 | 0.9 | 1.02 | 3.66 | 9 |
| FeO | 1.98 | 1.96 | 1.08 | 0.75 | 4.49 | 9 |
| MnO | 0.05 | 0.05 | 0.02 | 0.02 | 0.09 | 9 |
| MgO | 0.8 | 0.53 | 0.58 | 0.31 | 2.11 | 9 |
| CaO | 1.93 | 1.52 | 1.07 | 0.89 | 3.98 | 9 |
| Na2O | 3.11 | 2.8 | 0.79 | 2.13 | 4.61 | 9 |
| K2O | 4.36 | 5.3 | 2.23 | 0.95 | 7.14 | 9 |
| P2O5 | 0.13 | 0.12 | 0.08 | 0.04 | 0.31 | 9 |
| H2O+ | 0.74 | 0.64 | 0.41 | 0.43 | 1.73 | 9 |
| H2O- | 0.09 | 0.07 | 0.06 | 0.03 | 0.2 | 9 |
| CO2 | 0.09 | 0.05 | 0.1 | 05 | 0.31 | 9 |
| LOI | - | - | - | - | - | - |
| Ba | 608.67 | 607 | 138.89 | 382 | 801 | 9 |
| Li | 7.14 | 7 | 2.19 | 5 | 11 | 7 |
| Rb | 174.33 | 178 | 92.12 | 54 | 310 | 9 |
| Sr | 138.67 | 107 | 84.64 | 60 | 272 | 9 |
| Pb | 23.78 | 19 | 16.98 | 8 | 65 | 9 |
| Th | 33.44 | 32 | 12.86 | 19 | 63 | 9 |
| U | 6.22 | 6 | 4.79 |  | 17 | 9 |
| Zr | 408.33 | 420 | 82.71 | 253 | 501 | 9 |
| Nb | 30.11 | 25 | 15.38 | 14 | 55 | 9 |
| Y | 55.44 | 51 | 22.73 | 34 | 95 | 9 |
| La | 86.33 | 69 | 37.37 | 38 | 140 | 9 |
| Ce | 150.89 | 125 | 59.78 | 75 | 240 | 9 |
| Pr | - | - | - | - | - | - |
| Nd | 82.33 | 87 | 14.57 | 66 | 94 | 3 |
| Sc | 2.67 | 3 | 1.53 |  | 4 | 3 |
| V | 26.39 | 20 | 26.14 |  | 91 | 9 |
| Cr | 9.67 | 8 | 3.79 | 7 | 14 | 3 |
| Co | - | - | - | - | - | - |
| Ni | 6.44 | 4 | 5.41 | 2 | 16 | 9 |
| Cu | 7.89 | 6 | 5.82 | 2 | 19 | 9 |
| Zn | 43.11 | 36 | 24.72 | 22 | 100 | 9 |
| Sn | 6.78 | 6 | 2.77 | 2 | 11 | 9 |
| W | - | - | - | - | - | - |
| Mo | 1.5 |  | - |  |  | 2 |
| Ga | 20.33 | 21 | 1.15 | 19 | 21 | 3 |
| As | 0.5 |  | - |  |  | 3 |
| S | - | - | - | - | - | - |
| F | 100 | 100 | - | 100 | 100 | 1 |
| Cl | - | - | - | - | - | - |
| Be | - | - | - | - | - | - |
| Bi | - | - | - | - | - | - |
| Se | - | - | - | - | - | - |

# Briar Granite

## MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 72 | 72 | - | 72 | 72 | 1 |
| TiO2 | 0.31 | 0.31 | - | 0.31 | 0.31 | 1 |
| Al2O3 | 14 | 14 | - | 14 | 14 | 1 |
| Fe2O3 | 0.58 | 0.58 | - | 0.58 | 0.58 | 1 |
| FeO | 1.73 | 1.73 | - | 1.73 | 1.73 | 1 |
| MnO | 0.03 | 0.03 | - | 0.03 | 0.03 | 1 |
| MgO | 0.47 | 0.47 | - | 0.47 | 0.47 | 1 |
| CaO | 1.26 | 1.26 | - | 1.26 | 1.26 | 1 |
| Na2O | 3.03 | 3.03 | - | 3.03 | 3.03 | 1 |
| K2O | 5.66 | 5.66 | - | 5.66 | 5.66 | 1 |
| P2O5 | 0.08 | 0.08 | - | 0.08 | 0.08 | 1 |
| H2O+ | 0.71 | 0.71 | - | 0.71 | 0.71 | 1 |
| H2O- | 0.03 | 0.03 | - | 0.03 | 0.03 | 1 |
| CO2 | - | 01 | - | 01 | 01 | 1 |
| LOI | - | - | - | - | - | - |
| Ba | 560 | 560 | - | 560 | 560 | 1 |
| Li | - | - | - | - | - | - |
| Rb | 400 | 400 | - | 400 | 400 | 1 |
| Sr | 80 | 80 | - | 80 | 80 | 1 |
| Pb | 40 | 40 | - | 40 | 40 | 1 |
| Th | 75 | 75 | - | 75 | 75 | 1 |
| U | 10 | 10 | - | 10 | 10 | 1 |
| Zr | 300 | 300 | - | 300 | 300 | 1 |
| Nb | 30 | 30 | - | 30 | 30 | 1 |
| Y | 32 | 32 | - | 32 | 32 | 1 |
| La | 80 | 80 | - | 80 | 80 | 1 |
| Ce | 180 | 180 | - | 180 | 180 | 1 |
| Pr | - | - | - | - | - | - |
| Nd | - | - | - | - | - | - |
| Sc | - | - | - | - | - | - |
| V | 20 | 20 | - | 20 | 20 | 1 |
| Cr | - | - | - | - | - | - |
| Co | - | - | - | - | - | - |
| Ni | - | - | - | - | - | - |
| Cu | 2 | 2 | - | 2 | 2 | 1 |
| Zn | 28 | 28 | - | 28 | 28 | 1 |
| Sn | 17 | 17 | - | 17 | 17 | 1 |
| W | - | - | - | - | - | - |
| Mo | - | - | - | - | - | - |
| Ga | - | - | - | - | - | - |
| As | - | - | - | - | - | - |
| S | - | - | - | - | - | - |
| F | 1900 | 1900 | - | 1900 | 1900 | 1 |
| Cl | - | - | - | - | - | - |
| Be | - | - | - | - | - | - |
| Bi | - | - | - | - | - | - |
| Se | - | - | - | - | - | - |

