

1 PINE CREEK INLIER SYNTHESIS

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1.1 Executive Summary - Geology

The Pine Creek Inlier is one of the major mineral provinces of Australia. The Inlier hosts 30% of the world's known uranium resources (Ranger, Koongarra, Jabiluka and Nabarlek) and is a major gold producer with deposits such as Cosmo Howley, Enterprise, and Mount Todd. Historically, substantial amounts of base metals, silver, iron, tin and tungsten have also been mined.

The regional geology of the Pine Creek Inlier was reviewed by Needham and de Ross (1990) and Needham (1988). The main components of the Inlier are a series of late Archaean basement domes overlain by a Palaeoproterozoic sedimentary sequence deposited in a shallow intracontinental rift. This predominantly clastic sequence also contains some highly reactive rock units including carbonaceous shale, banded iron formation, evaporite, carbonate, and mafic and felsic volcanics. These units were deformed, metamorphosed and intruded by granite at around ~1875 Ma. A sequence of predominantly rift-related felsic volcanics was extruded unconformably over the deformed basement at around 1860-1830 Ma. These volcanics were overlain by platform sandstone of the Katherine River Group.

There are two main episodes of granite intrusion in the Pine Creek Inlier. The first major event was coeval with or later than the major deformation event and occurred between 1865 and 1850 Ma (Nimbuwah Suite, Allia Suite, Wagait Suite). The next major event was the intrusion of the Cullen Supersuite and the Jim Jim Suite from about 1830-1810 Ma. Both events were associated with felsic volcanism. All suites are Sr-depleted, Y-undepleted, indicating a plagioclase-residual source. Most suites are I-(granodiorite) type, although there is a reasonable proportion of S-types (the Allia Suite) in the Litchfield Block.

1.2 Executive Summary - Metallogenic Potential

This compilation has assessed the potential of each granite suite based on the criteria set out in the Project Proposal. Suites which have been identified as having potential for granite-related mineralisation are:

The Allia Creek Suite at ~1845 Ma is a felsic fractionated S-type suite with potential for Sn. The suite contains pegmatites and greisens.

The Cullen Supersuite at 1825 Ma is a felsic fractionated I-(granodioritic) type suite which has proven Au, Sn and W potential and has some minor Cu and base metal occurrences.

The Jim Jim Suite at 1825 Ma is a fractionated I-(granodioritic) suite which may have some potential for Sn and Au.

1.3 Future Work

In view of the abundance of data in the Pine Creek Inlier in comparison to some of the more poorly known Proterozoic provinces, further sampling in this province is not a high priority. Some more focused research could be carried out with respect to the Pb isotopes to resolve the issue as to whether the source of the Au is the granites or whether the Au is leached from the adjacent country rocks by interaction with magmatic fluids.

1.4 Methods

Information Sources: 1:250 000 maps and notes, 1:100 000 maps and commentaries where available, published ages, AGSO OZCHEM database supplemented with data from NTGS, BRS/AGSO Minloc database, AGSO magnetics and gravity.

Classification of Granites: In this report the granites have been divided into suites based on the age, geographic location, and geochemistry of each pluton. Using this method, four major and three minor suites are recognised (Table 1.1).

Host Rocks: The country rocks which are thought to be intruded by each suite have been summarised, and classified according to mineralogical characteristics thought to be important in determining the metallogenic potential of a granite intrusive event.

Relating Mineralisation: Very little direct dating of mineralisation is available in the Pine Creek Inlier, particularly for Au. Therefore, the method used has been to exclude all deposits more than 5 km from a known outcropping granite, then for those remaining, to make an assessment of the likelihood that they may be derived from granite intrusive activity (based on deposit style). The existence of known mineralisation thought to be associated with a granite has been a factor in categorising the metallogenic potential of that granite, however, it is only one criterion of several.

1.5 Acknowledgements This section has benefited greatly from the help provided by Zia Bajwah and Masood Ahmad of the Northern Territory Geological Survey.

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1.1 Table 1.1

Chpt #	Grouping (Type)	Age (Ma)	Potential					Confid Level	Rock Unit
			Cu	Au	Pb/Zn	Sn	Mo/W		
6	Gerowie (Kalkadoon)	1885	None	None	None	None	None	321	Gerowie Tuff
									Mount Bonnie Formation
									Tollis Formation
									Berinka Volcanics
									Warr's Volcanic Member
									Mulluk Mulluk Volcanic Member
									Burrell Creek Formation
									Yarrowonga Volcanic Member
									Meeway Volcanics
									Annaburroo Volcanic Member
2	Nimbuwah (Kalkadoon)	1865	None	None	None	None	None	210	Nimbuwah Complex intrusives
6	El Sherana (Kalkadoon)	1865	None	None	None	None	None	221	El Sherana Group
									Pul Pul Rhyolite
									Coronation Hill Sandstone
6	Wagait (Kalkadoon)	1850	Low	Low	Low	Low	Low	320	Wagait Granite
									Peppimenarti Granite
									Reynolds River Granite
									Koolendong Granite
3	Allia Creek (Allia)	1845	None	Low	None	High	Low	322	Allia Creek Granite
									Two Sisters Granite
									Murra-Kamangee Granodiorite
									Jamine Granite
									Fish Billabong Adamellite
									Mount Litchfield Granite
									Soldiers Creek Granite
4	Cullen (Cullen)	1825	Mod	High	Low	High	Mod	323	Allamber Springs Granite
									Bonrook Granite
									McKinlay Granite
									Mount Porter Granite
									Burnside Granite
									Douglas Leucogranite
									Frances Creek Leucogranite
									Mount Davis Granite
									Driffield Granite
Fingerpost Granodiorite									

Chpt #	Grouping (Type)	Age (Ma)	Potential					Confid Level	Rock Unit
			Cu	Au	Pb/Zn	Sn	Mo/W		
									Fenton Granite
									Tennysons Leucogranite
									Umbrawarra Leucogranite
									Wandie Granite
									Wolfram Hill Granite
									Yenberrie Leucogranite
									Foelsche Leucogranite
									Saunders Leucogranite
									Mount Bundey Granite
									Margaret Granite
									McMinns Bluff Granite
									Prices Springs Granite
									McCarthys Granite
									Minglo Granite
									Shoobridge Granite
									Tabletop Granite
5	Jim Jim (Nicholson)	1825	Low	Mod	None	High	High	322	Nabarlek Granite
									Tin Camp Granite
									Jim Jim Granite
									Malone Creek Granite
									Grace Creek Granite
									Eva Valley Granite
									Yeuralba Granite
									Edith River Volcanics
									Plum Tree Creek Volcanics
									Big Sunday Formation
									Gimbat Formation

2 NIMBUWAH SUITE

2.1 **Timing** 1865 Ma

2.2 **Individual Ages** **Primary Ages:**

- | | |
|---|-------------------|
| 1. Nimbuwah Complex (tonalite) ^{1,2} | 1866 ± 8 Ma, U-Pb |
| 2. Nimbuwah Complex (granite) ^{1,2} | 1866 ± 7 Ma, U-Pb |

Sources: [1] OZCHRON, [2] Page *et al.* (1980)

Note: an additional age of 1886 ± 5 Ma is often quoted for the Nimbuwah Complex (e.g., Page *et al.* 1980). However, this sample contains two pyroxenes, garnet, quartz, plagioclase, and biotite and is probably country rock.

2.3 **Regional Setting**

The Nimbuwah Suite comprises the Nimbuwah Complex and is extremely heterogeneous in the field. The name 'Nimbuwah Granite' was first applied by Dunn (1962) to describe a 'biotite-hornblende granite with mafic phases' which intruded high-grade Palaeoproterozoic sediments. The name was changed to 'Nimbuwah Complex' by Needham *et al.* (1973, 1974, 1975) who recognised the heterogeneous character of the rocks and also included metasedimentary schist and gneiss. These metasedimentary areas have subsequently been excluded from the Nimbuwah Complex (Needham 1982), as it is interpreted that the biotite-hornblende granite intruded high-grade metamorphic rocks, rather than being derived from them. The Nimbuwah Complex has itself been metamorphosed to granulite facies possibly at around 1800 Ma (based on a regional Rb-Sr isochron, Page *et al.* 1980) and in these areas it is difficult to determine which is granite *sensu stricto* related to the Nimbuwah intrusive event and which is highly metamorphosed country rock. Despite the post-intrusive metamorphism, the Nimbuwah Suite forms a relatively coherent geochemical group, suggesting that those samples that have been included in the database as Nimbuwah Complex are true intrusives.

The Nimbuwah Complex is unconformably overlain by the Kombolgie Formation of the Katherine River Group, the Cambrian Buckingham Bay Sandstone and the Mesozoic Bathurst Island Formation. It is intruded by the Oenpelli Dolerite and the Maningkorri Phonolite.

2.4 **Summary**

The Nimbuwah Suite is dominantly a restite suite with little or no evidence of fractionation. It has no known mineral deposits associated with it, although it could be argued that exploration in this area has been minimal. Uranium deposits in the vicinity are related to post-intrusive hydrothermal events at ~1600 Ma.

2.5 **Potential**

Because of the dominance of restite, the Nimbuwah Suite is not considered to have any potential.

Cu:	None
Au:	None
Pb/Zn:	None
Sn:	None
Mo/W:	None
Confidence Level:	210

- 2.6 Descriptive Data** *Location:* The Nimbuwah Suite crops out in northwestern Arnhem Land between the Goomadeer River estuary, Aurai Bay and Narbalek, and also occurs in the Caramal East and Beatrice Inliers. It crops out mainly on the Alligator Rivers 1:250 000 Sheet area and also extends onto the western Millingimbi 1:250 000 Sheet area.
- Dimensions and area:* The outcrop forms a roughly circular body in the north and as an isolated inlier surrounded by Kombolgie Formation. The unit crops out over an area 110 by 100 km, and the known outcrops cover 1100 km². Full dimensions are unknown as it is unconformably overlain by the Kombolgie Formation.
- 2.7 Intrusives** *Component plutons:* The Nimbuwah Complex.
- Form:* Crops out as a semi-circular body.
- Metamorphism and Deformation:* Some plutons are described as foliated, although massive textures appear to dominate. With metamorphism, it is difficult to determine from the descriptions if: (1) the granite is intruding high-grade metamorphics; (2) the 'migmatitic' textures reflect a high 'restitic' component; or (3) the 'migmatitic' textures reflect the upper amphibolite to granulite facies post-intrusive metamorphism. Given the description of the amphiboles as being poikilitic [poikiloblastic – ed.] and the granulite-facies mineral assemblages present, we argue that the Nimbuwah Suite has for the most part been strongly metamorphosed, which would make the actual boundaries between genuine 'intrusive' rocks and high-grade regionally metamorphosed rocks difficult to determine.
- Dominant intrusive rock types:* The dominant intrusive rock type is migmatite which ranges from banded rock consisting of alternating pale and dark layers up to 5 mm thick to massive rock in which a variety of migmatite textures is evident in lenticular to irregular masses. Less migmatitic rock types include tonalite, granodiorite, and granite which is strongly porphyritic in places with K-feldspar phenocrysts.
- Colour:* Grey.
- Veins, Pegmatites, Aplites, Greisens:* Granitic pegmatites form veins up to 1 m wide, commonly interlayered with aplite. These may be derived during metamorphism rather than as a result of magmatic processes.
- Distinctive mineralogical characteristics:* Biotite, hornblende, plagioclase, K-feldspar, quartz with accessory apatite, zircon and allanite with rare fluorite, magnetite and titanite. In the migmatized area in the Beatrice Inlier, orthopyroxene, clinopyroxene and garnet have been noted.
- Xenoliths:* Abundant in some places.
- Breccias:* None described.
- Alteration in the granite:* Feldspar phenocrysts are usually altered and green, with haloes up to 2 cm wide of pink altered groundmass with fine epidote veinlets. In some areas biotite is altered to chlorite. All alteration features described appear related to later metamorphism and deformation rather than to primary magmatic effects.
- 2.8 Extrusives** None formally noted, although there is a possibility that some outcrops mapped as El Sherana Group some 10 km east of the Ranger Uranium deposit, and also near Mount Basedow, may be comagmatic.
- 2.9 Country Rock** *Contact metamorphism:* None described, although the subsequent regional metamorphism would have overprinted this.
- Reaction with country rock:* None recorded.
- Units the granite intrudes:* Zamu Dolerite, Myra Falls Metamorphics.
- Dominant rock types:* Amphibolite, dolerite, schist, quartzite and gneiss.
- Potential hosts:* Amphibolite.
- 2.10 Mineralisation** There are uranium deposits and prospects in the vicinity of the Nimbuwah Suite. These are much younger in age and are related to processes that post-date deposition of the overlying Kombolgie Formation.

2.11 Geochemical Data

Data source: AGSO's OZCHEM database. The samples were collected as part of regional 1:100 000 mapping programs (Needham 1982, 1984; Needham *et al.* 1973, 1975; Needham and Stuart-Smith 1978); analysis of geochronological samples collected for both Rb-Sr and U-Pb zircon work (Page *et al.* 1980) and specialist collections made for granite geochemistry (Ferguson *et al.* 1980).

Data quality: Good, all analytical work was carried out in AGSO's laboratories.

Are the data representative? Given the lithological descriptions, the data are not all that representative. There are few samples from what has been described as the more northerly granitic mass which is also likely to be the most fractionated. However, it is recognised that given the degree of heterogeneity described, effectively sampling this suite would have been a problem. It is also difficult to relate different petrographic descriptions to the geochemistry, particularly with respect to degree of metamorphism.

Are the data adequate? If this is a restite system then yes. However, some further sampling of the more felsic rock types would give a more balanced assessment of this unit, and would further determine if there had been any late-stage fractionation of the granite itself.

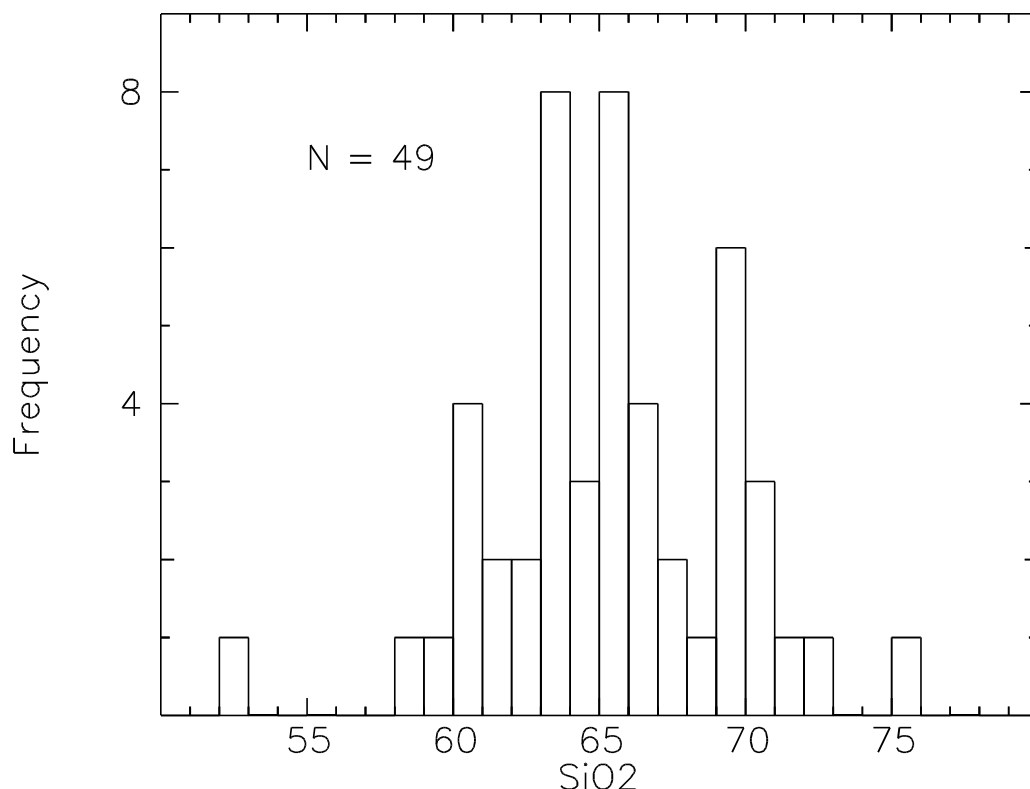


Figure 2.1. Frequency histogram for SiO₂ values for the Nimbuwah Suite

SiO₂ range (Fig. 2.1): The SiO₂ range is from 58 to 76 wt%. The distribution is very heterogeneous, reflecting the nature of the outcrop. Further, the area which was described as being fairly felsic has not been sampled.

Alteration (Figs. 2.1 & 2.2):

- **SiO₂:** No evidence of silicification.
- **K₂O/Na₂O:** Some evidence of sodic alteration.
- **Th/U:** The samples have lost considerable U presumably during the regional metamorphism. These are the only Proterozoic granites in the Pine Creek Inlier that have such high Th/U ratios; the only other granites with these high Th/U ratios are the Archaean Nanambu Complex.
- **Fe₂O₃/(FeO+Fe₂O₃):** The samples have been relatively reduced and have not been affected by oxidised alteration fluids that have been recorded in the nearby U deposits (Wilde and Wall 1987; Wilde *et al.* 1987).

Fractionation Plots (Fig. 2.3):

- **Rb**: One sample has high Rb, the remainder show only a weak increase with increasing SiO₂.
- **U**: No increase in U increase with increasing SiO₂.
- **Y**: No increase in Y increase with increasing SiO₂.
- **P₂O₅**: There is a general decrease in P₂O₅ with increasing SiO₂.
- **Th**: Weak increase with increasing SiO₂. Two high samples presumably reflect alteration.
- **K/Rb**: Scattered.
- **Rb-Ba-Sr**: Almost all samples plot in the anomalous granite field.
- **Sr**: Moderately high values which decrease with increasing SiO₂.
- **Rb/Sr**: No increase with increasing SiO₂.
- **Ba**: Scattered trend.
- **F**: Weak decrease with increasing SiO₂. Values are moderate to low for Australian Proterozoic granites.

Metals (Fig. 2.4):

- **Cu**: Decreases with increasing SiO₂.
- **Pb**: Increases weakly with increasing SiO₂.
- **Zn**: Decreases with increasing SiO₂.
- **Sn**: Values are low and there is no noticeable increase with increasing SiO₂.

High field strength elements (Fig. 2.5):

- **Zr**: Values are low and there is no significant increase with increasing SiO₂.
- **Nb**: Values are low.
- **Ce**: Values are low to moderate.

Classification (Fig. 2.6):

- **The CaO/Na₂O/K₂O plot of White, quoted in Sheraton and Simons (1992)**: The samples plot in the tonalite to granodiorite to monzogranite to granite fields.
- **Zr/Y vs Sr/Sr***: All samples plot below 1 indicating that they are Sr-depleted.
- **Spidergram**: The samples selected are both Sr-depleted and Y-undepleted.
- **Oxidation plot of Champion and Heinemann (1994)**: Samples range from oxidised to reduced. Reduced I-type granites appear to be common in the Pine Creek Inlier (*c.f.*, the Cullen Supersuite).
- **ASI**: Samples are metaluminous to weakly peraluminous.
- **A-type plot of Eby (1990)**: Most samples plot in the A-type field as defined by Eby (1980) for Palaeozoic granites.

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

Australian Proterozoic granite type: Kalkadoon.

2.12 Geophysical Signature

Radiometrics (Fig. 2.7): Samples would appear white to yellow due to the loss of U during metamorphism.

Gravity: Ten measured dry densities for the Nimbuwah Complex range from 2.57 to 2.77 gm/cm³ with an average of 2.68. On the AGSO regional gravity data, the Nimbuwah Complex plots for the most part on regional gravity highs.

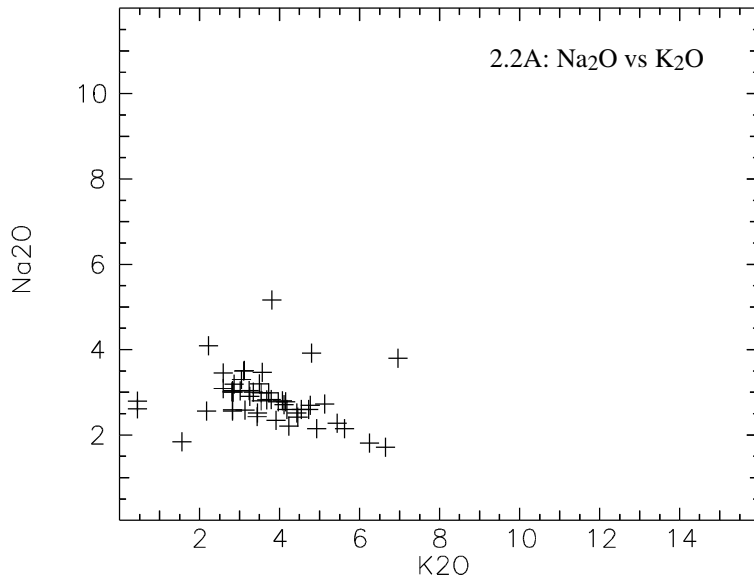
Magnetics: On the AGSO regional magnetic data the Nimbuwah Complex corresponds to magnetic lows.