# Dingo Granite

## MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 72.37 | 72.4 | 1.45 | 70.9 | 73.8 | 3 |
| TiO2 | 0.39 | 0.35 | 0.18 | 0.24 | 0.59 | 3 |
| Al2O3 | 13.2 | 13.2 | 0.1 | 13.1 | 13.3 | 3 |
| Fe2O3 | 0.99 | 1.02 | 0.08 | 0.9 | 1.05 | 3 |
| FeO | 2.1 | 2.1 | 0.86 | 1.24 | 2.95 | 3 |
| MnO | 0.05 | 0.05 | - | 0.05 | 0.05 | 3 |
| MgO | 0.48 | 0.5 | 0.18 | 0.3 | 0.65 | 3 |
| CaO | 1.48 | 1.42 | 0.31 | 1.2 | 1.81 | 3 |
| Na2O | 2.29 | 2.3 | 0.32 | 1.97 | 2.6 | 3 |
| K2O | 5.47 | 5.4 | 0.12 | 5.4 | 5.6 | 3 |
| P2O5 | 0.09 | 0.08 | 0.05 | 0.05 | 0.14 | 3 |
| H2O+ | 0.72 | 0.65 | 0.26 | 0.5 | 1 | 3 |
| H2O- | 0.08 | 0.08 | 0.03 | 0.06 | 0.11 | 3 |
| CO2 | 0.14 | 0.15 | 0.04 | 0.1 | 0.18 | 3 |
| LOI | - | - | - | - | - | - |
| Ba | 560 | 580 | 170.88 | 380 | 720 | 3 |
| Li | - | - | - | - | - | - |
| Rb | 336.67 | 330 | 40.41 | 300 | 380 | 3 |
| Sr | 86.67 | 90 | 15.28 | 70 | 100 | 3 |
| Pb | 38.67 | 38 | 3.06 | 36 | 42 | 3 |
| Th | 65 | 70 | 13.23 | 50 | 75 | 3 |
| U | 9.33 | 8 | 4.16 | 6 | 14 | 3 |
| Zr | 326.67 | 320 | 90.19 | 240 | 420 | 3 |
| Nb | 26.67 | 24 | 4.62 | 24 | 32 | 3 |
| Y | 55.33 | 50 | 12.86 | 46 | 70 | 3 |
| La | 116.67 | 110 | 11.55 | 110 | 130 | 3 |
| Ce | 203.33 | 210 | 11.55 | 190 | 210 | 3 |
| Pr | - | - | - | - | - | - |
| Nd | - | - | - | - | - | - |
| Sc | - | - | - | - | - | - |
| V | 26.67 | 30 | 15.28 | | 40 | 3 |
| Cr | - | - | - | - | - | - |
| Co | - | - | - | - | - | - |
| Ni | - | - | - | - | - | - |
| Cu | 4.33 | 4 | 3.51 | | 8 | 3 |
| Zn | 36.67 | 40 | 15.28 | 20 | 50 | 3 |
| Sn | 8.67 | 8 | 1.15 | 8 | 10 | 3 |
| W | - | - | - | - | - | - |
| Mo | - | - | - | - | - | - |
| Ga | - | - | - | - | - | - |
| As | - | - | - | - | - | - |
| S | - | - | - | - | - | - |
| F | 2300 | 2300 | 424.26 | 2000 | 2600 | 2 |
| Cl | - | - | - | - | - | - |
| Be | - | - | - | - | - | - |
| Bi | - | - | - | - | - | - |
| Se | - | - | - | - | - | - |

# Easter Egg Granite

## MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 73.8 | 72.13 | 8.44 | 64.85 | 87.81 | 5 |
| TiO2 | 0.55 | 0.47 | 0.37 | 0.14 | 1.15 | 5 |
| Al2O3 | 11.49 | 12.79 | 3.41 | 5.42 | 13.67 | 5 |
| Fe2O3 | 1.23 | 1.04 | 0.58 | 0.65 | 2.19 | 5 |
| FeO | 2.06 | 1.99 | 1.19 | 0.5 | 3.85 | 5 |
| MnO | 0.05 | 0.05 | 0.02 | 0.02 | 0.09 | 5 |
| MgO | 0.64 | 0.48 | 0.41 | 0.38 | 1.37 | 5 |
| CaO | 1.7 | 1.59 | 1.15 | 0.33 | 3.52 | 5 |
| Na2O | 2.1 | 2.59 | 1.06 | 0.22 | 2.74 | 5 |
| K2O | 5.11 | 5.59 | 1.16 | 3.17 | 6.01 | 5 |
| P2O5 | 0.13 | 0.1 | 0.11 | 0.03 | 0.31 | 5 |
| H2O+ | 0.61 | 0.63 | 0.07 | 0.51 | 0.68 | 4 |
| H2O- | 0.11 | 0.12 | 0.02 | 0.08 | 0.12 | 4 |
| CO2 | 0.16 | 0.14 | 0.06 | 0.1 | 0.25 | 4 |
| LOI | 0.8 | 0.8 | - | 0.8 | 0.8 | 1 |
| Ba | 753.2 | 684 | 275.44 | 414 | 1141 | 5 |
| Li | 20 | 23 | 4.12 | 15 | 23 | 5 |
| Rb | 303.8 | 305 | 84.68 | 187 | 426 | 5 |
| Sr | 96.2 | 89 | 43.38 | 42 | 163 | 5 |
| Pb | 27 | 30 | 12.57 | 6 | 40 | 5 |
| Th | 39.4 | 50 | 24.7 | 9 | 67 | 5 |
| U | 7.5 | 8 | 3.91 | 3.5 | 13 | 5 |
| Zr | 318.8 | 312 | 103.25 | 162 | 436 | 5 |
| Nb | 23.8 | 26 | 11.73 | 4 | 35 | 5 |
| Y | 55.8 | 63 | 19.95 | 22 | 74 | 5 |
| La | 112.6 | 107 | 68.68 | 25 | 216 | 5 |
| Ce | 194.6 | 192 | 106.29 | 41 | 340 | 5 |
| Pr | 3 | 3 | - | 3 | 3 | 1 |
| Nd | 58 | 74 | 36.72 | 16 | 84 | 3 |
| Sc | 7.33 | 4 | 7.57 | 2 | 16 | 3 |
| V | 28.2 | 18 | 27.2 | 9 | 76 | 5 |
| Cr | 2.33 | | 2.31 | | 5 | 3 |
| Co | 10 | 10 | 7 | 3 | 17 | 3 |
| Ni | 4.6 | 5 | 1.67 | 3 | 7 | 5 |
| Cu | 8.8 | 6 | 4.38 | 6 | 16 | 5 |
| Zn | 48.6 | 46 | 19.5 | 25 | 79 | 5 |
| Sn | 4.8 | 5 | 2.59 | | 8 | 5 |
| W | 5.67 | 6 | 0.58 | 5 | 6 | 3 |
| Mo | 3.33 | 4 | 2.08 | | 5 | 3 |
| Ga | 13.67 | 16 | 4.93 | 8 | 17 | 3 |
| As | 1 | 1 | 0.5 | 0.5 | 1.5 | 3 |
| S | 119.67 | 36 | 162.54 | 16 | 307 | 3 |
| F | 2233.33 | 2300 | 208.17 | 2000 | 2400 | 3 |
| Cl | 270.67 | 224 | 250.28 | 47 | 541 | 3 |
| Be | 3.75 | 4 | 1.26 | 2 | 5 | 4 |
| Bi | 1 | | - | | | 3 |
| Se | 0.5 | | - | | | 1 |

## Gidya Granite

### MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 71.28 | 72.07 | 2.78 | 66.04 | 76.52 | 16 |
| TiO2 | 0.45 | 0.38 | 0.26 | 0.14 | 0.93 | 16 |
| Al2O3 | 13.02 | 12.92 | 0.6 | 11.54 | 14.33 | 16 |
| Fe2O3 | 0.85 | 0.69 | 0.54 | 0.13 | 2.21 | 16 |
| FeO | 2.43 | 2.18 | 0.97 | 0.85 | 4.22 | 16 |
| MnO | 0.05 | 0.04 | 0.02 | 0.03 | 0.1 | 16 |
| MgO | 0.49 | 0.39 | 0.26 | 0.1 | 0.96 | 16 |
| CaO | 1.65 | 1.46 | 0.59 | 0.88 | 2.8 | 16 |
| Na2O | 2.7 | 2.73 | 0.19 | 2.23 | 2.98 | 16 |
| K2O | 5.63 | 5.7 | 0.33 | 4.88 | 6.21 | 16 |
| P2O5 | 0.11 | 0.08 | 0.09 | 0.02 | 0.29 | 16 |
| H2O+ | 0.66 | 0.68 | 0.13 | 0.42 | 0.92 | 16 |
| H2O- | 0.04 | 0.03 | 0.03 | 0.01 | 0.11 | 16 |
| CO2 | 0.06 | 0.05 | 0.02 | 0.05 | 0.1 | 16 |
| LOI | - | - | - | - | - | - |
| Ba | 646.81 | 483 | 410.26 | 114 | 1532 | 16 |
| Li | 21.88 | 23 | 6.54 | 8 | 29 | 16 |
| Rb | 317.75 | 327 | 88.86 | 168 | 445 | 16 |
| Sr | 92.75 | 78 | 41.83 | 29 | 182 | 16 |
| Pb | 37.25 | 35.5 | 7.84 | 27 | 53 | 16 |
| Th | 69.31 | 82 | 25.68 | 24 | 103 | 16 |
| U | 11.13 | 9.5 | 5.85 | 3 | 22 | 16 |
| Zr | 294.75 | 277 | 90.84 | 153 | 547 | 16 |
| Nb | 28.69 | 28.5 | 4.35 | 22 | 35 | 16 |
| Y | 70.06 | 69 | 10.42 | 53 | 95 | 16 |
| La | 158.13 | 155.5 | 27.82 | 110 | 211 | 16 |
| Ce | 270.94 | 277 | 41.44 | 195 | 354 | 16 |
| Pr | - | - | - | - | - | - |
| Nd | - | - | - | - | - | - |
| Sc | - | - | - | - | - | - |
| V | 16.44 | 12 | 14.23 | | 48 | 16 |
| Cr | - | - | - | - | - | - |
| Co | - | - | - | - | - | - |
| Ni | 1.44 | | 0.73 | | 3 | 16 |
| Cu | 8.38 | 6 | 8.7 | 3 | 39 | 16 |
| Zn | 44.25 | 37 | 19.01 | 21 | 80 | 16 |
| Sn | 8.94 | 9 | 4.37 | 3 | 18 | 16 |
| W | - | - | - | - | - | - |
| Mo | - | - | - | - | - | - |
| Ga | - | - | - | - | - | - |
| As | - | - | - | - | - | - |
| S | - | - | - | - | - | - |
| F | - | - | - | - | - | - |
| Cl | - | - | - | - | - | - |
| Be | - | - | - | - | - | - |
| Bi | - | - | - | - | - | - |
| Se | - | - | - | - | - | - |