2.13 References

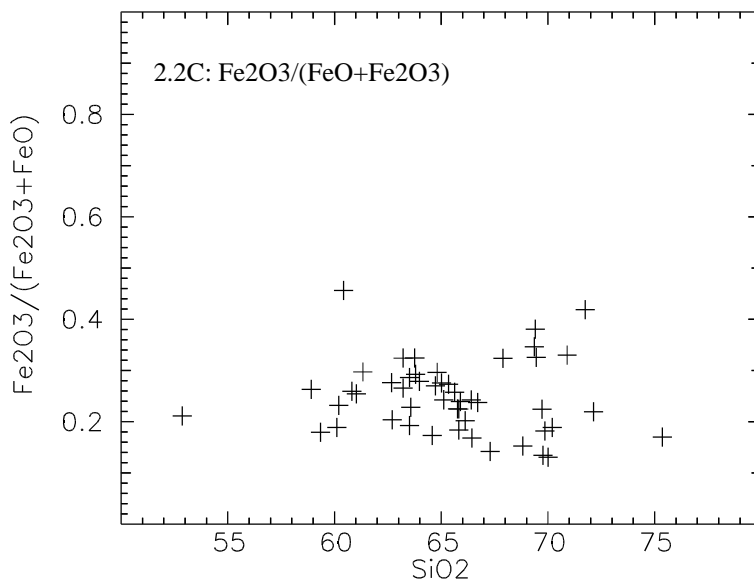
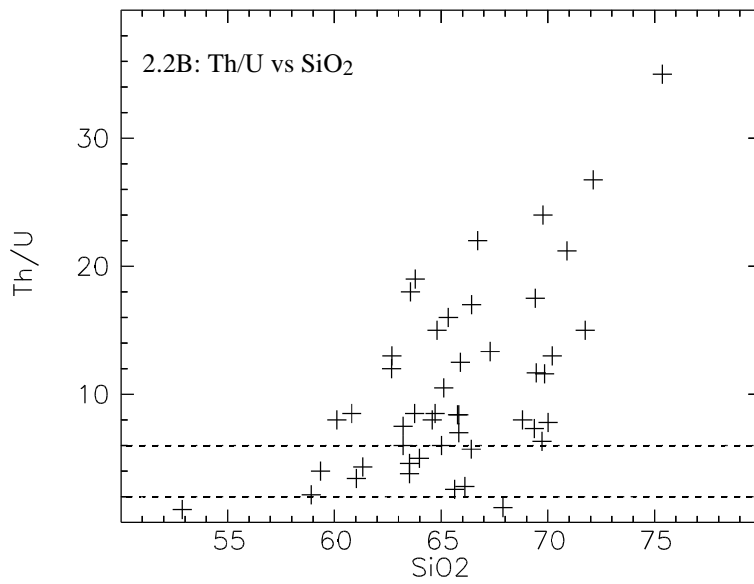
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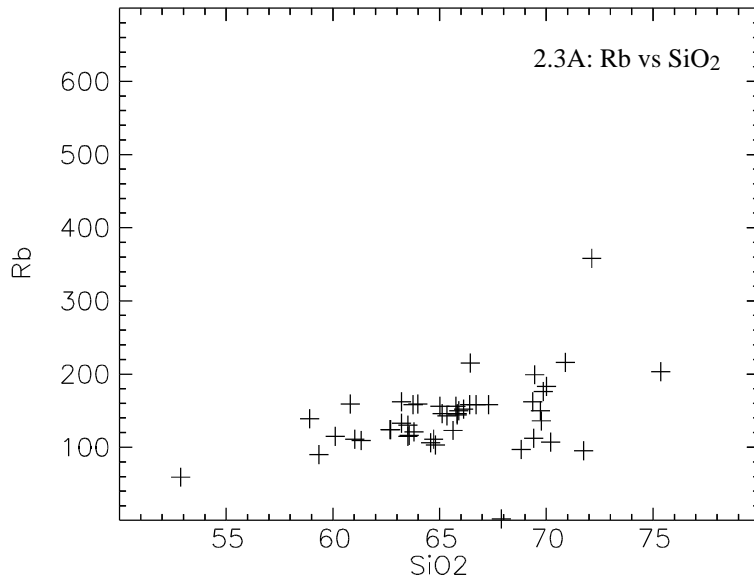
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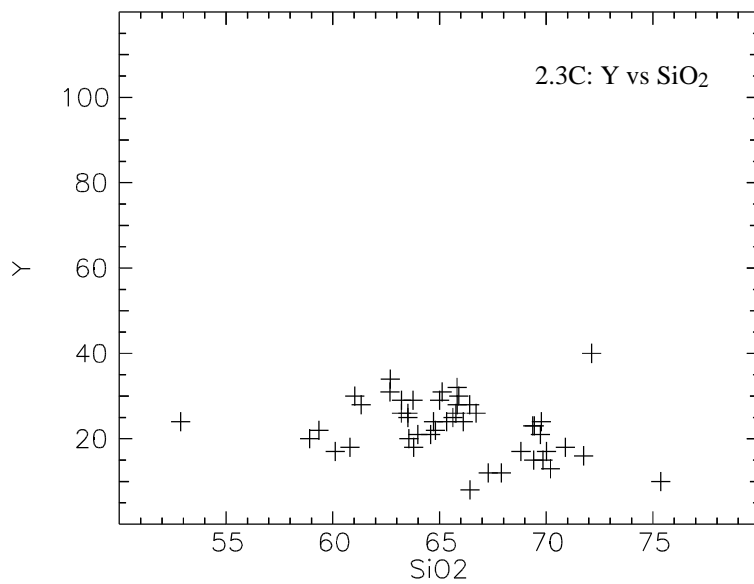
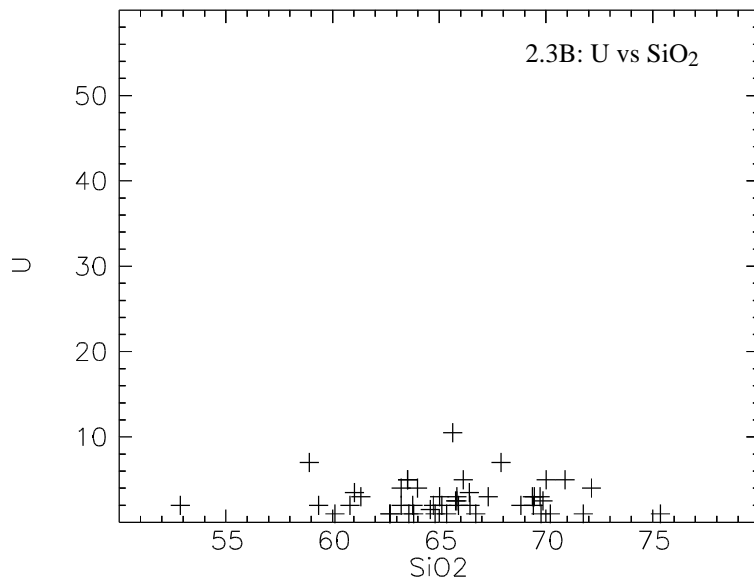
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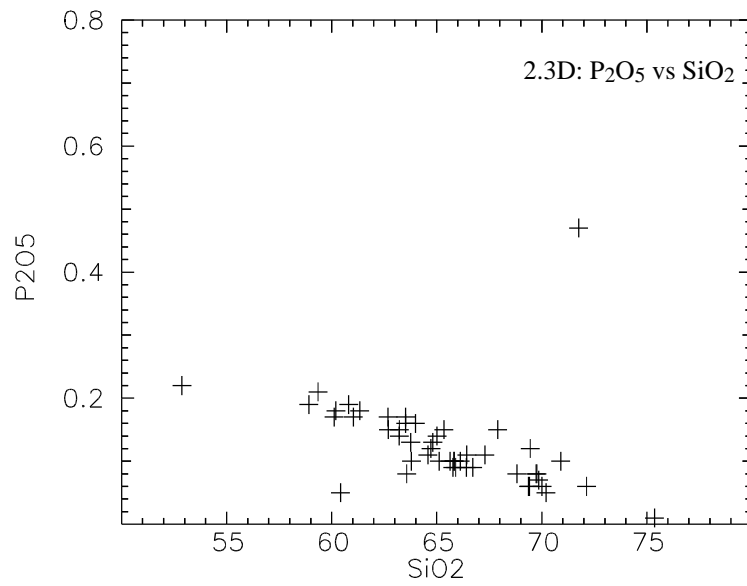
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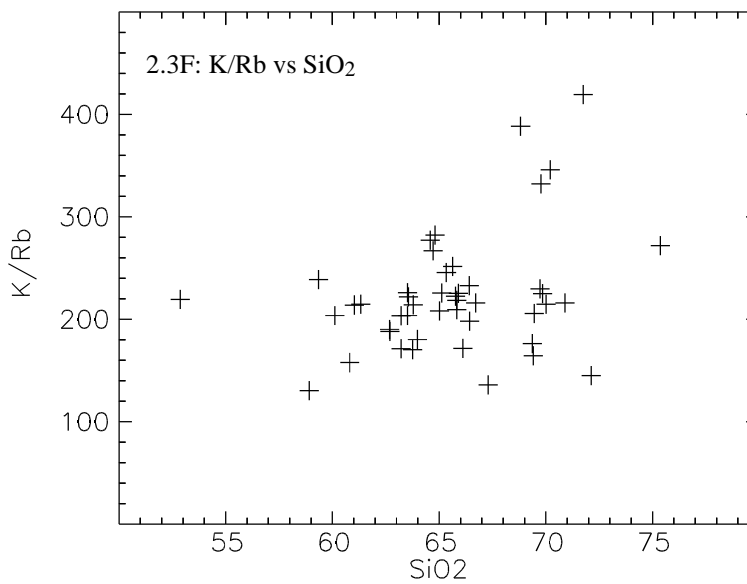
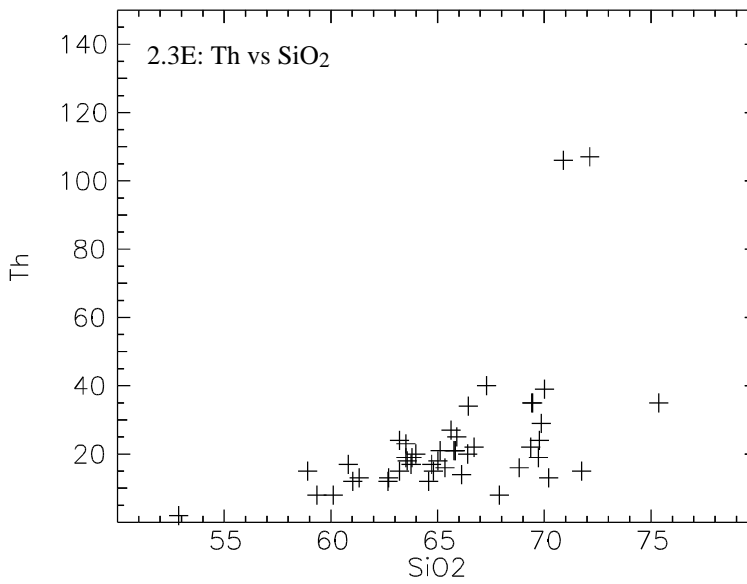
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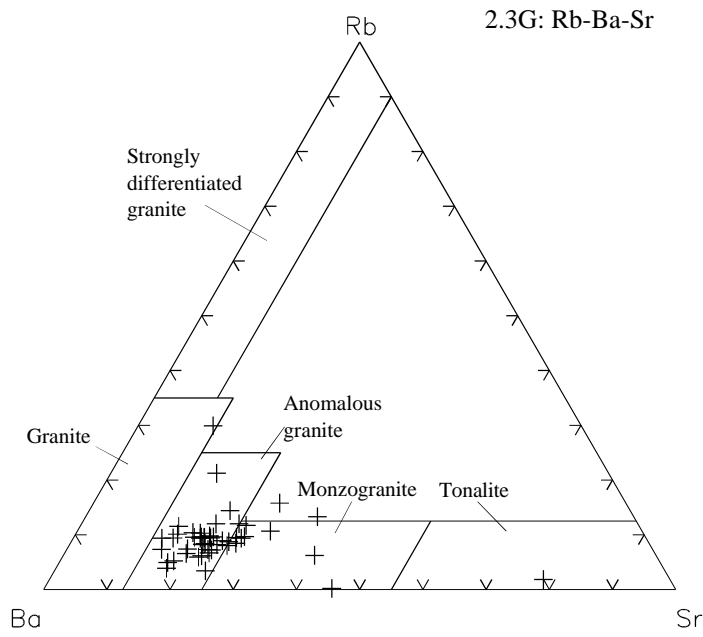
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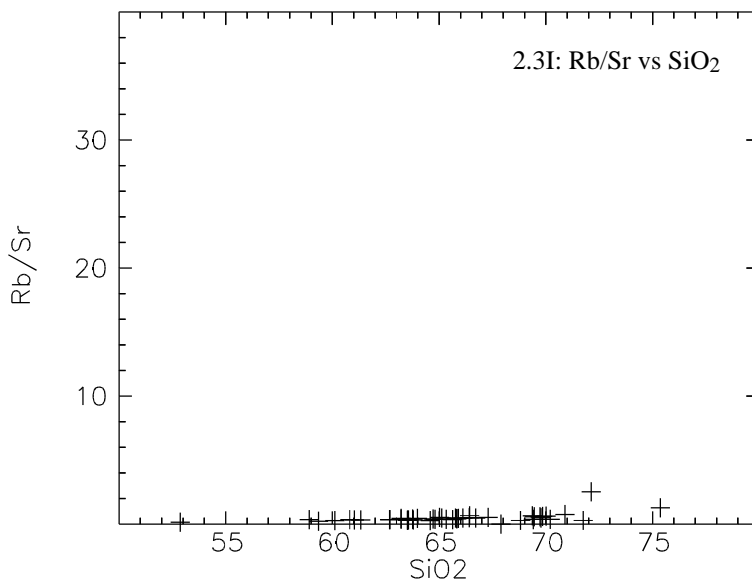
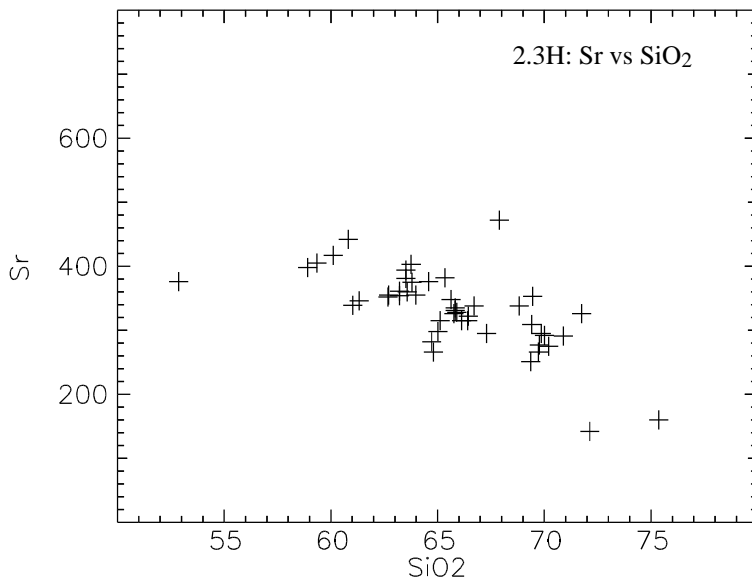
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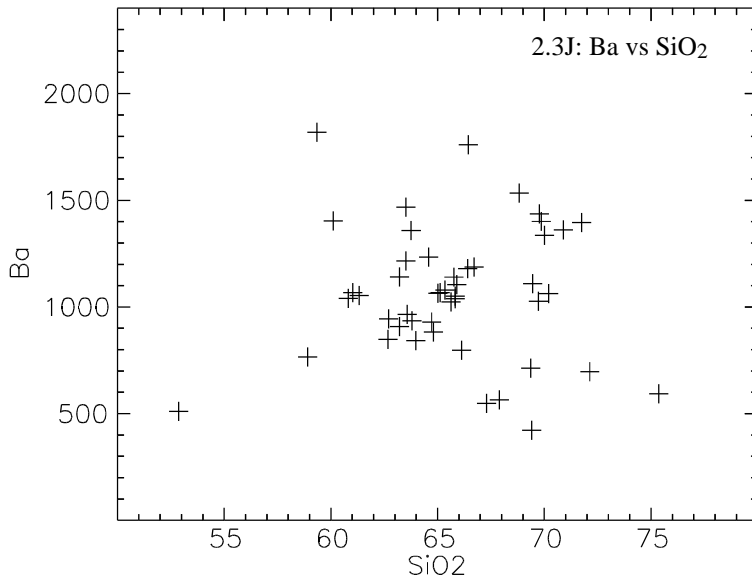
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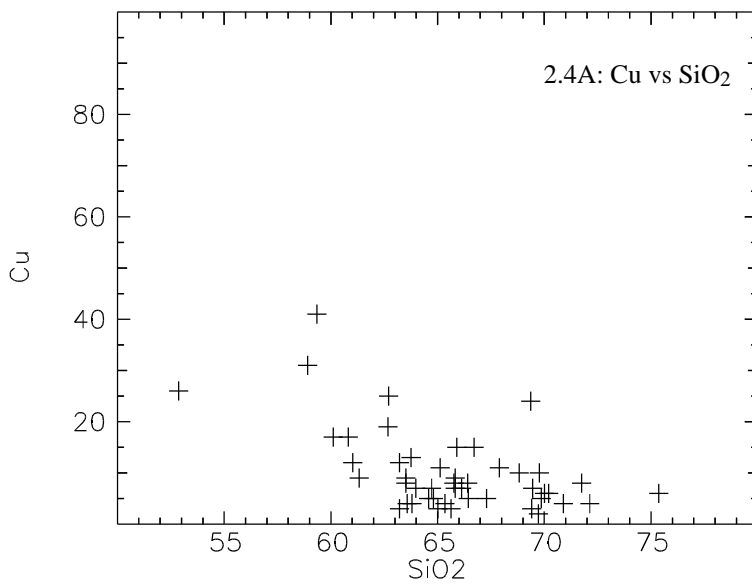
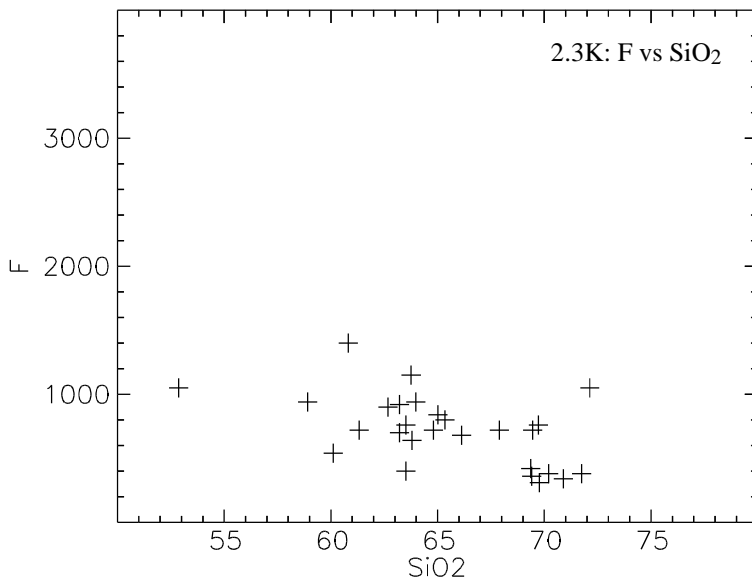
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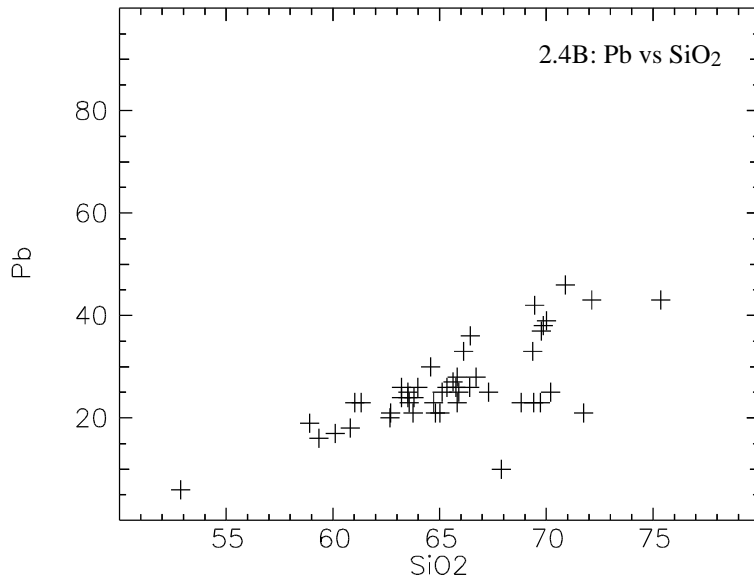
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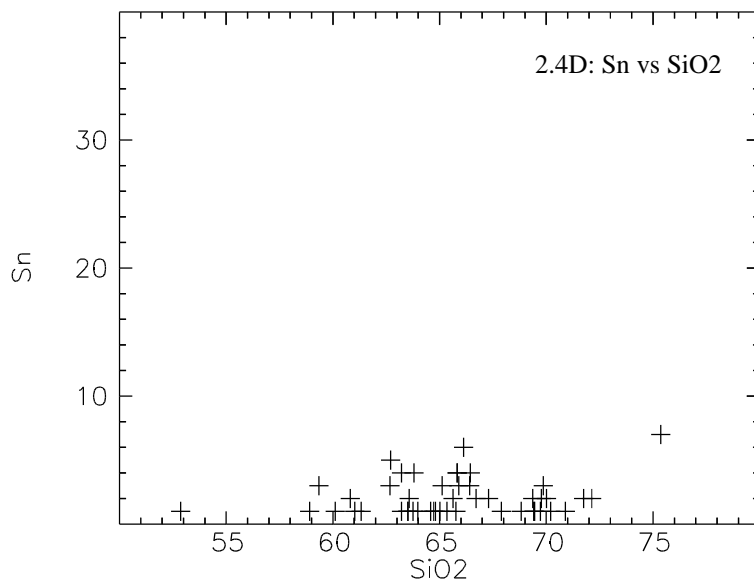
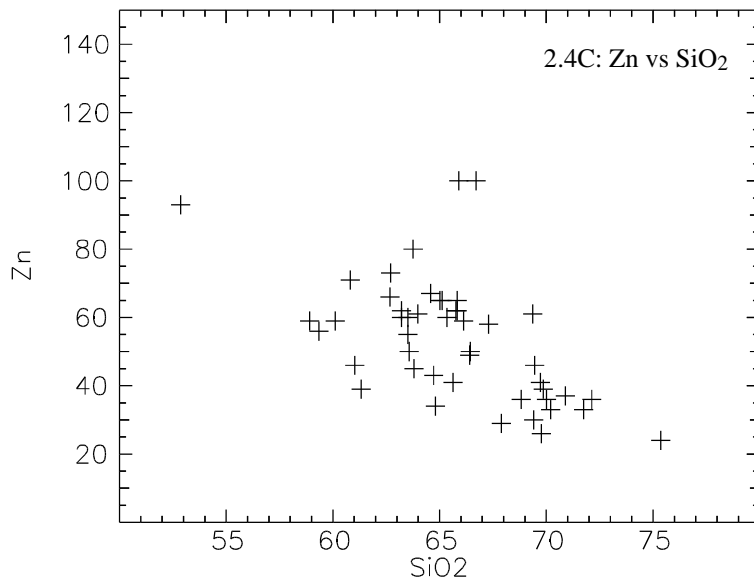
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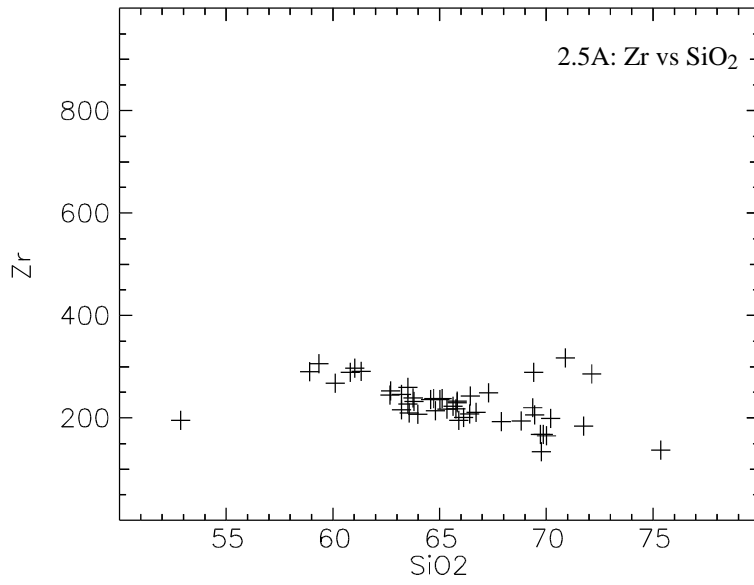
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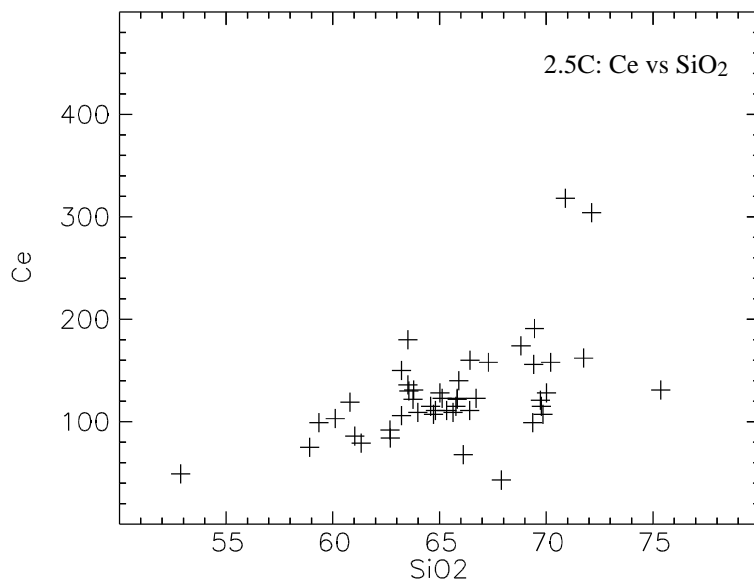
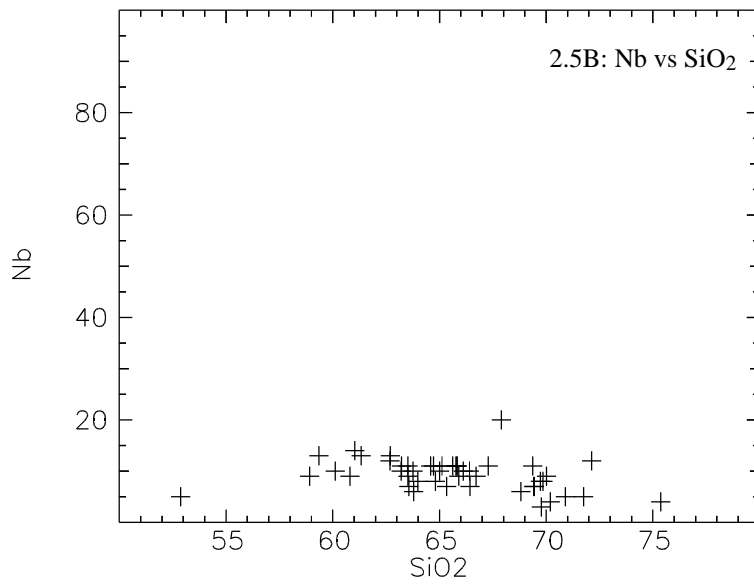
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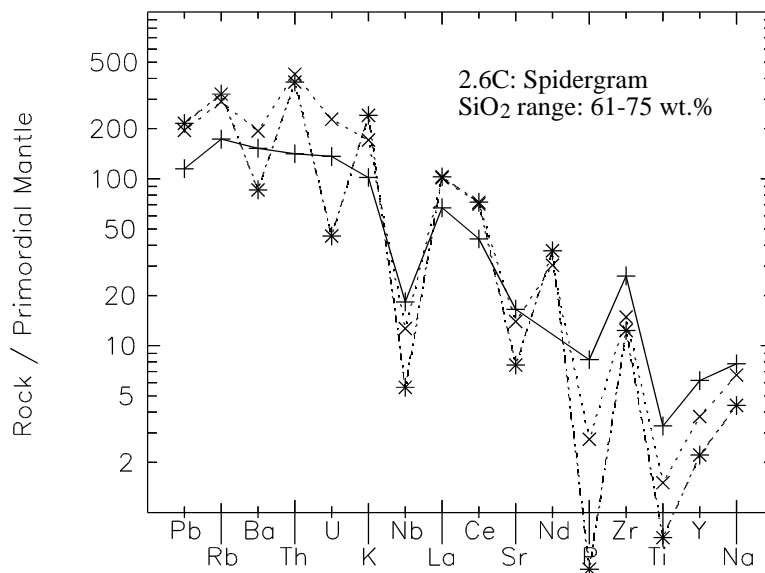
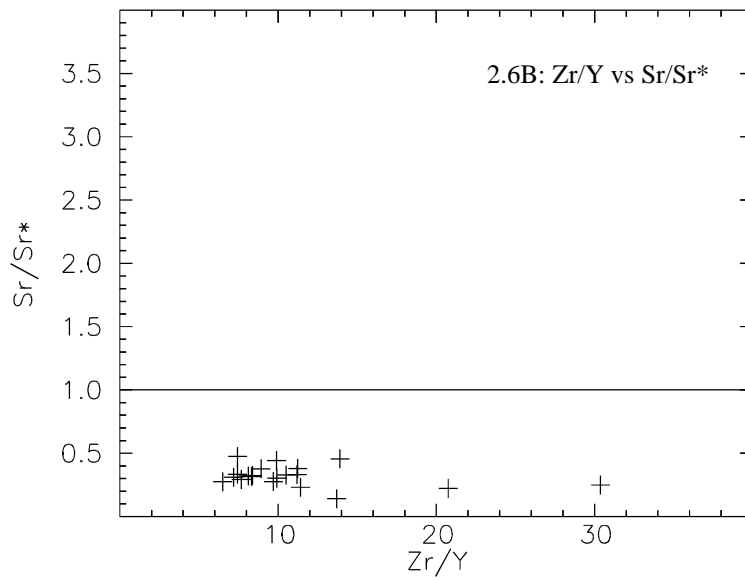
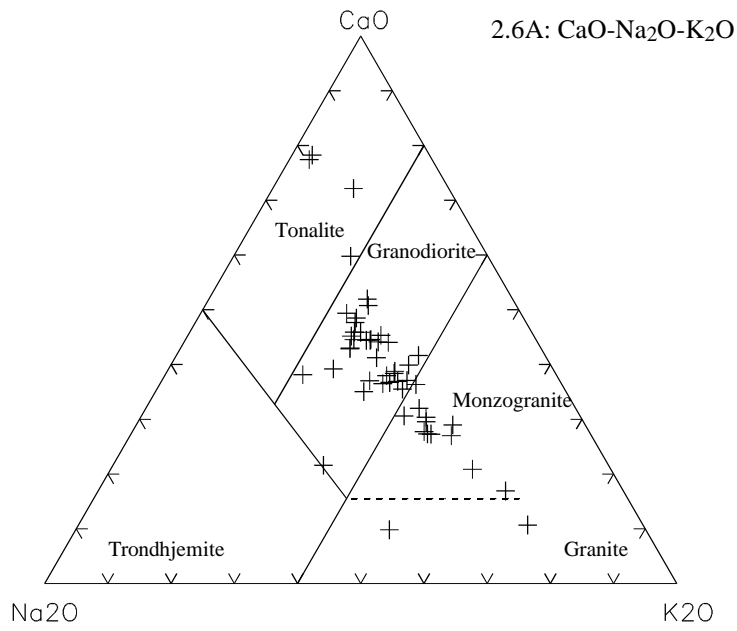
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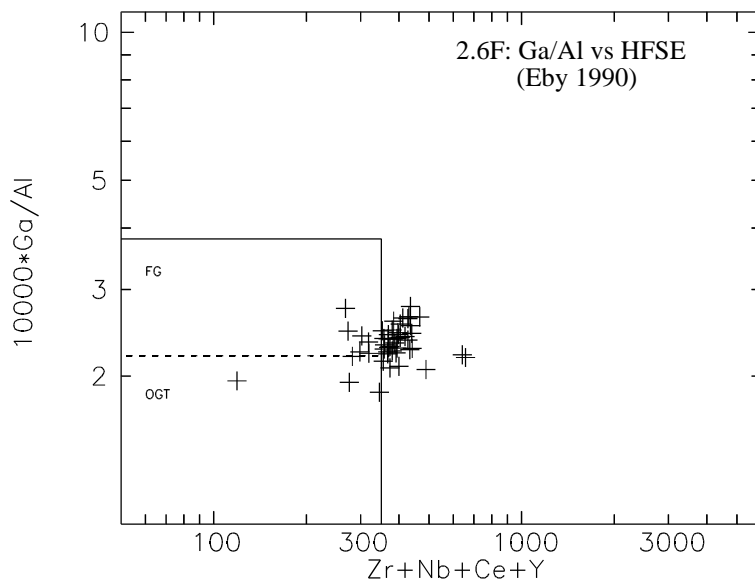
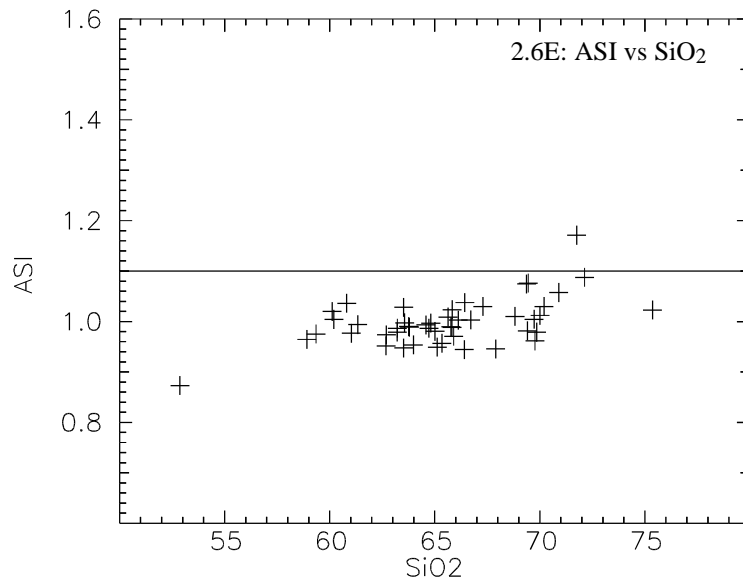
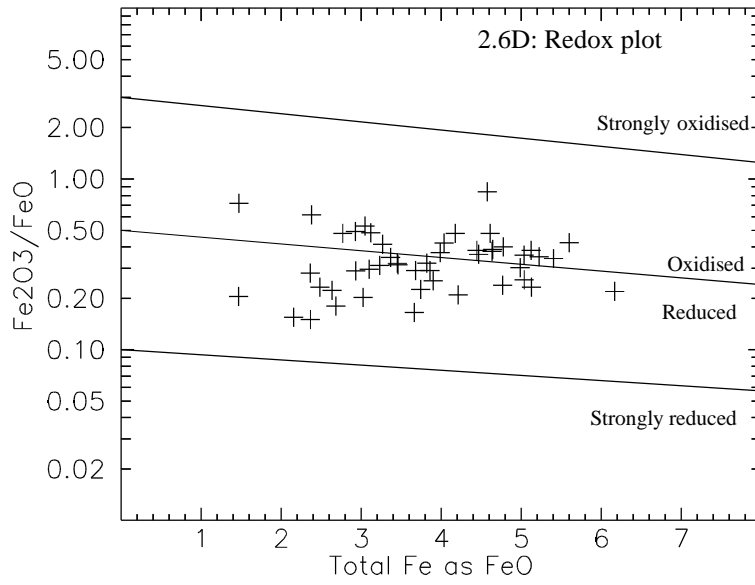
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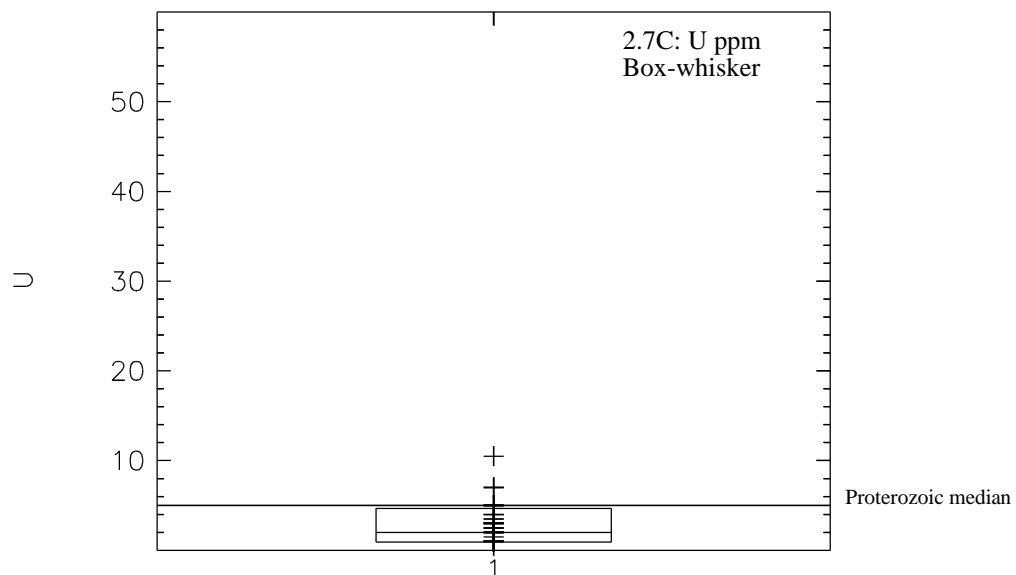
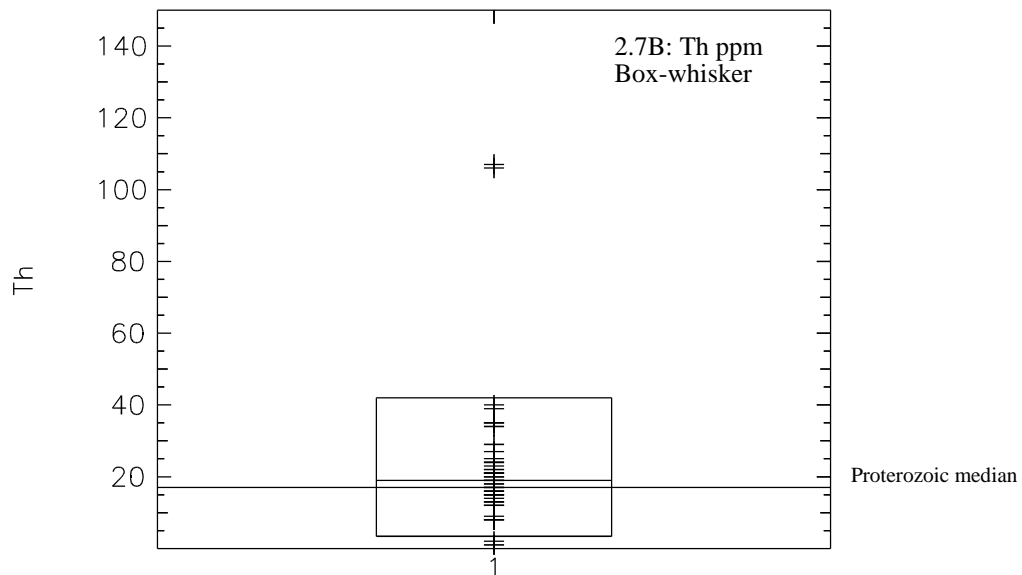
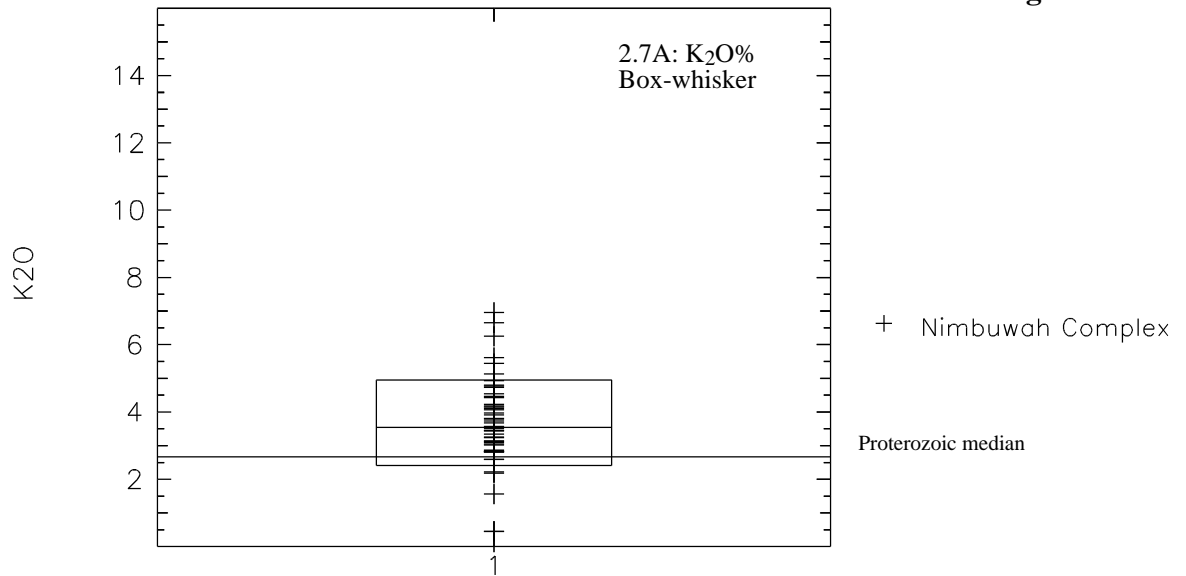
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Nimbuwah Complex intrusives