# Guns Knob Granite

## MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 70.02 | 69.73 | 1.81 | 67.94 | 73.9 | 9 |
| TiO2 | 0.74 | 0.75 | 0.25 | 0.3 | 1.07 | 9 |
| Al2O3 | 12.97 | 13 | 0.22 | 12.56 | 13.24 | 9 |
| Fe2O3 | 2.2 | 1.95 | 1.45 | 0.33 | 5.64 | 9 |
| FeO | 2.31 | 2.43 | 0.83 | 0.79 | 3.77 | 9 |
| MnO | 0.06 | 0.06 | 0.01 | 0.03 | 0.07 | 9 |
| MgO | 0.83 | 0.83 | 0.29 | 0.27 | 1.26 | 9 |
| CaO | 2.3 | 2.17 | 0.66 | 1.14 | 3.23 | 9 |
| Na2O | 2.75 | 2.61 | 0.57 | 1.83 | 3.8 | 9 |
| K2O | 4.45 | 5.21 | 1.46 | 2.27 | 5.81 | 9 |
| P2O5 | 0.2 | 0.2 | 0.08 | 0.05 | 0.32 | 9 |
| H2O+ | 0.64 | 0.64 | 0.16 | 0.4 | 0.89 | 9 |
| H2O- | 0.1 | 0.1 | 0.05 | 0.02 | 0.21 | 9 |
| CO2 | 0.11 | 0.1 | 0.07 | 0.04 | 0.24 | 9 |
| LOI | - | - | - | - | - | - |
| Ba | 710.67 | 740 | 263.71 | 296 | 991 | 9 |
| Li | 24.22 | 25 | 8.17 | 9 | 33 | 9 |
| Rb | 254.56 | 247 | 45.99 | 182 | 348 | 9 |
| Sr | 105.11 | 116 | 29.41 | 55 | 137 | 9 |
| Pb | 30.44 | 31 | 7.23 | 18 | 42 | 9 |
| Th | 42.44 | 36 | 14.49 | 27 | 73 | 9 |
| U | 10.17 | 8 | 5.52 | 6 | 24 | 9 |
| Zr | 312.56 | 318 | 105.68 | 145 | 509 | 9 |
| Nb | 22.78 | 22 | 2.54 | 20 | 27 | 9 |
| Y | 52.33 | 55 | 6.76 | 41 | 60 | 9 |
| La | 88.22 | 93 | 28.59 | 41 | 142 | 9 |
| Ce | 157.78 | 165 | 49.36 | 72 | 246 | 9 |
| Pr | - | - | - | - | - | - |
| Nd | 54.4 | 53 | 9.71 | 40 | 66 | 5 |
| Sc | 10 | 10 | 2.74 | 7 | 14 | 5 |
| V | 29.44 | 33 | 13.73 | 6 | 45 | 9 |
| Cr | 3.4 | 3 | 1.67 | | 5 | 5 |
| Co | 8 | 8 | 2.55 | 5 | 11 | 5 |
| Ni | 4.22 | 4 | 1.72 | 2 | 7 | 9 |
| Cu | 9.22 | 9 | 5.09 | | 17 | 9 |
| Zn | 50.11 | 53 | 17.94 | 17 | 73 | 9 |
| Sn | 5.11 | 6 | 2.37 | | 8 | 9 |
| W | 5.6 | 6 | 0.55 | 5 | 6 | 5 |
| Mo | 3.1 | 3 | 1.02 | | 4 | 5 |
| Ga | 17.2 | 17 | 0.45 | 17 | 18 | 5 |
| As | 0.9 | 1 | 0.22 | 0.5 | 1 | 5 |
| S | 48 | 36 | 37.91 | 17 | 114 | 5 |
| F | 1700 | 1800 | 244.95 | 1400 | 2000 | 5 |
| Cl | 252.4 | 243 | 66.59 | 193 | 365 | 5 |
| Be | 4.11 | 4 | 1.05 | 3 | 6 | 9 |
| Bi | 1 | | - | | | 5 |
| Se | - | - | - | - | - | - |

# Hay Mill Granite

## MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 73.5 | 73.69 | 3.27 | 69.1 | 78.78 | 6 |
| TiO2 | 0.33 | 0.23 | 0.24 | 0.11 | 0.77 | 6 |
| Al2O3 | 12.27 | 12.43 | 0.77 | 10.79 | 12.88 | 6 |
| Fe2O3 | 1.04 | 0.87 | 0.46 | 0.64 | 1.63 | 6 |
| FeO | 1.9 | 1.96 | 0.91 | 0.56 | 3.16 | 6 |
| MnO | 0.05 | 0.05 | 0.02 | 0.02 | 0.08 | 6 |
| MgO | 0.32 | 0.19 | 0.29 | 0.1 | 0.87 | 6 |
| CaO | 1.27 | 1.11 | 0.66 | 0.51 | 2.33 | 6 |
| Na2O | 2.73 | 2.74 | 0.34 | 2.31 | 3.11 | 6 |
| K2O | 5.48 | 5.56 | 0.33 | 5.02 | 5.9 | 6 |
| P2O5 | 0.07 | 0.03 | 0.08 | 0.01 | 0.21 | 6 |
| H2O+ | 0.61 | 0.6 | 0.16 | 0.39 | 0.86 | 6 |
| H2O- | 0.09 | 0.09 | 0.04 | 0.02 | 0.15 | 6 |
| CO2 | 0.13 | 0.14 | 0.05 | 0.05 | 0.2 | 6 |
| LOI | - | - | - | - | - | - |
| Ba | 843.17 | 888 | 194.04 | 591 | 1120 | 6 |
| Li | 20 | 21 | 8.02 | 7 | 29 | 6 |
| Rb | 225 | 236 | 39.88 | 170 | 276 | 6 |
| Sr | 95.67 | 101 | 31.61 | 56 | 132 | 6 |
| Pb | 28.33 | 28 | 1.97 | 26 | 31 | 6 |
| Th | 27.5 | 28.5 | 9.05 | 11 | 37 | 6 |
| U | 6.08 | 6.75 | 2.33 | 2 | 8 | 6 |
| Zr | 283.33 | 305.5 | 117.73 | 70 | 412 | 6 |
| Nb | 28.67 | 30 | 7.69 | 18 | 39 | 6 |
| Y | 54.17 | 59.5 | 19.41 | 25 | 79 | 6 |
| La | 92.17 | 97.5 | 22.99 | 56 | 119 | 6 |
| Ce | 173.67 | 186.5 | 44.39 | 102 | 223 | 6 |
| Pr | - | - | - | - | - | - |
| Nd | 48.67 | 47 | 19.55 | 30 | 69 | 3 |
| Sc | 4.67 | 5 | 1.53 | 3 | 6 | 3 |
| V | 10 | 2.5 | 16.12 | | 42 | 6 |
| Cr | 1 | | - | | | 3 |
| Co | 3.33 | 4 | 1.15 | 2 | 4 | 3 |
| Ni | 2.83 | 1.5 | 2.79 | | 8 | 6 |
| Cu | 6.83 | 6.5 | 4.62 | 2 | 14 | 6 |
| Zn | 61.83 | 61.5 | 19.45 | 40 | 86 | 6 |
| Sn | 4.58 | 4.5 | 3.58 | | 11 | 6 |
| W | 4.67 | 5 | 1.53 | 3 | 6 | 3 |
| Mo | 3.33 | 3 | 0.58 | 3 | 4 | 3 |
| Ga | 17 | 16 | 1.73 | 16 | 19 | 3 |
| As | 1 | 1 | - | 1 | 1 | 3 |
| S | 17 | 16 | 7.55 | 10 | 25 | 3 |
| F | 733.33 | 900 | 472.58 | 200 | 1100 | 3 |
| Cl | 165.33 | 152 | 67.99 | 105 | 239 | 3 |
| Be | 3.67 | 4 | 1.03 | 2 | 5 | 6 |
| Bi | 1 | | - | | | 3 |
| Se | - | - | - | - | - | - |

## Kahko Granodiorite

### MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 69.58 | 70.18 | 5.16 | 59.27 | 77.37 | 14 |
| TiO2 | 0.56 | 0.32 | 0.5 | 0.16 | 2.07 | 14 |
| Al2O3 | 13.9 | 13.77 | 1.7 | 10.87 | 16.6 | 14 |
| Fe2O3 | 1.23 | 0.87 | 0.99 | 0.37 | 3.91 | 14 |
| FeO | 2.83 | 2.07 | 2.09 | 0.8 | 8.91 | 14 |
| MnO | 0.06 | 0.05 | 0.04 | 0.03 | 0.18 | 14 |
| MgO | 0.86 | 0.69 | 0.67 | 0.25 | 2.29 | 14 |
| CaO | 2.25 | 2.04 | 1.1 | 0.95 | 3.99 | 14 |
| Na2O | 2.69 | 2.7 | 0.76 | 1.31 | 3.92 | 14 |
| K2O | 4.69 | 4.57 | 1.66 | 1.92 | 7.87 | 14 |
| P2O5 | 0.17 | 0.11 | 0.15 | 0.05 | 0.58 | 14 |
| H2O+ | 0.84 | 0.7 | 0.33 | 0.56 | 1.58 | 14 |
| H2O- | 0.04 | 0.03 | 0.03 | 01 | 0.11 | 14 |
| CO2 | 0.07 | 0.05 | 0.03 | 05 | 0.15 | 14 |
| LOI | - | - | - | - | - | - |
| Ba | 685.07 | 608 | 281.63 | 343 | 1205 | 14 |
| Li | 22.57 | 20.5 | 12.09 | 4 | 39 | 14 |
| Rb | 254.43 | 253 | 102.51 | 105 | 414 | 14 |
| Sr | 151.43 | 141 | 81.09 | 54 | 311 | 14 |
| Pb | 25.86 | 23.5 | 14.8 | 7 | 55 | 14 |
| Th | 44.21 | 29 | 30.93 | 17 | 122 | 14 |
| U | 6 | 6 | 3.42 | 2 | 12 | 14 |
| Zr | 302.07 | 243.5 | 227.17 | 60 | 1017 | 14 |
| Nb | 24.43 | 22 | 14.35 | 7 | 68 | 14 |
| Y | 49.71 | 42 | 39.99 | 19 | 174 | 14 |
| La | 112.93 | 106 | 65.61 | 20 | 265 | 14 |
| Ce | 196.71 | 197 | 111.1 | 31 | 432 | 14 |
| Pr | - | - | - | - | - | - |
| Nd | - | - | - | - | - | - |
| Sc | - | - | - | - | - | - |
| V | 32.86 | 22 | 35.2 | 2 | 118 | 14 |
| Cr | - | - | - | - | - | - |
| Co | - | - | - | - | - | - |
| Ni | 3.64 | 1.5 | 4.89 |  | 19 | 14 |
| Cu | 7.79 | 4.5 | 7.76 | 3 | 31 | 14 |
| Zn | 50.79 | 40 | 32.22 | 23 | 148 | 14 |
| Sn | 8.43 | 8 | 4.01 | 4 | 18 | 14 |
| W | - | - | - | - | - | - |
| Mo | - | - | - | - | - | - |
| Ga | - | - | - | - | - | - |
| As | - | - | - | - | - | - |
| S | - | - | - | - | - | - |
| F | - | - | - | - | - | - |
| Cl | - | - | - | - | - | - |
| Be | - | - | - | - | - | - |
| Bi | - | - | - | - | - | - |
| Se | - | - | - | - | - | - |

# Keithys Granite

## MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 74.84 | 74.82 | 1.22 | 73.14 | 76.91 | 15 |
| TiO2 | 0.24 | 0.23 | 0.08 | 0.11 | 0.36 | 15 |
| Al2O3 | 12.06 | 11.95 | 0.25 | 11.82 | 12.58 | 15 |
| Fe2O3 | 0.62 | 0.75 | 0.31 | 01 | 0.96 | 15 |
| FeO | 1.88 | 1.88 | 0.35 | 1.23 | 2.37 | 15 |
| MnO | 0.04 | 0.05 | 0.01 | 0.03 | 0.06 | 15 |
| MgO | 0.22 | 0.23 | 0.08 | 0.11 | 0.4 | 15 |
| CaO | 1.01 | 1.01 | 0.26 | 0.64 | 1.4 | 15 |
| Na2O | 2.89 | 2.99 | 0.5 | 1.47 | 3.42 | 15 |
| K2O | 5.36 | 5.27 | 0.22 | 5.1 | 5.85 | 15 |
| P2O5 | 0.03 | 0.03 | 0.02 | 01 | 0.07 | 15 |
| H2O+ | 0.61 | 0.62 | 0.07 | 0.44 | 0.71 | 15 |
| H2O- | 0.07 | 0.08 | 0.03 | 0.02 | 0.12 | 15 |
| CO2 | 0.1 | 0.1 | 0.04 | 0.05 | 0.15 | 15 |
| LOI | - | - | - | - | - | - |
| Ba | 705 | 753 | 322.09 | 37 | 1098 | 15 |
| Li | 12.93 | 11 | 5.13 | 6 | 24 | 15 |
| Rb | 253.53 | 245 | 47.13 | 200 | 377 | 15 |
| Sr | 68.47 | 72 | 25.03 | 16 | 103 | 15 |
| Pb | 23.67 | 23 | 4.58 | 18 | 37 | 15 |
| Th | 34.87 | 32 | 10.58 | 19 | 56 | 15 |
| U | 8.73 | 9 | 2.34 | 5 | 14 | 15 |
| Zr | 262.8 | 256 | 51.32 | 152 | 349 | 15 |
| Nb | 35.07 | 35 | 8.08 | 14 | 50 | 15 |
| Y | 74.33 | 77 | 23.06 | 51 | 131 | 15 |
| La | 96.93 | 90 | 26.95 | 70 | 173 | 15 |
| Ce | 182.47 | 166 | 47.73 | 122 | 314 | 15 |
| Pr | - | - | - | - | - | - |
| Nd | - | - | - | - | - | - |
| Sc | - | - | - | - | - | - |
| V | 5.87 | 5 | 3.91 | | 11 | 15 |
| Cr | - | - | - | - | - | - |
| Co | - | - | - | - | - | - |
| Ni | 2.6 | 3 | 0.91 | | 4 | 15 |
| Cu | 5.27 | 5 | 1.28 | 3 | 7 | 15 |
| Zn | 52.4 | 53 | 10.89 | 31 | 68 | 15 |
| Sn | 7.6 | 6 | 5.53 | 2 | 21 | 15 |
| W | - | - | - | - | - | - |
| Mo | - | - | - | - | - | - |
| Ga | - | - | - | - | - | - |
| As | - | - | - | - | - | - |
| S | - | - | - | - | - | - |
| F | 1725 | 1600 | 550 | 1200 | 2500 | 4 |
| Cl | - | - | - | - | - | - |
| Be | 4.89 | 5 | 1.36 | 3 | 7 | 9 |
| Bi | - | - | - | - | - | - |
| Se | - | - | - | - | - | - |