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	64.69	65.12	5.41	46.79	75.37	51
TiO2	0.54	0.49	0.35	0.1	2.01	51
Al2O3	15.95	15.76	1.73	10.2	20.3	51
Fe2O3	1.05	0.96	0.64	0.25	4.54	51
FeO	3.07	2.9	1.28	0.86	8.17	51
MnO	0.06	0.06	0.03	0.02	0.16	51
MgO	1.35	1.19	0.86	0.26	4.68	51
CaO	4.43	4.15	1.93	0.95	11.12	51
Na2O	2.85	2.79	0.6	1.71	5.16	51
K2O	3.68	3.54	1.28	0.45	6.96	51
P2O5	0.13	0.11	0.08	0.01	0.47	51
H2O+	0.3	0.3	-	0.3	0.3	1
CO2	0.1	0.1	0.06	0.05	0.25	29
LOI	1.57	1.52	0.6	0.56	3.12	50
Ba	1057.02	1063	340.78	121	1819	49
Li	24.66	25	11.01	7	51	29
Rb	137.41	139	53.21	2	358	49
Sr	339.67	338	69.4	142	540	49
Pb	25.37	24	8.76	5	46	49
Th	22.69	19	19.49		107	49
U	2.79	2	1.9		10.5	49
Zr	226.57	227	49.07	65	317	49
Nb	9.35	10	3.02	3	20	49
Y	22.61	24	6.84	8	40	49
La	68.84	64	29.86	21	180	49
Ce	125.53	121	50.68	34	318	49
Pr	11.3	11	1.98	8	15	20
Nd	44	44	6.46	34	59	20
Sc	13.8	13	6.81		42	49
V	47.82	38	33.19	6	162	49
Cr	172.5	198.5	67.97	18	251	20
Mn	407.65	427	135.11	156	708	20
Co	10.08	9	3.45	6	16	12
Ni	6.77	6	3.49		19	49
Cu	10.57	8	8.14	2	41	49
Zn	55.59	58	20.38	24	121	49
Sn	2.08	2	1.44		7	49
W	1.92	2	0.93		5	26
Mo	3.2	2	2.13		9	49
Ga	19.88	20	2.56	14	26	49
As	1.23		0.55		4	49
S	183.92	100	261.2	d	1300	50
F	752.41	720	288.98	310	1400	29
Cl	243.55	159	208.43	55	1000	20
Be	3.13	3	0.92	2	5	15
Bi	1.05		0.22		2	20
Hf	6.94	7	2.23	2	12	49
Ta	1		-			20
Cs	9	9	3.89		17	21
Ge	1	1	0.4	0.5	1.5	20
Se	0.55		0.15		1	20

3 ALLIA SUITE

3.1 Timing 1845 Ma

3.2 Individual Ages **Primary Ages:**

- | | |
|---|----------------------------|
| 1. Murra-Kamangee Granite ^{1, 2} | 1852 ± 33 Ma, Rb-Sr |
| 2. Murra-Kamangee Granite ^{1, 2} | 1850 ± 2 Ma, U-Pb xenotime |
| 3. Murra-Kamangee Granite ^{1, 2} | 1840 ± 5 Ma, U-Pb zircon |
| 4. Mount Litchfield Granite ^{1, 2} | 1768 ± 16 Ma, Rb-Sr* |
| 5. Two Sisters Granite ^{1, 2} | 1768 ± 16 Ma, Rb-Sr* |

Sources: [1] OZCHRON, [2] Page *et al.* (1985) *Gneissic sample, age reset by metamorphism.

3.3 Regional Setting The Allia Suite is located in the Litchfield Province in the western part of the Pine Creek Inlier. The suite intrudes pre-1860 Ma rocks, mainly the Burrell Creek Formation, Hermit Creek Metamorphics and Wangi Basics. There are no U-Pb SHRIMP ages available and hence the age of the intrusives is tentative. The granites were intruded immediately after a major regional metamorphic event which produced metamorphism up to granulite facies. It is possible that some parts of Suite may have been generated by the metamorphic event.

3.4 Summary The Allia Suite is clearly S-type containing peraluminous minerals such as andalusite, cordierite and muscovite. Some members of the suite are characterised by abundant pegmatite which occurs both within the granite and extends into the adjacent country rocks. Alteration is commonly associated with these phases. The Allia Suite is rare in the context of Australian Proterozoic granites in that it represents one of the few S-type suites found, and what is more unusual, it is also a fractionated suite.

3.5 Potential As a fractionated S-type, the Allia Suite has high potential for further discoveries of Sn given the strong evidence for a large amount of late-stage pegmatites and the extent of hydrothermal alteration. Some Sn, Ta with minor Au, and W mineralisation are associated with the Allia Suite, in particular the Two Sisters and Soldiers Creek Granites. However, no significant grades and tonnages have been recorded as yet. Minor Au may be generated by mobilisation from the adjacent metasediments given the amount of fluid interaction with the country rock. The Allia Suite is unlikely to be associated with Cu, Pb or Zn.

Cu:	None
Au:	Low
Pb/Zn:	None
Sn:	High
Mo/W:	Low
Confidence Level:	322

3.6 Descriptive Data **Location:** On the western part of the Pine Creek Inlier on the Port Keats, Cape Scott, and Fog Bay 1:250 000 Sheet areas.

Dimensions and area: The Allia Suite extends in a northerly direction over an area of 220 km by 75 km. Much of the suite is covered by Cainozoic alluvium and the total area of actual outcrop is 415 km².

3.7 Intrusives

Component plutons: Two Sisters Granite, Mount Litchfield Granite, Murra-Kamangee Granodiorite, Fish Billabong Adamellite, Jamine Granite, Allia Creek Granite, and Soldiers Creek Granite. Units previously mapped as the Turnbull Bay Granite and the Roberts Creek Granite are now mapped as the Two Sisters Granite.

Form: Some plutons are circular or elliptical. However, most members of the suite occur as scattered outcrops under cover, and the true shape of the plutons is difficult to discern. Specifically: Mount Litchfield Granite - large elliptical intrusion elongate in a northeasterly direction. Murra-Kamangee Granodiorite - large northeast-trending pluton, fault-bounded on the northern and northeastern sides. Allia Creek Granite - circular pluton.

Metamorphism and Deformation: Most plutons have been deformed to some degree, and all show a metamorphic overprint up to at least lower greenschist facies. Specifically: Two Sisters Granite - variably deformed, mildly foliated to gneissic, metamorphosed to lower greenschist facies. Mount Litchfield Granite - variably foliated, metamorphosed to lower greenschist facies. Murra-Kamangee Granodiorite - weakly foliated. Soldiers Creek Granite - near the Fish River Fault and parts of the Collah Fault the granite has been extensively sheared.

Dominant intrusive rock types: The dominant rock types are leucogranite, pegmatites and monzogranite with minor granodiorite. Specifically: Two Sisters Granite - medium-grained monzogranite to granodiorite, with a coarse-grained tourmaline- garnet pegmatite granite (formerly called the Roberts Creek Granite). Mount Litchfield Granite - medium to coarse-grained monzogranite to granodiorite. Murra-Kamangee Granodiorite - tonalite to granodiorite, monzogranite. Fish Billabong Adamellite - monzogranite. Jamine Granite - medium-grained leucogranite. Allia Creek Granite - granodiorite, porphyritic in places. Soldiers Creek Granite - leucocratic porphyritic granite with microcline phenocrysts, monzogranite and granodiorite.

Colour: Colour recorded only for the Two Sisters Granite which is pink to grey.

Veins, Pegmatites, Aplites, Greisens: Pegmatites characterise this suite; they are commonly cassiterite and tantalite bearing. Specifically: Two Sisters Granite - quartz-muscovite-feldspar pegmatite common with minor tourmaline-rich and garnet-rich pegmatite. Mount Litchfield Granite - coarse pegmatite veins are common, and some thin veins of adularia containing minor carbonate. Murra-Kamangee Granodiorite - cross-cutting tourmaline-bearing pegmatite veins. Fish Billabong Adamellite - some quartz-adularia veins with rare fluorite-filled joints at one locality (Dundas *et al.* 1987), some aplite. Allia Creek Granite - veins of pegmatite are common within the Burrell Creek Formation near the contact with the granite. Soldiers Creek Granite - numerous greisen and pegmatite veins extend from the granite into the metasediments for several hundred metres.

Distinctive mineralogical characteristics: The mineral assemblage of the Allia Suite is characteristically S-type, with andalusite and cordierite being recorded. Biotite and muscovite are intergrown, a characteristic of S-type granites. Some sulphides have been recorded attesting to the reduced nature of parts of this suite, whilst some of the late veins contain hematite, suggesting that the suite became more oxidised with fractionation. Specifically: Two Sisters Granite - quartz, plagioclase, orthoclase, microcline, biotite, minor muscovite, opaques, garnet, titanite, pyrite, pyrrhotite, apatite, and zircon. Mount Litchfield Granite - quartz, plagioclase, K-feldspar, biotite, minor muscovite, accessory tourmaline, leucoxene (after ilmenite), zircon, apatite, opaque minerals. Murra-Kamangee Granodiorite - quartz, plagioclase, K-feldspar, biotite, apatite, titanite, ilmenite, magnetite, hematite, muscovite, andalusite, sillimanite, cordierite, zircon and tourmaline. Fish Billabong Adamellite - quartz, plagioclase, K-feldspar, biotite. Jamine Granite - quartz, microcline, subordinate coarse muscovite, minor tourmaline. Allia Creek Granite - quartz, microcline, plagioclase, biotite, rare muscovite, apatite and zircon. Soldiers Creek Granite - quartz, orthoclase, microcline, plagioclase, biotite and muscovite commonly intergrown.

Breccias: None recorded.

Alteration in the granite: Sericitic alteration is common, particularly in those plutons that are associated with the pegmatites. Specifically: Two Sisters Granite, Mount Litchfield Granite - hydrothermal alteration has caused mild to intense alteration of feldspar, biotite and muscovite to sericite and chlorite. Where the alteration is intense, secondary quartz and sericite pervade the rock as well as forming numerous intersecting veins. Murra-Kamangee Granodiorite - feldspars and mafic minerals are pervasively altered, plagioclase altered to sericite and clay. Soldiers Creek Granite - almost all of the granite shows some degree of late-stage alteration and

greisenisation with plagioclase invariably altered to sericite \pm kaolinite, biotite is altered to chlorite and iron oxide, and in the more altered samples K-feldspar has been converted to sericite and quartz.

3.8 Extrusives

None recorded.

3.9 Country Rock

Contact metamorphism: Contact effects are common and can extend for up to 10 km from the granite boundaries. Hornfels commonly contains andalusite and cordierite porphyroblasts. *Specifically:* Two Sisters Granite - 10 km-wide contact aureole in the Burrell Creek Formation. Murra-Kamangee Granodiorite - Hermit Creek Metamorphics are hornfelsed with porphyroblasts of cordierite and andalusite. Jamine Granite - contact metamorphosed the Burrell Creek Formation to hornfels which contains large porphyroblasts of andalusite and clusters of biotite, muscovite and quartz. Allia Creek Granite - Burrell Creek Formation is hornfelsed producing andalusite-muscovite schist which contain garnet and cordierite in places. Soldiers Creek Granite - metamorphic aureole up to 1 km wide marked by the development of coarse muscovite in phyllite and local growth of porphyroblastic andalusite.

Reaction with country rock: Metasomatic tourmaline has been recorded adjacent to some plutons. *Specifically:* Two Sisters Granite - tourmaline commonly developed in country rock adjacent to pegmatites. Mount Litchfield Granite - metasomatic production of tourmaline in schist.

Units the granite intrudes: Wangi Basics, Welltree Metamorphics, Burrell Creek Formation, Hermit Creek Metamorphics

Dominant rock types: Schist, phyllite, quartz-mica schist, sillimanite-andalusite-muscovite schist, quartzite, altered and metamorphosed basic igneous rocks, gabbro, leucogabbro, dolerite, minor anorthosite, troctolite.

Potential hosts: Schist, mafic igneous rocks.

3.10 Mineralisation

Some Sn and Ta with minor Au and W mineralisation is associated with the Allia Suite, in particular the Two Sisters and Soldiers Creek Granites. *Specifically:* Greisen-bordered veins related to the Soldiers Creek Granite in the Buldiva tin field are the sites of small tin mines. However, the veins are too widely spaced to provide substantial mineable ore tonnages. Most production has come from eluvial and colluvial workings in the southern part of the granite. Cassiterite and more commonly specular hematite occur in greisen veins emanating from the Soldiers Creek Granite into the Burrell Creek Formation. The Fletchers Gully Gold mine, which produced 70 kg Au, is related to quartz veins in the core of an anticline in contact metamorphosed graphitic slate, phyllite and schist in the core of an anticline adjacent to the Allia Creek Granite.

Minor Cu mineralisation associated with the Murra-Kamangee Granodiorite. The occurrence consists of gossanous veins of malachite, azurite and chalcocite within altered granite.

An extensive south-southwest-trending zone of pegmatites in hornfelsed metasediments along the eastern margin of the Two Sisters Granite extends for 70 km south of Darwin. More than 90 tin-tantalum-niobium mines and prospects have been documented, mainly associated with tourmaline, cassiterite, and tantalite-bearing pegmatites. Total production is 562.3 tonnes of Sn and 12 tons of Ta. The pegmatites are decomposed to kaolin-quartz-muscovite assemblages. Minor Au is also associated with some of these pegmatites, and the Golden Boulder mine produced 17.4 kg Au.

3.11 Geochemical Data

Data source: The data are from AGSO and the NTGS. Most of the AGSO data are from geochronological samples collected by Page *et al.* (1985) and are housed in AGSO's OZCHEM data base. Data supplied to the project by the NTGS were collected as part of the regional mapping program in the Litchfield province and are available from them.

Data quality: Good, although the NTGS data have a very limited trace element suite.

Are the data representative? The samples seem to be representative of the rock types described.

Are the data adequate? The data are adequate to define this suite as having potential, but a more comprehensive trace element set of analyses on the NTGS samples is highly desirable to fully understand the process of fractionation within this suite.

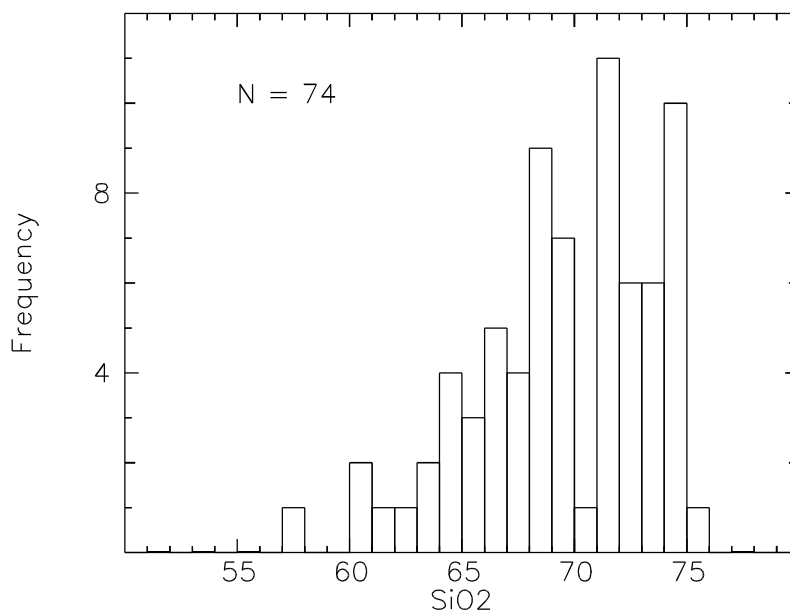


Figure 3.1. Frequency histogram of rocks of the Allia Suite

SiO₂ range (Fig. 3.1): The SiO₂ range is from 57 to 76 wt%, with a peak at 72 wt%.

Alteration (Figs. 3.1 & 3.2):

- **SiO₂:** Silicification has been reported, but was not evident in the geochemical data.
- **K₂O/Na₂O:** The samples with ~ 2% K₂O are possibly sericite-altered.
- **Th/U:** Most ratios are within the normal range.
- **Fe₂O₃/(FeO+Fe₂O₃):** Some of the more fractionated samples are more oxidised, reflecting the hematite which has been recorded as being common in the late stage phases.

Fractionation Plots (Fig. 3.3):

- **Rb:** Increases exponentially to very high levels with increasing SiO₂ in the Two Sisters, Jamine and Soldiers Creek Granites.
- **U:** Late increase in some plutons with increasing SiO₂.
- **Y:** No increase with increasing SiO₂.
- **P₂O₅:** No change with increasing SiO₂.
- **Th:** No increase with increasing SiO₂.
- **K/Rb:** Decreases with increasing SiO₂ in all plutons with the exception of the Murra-Kamangee Granodiorite and the Allia Creek Granite.
- **Rb-Ba-Sr:** Some samples plot in the strongly differentiated field.
- **Sr:** The Mount Litchfield Granite, Two Sisters Granite and Fish Billabong Adamellite all have noticeably higher Sr contents than the Murra-Kamangee Granodiorite, Soldiers Creek Granite and the Allia Creek Granite. This may suggest two different suites, although being S-type, it is possible that the different Sr contents are related to local variations in the sediment sources.
- **Rb/Sr:** Increases exponentially to very high levels with increasing SiO₂ in the Two Sisters, Jamine and Soldiers Creek Granites.
- **Ba:** Decreases with increasing SiO₂.
- **F:** No data available.

Metals (Fig. 3.4):

- **Cu:** Low to moderate values.
- **Pb:** Weakly increasing values with increasing SiO₂.
- **Zn:** Decreases with increasing SiO₂.

- **Sn:** Increases with increasing SiO₂ to quite high values for Australian Proterozoic granites.

High field strength elements (Fig. 3.5):

- **Zr:** Low values.
- **Nb:** Low values.
- **Ce:** Limited data, but values are low.

Classification (Fig. 3.6):

- **The CaO/Na₂O/K₂O plot of White, quoted in Sheraton and Simons (1992):** Most samples are in the monzogranite to granite field.
- **Zr/Y vs Sr/Sr*:** Insufficient data, but all samples plotted are Sr-depleted.
- **Spidergram:** Plots are variable and may reflect heterogeneous sedimentary sources.
- **Oxidation plot of Champion and Heinemann (1994):** Most samples are reduced, but become increasingly oxidised with decreasing Fe content, which in turn reflects increasing fractionation. The oxidised samples, although unusual in S-type granite suites, are not unexpected given the presence of hematite recorded in some of the late-stage phases.
- **ASI:** All samples are peraluminous, even at relatively low SiO₂ contents reflecting the true S-type character of the Allia Suite.
- **A-type plot of Eby (1990):** Insufficient data, but all available samples plot in the normal field for Palaeozoic granites.

Granite type (Chappell and White 1974; Chappell and Stephens 1988): S-type.

Australian Proterozoic granite type: Allia Suite - the type example.

3.12 Geophysical Signature

Radiometrics (Fig. 3.7): Most samples would appear white to purple given the relatively low Th contents relative to average Proterozoic granites.

Gravity: The AGSO regional gravity data are too coarse, although granites of the Allia Suite consistently appear as gravity highs.

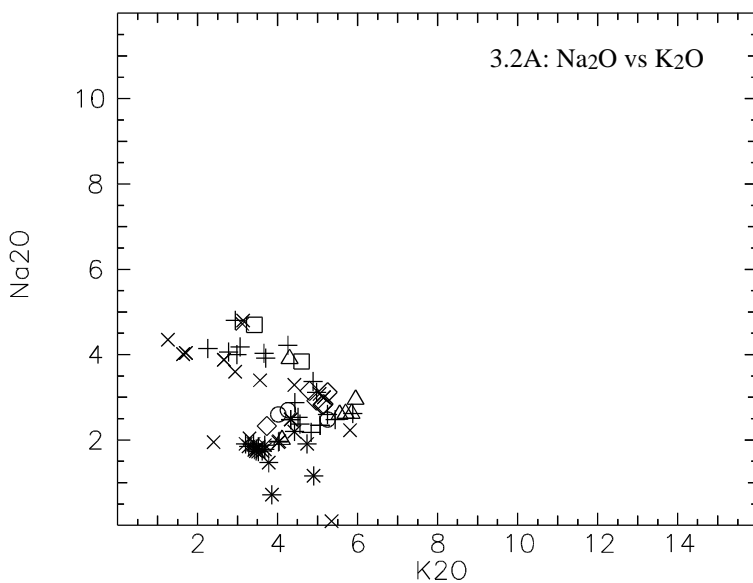
Magnetics: The AGSO regional magnetic data are relatively coarse, and most plutons plot as magnetic lows.