## aplites

### MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 75.29 | 75.62 | 2.74 | 69.21 | 82.66 | 25 |
| TiO2 | 0.22 | 0.13 | 0.22 | 0.04 | 1.03 | 25 |
| Al2O3 | 12.08 | 12.3 | 1.37 | 7.03 | 13.53 | 25 |
| Fe2O3 | 0.88 | 0.65 | 0.68 | 0.04 | 3.04 | 25 |
| FeO | 1.03 | 1.11 | 0.44 | 0.28 | 2.29 | 25 |
| MnO | 0.03 | 0.02 | 0.02 | 0.01 | 0.09 | 25 |
| MgO | 0.26 | 0.16 | 0.24 | 0.06 | 1.24 | 25 |
| CaO | 1.66 | 0.74 | 2.16 | 0.01 | 8.29 | 25 |
| Na2O | 2.97 | 3.02 | 0.87 | 0.19 | 4.36 | 25 |
| K2O | 4.68 | 5.61 | 2.07 | 0.19 | 6.36 | 25 |
| P2O5 | 0.04 | 0.01 | 0.05 | 01 | 0.24 | 25 |
| H2O+ | 0.52 | 0.53 | 0.14 | 0.21 | 0.72 | 25 |
| H2O- | 0.08 | 0.08 | 0.06 | 01 | 0.2 | 25 |
| CO2 | 0.1 | 0.05 | 0.1 | 0.04 | 0.44 | 25 |
| LOI | - | - | - | - | - | - |
| Ba | 213.92 | 97 | 303.25 | 25 | 1244 | 25 |
| Li | 15.72 | 12 | 15.05 | 2 | 58 | 25 |
| Rb | 235.68 | 262 | 116.39 | 5 | 443 | 25 |
| Sr | 76 | 33 | 111.79 | 7 | 513 | 25 |
| Pb | 33.36 | 35 | 18.28 | 6 | 79 | 25 |
| Th | 49.32 | 45 | 21.98 | 15 | 120 | 25 |
| U | 14.58 | 11 | 12.14 | 2.5 | 57 | 25 |
| Zr | 221.52 | 217 | 114.13 | 68 | 487 | 25 |
| Nb | 40.8 | 27 | 39.38 | 12 | 196 | 25 |
| Y | 84.44 | 67 | 70.06 | 21 | 386 | 25 |
| La | 112.36 | 104 | 75.41 | 7 | 322 | 25 |
| Ce | 202.36 | 202 | 126.64 | 20 | 583 | 25 |
| Pr | - | - | - | - | - | - |
| Nd | 67.33 | 53.5 | 64.58 | 5 | 187 | 6 |
| Sc | 3.67 | 4 | 2.42 | | 7 | 6 |
| V | 5.36 | 2 | 9.81 | | 49 | 25 |
| Cr | 1 | | - | | | 6 |
| Co | 5.83 | 6 | 3.13 | | 9 | 6 |
| Ni | 2.12 | 2 | 0.93 | | 4 | 25 |
| Cu | 5.32 | 4 | 5.06 | | 24 | 25 |
| Zn | 36.4 | 27 | 29.68 | 10 | 131 | 25 |
| Sn | 5.76 | 5 | 3.6 | | 15 | 25 |
| W | 10 | 8.5 | 6.57 | 3 | 21 | 6 |
| Mo | 3.25 | 2.25 | 2.91 | | 9 | 6 |
| Ga | 21.17 | 19 | 5.98 | 16 | 32 | 6 |
| As | 0.58 | 0.5 | 0.34 | 50 | 1 | 6 |
| S | 18.67 | 19 | 4.89 | 11 | 26 | 6 |
| F | 1183.33 | 1000 | 767.9 | 400 | 2400 | 6 |
| Cl | 181.5 | 162.5 | 77.76 | 111 | 324 | 6 |
| Be | 4.53 | 4 | 1.47 | 2 | 8 | 19 |
| Bi | 1.17 | | 0.41 | | 2 | 6 |
| Se | - | - | - | - | - | - |

## pegmatites

### MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 71.19 | 75.13 | 9.3 | 51.83 | 78.2 | 8 |
| TiO2 | 0.42 | 0.07 | 0.67 | 01 | 1.67 | 8 |
| Al2O3 | 12.31 | 11.88 | 2.16 | 8.6 | 15.35 | 8 |
| Fe2O3 | 1.99 | 0.85 | 2.44 | 01 | 6.41 | 8 |
| FeO | 3.65 | 0.74 | 5.86 | 0.12 | 14.72 | 8 |
| MnO | 0.13 | 0.03 | 0.21 | 01 | 0.53 | 8 |
| MgO | 0.24 | 0.08 | 0.33 | 0.03 | 0.89 | 8 |
| CaO | 0.82 | 0.91 | 0.36 | 0.31 | 1.37 | 8 |
| Na2O | 2.99 | 3.02 | 2.42 | 0.03 | 7.41 | 8 |
| K2O | 4.36 | 4.52 | 2.79 | 0.53 | 9.63 | 8 |
| P2O5 | 0.11 | 0.01 | 0.19 | 01 | 0.43 | 8 |
| H2O+ | 0.93 | 0.54 | 0.86 | 0.25 | 2.48 | 7 |
| H2O- | 0.17 | 0.18 | 0.11 | 0.06 | 0.32 | 7 |
| CO2 | 0.15 | 0.04 | 0.18 | 0.04 | 0.5 | 7 |
| LOI | 0.35 | 0.35 | - | 0.35 | 0.35 | 1 |
| Ba | 233.75 | 157 | 226.31 | 12 | 595 | 8 |
| Li | 277.63 | 45 | 459.08 | 3 | 1148 | 8 |
| Rb | 555.5 | 358 | 470.61 | 17 | 1336 | 8 |
| Sr | 24.25 | 21 | 13.27 | 12 | 54 | 8 |
| Pb | 46.25 | 43 | 15.78 | 31 | 81 | 8 |
| Th | 125 | 51 | 161.35 | 15 | 436 | 8 |
| U | 22.75 | 17.5 | 15.29 | 9 | 54 | 8 |
| Zr | 1308.5 | 157 | 2189.86 | 49 | 5052 | 8 |
| Nb | 158.63 | 79 | 194.89 | 3 | 473 | 8 |
| Y | 229.25 | 169 | 195.33 | 36 | 589 | 8 |
| La | 574.75 | 56.5 | 963.52 | 21 | 2288 | 8 |
| Ce | 954.13 | 90.5 | 1585.58 | 49 | 3894 | 8 |
| Pr | 6 | 6 | - | 6 | 6 | 1 |
| Nd | 311.38 | 50 | 501.42 | 18 | 1225 | 8 |
| Sc | 11.13 | 4 | 14.51 | | 36 | 8 |
| V | 4.13 | | 5.84 | | 15 | 8 |
| Cr | 1 | | - | | | 8 |
| Co | 5.63 | 5.5 | 3.11 | | 10 | 8 |
| Ni | 1.38 | | 0.52 | | 2 | 8 |
| Cu | 12 | 3.5 | 22.35 | | 67 | 8 |
| Zn | 177.75 | 41.5 | 271.28 | 4 | 697 | 8 |
| Sn | 38.13 | 27 | 30.21 | 5 | 78 | 8 |
| W | 19.13 | 16.5 | 10.58 | 6 | 37 | 8 |
| Mo | 3.63 | .50 | 4.39 | | 14 | 8 |
| Ga | 31.5 | 25 | 13.08 | 21 | 59 | 8 |
| As | 1.38 | 0.75 | 1.55 | 50 | 4.5 | 8 |
| S | 58.13 | 15 | 86 | 3 | 225 | 8 |
| F | 4035.71 | 3500 | 3423.05 | 950 | 11300 | 7 |
| Cl | 206.88 | 105 | 222.23 | 39 | 584 | 8 |
| Be | 6.75 | 6.5 | 2.96 | 3 | 13 | 8 |
| Bi | 2.13 | | 1.81 | | 5 | 8 |
| Se | 0.83 | | 0.29 | | | 3 |

## Steeles Granite

### MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 69.07 | 68.52 | 4.99 | 55 | 76 | 16 |
| TiO2 | 0.66 | 0.71 | 0.35 | 0.09 | 1.18 | 16 |
| Al2O3 | 13.29 | 13.25 | 0.43 | 12.8 | 14.3 | 16 |
| Fe2O3 | 1.19 | 1.22 | 0.48 | 0.45 | 2.17 | 16 |
| FeO | 3.22 | 3.33 | 1.92 | 0.47 | 6.95 | 16 |
| MnO | 0.06 | 0.06 | 0.02 | 0.03 | 0.13 | 16 |
| MgO | 1.18 | 0.88 | 1.6 | 0.06 | 7 | 16 |
| CaO | 2.68 | 2.63 | 1.75 | 0.96 | 8.4 | 16 |
| Na2O | 2.36 | 2.29 | 0.68 | 1.58 | 4.45 | 16 |
| K2O | 4.76 | 4.93 | 1.35 | 1 | 6.2 | 16 |
| P2O5 | 0.18 | 0.19 | 0.1 | 0.02 | 0.36 | 16 |
| H2O+ | 0.78 | 0.73 | 0.34 | 0.35 | 1.85 | 16 |
| H2O- | 0.13 | 0.08 | 0.23 | 0.04 | 1 | 16 |
| CO2 | 0.09 | 0.08 | 0.07 | 05 | 0.18 | 16 |
| LOI | - | - | - | - | - | - |
| Ba | 818.63 | 890 | 486.2 | 79 | 1450 | 16 |
| Li | 13.67 | 18 | 8.39 | 4 | 19 | 3 |
| Rb | 230.5 | 224.5 | 86.41 | 70 | 430 | 16 |
| Sr | 130.31 | 141.5 | 54.09 | 28 | 200 | 16 |
| Pb | 28.31 | 29 | 8.58 | 12 | 50 | 16 |
| Th | 35.44 | 33 | 13.92 | 20 | 65 | 16 |
| U | 6.06 | 6 | 3.42 | | 14 | 16 |
| Zr | 376.81 | 370 | 186.78 | 110 | 680 | 16 |
| Nb | 26.13 | 26 | 9.51 | 7 | 42 | 16 |
| Y | 45.56 | 49 | 14.45 | 19 | 65 | 16 |
| La | 100.13 | 100 | 39.95 | 30 | 194 | 16 |
| Ce | 170.5 | 170 | 70.56 | 50 | 326 | 16 |
| Pr | - | - | - | - | - | - |
| Nd | 70.67 | 62 | 19.5 | 57 | 93 | 3 |
| Sc | 8 | 11 | 6.08 | | 12 | 3 |
| V | 33.88 | 30 | 14.07 | | 60 | 16 |
| Cr | 6 | 5 | 4.58 | 2 | 11 | 3 |
| Co | 11.5 | 11.5 | 0.71 | 11 | 12 | 2 |
| Ni | 3.67 | 3 | 2.08 | 2 | 6 | 3 |
| Cu | 21.31 | 16 | 27.33 | | 110 | 16 |
| Zn | 43.88 | 46 | 22.89 | 6 | 70 | 16 |
| Sn | 3.69 | 3.5 | 2.52 | | 10 | 16 |
| W | 5 | 5 | 2.83 | 3 | 7 | 2 |
| Mo | 2.25 | 2.25 | 1.06 | | 3 | 2 |
| Ga | 16 | 16 | 2 | 14 | 18 | 3 |
| As | 0.58 | 50 | 0.38 | | 1 | 3 |
| S | 31.5 | 31.5 | 3.54 | 29 | 34 | 2 |
| F | 1175 | 1300 | 888.35 | 100 | 2000 | 4 |
| Cl | 239 | 239 | 59.4 | 197 | 281 | 2 |
| Be | 5 | 5 | 1.41 | 4 | 6 | 2 |
| Bi | 1 | | - | | | 2 |
| Se | - | - | - | - | - | - |

## Carters Bore Rhyolite

## MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 74.49 | 74.51 | 0.98 | 73.2 | 76.1 | 7 |
| TiO2 | 0.29 | 0.25 | 0.17 | 0.05 | 0.47 | 7 |
| Al2O3 | 11.68 | 11.6 | 0.78 | 10.7 | 12.76 | 7 |
| Fe2O3 | 1.64 | 0.66 | 1.52 | 0.49 | 3.88 | 7 |
| FeO | 0.38 | 0.35 | 0.15 | 0.2 | 0.62 | 7 |
| MnO | 0.01 | 0.01 | - | 0.01 | 0.01 | 7 |
| MgO | 0.74 | 0.94 | 0.5 | 0.13 | 1.31 | 7 |
| CaO | 0.18 | 0.17 | 0.14 | 01 | 0.45 | 7 |
| Na2O | 0.18 | 0.2 | 0.09 | 0.06 | 0.34 | 7 |
| K2O | 8.88 | 9.2 | 0.96 | 7.02 | 9.76 | 7 |
| P2O5 | 0.09 | 0.06 | 0.1 | 0.02 | 0.29 | 7 |
| H2O+ | 0.44 | 0.53 | 0.23 | 0.1 | 0.6 | 4 |
| H2O- | 0.19 | 0.2 | 0.11 | 0.05 | 0.29 | 4 |
| CO2 | 0.2 | 0.04 | 0.33 | 05 | 0.7 | 4 |
| LOI | 1.27 | 1.33 | 0.27 | 0.97 | 1.51 | 3 |
| Ba | 237 | 202 | 83.22 | 132 | 342 | 7 |
| Li | 14.83 | 5.5 | 16.19 | 3 | 39 | 6 |
| Rb | 219.71 | 140 | 192.74 | 96 | 642 | 7 |
| Sr | 13 | 11 | 5.42 | 7 | 23 | 7 |
| Pb | 8.71 | 7 | 6.65 | | 22 | 7 |
| Th | 41.86 | 30 | 23.82 | 26 | 92 | 7 |
| U | 15 | 9 | 12.37 | 6 | 39 | 7 |
| Zr | 307.57 | 347 | 125.79 | 122 | 450 | 7 |
| Nb | 42 | 35 | 18.85 | 25 | 74 | 7 |
| Y | 92.43 | 59 | 59.75 | 50 | 208 | 7 |
| La | 74.57 | 87 | 36.49 | 14 | 110 | 7 |
| Ce | 145.43 | 175 | 64.02 | 34 | 203 | 7 |
| Pr | 11 | 9 | 9.17 | 3 | 21 | 3 |
| Nd | 60.83 | 72 | 26.58 | 14 | 83 | 6 |
| Sc | 2.2 | 2 | 0.84 | | 3 | 5 |
| V | 7.5 | 5.5 | 4.76 | | 12 | 6 |
| Cr | 3.36 | | 2.46 | | 6 | 7 |
| Mn | 60 | 60 | - | 60 | 60 | 1 |
| Co | 2.5 | | - | | | 1 |
| Ni | 2.67 | 1.5 | 2.73 | 1 | 8 | 6 |
| Cu | 25.71 | 6 | 53.96 | 2 | 148 | 7 |
| Zn | 8.57 | 8 | 3.82 | 4 | 14 | 7 |
| Sn | 10.43 | 6 | 8.28 | 5 | 23 | 7 |
| W | - | - | - | - | - | - |
| Mo | 10 | 6 | 11.53 | | 23 | 3 |
| Ga | 17.6 | 19 | 11.33 | 6 | 30 | 5 |
| As | 1.44 | 0.63 | 1.74 | | 4 | 4 |
| S | 32.33 | 30 | 6.81 | 27 | 40 | 3 |
| F | - | - | - | - | - | - |
| Cl | 55.5 | 55.5 | 28.99 | 35 | 76 | 2 |
| Be | 4.33 | 4 | 0.58 | 4 | 5 | 3 |
| Ag | 1 | 1 | - | 1 | 1 | 1 |
| Bi | 1 | | - | | | 3 |
| Hf | 13 | 13 | - | 13 | 13 | 1 |
| Ta | 3 | 3 | - | 3 | 3 | 1 |
| Cs | 1.5 | | - | | | 1 |
| Ge | 2 | 2 | - | 2 | 2 | 1 |
| Se | 0.5 | | - | | | 3 |