3.13 References

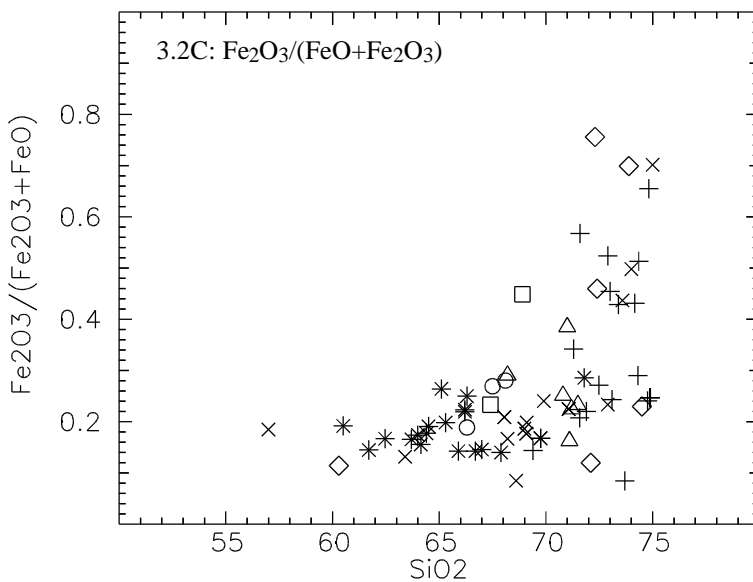
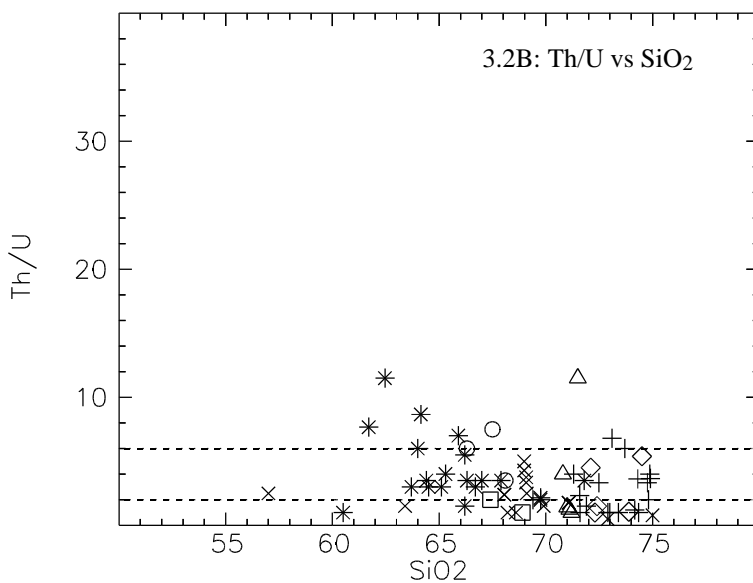
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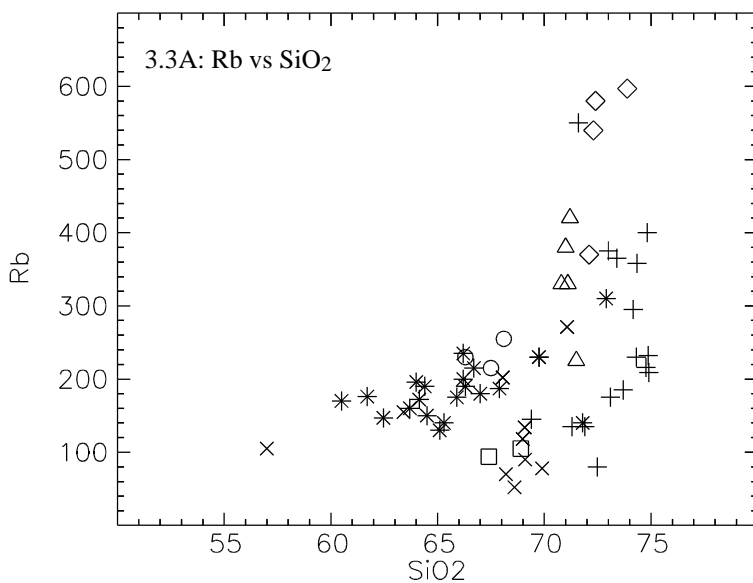
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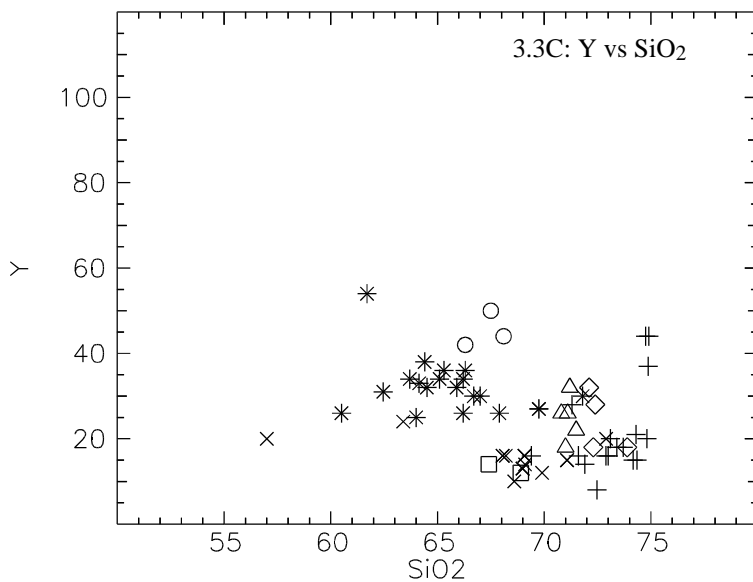
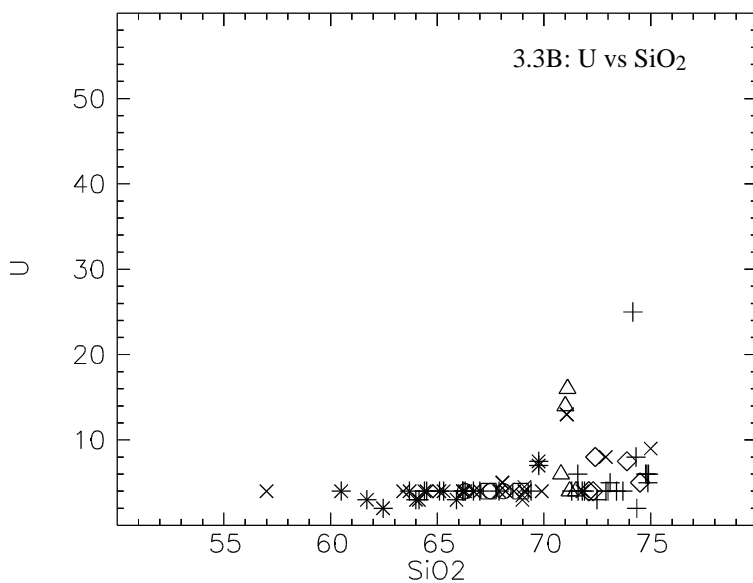
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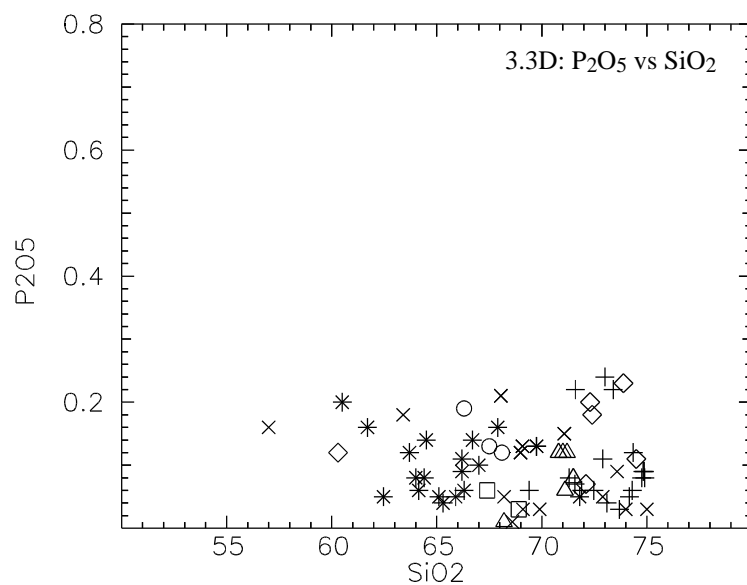
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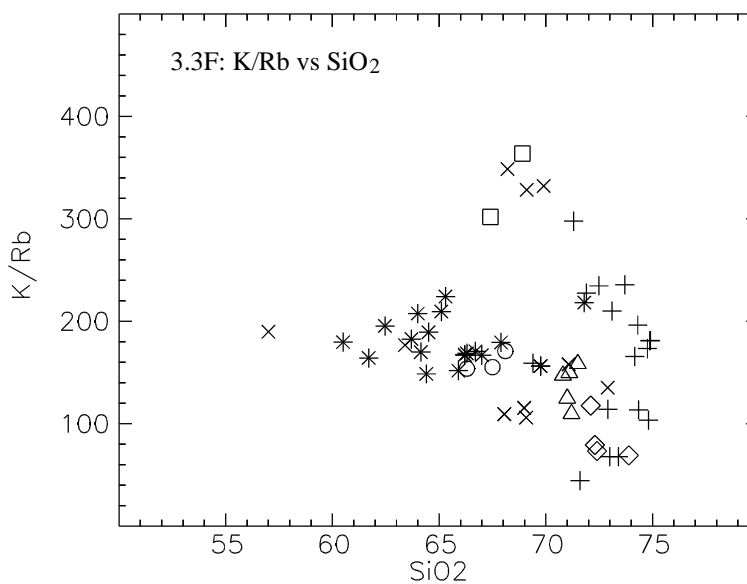
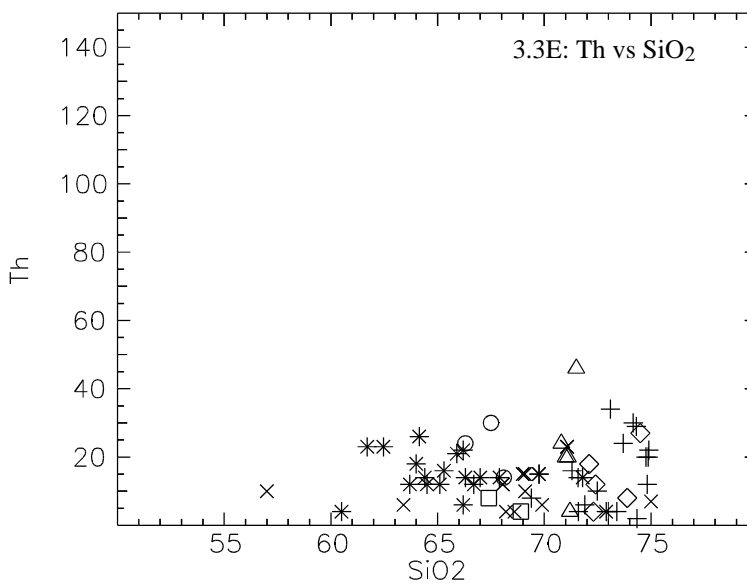
- + Two Sisters Granite
- x Mount Litchfield Gra
- * Murra-Kamangee Grani
- Fish Billabong Adame
- ◇ Jamine Granite
- Allia Creek Granite
- △ Soldiers Creek Grani



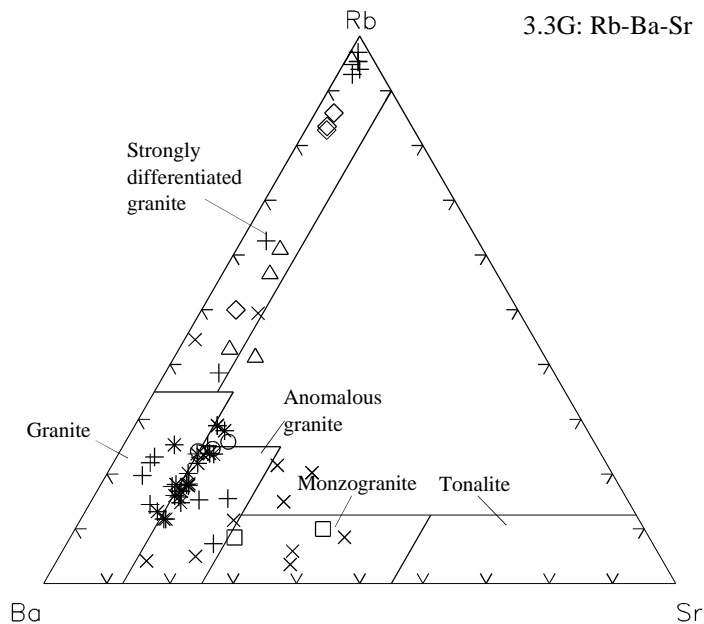
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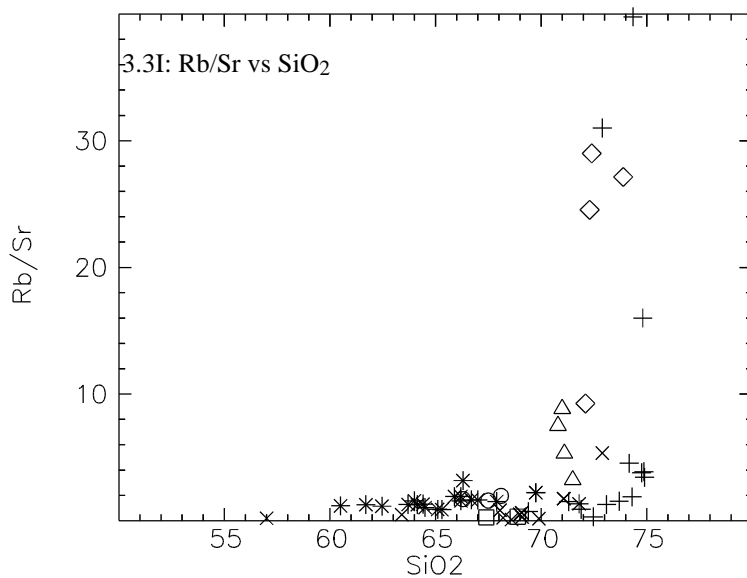
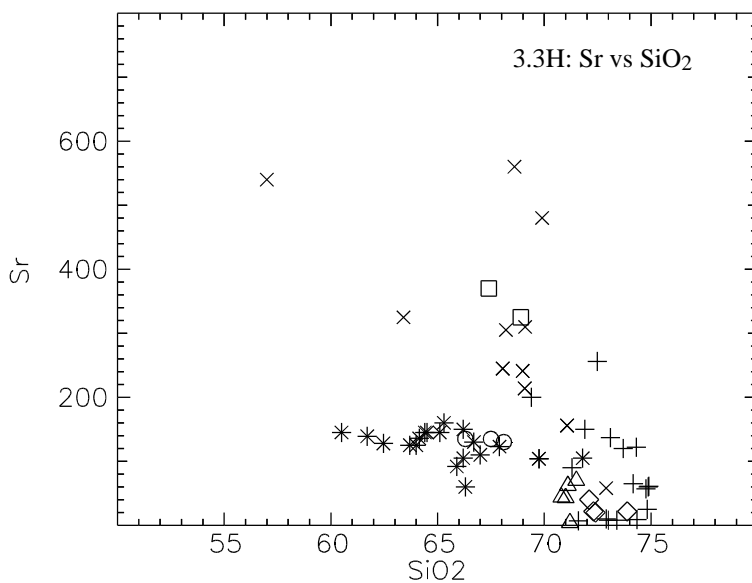
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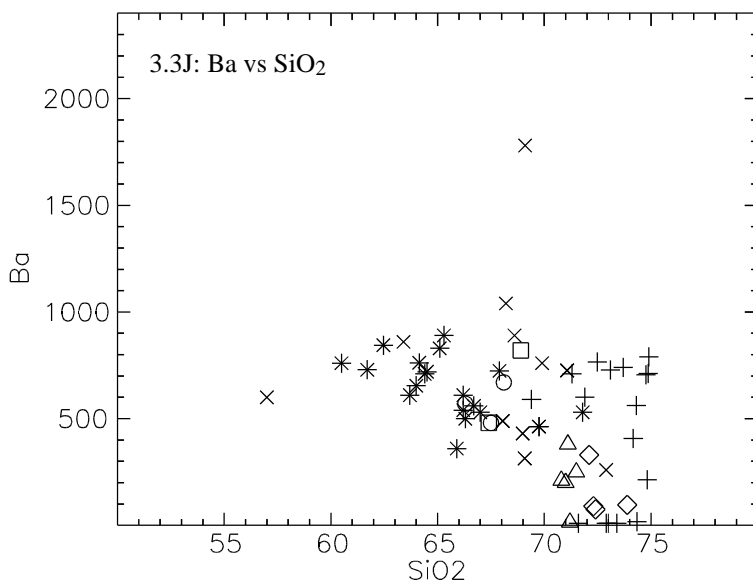
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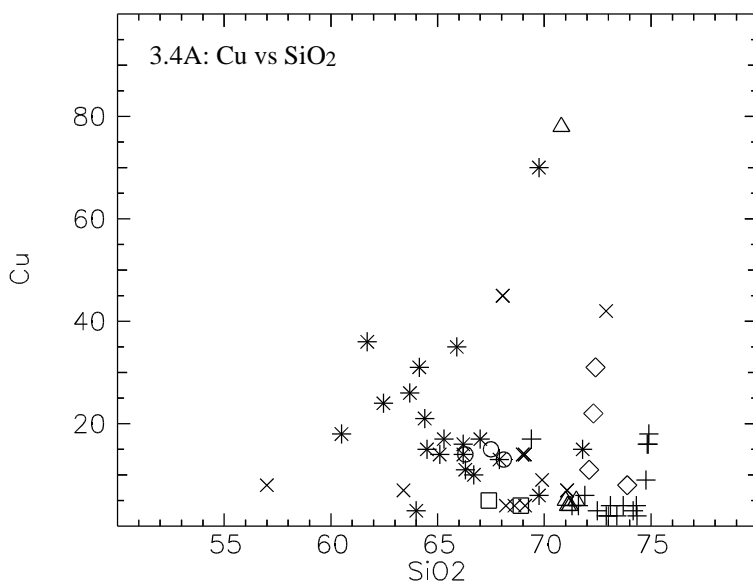
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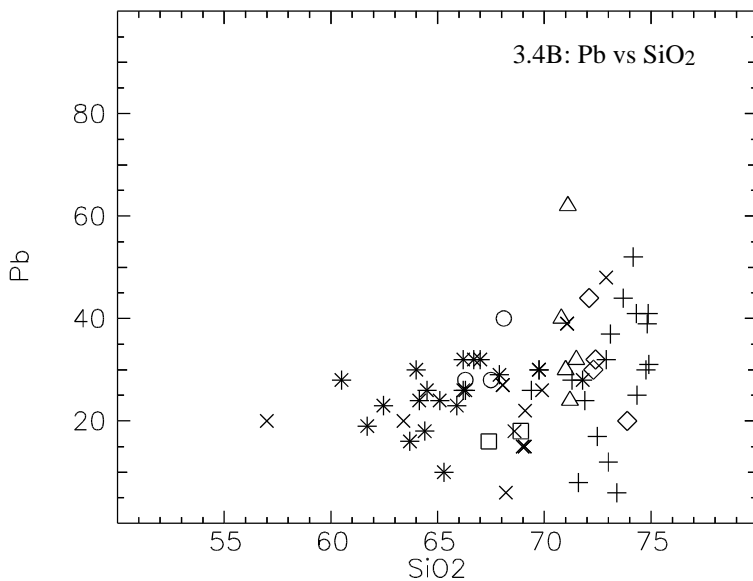
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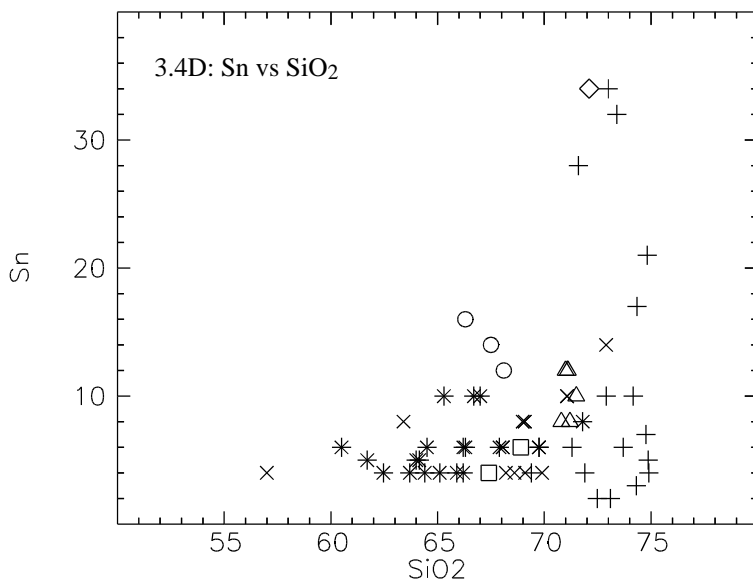
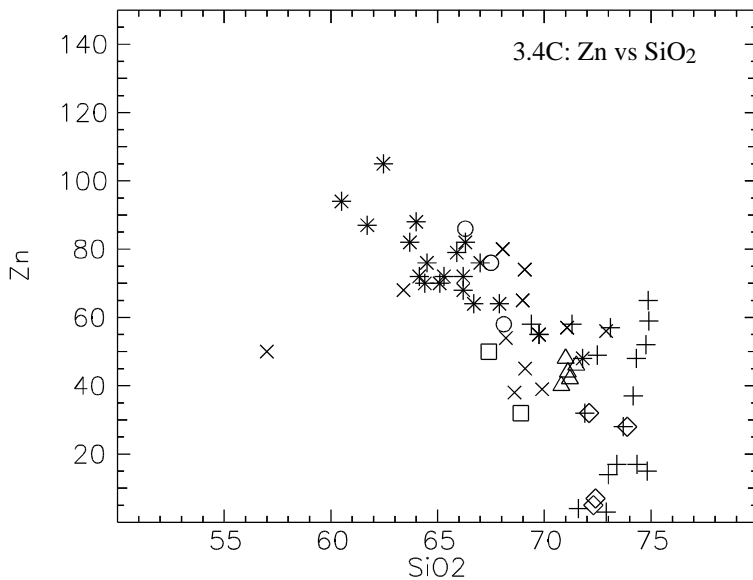
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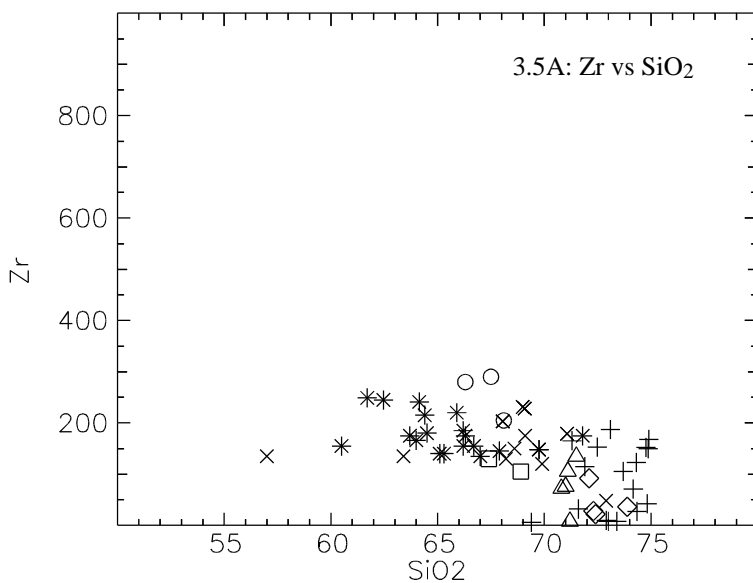
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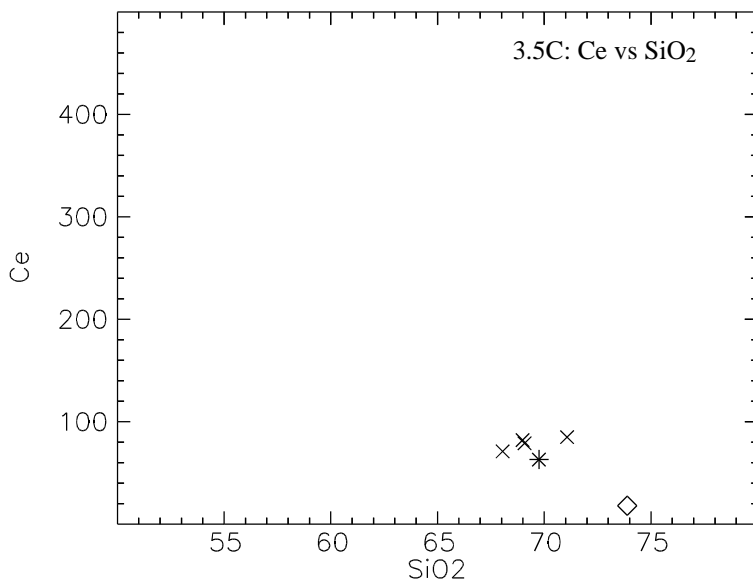
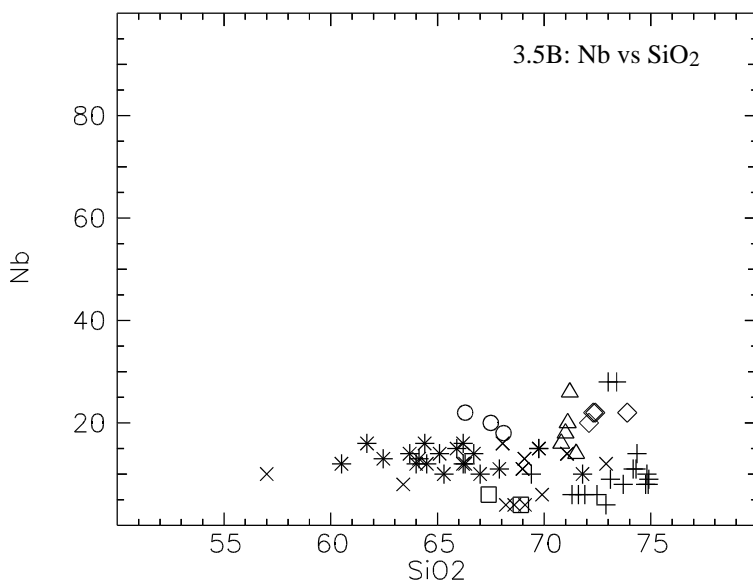
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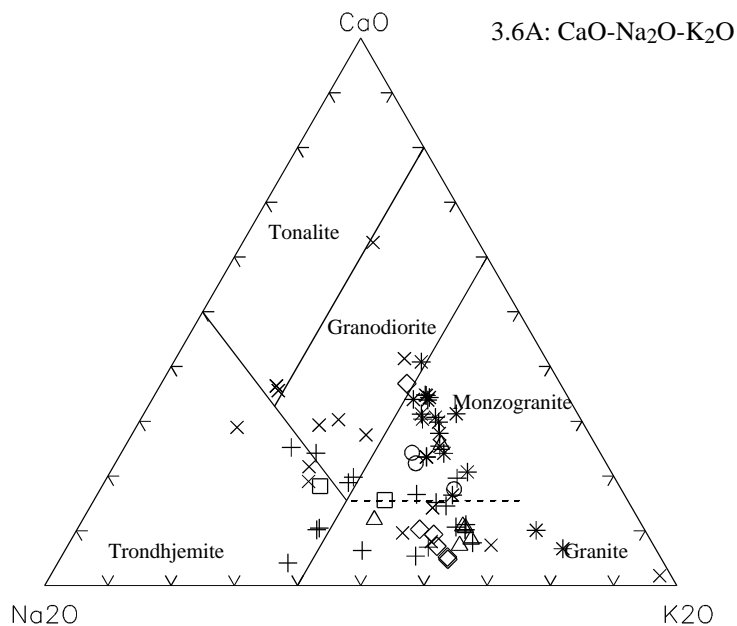
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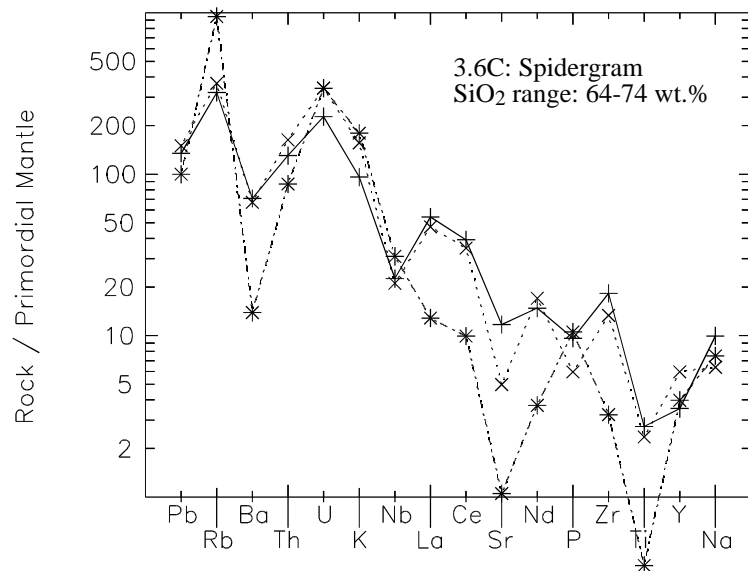
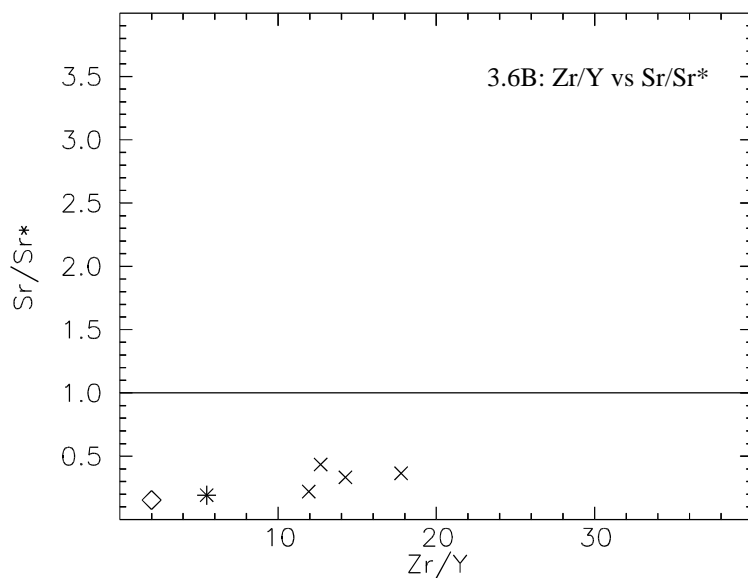
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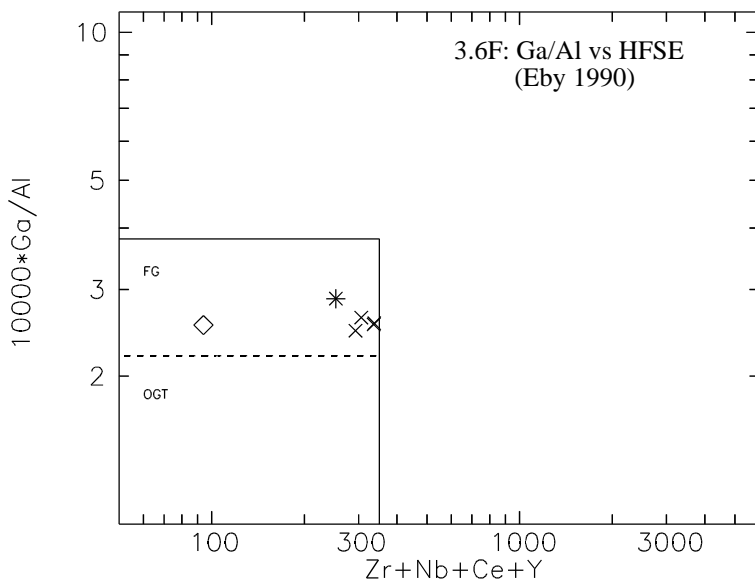
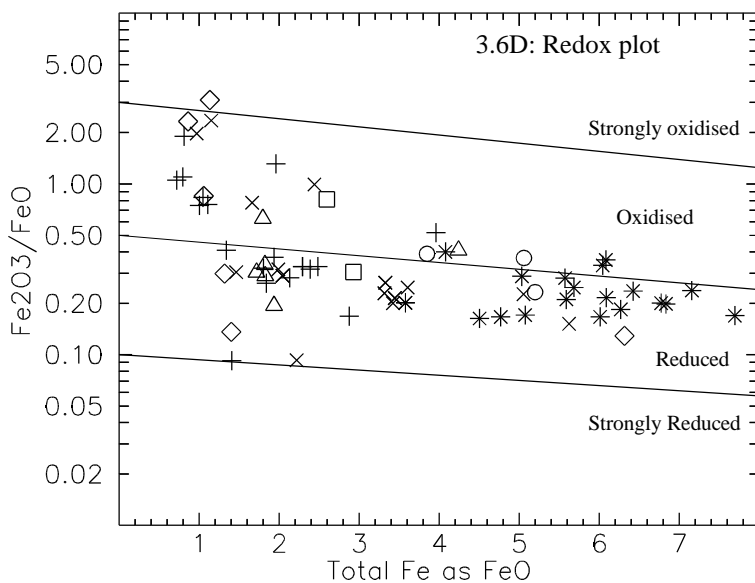
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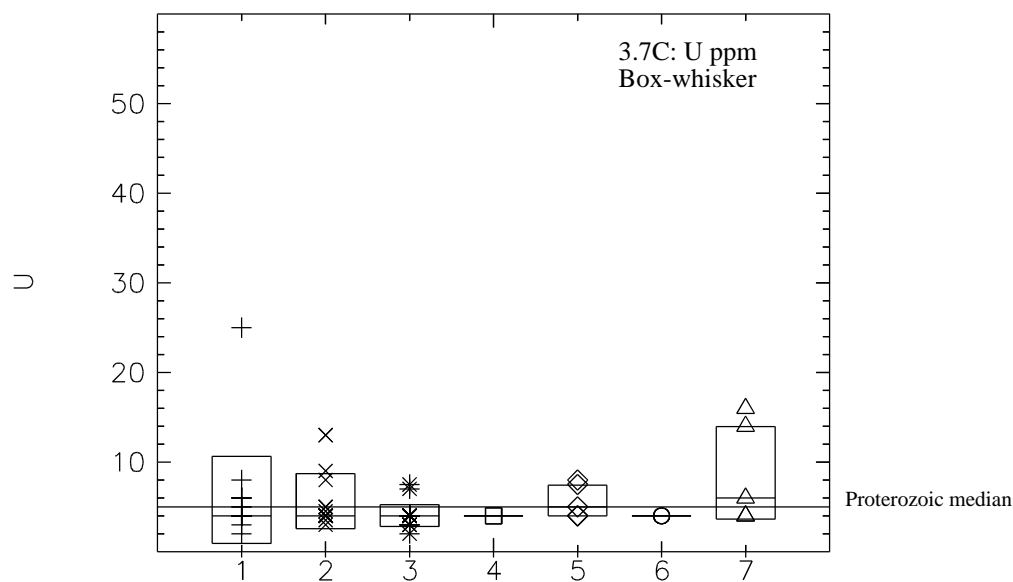
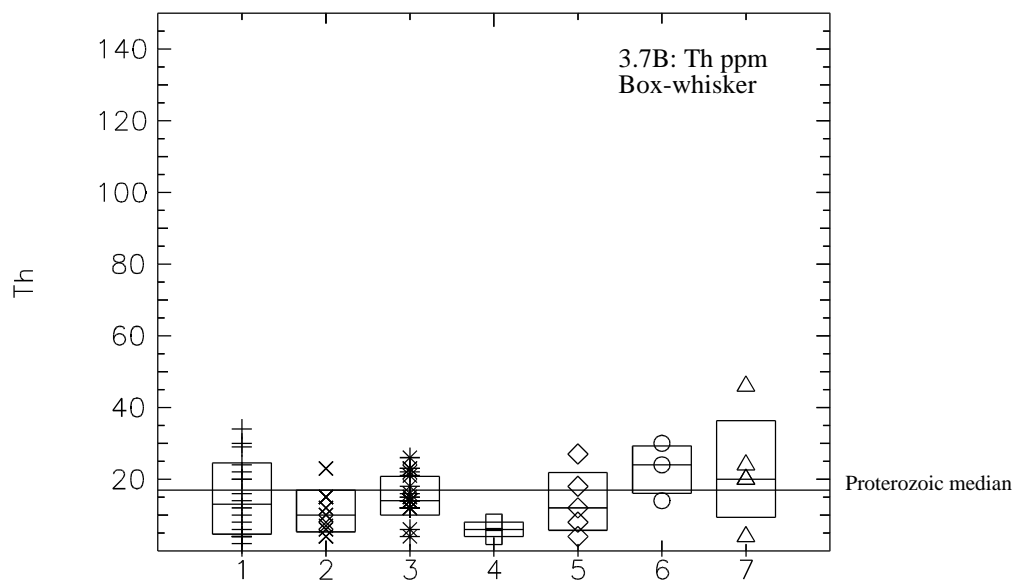
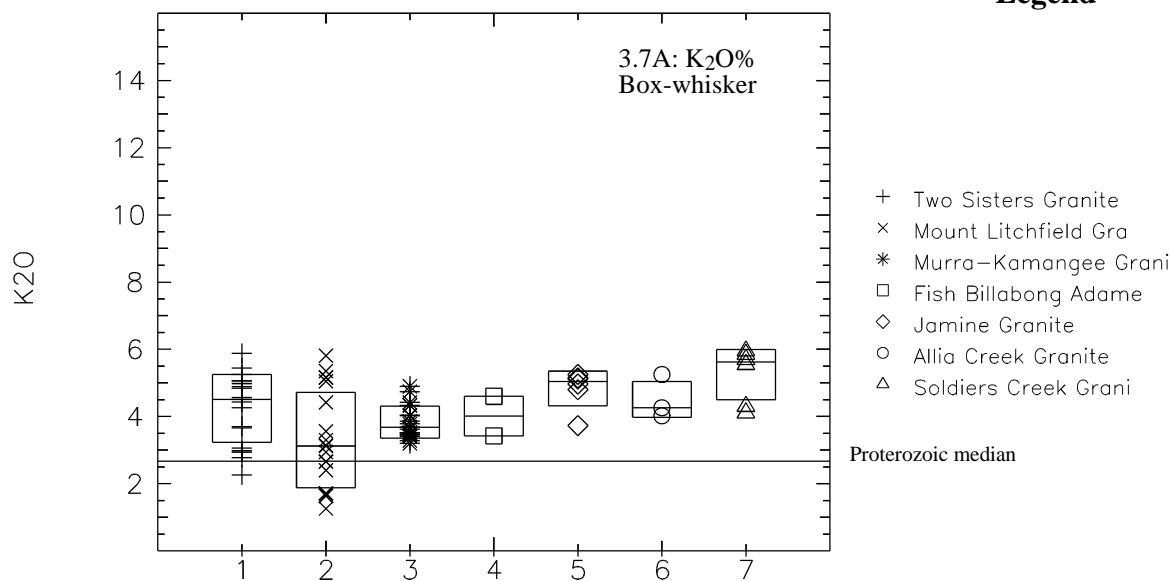
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- × Mount Litchfield Gra
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- Fish Billabong Adame
- ◇ Jamine Granite
- Allia Creek Granite
- △ Soldiers Creek Grani