## Widgewarra Granite

### MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 70.39 | 72.73 | 3.7 | 65.01 | 73.88 | 7 |
| TiO2 | 0.57 | 0.39 | 0.35 | 0.24 | 1.07 | 7 |
| Al2O3 | 12.98 | 13.07 | 0.4 | 12.33 | 13.47 | 7 |
| Fe2O3 | 1.28 | 1.16 | 0.62 | 0.57 | 2.28 | 7 |
| FeO | 2.96 | 2.06 | 1.39 | 1.73 | 4.82 | 7 |
| MnO | 0.07 | 0.05 | 0.03 | 0.04 | 0.1 | 7 |
| MgO | 0.53 | 0.35 | 0.33 | 0.23 | 1.06 | 7 |
| CaO | 2.1 | 1.56 | 0.83 | 1.34 | 3.32 | 7 |
| Na2O | 2.57 | 2.62 | 0.18 | 2.31 | 2.83 | 7 |
| K2O | 5.28 | 5.39 | 0.41 | 4.74 | 5.89 | 7 |
| P2O5 | 0.16 | 0.08 | 0.13 | 0.05 | 0.34 | 7 |
| H2O+ | 0.71 | 0.69 | 0.18 | 0.44 | 1.04 | 7 |
| H2O- | 0.09 | 0.1 | 0.05 | 0.01 | 0.14 | 7 |
| CO2 | 0.14 | 0.15 | 0.09 | 0.05 | 0.25 | 7 |
| LOI | - | - | - | - | - | - |
| Ba | 1007.86 | 929 | 393.77 | 516 | 1503 | 7 |
| Li | 17.43 | 16 | 7.23 | 6 | 27 | 7 |
| Rb | 183.43 | 182 | 50.51 | 91 | 249 | 7 |
| Sr | 136.57 | 128 | 38.75 | 91 | 196 | 7 |
| Pb | 27.86 | 29 | 9.25 | 9 | 37 | 7 |
| Th | 23.57 | 23 | 10.29 | 9 | 43 | 7 |
| U | 3.29 | 3 | 2.21 | | 7 | 7 |
| Zr | 367.14 | 350 | 126.2 | 213 | 543 | 7 |
| Nb | 28.57 | 27 | 9.76 | 18 | 47 | 7 |
| Y | 51.86 | 57 | 22.54 | 23 | 86 | 7 |
| La | 107.57 | 118 | 36.75 | 60 | 156 | 7 |
| Ce | 189.43 | 216 | 69.68 | 93 | 272 | 7 |
| Pr | - | - | - | - | - | - |
| Nd | 73 | 73 | - | 73 | 73 | 1 |
| Sc | 16 | 16 | - | 16 | 16 | 1 |
| V | 23.29 | 14 | 18.25 | 6 | 48 | 7 |
| Cr | 4 | 4 | - | 4 | 4 | 1 |
| Co | 13 | 13 | - | 13 | 13 | 1 |
| Ni | 3.71 | 4 | 1.5 | 2 | 6 | 7 |
| Cu | 11.29 | 11 | 6.7 | 3 | 23 | 7 |
| Zn | 68.71 | 55 | 27.08 | 36 | 100 | 7 |
| Sn | 5.29 | 6 | 2.43 | 2 | 9 | 7 |
| W | 6 | 6 | - | 6 | 6 | 1 |
| Mo | 6 | 6 | - | 6 | 6 | 1 |
| Ga | 18 | 18 | - | 18 | 18 | 1 |
| As | 2 | 2 | - | 2 | 2 | 1 |
| S | 239 | 239 | - | 239 | 239 | 1 |
| F | 1500 | 1500 | 565.69 | 1100 | 1900 | 2 |
| Cl | 654 | 654 | - | 654 | 654 | 1 |
| Be | 3.75 | 4 | 1.26 | 2 | 5 | 4 |
| Bi | 1 | | - | | | 1 |
| Se | - | - | - | - | - | - |

## Wonomo Granite

## MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 75.8 | 75.9 | 0.76 | 75 | 76.5 | 3 |
| TiO2 | 0.17 | 0.2 | 0.06 | 0.1 | 0.22 | 3 |
| Al2O3 | 12.3 | 12.3 | 0.6 | 11.7 | 12.9 | 3 |
| Fe2O3 | 0.65 | 0.73 | 0.22 | 0.4 | 0.81 | 3 |
| FeO | 1.26 | 1.46 | 0.47 | 0.72 | 1.6 | 3 |
| MnO | 0.04 | 0.04 | 0.01 | 0.03 | 0.05 | 3 |
| MgO | 0.16 | 0.2 | 0.1 | 0.05 | 0.24 | 3 |
| CaO | 1.02 | 0.96 | 0.12 | 0.94 | 1.16 | 3 |
| Na2O | 2.56 | 2.54 | 0.03 | 2.54 | 2.6 | 3 |
| K2O | 5.39 | 5.25 | 0.55 | 4.92 | 6 | 3 |
| P2O5 | 0.03 | 0.03 | 0.01 | 0.02 | 0.04 | 3 |
| H2O+ | 0.45 | 0.45 | 0.05 | 0.4 | 0.5 | 3 |
| H2O- | 0.2 | 0.05 | 0.26 | 0.05 | 0.5 | 3 |
| CO2 | 0.2 | 0.05 | 0.26 | 0.05 | 0.5 | 3 |
| LOI | - | - | - | - | - | - |
| Ba | 286.67 | 320 | 66.58 | 210 | 330 | 3 |
| Li | - | - | - | - | - | - |
| Rb | 346.67 | 330 | 37.86 | 320 | 390 | 3 |
| Sr | 48.33 | 48 | 6.51 | 42 | 55 | 3 |
| Pb | 43.67 | 38 | 9.81 | 38 | 55 | 3 |
| Th | 54.33 | 55 | 6.03 | 48 | 60 | 3 |
| U | 10.67 | 10 | 3.06 | 8 | 14 | 3 |
| Zr | 216.67 | 240 | 87.37 | 120 | 290 | 3 |
| Nb | 38.67 | 36 | 4.62 | 36 | 44 | 3 |
| Y | 58.33 | 60 | 7.64 | 50 | 65 | 3 |
| La | 86.67 | 100 | 51.32 | 30 | 130 | 3 |
| Ce | 168.33 | 190 | 94.38 | 65 | 250 | 3 |
| Pr | - | - | - | - | - | - |
| Nd | - | - | - | - | - | - |
| Sc | - | - | - | - | - | - |
| V | 13.33 | | 5.77 | | 20 | 3 |
| Cr | - | - | - | - | - | - |
| Co | - | - | - | - | - | - |
| Ni | - | - | - | - | - | - |
| Cu | 6 | | 8.66 | | 16 | 3 |
| Zn | 20 | 24 | 14.42 | 4 | 32 | 3 |
| Sn | 6 | 7 | 2.65 | 3 | 8 | 3 |
| W | - | - | - | - | - | - |
| Mo | - | - | - | - | - | - |
| Ga | - | - | - | - | - | - |
| As | - | - | - | - | - | - |
| S | - | - | - | - | - | - |
| F | 2300 | 2300 | - | 2300 | 2300 | 1 |
| Cl | - | - | - | - | - | - |
| Be | - | - | - | - | - | - |
| Bi | - | - | - | - | - | - |
| Se | - | - | - | - | - | - |

## Th-rich phase of Queen Elizabeth Granite

### MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 74.38 | 74.82 | 2.28 | 71.29 | 78.67 | 13 |
| TiO2 | 0.14 | 0.1 | 0.09 | 0.02 | 0.29 | 13 |
| Al2O3 | 12.75 | 12.49 | 1.32 | 11.04 | 16.46 | 13 |
| Fe2O3 | 1.02 | 1 | 0.41 | 0.51 | 2 | 13 |
| FeO | 1.05 | 0.91 | 0.67 | 0.25 | 2.32 | 13 |
| MnO | 0.04 | 0.04 | 0.02 | 0.02 | 0.08 | 13 |
| MgO | 0.1 | 0.1 | 0.04 | 0.04 | 0.16 | 13 |
| CaO | 1.11 | 1.01 | 0.26 | 0.65 | 1.51 | 13 |
| Na2O | 3.34 | 3.16 | 0.95 | 2.82 | 6.45 | 13 |
| K2O | 4.82 | 5 | 1.25 | 0.96 | 5.89 | 13 |
| P2O5 | 0.02 | 0.02 | 0.01 | 0.01 | 0.05 | 13 |
| H2O+ | 0.39 | 0.39 | 0.11 | 0.24 | 0.57 | 13 |
| H2O- | 0.17 | 0.17 | 0.06 | 0.06 | 0.29 | 13 |
| CO2 | 0.07 | 0.06 | 0.04 | 0.02 | 0.15 | 13 |
| LOI | - | - | - | - | - | - |
| Ba | 428.23 | 281 | 378.94 | 76 | 1341 | 13 |
| Li | 56.46 | 48 | 31.2 | 19 | 125 | 13 |
| Rb | 363.46 | 339 | 125.74 | 97 | 582 | 13 |
| Sr | 39 | 31 | 21.73 | 15 | 89 | 13 |
| Pb | 49.92 | 50 | 7.25 | 38 | 63 | 13 |
| Th | 54.46 | 52 | 12.11 | 34 | 84 | 13 |
| U | 14.65 | 11 | 9.63 | 7 | 40 | 13 |
| Zr | 251.62 | 210 | 122.66 | 111 | 470 | 13 |
| Nb | 76.15 | 75 | 21.07 | 18 | 111 | 13 |
| Y | 164.46 | 153 | 59.28 | 80 | 260 | 13 |
| La | 127.08 | 92 | 74.25 | 52 | 259 | 13 |
| Ce | 238.69 | 200 | 126.02 | 105 | 464 | 13 |
| Pr | - | - | - | - | - | - |
| Nd | 80.77 | 77 | 36.38 | 43 | 148 | 13 |
| Sc | 4.62 | 3 | 2.93 | 2 | 11 | 13 |
| V | 1.38 | | 1.12 | | 5 | 13 |
| Cr | 1 | | - | | | 13 |
| Co | 5.46 | 5 | 1.13 | 4 | 7 | 13 |
| Ni | 1.38 | | 0.51 | | 2 | 13 |
| Cu | 4.69 | 2 | 8.15 | | 31 | 13 |
| Zn | 54.54 | 49 | 32.58 | 12 | 116 | 13 |
| Sn | 18.69 | 11 | 17.55 | 6 | 66 | 13 |
| W | 13.31 | 12 | 5.51 | 7 | 24 | 13 |
| Mo | 2.38 | | 1.26 | | 5 | 13 |
| Ga | 24.08 | 23 | 2.9 | 21 | 31 | 13 |
| As | 0.54 | 0.5 | 0.22 | 50 | 1 | 13 |
| S | 18.69 | 16 | 12.06 | 4 | 50 | 13 |
| F | 4115.38 | 3900 | 1950.15 | 400 | 7300 | 13 |
| Cl | 157.08 | 153 | 93.06 | 46 | 345 | 13 |
| Be | 9.08 | 8 | 4.46 | 5 | 22 | 13 |
| Bi | 1.08 | | 0.28 | | 2 | 13 |
| Se | - | - | - | - | - | - |

## Queen Elizabeth Granite

### MEANS AND STANDARD DEVIATIONS

| Element | Mean | Median | Standard Deviation | Minimum | Maximum | Number of Items |
|---|---|---|---|---|---|---|
| SiO2 | 70.62 | 69.99 | 3.09 | 63.96 | 81.8 | 52 |
| TiO2 | 0.38 | 0.37 | 0.17 | 0.06 | 0.86 | 52 |
| Al2O3 | 13.43 | 13.19 | 1.35 | 9.18 | 17.82 | 52 |
| Fe2O3 | 1.39 | 1.4 | 0.51 | 0.37 | 2.62 | 52 |
| FeO | 2.29 | 2.32 | 0.76 | 0.55 | 3.88 | 52 |
| MnO | 0.07 | 0.08 | 0.03 | 0.01 | 0.13 | 52 |
| MgO | 0.36 | 0.26 | 0.25 | 0.07 | 1.13 | 52 |
| CaO | 1.78 | 1.74 | 0.6 | 0.7 | 3.75 | 52 |
| Na2O | 2.86 | 2.89 | 0.42 | 1.95 | 4.2 | 52 |
| K2O | 5.39 | 5.46 | 0.59 | 3.93 | 6.49 | 52 |
| P2O5 | 0.08 | 0.07 | 0.06 | 01 | 0.25 | 52 |
| H2O+ | 0.56 | 0.54 | 0.22 | 0.18 | 1.61 | 52 |
| H2O- | 0.19 | 0.16 | 0.1 | 0.05 | 0.58 | 52 |
| CO2 | 0.15 | 0.15 | 0.07 | 0.03 | 0.37 | 52 |
| LOI | - | - | - | - | - | - |
| Ba | 1302.1 | 1303.5 | 512.48 | 25 | 2312 | 52 |
| Li | 41.79 | 44 | 14.44 | 1 | 76 | 52 |
| Rb | 234.46 | 228.5 | 31.47 | 175 | 297 | 52 |
| Sr | 109.65 | 112.5 | 41.79 | 6 | 228 | 52 |
| Pb | 37.13 | 37 | 4.71 | 24 | 53 | 52 |
| Th | 30.48 | 30 | 9.01 | 13 | 56 | 52 |
| U | 5.18 | 4.5 | 2.13 | 2 | 11 | 52 |
| Zr | 447.19 | 436.5 | 146.66 | 108 | 792 | 52 |
| Nb | 49.5 | 49 | 15.92 | 14 | 82 | 52 |
| Y | 87.27 | 86.5 | 24.29 | 20 | 140 | 52 |
| La | 170.44 | 163.5 | 73.92 | 13 | 402 | 52 |
| Ce | 303.21 | 297.5 | 124.48 | 31 | 702 | 52 |
| Pr | - | - | - | - | - | - |
| Nd | 98.28 | 98 | 33.07 | 31 | 205 | 50 |
| Sc | 8.76 | 9 | 3.05 | | 14 | 50 |
| V | 8.46 | 4 | 10.59 | | 43 | 52 |
| Cr | 2.16 | | 3.63 | | 15 | 50 |
| Co | 6.36 | 5.5 | 3.34 | | 16 | 50 |
| Ni | 2.31 | 2 | 2.21 | | 11 | 52 |
| Cu | 13.58 | 6.5 | 46.07 | | 338 | 52 |
| Zn | 88.5 | 92 | 25.53 | 18 | 139 | 52 |
| Sn | 5.58 | 6 | 2.02 | | 11 | 52 |
| W | 6.34 | 6.5 | 1.72 | 3 | 10 | 50 |
| Mo | 3.57 | 4 | 0.98 | | 5 | 50 |
| Ga | 20.66 | 21 | 2.99 | 13 | 29 | 50 |
| As | 0.63 | 0.5 | 0.31 | 50 | 1.5 | 50 |
| S | 35.38 | 30 | 32.08 | 6 | 240 | 50 |
| F | 2138 | 2200 | 630.16 | 600 | 3600 | 50 |
| Cl | 305.86 | 325 | 127.98 | 89 | 640 | 50 |
| Be | 5.78 | 5 | 2.09 | 3 | 17 | 51 |
| Bi | 1.34 | | 1.32 | | 10 | 50 |
| Se | - | - | - | - | - | - |