Legend



Legend



Allia Creek Granite

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	67.3	67.5	0.92	66.3	68.1	3
TiO2	0.62	0.66	0.14	0.46	0.74	3
Al2O3	14.27	14.2	0.31	14	14.6	3
Fe2O3	1.17	1.11	0.21	1	1.4	3
FeO	3.65	3.8	0.74	2.85	4.3	3
MnO	0.06	0.06	0.01	0.05	0.06	3
MgO	1.03	1.11	0.23	0.77	1.21	3
CaO	1.92	2	0.24	1.65	2.12	3
Na2O	2.59	2.6	0.11	2.48	2.7	3
K2O	4.51	4.26	0.65	4.02	5.25	3
P2O5	0.15	0.13	0.04	0.12	0.19	3
H2O+	-	-	-	-	-	-
H2O-	-	-	-	-	-	-
CO2	-	-	-	-	-	-
LOI	1.06	1.07	0.12	0.94	1.17	3
Ba	573.33	570	95.04	480	670	3
Li	91.67	85	25.66	70	120	3
Rb	233.33	230	20.21	215	255	3
Sr	133.33	135	2.89	130	135	3
Pb	32	28	6.93	28	40	3
Th	22.67	24	8.08	14	30	3
U	4	4	-	4	4	3
Zr	258.33	280	46.46	205	290	3
Nb	20	20	2	18	22	3
Y	45.33	44	4.16	42	50	3
La	-	-	-	-	-	-
Ce	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	55	55	15	40	70	3
Cr	-	-	-	-	-	-
Co	7.33	8	1.15	6	8	3
Ni	-	-	-	-	-	-
Cu	14	14	1	13	15	3
Zn	73.33	76	14.19	58	86	3
Sn	14	14	2	12	16	3
W	11.67	10	2.89	10	15	3
Mo	-	-	-	-	-	-
Ga	16.67	17	1.53	15	18	3
As	-	-	-	-	-	-
S	-	-	-	-	-	-
Cl	-	-	-	-	-	-
Be	5	5	-	5	5	3
Bi	-	-	-	-	-	-
Ta	10	10	-	10	10	3
Cs	20	20	-	20	20	3

Fish Billabong Adamellite

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	68.15	68.15	1.06	67.4	68.9	2
TiO2	0.29	0.29	0.07	0.24	0.34	2
Al2O3	15.6	15.6	0.42	15.3	15.9	2
Fe2O3	0.96	0.96	0.37	0.7	1.22	2
FeO	1.9	1.9	0.57	1.5	2.3	2
MnO	0.04	0.04	0.01	0.03	0.04	2
MgO	0.85	0.85	0.22	0.69	1	2
CaO	1.68	1.68	0.17	1.56	1.8	2
Na2O	4.27	4.27	0.61	3.84	4.7	2
K2O	4.01	4.01	0.83	3.42	4.6	2
P2O5	0.04	0.04	0.02	0.03	0.06	2
H2O+	-	-	-	-	-	-
H2O-	-	-	-	-	-	-
CO2	-	-	-	-	-	-
LOI	0.81	0.81	0.34	0.57	1.05	2
Ba	650	650	240.42	480	820	2
Li	40	40	7.07	35	45	2
Rb	99.5	99.5	7.78	94	105	2
Sr	347.5	347.5	31.82	325	370	2
Pb	17	17	1.41	16	18	2
Th	6	6	2.83	4	8	2
U	4	4	-	4	4	2
Zr	117.5	117.5	17.68	105	130	2
Nb	5	5	1.41	4	6	2
Y	13	13	1.41	12	14	2
La	-	-	-	-	-	-
Ce	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	35	35	7.07	30	40	2
Cr	-	-	-	-	-	-
Co	5	5	-	5	5	2
Ni	-	-	-	-	-	-
Cu	4.5	4.5	0.71	4	5	2
Zn	41	41	12.73	32	50	2
Sn	5	5	1.41	4	6	2
W	10	10	-	10	10	2
Mo	-	-	-	-	-	-
Ga	13.5	13.5	4.95	10	17	2
As	-	-	-	-	-	-
S	-	-	-	-	-	-
Cl	-	-	-	-	-	-
Be	5	5	-	5	5	2
Bi	-	-	-	-	-	-
Ta	10	10	-	10	10	2
Cs	20	20	-	20	20	2

Jamine Granite

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	70.92	72.35	5.29	60.3	74.5	6
TiO2	0.23	0.11	0.3	0.08	0.85	6
Al2O3	15.07	14.42	2.11	13.5	19.27	6
Fe2O3	0.55	0.58	0.28	0.17	0.93	6
FeO	1.52	0.82	2.06	0.28	5.66	6
MnO	0.04	0.03	0.02	0.02	0.07	6
MgO	0.48	0.26	0.55	0.24	1.61	6
CaO	1.13	0.74	1.2	0.4	3.54	6
Na2O	2.86	2.88	0.3	2.33	3.15	6
K2O	4.84	5.05	0.56	3.73	5.25	6
P2O5	0.15	0.15	0.06	0.07	0.23	6
H2O+	1.06	1.08	0.26	0.79	1.3	3
H2O-	0.09	0.08	0.06	0.03	0.15	3
CO2	0.61	0.61	0.49	0.26	0.95	2
LOI	1	1	-	1	1	3
Ba	147.75	93	121.82	75	330	4
Li	228	225	10.46	220	242	4
Rb	521.75	560	103.95	370	597	4
Sr	26	22	9.38	20	40	4
Pb	31.5	31	9.85	20	44	4
Th	13.8	12	9.01	4	27	5
U	5.7	5	1.92	4	8	5
Zr	44.5	32	32.18	22	92	4
Nb	21.5	22	1	20	22	4
Y	24	23	7.12	18	32	4
La	9	9	-	9	9	1
Ce	18	18	-	18	18	1
Nd	5	5	-	5	5	1
Sc	4	4	-	4	4	1
V	8	10	4	2	10	4
Cr	4	4	-	4	4	1
Co	6	5	1.73	5	8	3
Ni	1		-			1
Cu	18	16.5	10.55	8	31	4
Zn	18	17.5	13.98	5	32	4
Sn	50.5	55	11.36	34	58	4
W	15	15	5	10	20	3
Mo	1.5		-			1
Ga	19.5	19.5	6.14	12	27	4
As	22	22	-	22	22	1
S	37	d	22.52	d	11	3
Cl	75	75	-	75	75	1
Be	11.75	12.5	5.38	5	17	4
Bi	3	3	-	3	3	1
Ta	10	10	-	10	10	3
Cs	75	100	43.3	25	100	3

Mount Litchfield Granite

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	69.81	69.08	4.73	57	80.4	19
TiO2	0.36	0.38	0.19	0.05	0.63	19
Al2O3	15.11	15.49	1.88	9.8	20.2	19
Fe2O3	0.66	0.63	0.23	0.19	1.28	19
FeO	2.24	2.69	1.2	0.35	4.95	19
MnO	0.04	0.04	0.02	0.01	0.07	19
MgO	0.91	0.93	0.56	0.24	2.46	19
CaO	2.43	2.64	1.59	0.1	7.3	19
Na2O	3.34	3.6	1.14	0.1	4.8	19
K2O	3.3	3.12	1.46	1.26	5.81	19
P2O5	0.1	0.12	0.07	0.01	0.21	19
H2O+	0.77	0.79	0.22	0.35	1.06	7
H2O-	0.08	0.08	0.03	0.03	0.11	5
CO2	0.26	0.28	0.12	0.12	0.36	4
LOI	0.88	0.76	0.37	0.48	1.83	12
Ba	651.88	544.5	382.22	260	1780	16
Li	70.13	66	27.81	30	121	16
Rb	160.94	134	82.06	52	310	16
Sr	268.75	243	153.77	10	560	16
Pb	22.5	20	11.51	6	48	16
Th	11.12	10	6.01	4	23	17
U	5.65	4	3.17	3	13	17
Zr	163.44	177	60.32	40	231	16
Nb	10.38	11	4.11	4	16	16
Y	16	16	3.54	10	24	16
La	45.75	47.5	5.32	38	50	4
Ce	79.25	80.5	6.02	71	85	4
Nd	24	24	3.27	20	28	4
Sc	8.5	9	2.52	5	11	4
V	31	30.5	23.45	8	100	16
Cr	15	16	5.03	8	20	4
Co	7.5	5.5	4.17	5	16	8
Ni	6	5	3.46	3	11	4
Cu	15	8.5	14.93	2	45	16
Zn	56.63	57	19.29	4	80	16
Sn	7.63	8	3.59	4	16	16
W	10	10	-	10	10	8
Mo	2.25	2.25	0.87		3	4
Ga	19.44	21	4.08	11	27	16
As	0.75	0.75	0.29	0.5	1	4
S	38.29	12	15.86	d	51	7
Cl	76.5	76	40.48	40	114	4
Be	4.5	4	2.42	2	10	16
Bi	1		-			4
Ta	10	10	-	10	10	8
Cs	20	20	-	20	20	8

Murra-Kamangee Granodiorite

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO ₂	65.67	65.6	2.76	60.5	71.8	20
TiO ₂	0.66	0.62	0.16	0.32	1.02	20
Al ₂ O ₃	15.56	15.35	1.17	12.9	18.65	20
Fe ₂ O ₃	1.06	1.14	0.3	0.61	1.65	20
FeO	4.69	4.65	1	3	6.68	20
MnO	0.06	0.06	0.02	0.03	0.1	20
MgO	1.79	1.85	0.44	1.01	2.51	20
CaO	2.18	2.32	0.78	0.33	3.84	20
Na ₂ O	1.81	1.85	0.39	0.72	2.48	20
K ₂ O	3.83	3.68	0.49	3.2	4.9	20
P ₂ O ₅	0.1	0.09	0.05	0.04	0.2	20
H ₂ O ⁺	1.21	1.21	-	1.21	1.21	1
H ₂ O ⁻	0.11	0.11	-	0.11	0.11	1
CO ₂	0.2	0.2	-	0.2	0.2	1
LOI	1.51	1.33	0.54	0.91	2.52	19
Ba	639.45	632	144.92	360	890	20
Li	50.5	51	10.86	30	70	20
Rb	180.65	178	31.15	130	235	20
Sr	123.8	126.5	24.06	60	160	20
Pb	25.3	26	5.89	10	32	20
Th	15.35	14	5.55	4	26	20
U	4.03	4	1.24	2	7.5	20
Zr	177.35	170.5	37.04	135	249	20
Nb	13.1	13	2.02	10	16	20
Y	32.05	31.5	6.43	25	54	20
La	33	33	-	33	33	1
Ce	63	63	-	63	63	1
Nd	23	23	-	23	23	1
Sc	13	13	-	13	13	1
V	87	90	25.11	42	130	20
Cr	33	33	-	33	33	1
Co	13	13	2.49	10	18	12
Ni	10	10	-	10	10	1
Cu	20.6	16.5	14.55	3	70	20
Zn	73.95	72	13.7	48	105	20
Sn	5.95	6	2.04	4	10	20
W	10	10	-	10	10	12
Mo	3	3	-	3	3	1
Ga	18.65	20	5.61	2	25	20
As	1.5	1.5	-	1.5	1.5	1
S	29	29	-	29	29	1
Cl	199	199	-	199	199	1
Be	4.7	5	1.53	3	10	20
Bi	1	-	-	-	-	1
Ta	10	10	-	10	10	12
Cs	20	20	-	20	20	12

Soldiers Creek Granite

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	70.63	71.05	1.21	68.2	71.5	6
TiO2	0.25	0.2	0.11	0.18	0.47	6
Al2O3	14.72	14.35	0.9	14.2	16.53	6
Fe2O3	0.6	0.44	0.35	0.32	1.27	6
FeO	1.68	1.42	0.71	1.15	3.1	6
MnO	0.03	0.02	0.02	0.01	0.07	6
MgO	0.58	0.41	0.44	0.37	1.47	6
CaO	1.12	0.99	0.52	0.7	2.12	6
Na2O	2.78	2.62	0.63	2.01	3.9	6
K2O	5.24	5.63	0.82	4.11	5.95	6
P2O5	0.09	0.1	0.04	0.01	0.12	6
H2O+	0.66	0.66	-	0.66	0.66	1
H2O-	0.01	0.01	-	0.01	0.01	1
CO2	-	-	-	-	-	-
LOI	0.84	0.88	0.14	0.61	0.97	5
Ba	211	210	130.98	15	380	5
Li	42	40	9.08	30	55	5
Rb	337	330	73.11	225	420	5
Sr	44.6	44	25.49	4	70	5
Pb	37.6	32	14.79	24	62	5
Th	22.8	20	15.07	4	46	5
U	8.8	6	5.76	4	16	5
Zr	79.2	76	47.2	8	135	5
Nb	18.8	18	4.6	14	26	5
Y	24.8	26	5.22	18	32	5
La	-	-	-	-	-	-
Ce	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	17	10	9.75	10	30	5
Cr	-	-	-	-	-	-
Co	5	5	-	5	5	5
Ni	-	-	-	-	-	-
Cu	19.2	5	32.87	4	78	5
Zn	44	44	3.16	40	48	5
Sn	10	10	2	8	12	5
W	10	10	-	10	10	5
Mo	-	-	-	-	-	-
Ga	23	23	2.12	20	25	5
As	-	-	-	-	-	-
S	50	d	-	d	d	1
Cl	-	-	-	-	-	-
Be	5	5	-	5	5	5
Bi	-	-	-	-	-	-
Ta	10	10	-	10	10	5
Cs	20	20	-	20	20	5

Two Sisters Granite

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	73.23	73.4	1.54	69.4	74.9	19
TiO2	0.14	0.1	0.12	0.1	0.37	19
Al2O3	14.02	14.17	1.1	12.23	15.48	19
Fe2O3	0.56	0.5	0.28	0.12	1.4	19
FeO	1.3	1.4	0.71	0.3	2.7	19
MnO	0.05	0.04	0.08	0.01	0.38	19
MgO	0.33	0.31	0.23	0.06	0.92	19
CaO	1.14	0.94	0.57	0.33	2.18	19
Na2O	3.27	3.12	0.85	2.18	4.8	19
K2O	4.24	4.51	1.04	2.26	5.88	19
P2O5	0.1	0.08	0.06	0.03	0.24	19
H2O+	0.86	0.86	0.01	0.85	0.86	2
H2O-	0.09	0.09	-	0.09	0.09	1
CO2	0.42	0.42	-	0.42	0.42	1
LOI	0.75	0.71	0.17	0.46	1.1	17
Ba	446	590	321.26	10	790	17
Li	105.24	65	80.87	30	270	17
Rb	258.53	230	121.75	80	550	17
Sr	81.47	61	73.79	7	256	17
Pb	29	30	12.93	6	52	17
Th	14.61	13	10.23	2	34	18
U	5.78	4	4.99	2	25	18
Zr	89.53	105	66.79	6	187	17
Nb	10.71	9	6.94	4	28	17
Y	21.53	18	10.51	8	44	17
La	-	-	-	-	-	-
Ce	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	14.94	10	14.74	2	55	17
Cr	-	-	-	-	-	-
Co	5.13	5	0.35	5	6	8
Ni	-	-	-	-	-	-
Cu	6.82	4	5.94	2	18	17
Zn	36.06	37	21.2	3	65	17
Sn	11.47	6	10.81	2	34	17
W	10	10	-	10	10	8
Mo	-	-	-	-	-	-
Ga	15.94	15	5.09	9	28	17
As	-	-	-	-	-	-
S	50	d	-	d	d	1
Cl	-	-	-	-	-	-
Be	5.06	5	4.46	1	20	17
Bi	-	-	-	-	-	-
Ta	10	10	-	10	10	8
Cs	26.88	20	19.45	20	75	8

4 CULLEN SUPERSUITE

4.1 Timing 1825 Ma

4.2 Individual Ages **Primary Ages:**

1. Margaret Granite ^{1, 2}	1860 ± 25 Ma, U-Pb
2. Fingerpost Granodiorite ^{1, 2}	1843 ± 22 Ma, U-Pb
3. McMinns Bluff Granite ^{1, 2}	1835 ± 6 Ma, SHRIMP
4. Mount Bunday Granite ¹	1831 ± 6 Ma, U-Pb
5. Allamber Springs Granite ¹	1826 ± 18 Ma, U-Pb
6. Allamber Springs Granite ^{1, 2}	1826 ± 32 Ma, U-Pb
7. Umbrawarra Leucogranite ^{1, 2}	1825 ± 7 Ma, SHRIMP
8. Fingerpost Granodiorite ^{1, 2}	1823 ± 3 Ma, SHRIMP
9. Allamber Springs Granite ^{1, 2}	1822 ± 6 Ma, SHRIMP
10. Allamber Springs Granite ^{1, 2}	1818 ± 5 Ma, SHRIMP
11. McMinns Bluff Granite ^{1, 2}	1818 ± 3 Ma, U-Pb
12. Umbrawarra Leucogranite ^{1, 2}	1805 ± 12 Ma, U-Pb
13. Prices Springs Granite ^{1, 2}	1804 ± 50 Ma, U-Pb
14. Burnside Granite ^{1, 2}	1800 ± 5 Ma, SHRIMP
15. Shoobridge Granite ^{1, 2}	1775 ± 16 Ma, U-Pb
16. Burnside Granite ^{1, 2}	1750 ± 56 Ma, U-Pb

Sources: [1] OZCHRON, [2] Stuart-Smith *et al.* 1993.

4.3 Regional Setting

The Cullen Supersuite was intruded into the central part of the Pine Creek Inlier. It is believed to be synchronous with the major extensional event that led to the deposition of the lower Katherine River Group, including the Kombolgie Formation (Jagodzinski and Wyborn 1995). The Cullen Supersuite is predominantly felsic, with minor coeval doleritic magmas (Stuart-Smith *et al.* 1993). There are no clear comagmatic volcanic equivalents to this suite, although felsic volcanics of the Edith River Group of the adjacent Jim Jim Suite are clearly coeval. The Supersuite intrudes a wide range of rock types, and is associated with a wide variety of Au ± base metal deposits.

4.4 Summary

The Cullen Supersuite is an I-(granodiorite) type suite that has undergone significant fractionation. It shows clear evidence of late-stage release of magmatic fluids and there is abundant pegmatite, aplite and greisen. The granite has also significantly thermally metamorphosed the surrounding country rock. The source of the metals, particularly Au, remains enigmatic, with several authors arguing that the Au is leached from the country rock as a result of hydrothermal solutions emanating from the granite, whilst others argue that the metals are sourced from within the granite. It is quite clear that the fluids emanating from some plutons of the Cullen Supersuite are clearly associated with mineralisation; whether the granite is the source of Au or not may not necessarily be all that relevant.

4.5 Potential

The Cullen Mineral Field has been a major center of metal production, mainly for Au, Ag, Pb, Cu, Sn, W and Fe. The dominant geological unit in this field is the Cullen Suite, and a magmatic source, particularly fractionated leucogranites, is indicated for some of the metals. Chemical analyses of the granite show that U, Sn and W deposits

are more common near the most fractionated leucogranites, whilst precipitation of Au, Cu, Ag, Pb and Zn is controlled by the presence of specific host rocks. The preferred host rocks for this mineralisation appear to be carbonaceous sediments, banded iron formation and turbidite. Structural control is clearly critical at the majority of the deposits.

Cu:	Moderate
Au:	High
Pb/Zn:	Low
Sn:	High
Mo/W:	Moderate
Confidence Level:	323

4.6 Descriptive Data

Location: Central and southern Pine Creek Inlier, mainly on the Darwin, Pine Creek, Mount Evelyn, Fergusson River, and Katherine 1:250 000 Sheet areas.

Dimensions and area: Outcrop of the Cullen Supersuite extends 175 km in a northerly direction by 120 km east-west. Total area covered by the Supersuite is 3330 km². It is highly probable that the unit extends farther south under Cambrian cover. To the north between the Burnside Granite and Mount Bunday Granite, regional aeromagnetic data clearly indicate extensions of the Cullen Supersuite intruding lower Palaeoproterozoic metasedimentary rocks.

4.7 Intrusives

Component plutons: Saunders Leucogranite, Foelsche Leucogranite, Burnside Granite, Douglas Leucogranite, Frances Creek Leucogranite, Wandie Granite, Tennysons Leucogranite, Yenberrie Leucogranite, Wolfram Hill Granite, Fenton Granite, Umbrawarra Leucogranite, Fingerpost Granodiorite, McCarthys Granite, Minglo Granite, McMinns Bluff Granite, Margaret Granite, Prices Springs Granite, Mount Porter Granite, McKinlay Granite, Shoobridge Granite, Tabletop Granite, Driffield Granite, Mount Davis Granite, Allamber Springs Granite, Bonrook Granite, Mount Bunday Granite.

On the basis of geochemistry, petrography and associated mineral deposits, the plutons were divided into the following suites:

Group 1) Leucogranite-dominated plutons:

- A) Saunders Suite: Saunders and Foelsche Leucogranites.
- B) Burnside Suite: Burnside Granite, Douglas Leucogranite, Frances Creek Leucogranite and Wandie Granite.
- C) Tennysons Suite: Tennysons Leucogranite, Wolfram Hill Granite, Fenton Granite and Umbrawarra Leucogranite, Yenberrie Leucogranite.

Group 2) Granite-dominated plutons.

- A) Fingerpost Suite (hornblende dominated): Fingerpost Granodiorite, Minglo Granite, McCarthys Granite.
- B) McMinns Suite (biotite dominated): McMinns Bluff Granite
- C) Margaret Suite (hornblende/biotite equal): Margaret Granite, Prices Springs Granite, Mount Porter Granite, McKinlay Granite.

Group 3) Concentrically zoned transitional granite and leucogranite-dominated plutons:

- A) Shoobridge Suite (hornblende-dominated): Shoobridge Granite, Driffield Granite, Tabletop Granite.
- B) Allamber Springs Suite (biotite-dominated): Allamber Springs Granite, Bonrook Granite.

Form: Mainly as circular to elliptical intrusions. Specifically: Saunders Leucogranite - small oval pluton. Foelsche Leucogranite - four irregular bodies. Burnside Granite - elliptical, covering about 90 km². Douglas Leucogranite - roughly circular, 6 kms across. Frances Creek Leucogranite - five separate intrusions up to 15 km across. Wandie Granite - two small plutons totalling about 3 km². Yenberrie Leucogranite - two small stocks covering a total area of 2 km². Umbrawarra Leucogranite - a roughly triangular pluton. Mount Porter Granite - small triangular pluton. McKinlay Granite - oval pluton. Shoobridge Granite - concentrically zoned pluton. Tabletop Granite - roughly circular. Driffield Granite - irregular shaped, broadly concentrically zoned pluton. Mount Davis Granite - elliptical. Allamber Springs Granite -

semi-circular covering 650 km². Bonrook Granite - roughly square pluton covering 7.5 km, weakly zoned.

Metamorphism and Deformation: Most samples appear to have a greenschist facies overprint, with chlorite in the southeast and biotite in the far northwest. The major Pine Creek Shear Zone trends north-northwest through the middle of the Cullen Supersuite, and many plutons have been affected by it. This shear zone is believed to have operated during the emplacement of the granite, and there is a strong foliation developed in plutons near this shear zone with quartz veining being prominent locally. Specifically: Tennysons Leucogranite - eastern part of the pluton lies within the Pine Creek Shear Zone and is cut by fault breccias and shear zones. Fenton Granite - weakly developed but widespread north-trending foliation parallels major faults and shear zones within the granite. McMinns Bluff Granite - shear zones metamorphosed to biotite grade. Tabletop Granite - cut by mylonites. Driffield Granite - extensively faulted and sheared along the Pine Creek Shear Zone.

Dominant intrusive rock types: The rock types range from granodiorite to monzogranite, granite and leucogranite. Some phases are strongly porphyritic. Specifically: Saunders Leucogranite - fine to medium even-grained leucogranite. Foelsche Leucogranite - fine to medium even-grained leucogranite and alkali-feldspar granite. Burnside Granite - fine to medium even-grained leucogranite, slightly porphyritic in places. Douglas Leucogranite - fine-grained porphyritic leucogranite and medium to coarse even-grained leucogranite. Frances Creek Leucogranite - leucogranite. Wandie Granite - medium even-grained leucogranite. Tennysons Leucogranite - coarse porphyritic leucogranite with interspersed phases of medium and fine-grained leucogranite. Yenberrie Leucogranite - fine and coarse-grained leucogranite and minor greisen. Fenton Granite - leucogranite, granite, monzogranite. Umbrawarra Leucogranite - coarse porphyritic leucogranite. Fingerpost Granodiorite - coarse-grained porphyritic granodiorite which grades into strongly porphyritic granite with up to 50% K-feldspar megacrysts. McCarthy's Granite - coarse porphyritic granite which is gradational with coarse-grained granite and fine to coarse-grained leucogranites. Minglo Granite - homogeneous coarse-grained porphyritic granite, monzonites, leucogranite. McMinns Bluff Granite - coarse-grained, porphyritic granite, fine-grained granite. Margaret Granite - monzogranite. Prices Springs Granite - medium to coarse-grained porphyritic granite with two textural varieties: the first has numerous phenocrysts of K-feldspar in a medium-grained groundmass, and the second contains a few phenocrysts in a finer-grained groundmass. Mount Porter Granite - coarse-grained porphyritic granite. McKinlay Granite - granite, granodiorite. Shoobridge Granite - zoned from granodiorite through monzogranite to leucocratic monzogranite. Tabletop Granite - coarse-grained porphyritic granite, coarse-grained leucogranite, fine even-grained granite. Driffield Granite - two distinctive phases: an outer marginal phase of fine to medium-grained granite and a coarse-grained core with K-feldspar megacrysts. Mount Davis Granite - even-grained leucogranite, coarse-grained porphyritic leucogranite. Allamber Springs Granite - mainly massive and homogeneous coarse-grained leucogranite and even-grained leucogranite with coarse-grained porphyritic granite at the margins. Bonrook Granite - two main phases present: coarse-grained porphyritic granite, and fine even-grained leucogranite. Mount Bunday Granite - massive medium-grained granite.

Colour: The plutons are mainly grey to pink: where plagioclase is heavily sericitised the colour is green. *Specifically:* Saunders Leucogranite - pale pink. Burnside Granite - grey. Douglas Leucogranite - light grey. Frances Creek Leucogranite - pale pink. Fenton Granite - grey. Umbrawarra Leucogranite - light grey, pink. McCarthy's Granite - pink and green. Minglo Granite - white to pink. McMinns Bluff Granite - grey to pink. Margaret Granite - pink and green. Prices Springs Granite - grey. Mount Porter Granite - pink and green. McKinlay Granite - pink and green. Driffield Granite - pink and green. Allamber Springs Granite - grey to pink. Bonrook Granite - grey. Mount Bunday Granite - pink.

Veins, Pegmatites, Aplites, Greisens: Around some of the more fractionated intrusions, greisen, pegmatite and aplite predominate; many of these are mineralised. *Specifically:* Burnside Granite - veins of aplite, quartz, pegmatite, and microgranite, and patches of greisen. Tennysons Leucogranite - cut by numerous north-northwest-trending quartz veins and greisen zones. Yenberrie Leucogranite - granite intruded by numerous north-northwest-trending quartz and aplite dykes; greisen and a dyke of silicite (an igneous rock composed almost entirely of quartz) also present. Wolfram Hill Granite - extensive zones of muscovite-quartz greisen and vein quartz are common. Umbrawarra Leucogranite - numerous quartz, aplite, and greisen veins and stockworks which are parallel to the major north to northwest and east-southeast joint directions. McMinns Bluff Granite - alteration near zones of quartz veining. Mount Porter Granite - at the margin the granite grades into dykes and veinlets of microgranite

and tourmaline pegmatite. Tabletop Granite - minor greisen dykes cut the granite. Driffield Granite - greisen present. Mount Davis Granite - greisen and quartz stockworks common throughout the pluton. Allamber Springs Granite - cut by numerous north-trending quartz veins up to 3 km long, minor dykes of aplite and fine even-grained leucogranite are also present, extensive greisenisation over about 4 km² on northwest side of the pluton. Bonrook Granite - massive greisen and extensive aplite.

Distinctive mineralogical characteristics: The dominant minerals are typical of I-type granite and include quartz, plagioclase, K-feldspar, biotite and hornblende. The plagioclase grains are almost universally altered, and some plutons contain sulphides reflecting the relatively reduced nature of this suite. Specifically: Saunders Leucogranite - biotite, microcline, quartz, plagioclase, allanite, zircon, apatite. Foelsche Leucogranite - pyrite, biotite, granophyric intergrowths of quartz and K-feldspar. Burnside Granite - quartz, plagioclase, biotite with traces of muscovite, allanite, fluorite and apatite. Douglas Leucogranite - quartz, plagioclase, microcline, red-brown biotite, muscovite, apatite, opaques. Frances Creek Leucogranite - quartz, plagioclase, microcline, biotite, muscovite, allanite, apatite. Tennysons Leucogranite - quartz, plagioclase, K-feldspar, biotite, muscovite, apatite. Yenberrie Leucogranite - quartz, plagioclase, K-feldspar, biotite, muscovite, apatite. Wolfram Hill Granite - quartz, plagioclase, K-feldspar, biotite, fluorite. Fenton Granite - quartz, K-feldspar, plagioclase, biotite, hornblende with traces of allanite, muscovite, titanite, garnet. Umbrawarra Leucogranite - quartz, perthitic K-feldspar, biotite and muscovite, apatite. Fingerpost Granodiorite - quartz, plagioclase, K-feldspar, hornblende, biotite, zircon and apatite. McCarthy's Granite - quartz, K-feldspar, plagioclase, hornblende, biotite, muscovite with garnet, titanite, opaques. Minglo Granite - quartz, plagioclase, K-feldspar, hornblende, biotite, allanite. McMinns Bluff Granite - quartz, plagioclase, K-feldspar, hornblende, biotite, zircon, apatite, allanite. Margaret Granite - quartz, altered plagioclase, K-feldspar, biotite, apatite, fluorite and titanite. Prices Springs Granite - quartz, K-feldspar, highly altered plagioclase, hornblende, biotite, allanite, and muscovite. Mount Porter Granite - quartz, K-feldspar, plagioclase, biotite, hornblende and muscovite. Shoobridge Granite - quartz, K-feldspar, plagioclase, biotite, hornblende. Tabletop Granite - quartz, K-feldspar, plagioclase, biotite, hornblende with accessory allanite, apatite and opaques. Driffield Granite - quartz, K-feldspar, plagioclase, biotite, allanite, zircon, apatite and pyrite. Mount Davis Granite - quartz, K-feldspar, plagioclase, biotite, hornblende, allanite. Allamber Springs Granite - quartz, K-feldspar, plagioclase, biotite, hornblende, allanite, magnetite, apatite, zircon. Bonrook Granite - quartz, K-feldspar, plagioclase, biotite, allanite, apatite, zircon. Mount Bundey Granite - quartz, plagioclase hornblende, biotite, apatite, allanite.

Breccias: Breccias are common in the later more fractionated granites. Some of the breccias may be related to deformation associated with the development of the Pine Creek Shear Zone and related structures. Specifically: Tennysons Leucogranite - cut by breccias. Umbrawarra Leucogranite - cut by numerous north-trending breccias. McMinns Bluff Granite - breccias can be up to 2 km long and up to 2 m wide and are surrounded by 10 m-wide zones of sheared and altered granite. Tabletop Granite - numerous north-northeast to northeast-trending quartz breccias cut the pluton, particularly in the west. Mount Davis Granite - quartz breccias present.

Alteration in the granite: Alteration is pervasive. In all plutons with the exception of the Shoobridge Granite, the plagioclase grains have been altered to sericite, and biotite is commonly altered to chlorite. Specifically: Saunders Leucogranite - epidote, chlorite, sericite, plagioclase altered to sericite. Foelsche Leucogranite - chlorite, calcite, epidote and sericite. Burnside Granite - plagioclase sericitised and the cores altered to clay. Douglas Leucogranite - chlorite and plagioclase persistently altered to sericite. Frances Creek Leucogranite - chlorite, epidote, sericite; plagioclase altered to sericite. Wandie Granite - chlorite, sericite. Tennysons Leucogranite - zones of alteration present with chlorite, sericite; near the Pine Creek Shear Zone, plagioclase everywhere is altered to sericite. Yenberrie Leucogranite - chlorite and plagioclase everywhere altered to sericite. Wolfram Hill Granite - plagioclase partly replaced by sericite and biotite partly chloritised, plus some carbonate. Fenton Granite - plagioclase altered to sericite. Umbrawarra Leucogranite - plagioclase altered to sericite. Fingerpost Granodiorite - epidote, plagioclase altered to sericite, biotite altered to chlorite. McCarthy's Granite - all samples have sericitised plagioclase, and the more altered samples have epidote, chlorite and calcite. Minglo Granite - epidote, chlorite, plagioclase altered to sericite. McMinns Bluff Granite - epidote, muscovite. Margaret Granite - sericitised plagioclase and chlorite. Prices Springs Granite - sericitised plagioclase, epidote. Mount Porter Granite - sericitised plagioclase. Shoobridge Granite - plagioclase partly altered to sericite, and less altered than in other plutons. Tabletop Granite - sericitised plagioclase, chlorite, sericite with titanite, calcite

and epidote more common in the deformed samples. **Driffield Granite** - chlorite, muscovite, epidote, sericitised plagioclase. **Mount Davis Granite** - chlorite, plagioclase altered to sericite. **Allamber Springs Granite** - chlorite, sericitised plagioclase, with epidote in the more deformed samples. **Bonrook Granite** - sericitised plagioclase, chlorite. **Mount Bunday Granite** - chlorite, epidote and carbonate alteration of feldspars with some borders of the crystals being pure albite.

4.8 Extrusives

The coeval Plum Tree Creek Volcanics of the Edith River Group are considered to be part of the Jim Jim Suite, rather than the Cullen Supersuite. It is accepted that some of these volcanics may in fact belong to the Cullen Supersuite, and although detailed geochemical data are available for these volcanics in the Coronation Hill area, a comprehensive geochemical study has not yet been carried out on a regional scale throughout the Pine Creek Inlier.

4.9 Country Rock

Contact metamorphism: A fairly strong contact metamorphic aureole is developed extending up to 5 km around the margin of the granite outcrop. Most of the contact aureole is albite-epidote hornfels facies with a narrower inner continuous zone of hornblende hornfels facies.

Reaction with country rock: Some of the contacts have been greisenised, and pegmatite and quartz veins intrude along some of the contacts.

Units the granite intrudes: Masson Formation, Mundogie Formation, Wildman Siltstone, Koolpin Formation, Gerowie Tuff, Mount Bonnie Formation, Zamu Dolerite, Burrell Creek Formation, Tollis Formation, Plum Tree Creek Volcanics.

Dominant rock types: Carbonaceous phyllite, slate, siltstone, quartzite, conglomerate, dolomite, marble, tuffaceous greywacke, arkose, pyritic shale, tuff, chert, mudstone, argillite, banded iron formation, mafic volcanics, felsic volcanics, ignimbrite, rhyolite, sandstone.

Potential hosts: Carbonaceous shale, pyritic shale, iron formation, dolomite.

4.10 Mineralisation

There is a strong spatial association between Au and base metal mineralisation and the intrusives of the Cullen Supersuite, and several significant Au deposits (Cosmopolitan Howley, Enterprise, Mount Todd, Golden Dyke, Goodall) occur within the contact aureole. There appears to be an association of mineral deposit types either within or surrounding particular granite types. The degree of fractionation within the leucogranite suites controls the associated mineral deposits and occurrences. The Saunders Suite is the least fractionated of the leucogranite suites and is unmineralised. In contrast, the relatively oxidised Burnside Suite shows some signs of fractionation and has the greatest range of mineralisation types in the nearby contact aureoles, whilst the most fractionated and relatively reduced Tennysons Suite has vein mineralisation associated with it, particularly Sn, W and U.

As Cu, Au, Pb, Ag and Zn deposits are mostly located in the contact aureole, it is difficult to relate some of the more distal deposits to a particular granite pluton especially as Au, Pb and Zn can occur up to 3 km from the pluton boundary. Precipitation of these metals appears to occur either by interaction with a specific host rock or by fluid mixing (Matthai *et al.* 1995a, b; Partington and McNaughton, *in press*). Where there is clear host-rock control, Au deposits are commonly hosted either by reduced carbonaceous mudstone or pyritic chert-banded dolomite in the contact aureole (e.g., Koolpin Formation, Mount Bonnie Formation) or by greywacke and siltstone (Burrell Creek Formation), whilst Pb and Zn are predominantly hosted by carbonate-rich rocks (eg parts of the Koolpin Formation). Small Cu deposits are associated with the zoned plutons, particularly those rich in hornblende. Although hosted by similar rock types to the Au deposits, they are not spatially related to them and are also confined to within 1500 m of granite boundaries.

4.11 Geochemical Data

Data source: The data are from either AGSO or from the NTGS. The AGSO and NTGS samples were collected as part of specialist studies (Ewers and Scott 1977; Stuart-Smith *et al.* 1993; Bajwah 1994a, 1994b). The AGSO data are housed in OZCHEM whilst the NTGS data are part of their database system.

Data quality: Good.

Are the data representative? Some plutons do not have many analyses, but overall the data are representative.

Are the data adequate? To assess the mineral potential of the Supersuite as a whole the data are adequate.

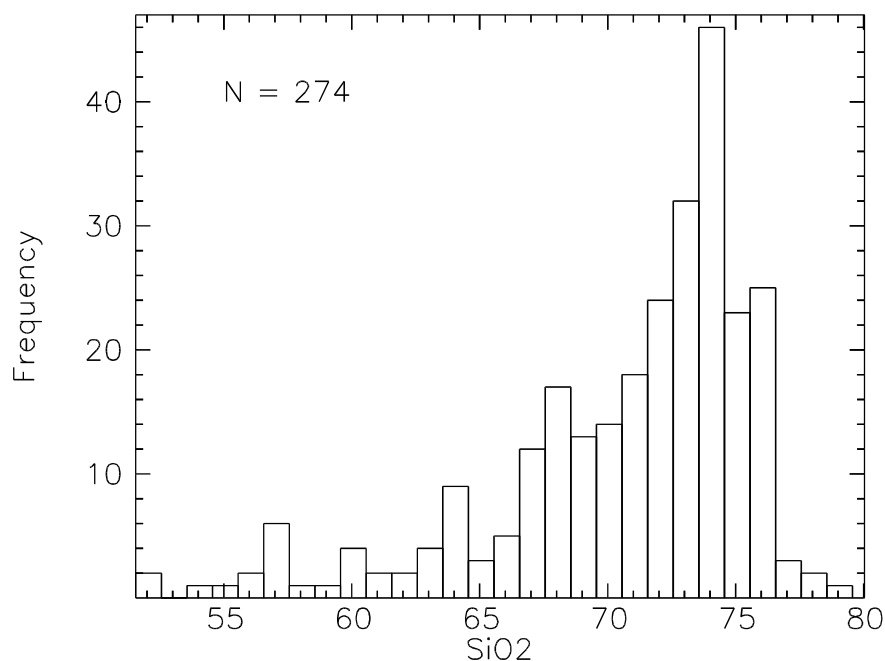


Figure 4.1. Histogram of SiO₂ values for the Cullen Supersuite

SiO₂ range (Fig. 4.1): The SiO₂ range is very wide from about 54 to 79 wt%, with a peak at 74 wt%.

Alteration (Figs. 4.1 & 4.2):

- **SiO₂:** Some silicification, probably related to quartz veining.
- **K₂O/Na₂O:** Considering the degree of alteration observed in thin section, this plot is remarkably coherent. The samples with the lowest K₂O are probably the ones that are the most sericitised.
- **Th/U:** Most samples plot in the normal range for Th/U ratios.
- **Fe₂O₃/(FeO+Fe₂O₃):** Most samples are relatively reduced.

Fractionation Plots (Fig. 4.3):

- **Rb:** There is an exponential increase in Rb with increasing SiO₂.
- **U:** There is an exponential increase in U with increasing SiO₂.
- **Y:** There is an exponential increase in Y with increasing SiO₂.
- **P₂O₅:** P₂O₅ values decrease linearly with increasing SiO₂.
- **Th:** There is a weak increase in Th with increasing SiO₂.
- **K/Rb:** For some plutons, particularly the plutons of the Burnside and Tennysons Suite there is a decrease with increasing SiO₂.
- **Rb-Ba-Sr:** Most samples plot in the anomalous granite or unnamed fields.
- **Sr:** There is a linear decrease with increasing SiO₂. Samples of the Shoobridge Granite from the zoned, hornblende-dominated group have the highest Sr, and the plagioclase in this granite is the least altered in the Cullen Supersuite.
- **Rb/Sr:** There is a late, strong exponential increase in Rb/Sr with increasing SiO₂.
- **Ba:** Ba decreases with increasing SiO₂.
- **F:** F values are quite high and increase with increasing SiO₂.

Metals (Fig. 4.4):

- **Cu:** Values are very low for Proterozoic granites.
- **Pb:** Values are moderate for Proterozoic granites.
- **Zn:** Values decrease with increasing SiO₂.
- **Sn:** Values are very low for Proterozoic granites.

High field strength elements (Fig. 4.5):

- **Zr:** Zr increases weakly and then decreases with increasing SiO₂.
- **Nb:** Values are low for Proterozoic granites.

- *Ce*: Values are moderate for Proterozoic granites.

Classification (Fig. 4.6):

- **The CaO/Na₂O/K₂O plot of White, quoted in Sheraton and Simons (1992):** Most samples plot in the monzogranite to granite field.
- **Zr/Y vs Sr/Sr*:** All samples plot below 1.0 indicating that they are all Sr depleted.
- **Spidergram:** The pattern is typical Sr-depleted, Y-undepleted.
- **Oxidation plot of Champion and Heinemann (1994):** Most samples plot in the reduced field proving that Au is not necessarily related to magnetite or oxidised granites. The low oxidation state is related to interaction with the locally reduced country rocks.
- **ASI:** All samples are metaluminous to weakly peraluminous.
- **A-type plot of Eby (1990):** Most samples straddle the boundary between A-type and normal granites as defined for Palaeozoic granites.

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

Australian Proterozoic granite type: Cullen type - the type example.

4.12 Geophysical Signature

Radiometrics (Fig. 4.7): The majority of the samples would appear white in a RGB image.

Gravity: Measured dry densities for 50 samples range between 2.61 to 2.71 gm.cm³ with an average of 2.65 (Tucker *et al.* 1980). The individual plutons are predominantly gravity lows, but some overlie gravity highs.

Magnetics: On the AGSO regional aeromagnetic data, all plutons are magnetic lows, confirming the reduced nature of this Supersuite. The contact aureoles are quite magnetic, reflecting the conversion of pyrite to pyrrhotite during contact metamorphism.

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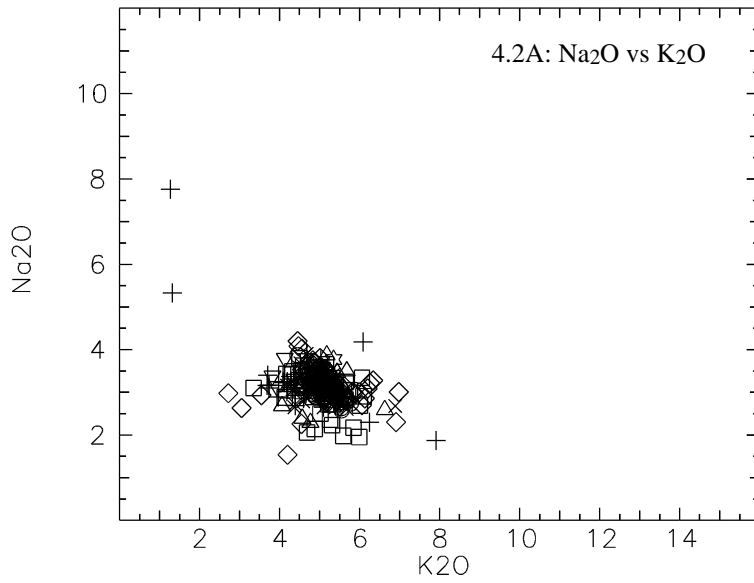
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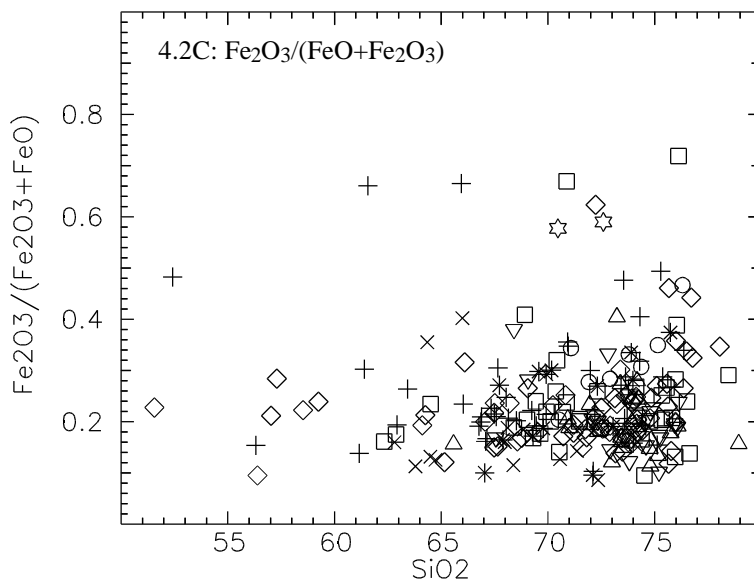
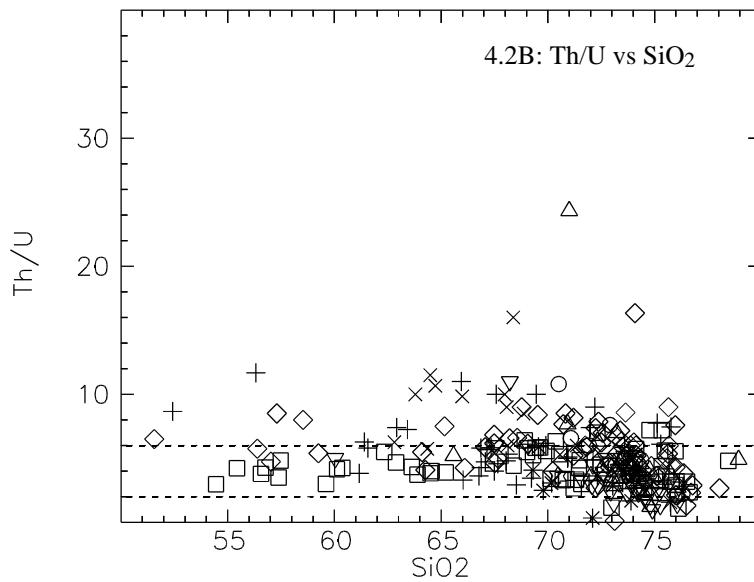
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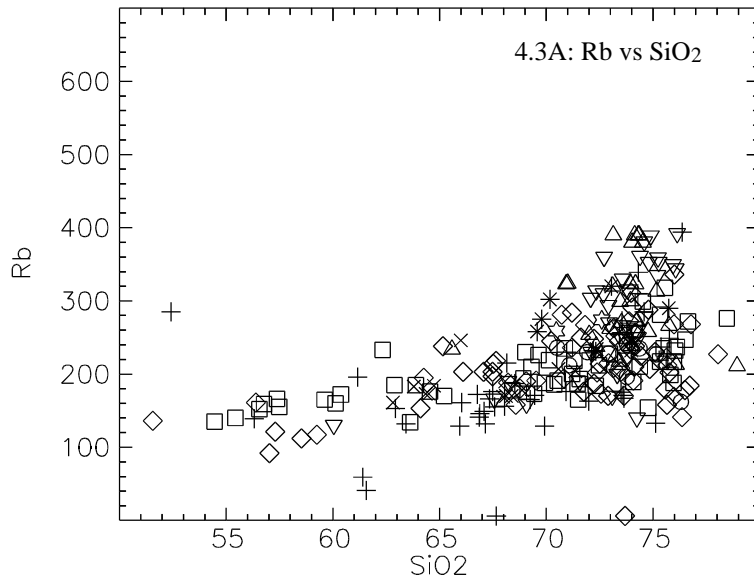
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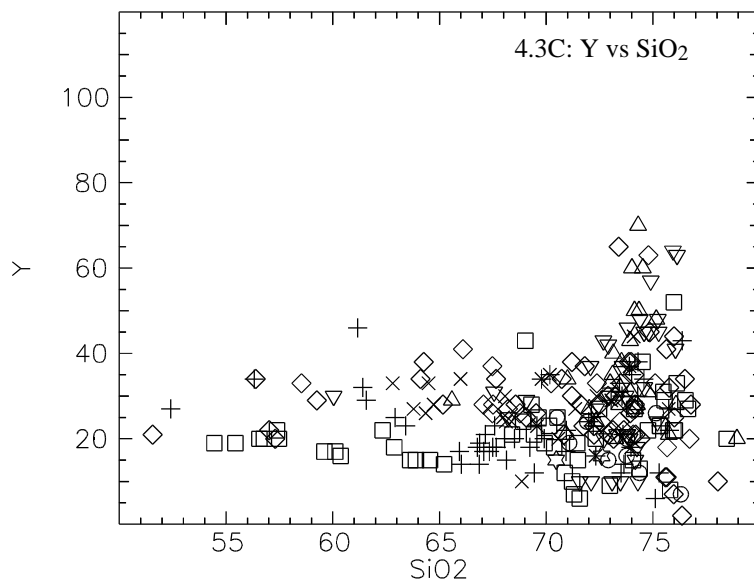
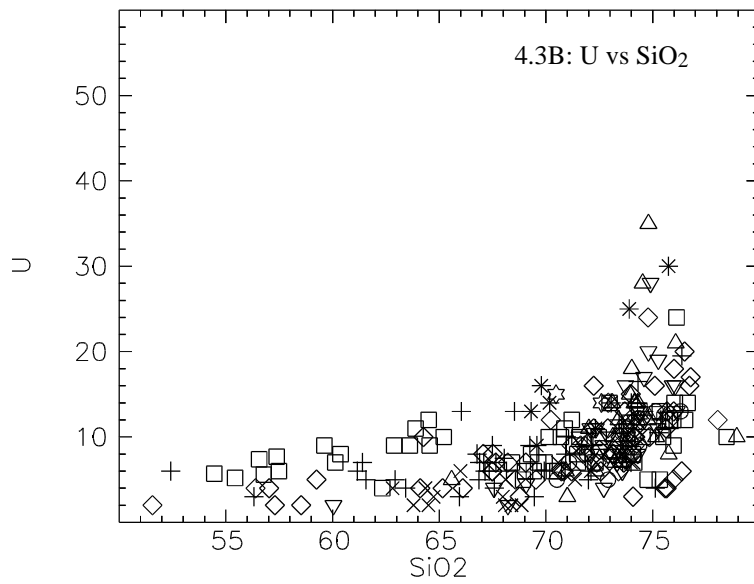
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- ▽ Tennysons Suite
- ☆ Mount Bunday Granite



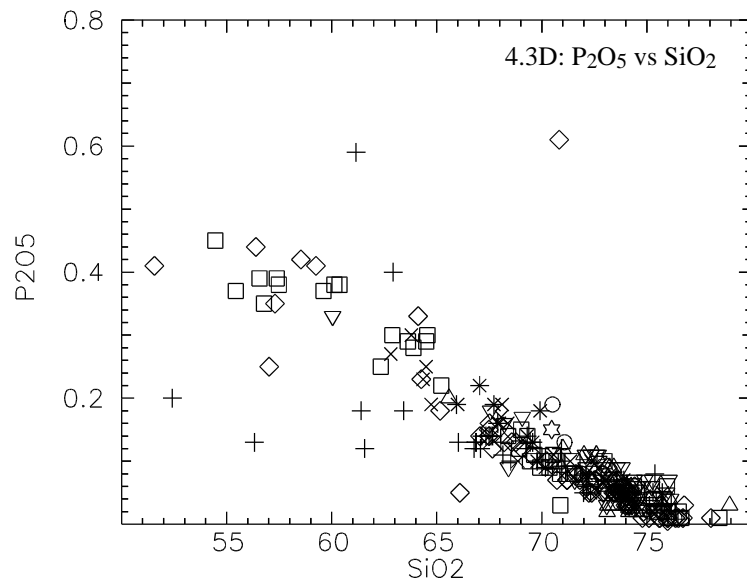
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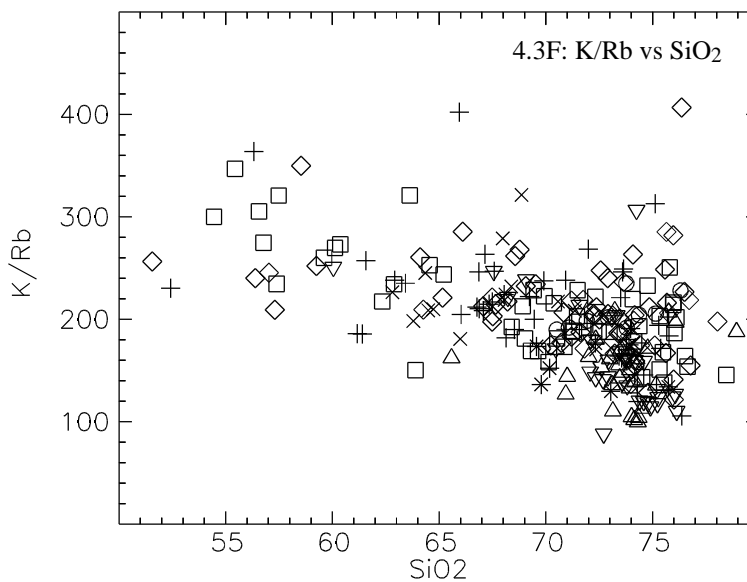
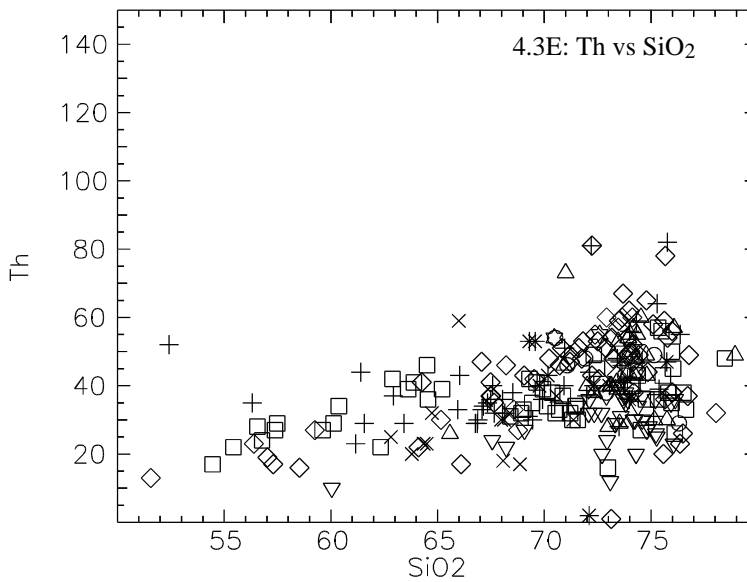
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- ☆ Mount Bunday Granite



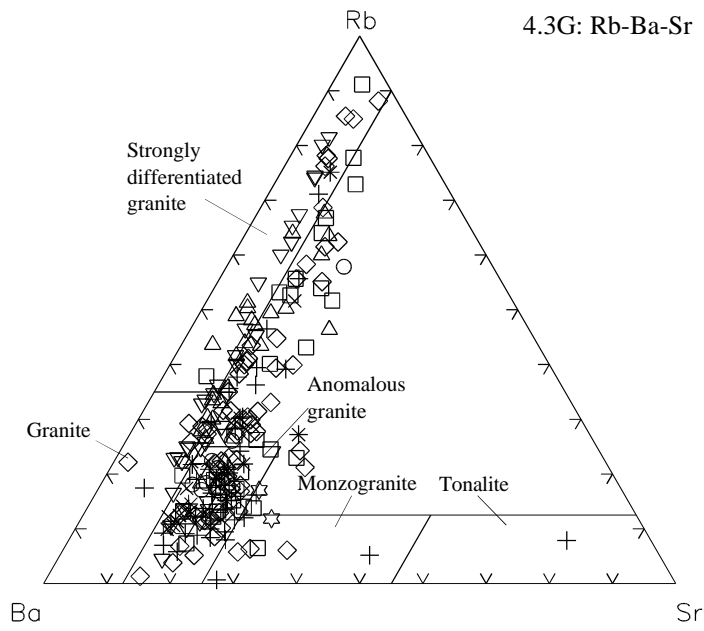
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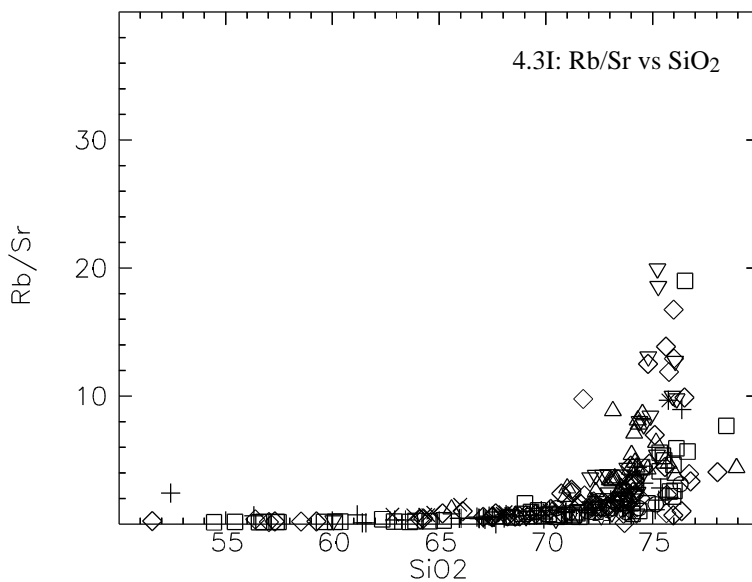
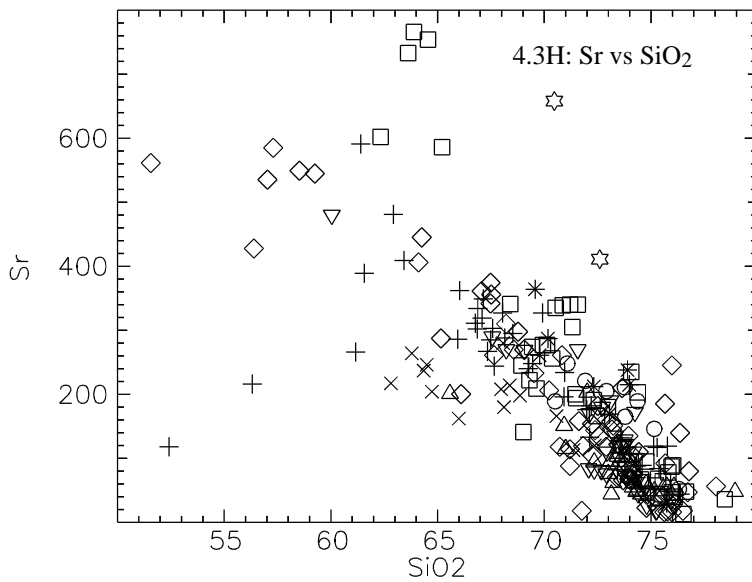
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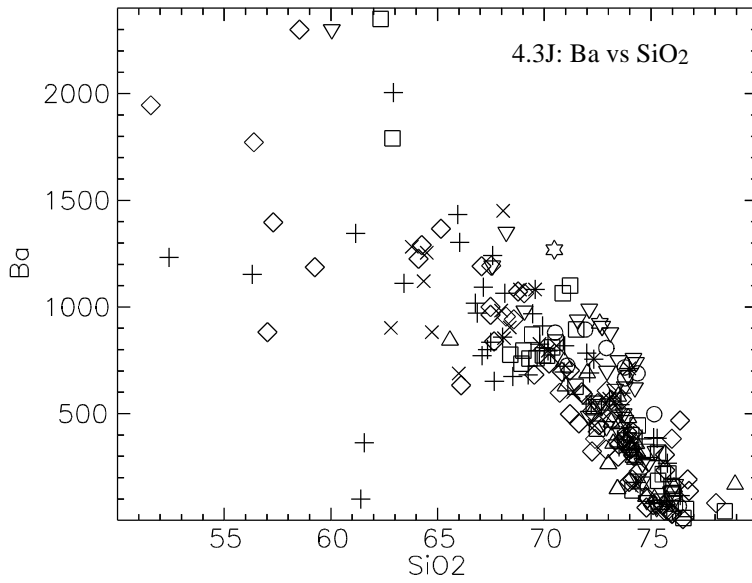
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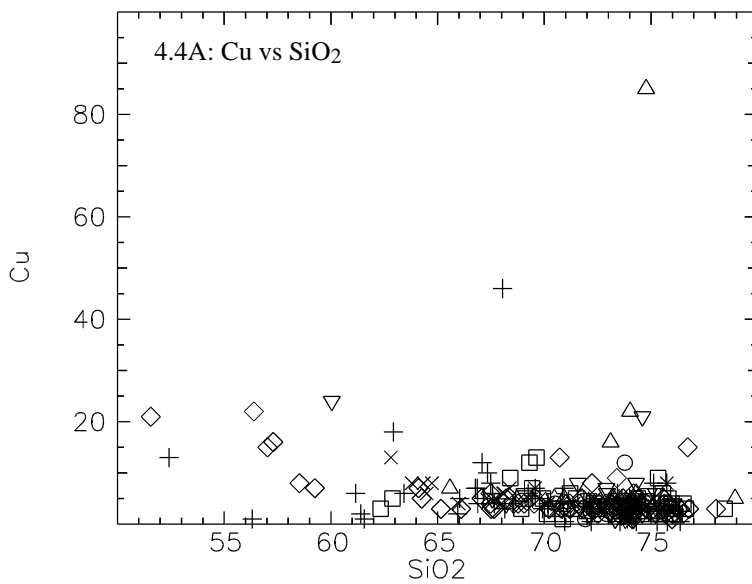
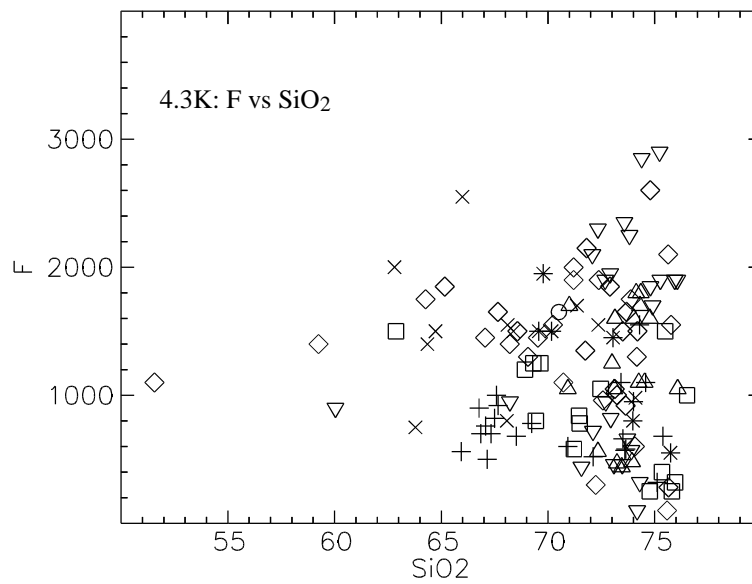
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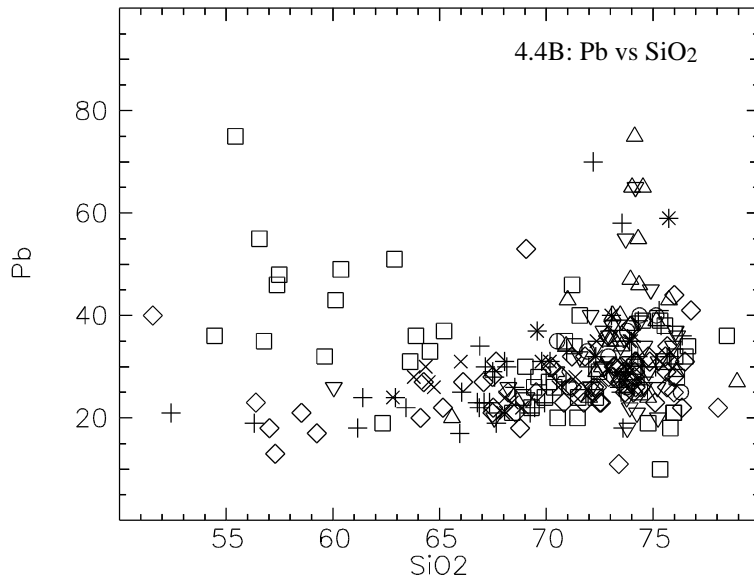
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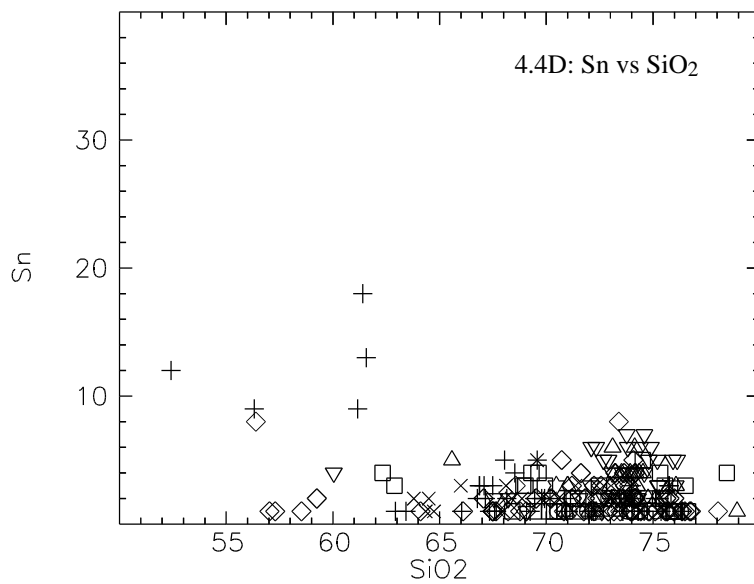
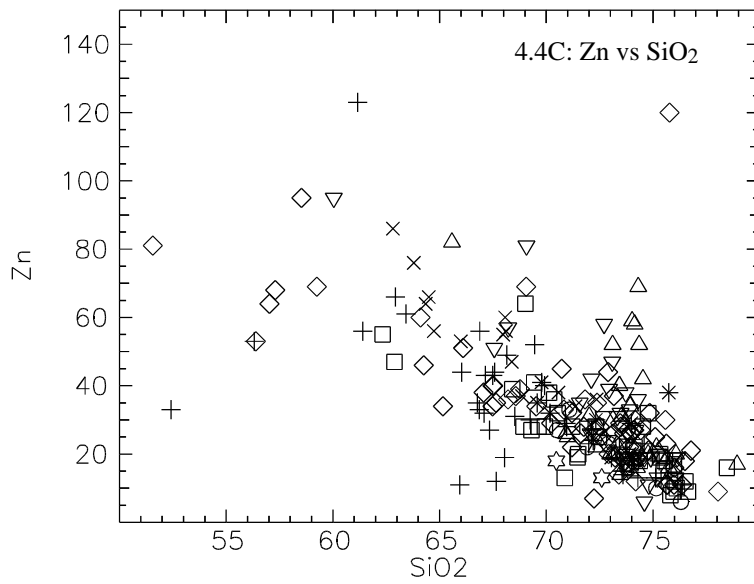
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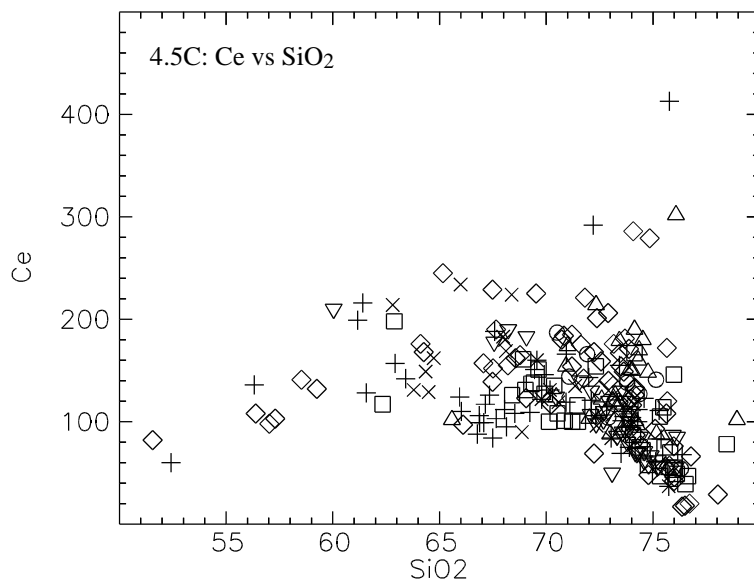
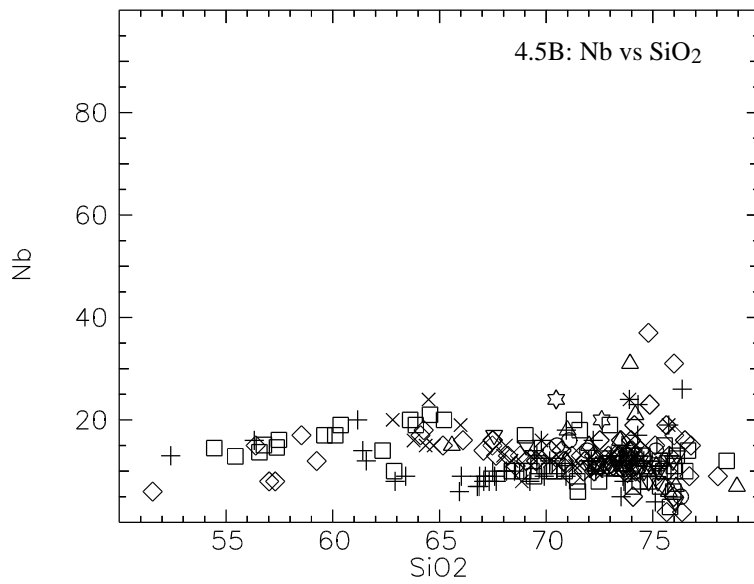
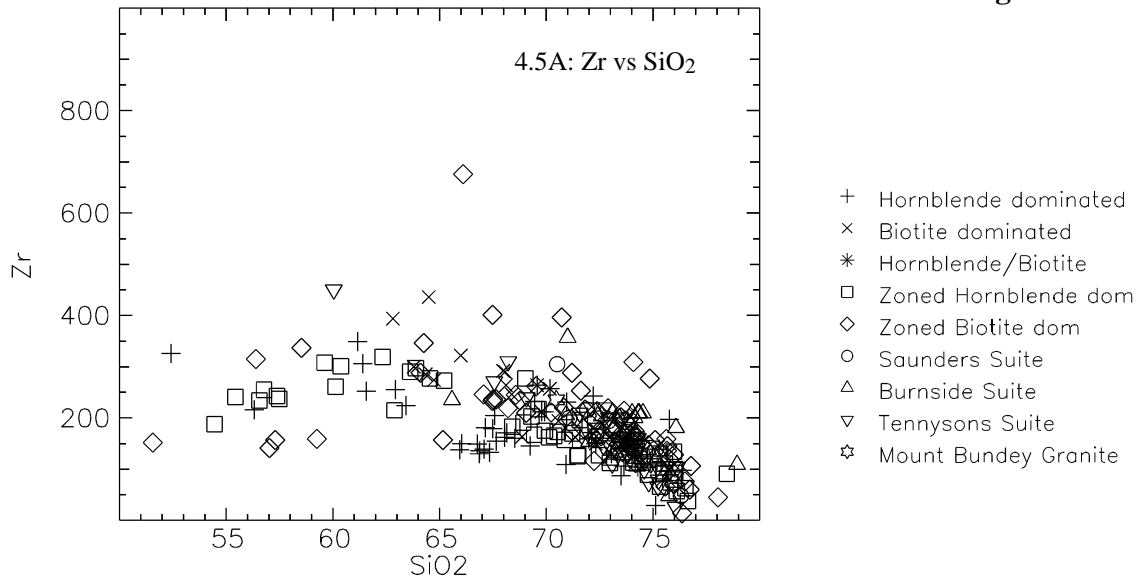
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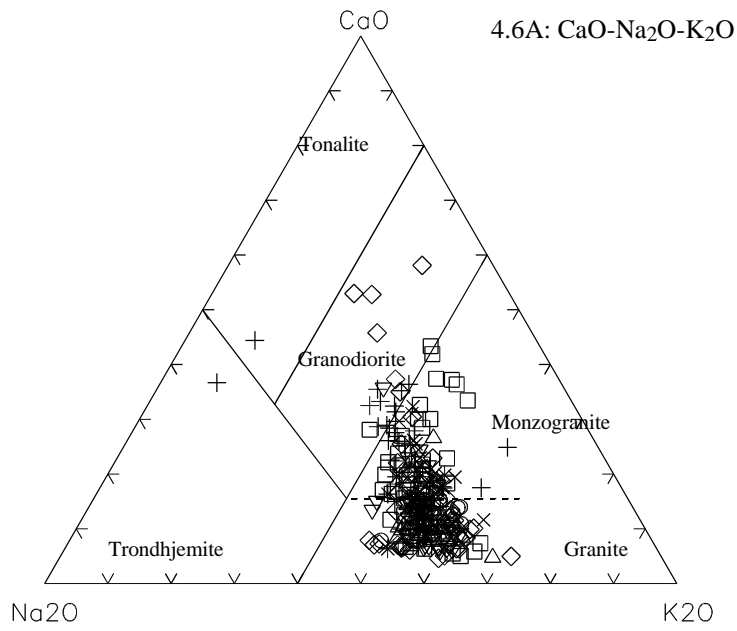
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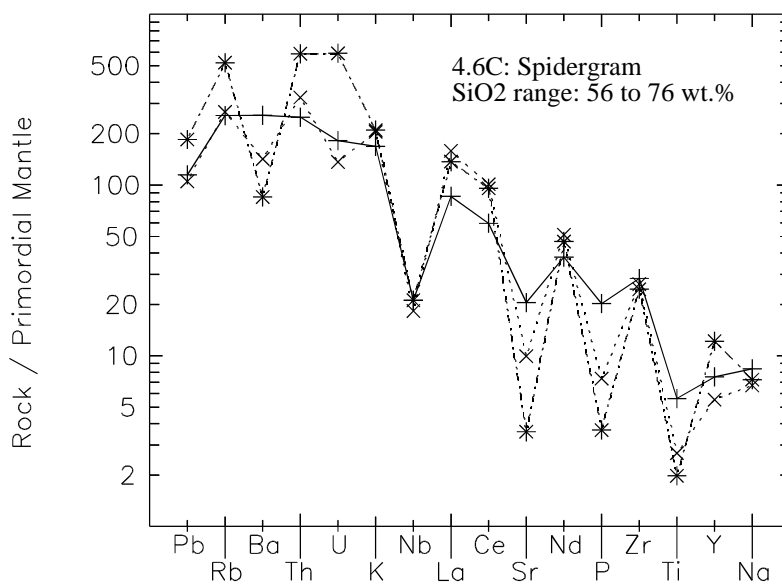
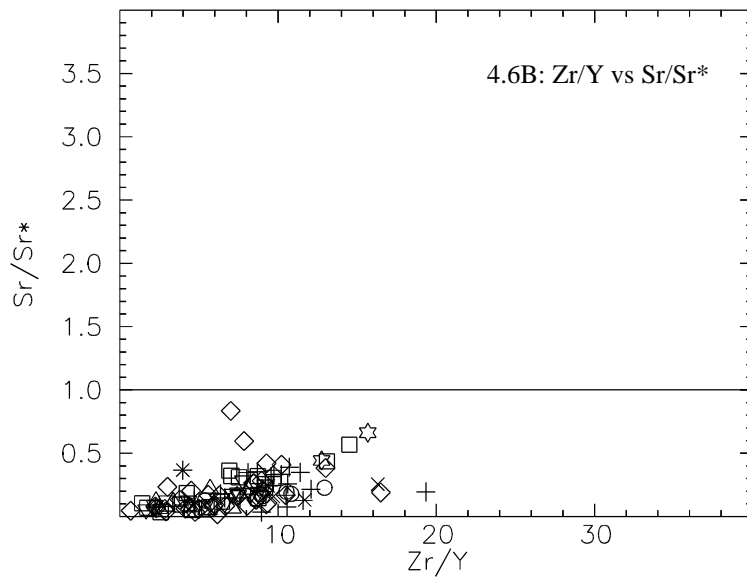
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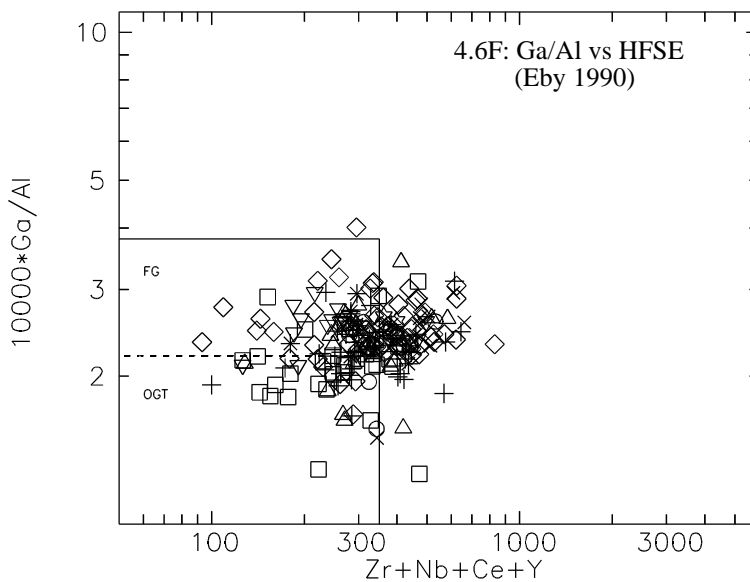
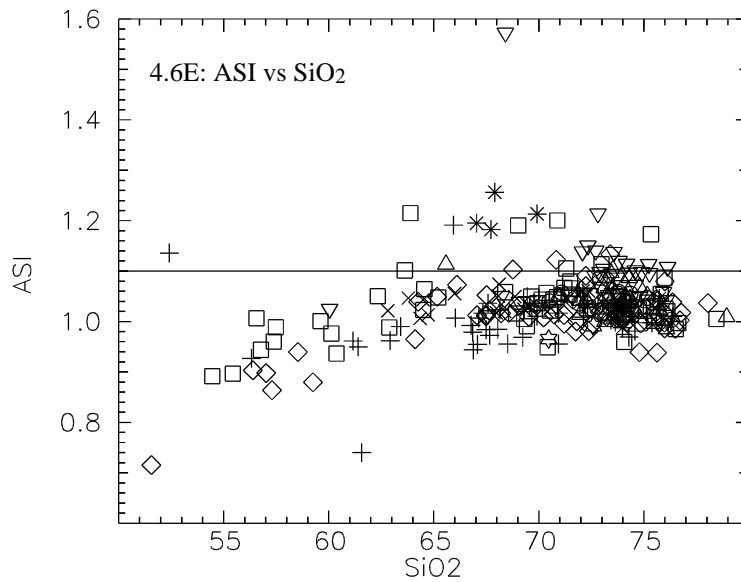
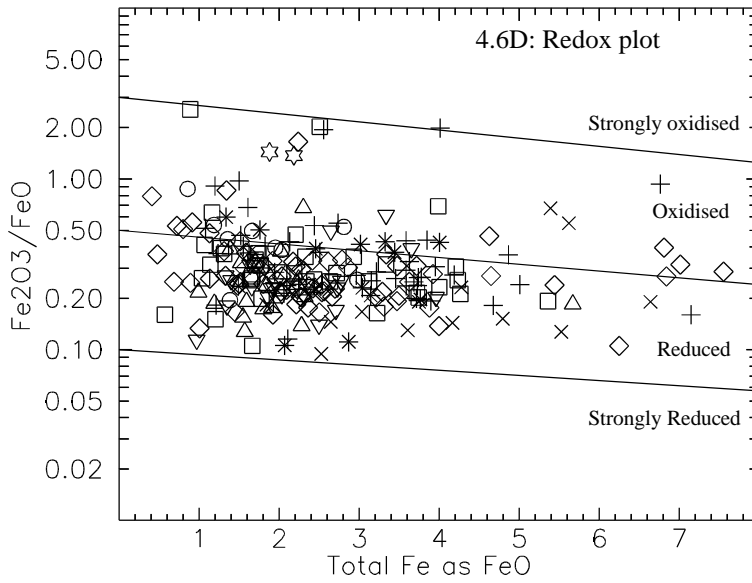
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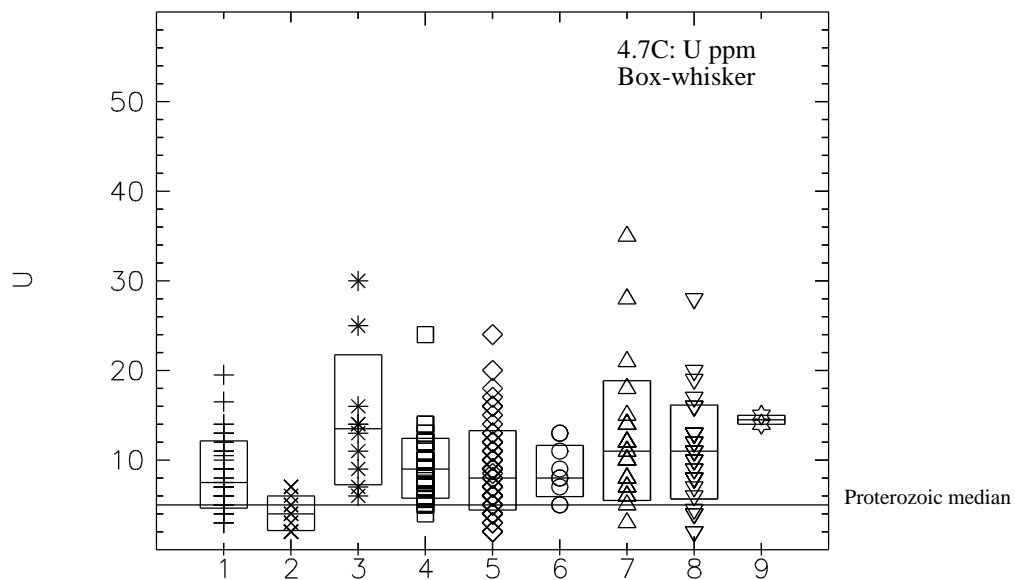
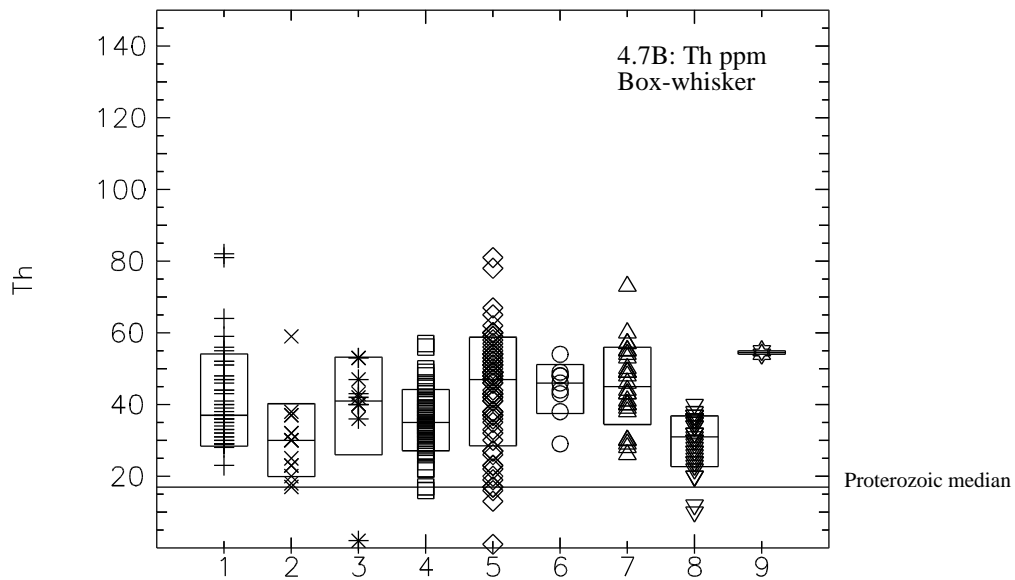
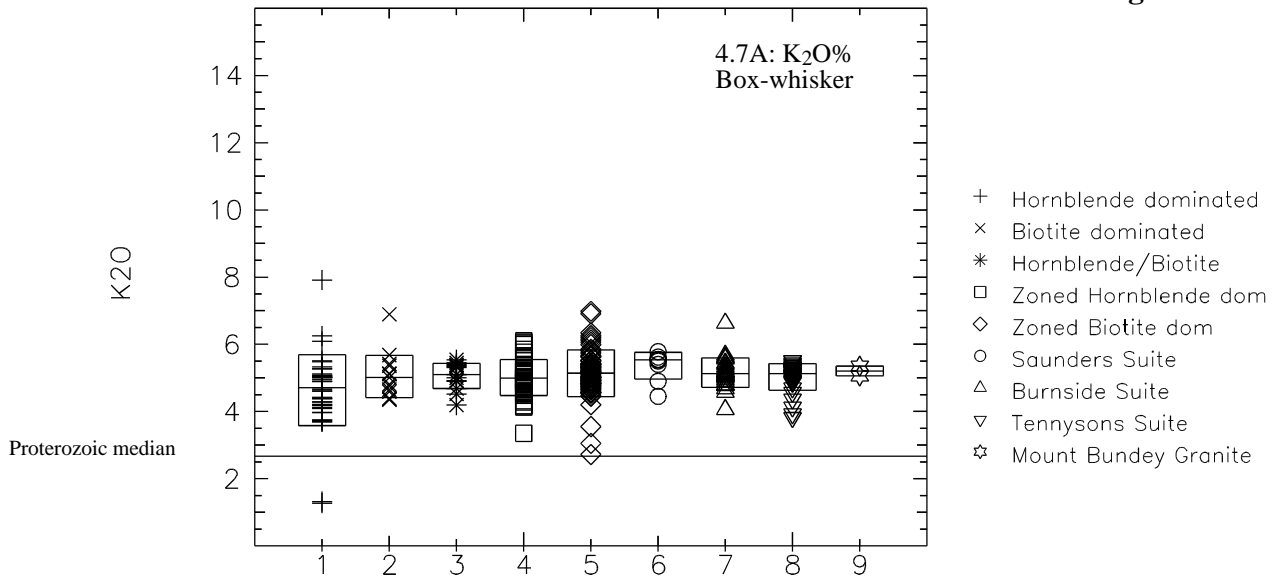
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Legend



Legend



Allamber Springs Granite (Zoned, biotite dominated)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	72.96	73.5	2.94	66.1	80.03	63
TiO2	0.22	0.21	0.11	0.02	0.46	63
Al2O3	13.24	13.07	0.98	9.81	15.47	63
Fe2O3	0.49	0.46	0.26	0.12	1.51	63
FeO	1.71	1.69	0.79	0.24	3.35	63
MnO	0.04	0.04	0.02	0.01	0.09	63
MgO	0.4	0.34	0.27	0.1	1.36	63
CaO	1.17	1.14	0.5	0.41	2.48	63
Na2O	3.21	3.18	0.36	2.26	4.2	63
K2O	5.27	5.18	0.53	4.45	6.98	63
P2O5	0.07	0.05	0.08	0.1	0.61	63
H2O+	0.62	0.63	0.21	0.29	1.09	34
H2O-	0.02	0.1	0.03	0.1	0.1	32
CO2	0.16	0.13	0.16	0.1	0.77	36
LOI	0.9	0.88	0.28	0.46	1.62	29
Ba	460.68	412	305.46	6	1193	63
Li	18.09	18.5	8.52	3	37	58
Rb	215.98	212	47.84	6	336	63
Sr	140.27	121	95.03	16	374	63
Pb	34.62	27	53.01	11	446	63
Th	46.67	48	13.42		81	63
U	9.67	9	4.23	3	24	63
Zr	184.75	175	97.48	13	676	63
Nb	13.16	13	5.28	2	37	63
Y	27.68	27	10.73	2	65	63
La	72.65	78	34.8	6	163	63
Ce	131.76	135	58.75	17	286	63
Pr	13.6	13	8.85	5	28	5
Nd	44.47	47.5	19.91	9	99	32
Sc	2.63		2.96		15	32
V	20.33	14	18.29		79	63
Cr	6.16	6	3.23		13	32
Mn	-	-	-	-	-	-
Co	5	5	1.9		9	58
Ni	3.08	3	1.86		13	63
Cu	3.86	3	2.32		15	63
Zn	32.1	27	36.18	7	285	63
Sn	1.87		1.35		8	63
W	3.11	3	1.87		9	58
Mo	3.66		3.59		16	61
Ga	17.85	18	2.45	13	26	61
As	1.78		1.76		10	61
S	155.17	100	98.51	100	600	29
F	1364.14	1450	563.66	100	2600	29
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	1		-			5
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	1		-			5

Bonrook Granite (Zoned, biotite dominated)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	75.61	76.31	1.74	73.02	76.8	4
TiO2	0.11	0.08	0.09	0.04	0.24	4
Al2O3	12.57	12.34	0.48	12.31	13.28	4
Fe2O3	0.37	0.34	0.15	0.22	0.57	4
FeO	0.91	0.8	0.61	0.29	1.74	4
MnO	0.03	0.02	0.01	0.02	0.04	4
MgO	0.25	0.2	0.18	0.08	0.5	4
CaO	0.68	0.6	0.31	0.42	1.11	4
Na2O	3.4	3.38	0.36	2.99	3.87	4
K2O	4.89	4.89	0.34	4.48	5.28	4
P2O5	0.03	0.02	0.03	0.01	0.07	4
H2O+	0.65	0.6	0.22	0.46	0.94	4
H2O-	-	01	-	01	01	4
CO2	0.21	0.19	0.16	10	0.41	4
LOI	-	-	-	-	-	-
Ba	188	114.5	212.44	23	500	4
Li	16.75	16.5	2.5	14	20	4
Rb	314.75	313	52.99	259	374	4
Sr	67.5	47.5	62.32	17	158	4
Pb	32.5	33	2.52	29	35	4
Th	38.5	39	1.91	36	40	4
U	17.25	18	4.57	11	22	4
Zr	103	91.5	30.14	82	147	4
Nb	14.25	14	2.22	12	17	4
Y	39.5	38	10.75	28	54	4
La	25	20	15.98	12	48	4
Ce	49.75	40.5	25.4	31	87	4
Pr	-	-	-	-	-	-
Nd	25	22	8.16	19	37	4
Sc	2.25	2	0.5	2	3	4
V	7.25	4.5	8.02		19	4
Cr	6	6.5	1.41	4	7	4
Mn	-	-	-	-	-	-
Co	3.5	3.5	0.58	3	4	4
Ni	1.75	1.5	0.96		3	4
Cu	2.5	2.5	0.58	2	3	4
Zn	14.25	13	4.03	11	20	4
Sn	1.75	1.5	0.96		3	4
W	3.63	4	1.49		5	4
Mo	1.88		0.75		3	4
Ga	15	15	1.63	13	17	4
As	1.25		0.5		2	4
S	-	-	-	-	-	-
F	-	-	-	-	-	-
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Burnside Granite (Burnside Suite)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	73.79	74.02	0.82	71.96	74.8	11
TiO2	0.17	0.16	0.05	0.13	0.3	11
Al2O3	13.42	13.32	0.27	13	13.87	11
Fe2O3	1.36	1.82	0.78	0.18	2.06	11
FeO	1.4	1.38	0.08	1.32	1.51	4
MnO	0.04	0.04	0.01	0.03	0.05	11
MgO	0.27	0.23	0.15	0.13	0.68	11
CaO	0.92	0.93	0.1	0.75	1.07	11
Na2O	3.53	3.5	0.15	3.35	3.87	11
K2O	5.06	5.05	0.28	4.68	5.68	11
P2O5	0.03	0.03	0.01	0.02	0.07	11
H2O+	0.58	0.58	0.02	0.55	0.61	4
H2O-	0.05	0.04	0.01	0.04	0.06	3
CO2	0.11	0.1	0.03	0.09	0.14	3
LOI	0.71	0.46	0.4	0.45	1.53	7
Ba	375	350	115.88	170	540	8
Li	65.88	64.5	26.7	32	102	8
Rb	370.5	385	30.27	320	390	8
Sr	63.5	52.5	23.21	44	102	8
Pb	52.75	50.5	14.36	38	75	8
Th	48.6	49	7.31	40	60	10
U	17.2	14	8	10	35	10
Zr	202.13	210	12.15	180	210	8
Nb	31	31	-	31	31	1
Y	51	50	11.75	35	70	8
La	86	89	15	60	100	8
Ce	155.13	155.5	25.61	120	190	8
Pr	-	-	-	-	-	-
Nd	44	44	-	44	44	1
Sc	4	4	-	4	4	1
V	9	9	-	9	9	1
Cr	1	-	-	-	-	1
Mn	-	-	-	-	-	-
Co	-	-	-	-	-	-
Ni	1	-	-	-	-	1
Cu	7.38	4	7.5	-	22	8
Zn	48.25	52	15.63	20	69	8
Sn	3.75	4	1.67	-	6	8
W	-	-	-	-	-	-
Mo	4.21	4	1.52	-	6	7
Ga	24	24	-	24	24	1
As	0.25	50	-	50	50	1
S	46.45	d	11.76	d	11	11
F	1521.43	1600	316.04	1050	1800	7
Be	6	6	-	6	6	1
Ag	-	-	-	-	-	-
Bi	1	-	-	-	-	1
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Douglas Leucogranite (Burnside Suite)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO ₂	73.63	73.53	4.09	65.58	78.94	7
TiO ₂	0.27	0.22	0.22	0.1	0.72	7
Al ₂ O ₃	12.74	13.06	1.33	10.13	14.45	7
Fe ₂ O ₃	0.35	0.28	0.25	0.18	0.9	7
FeO	1.96	1.65	1.36	0.83	4.86	7
MnO	0.04	0.03	0.02	0.02	0.09	7
MgO	0.51	0.35	0.49	0.2	1.59	7
CaO	1.26	1.14	0.73	0.46	2.52	7
Na ₂ O	2.68	2.68	0.29	2.29	3.13	7
K ₂ O	5.11	5.09	0.82	4.06	6.63	7
P ₂ O ₅	0.07	0.06	0.06	0.03	0.2	7
H ₂ O ⁺	0.66	0.57	0.29	0.4	1.19	6
H ₂ O ⁻	0.04	10	0.02	10	01	6
CO ₂	0.12	0.1	0.07	10	0.22	6
LOI	0.98	0.98	-	0.98	0.98	1
Ba	296.71	168	271.46	97	844	7
Li	33.86	44	14.62	14	46	7
Rb	253.29	262	35.5	211	313	7
Sr	89.71	76	53.71	48	201	7
Pb	32.29	34	7.83	20	43	7
Th	33	30	8.16	26	49	7
U	8	8	1.73	5	10	7
Zr	136.71	120	61.98	48	235	7
Nb	10.29	11	3.04	6	15	7
Y	31	29	9.8	20	48	7
La	51.14	48	20.92	27	94	7
Ce	100.57	92	38.31	53	179	7
Pr	-	-	-	-	-	-
Nd	41.5	38.5	16.69	20	71	6
Sc	4.17	3.5	3.71		11	6
V	20	15	21.18	4	65	7
Cr	14.17	7.5	17.15	5	49	6
Mn	-	-	-	-	-	-
Co	5.86	4	3.67	4	14	7
Ni	6.86	5	6.77	3	22	7
Cu	3.86	4	1.77	2	7	7
Zn	32.57	22	23.41	16	82	7
Sn	2.43	2	1.62		5	7
W	4.5	5	2.1		7	7
Mo	2.79		2.2		6	7
Ga	13.86	14	3.34	10	19	7
As	1.29		0.49		2	7
S	100	100	-	100	100	1
F	1250	1250	-	1250	1250	1
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Driffield Granite (Zoned, hornblende dominated)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	74.35	75.05	1.96	71.49	75.81	4
TiO2	0.15	0.11	0.07	0.1	0.25	4
Al2O3	12.82	12.49	0.84	12.24	14.06	4
Fe2O3	0.41	0.46	0.13	0.22	0.51	4
FeO	1.51	1.61	0.54	0.84	1.98	4
MnO	0.04	0.05	0.02	0.01	0.06	4
MgO	0.57	0.54	0.24	0.35	0.84	4
CaO	0.94	0.81	0.49	0.54	1.61	4
Na2O	2.92	2.98	0.57	2.23	3.49	4
K2O	5.05	4.93	0.77	4.32	6.01	4
P2O5	0.05	0.04	0.02	0.03	0.08	4
H2O+	-	-	-	-	-	-
H2O-	-	-	-	-	-	-
CO2	-	-	-	-	-	-
LOI	1.23	1.27	0.44	0.66	1.72	4
Ba	438	319	308.3	219	895	4
Li	10.5	10	3.42	7	15	4
Rb	183.75	182	29.3	154	217	4
Sr	101.5	86.5	65.97	39	194	4
Pb	17.75	18.5	5.8	10	24	4
Th	36	36	1.63	34	38	4
U	7.25	6	3.3	5	12	4
Zr	89	81.5	27.07	66	127	4
Nb	6	6.5	2.16	3	8	4
Y	17	18.5	6.98	8	23	4
La	33	29	16.69	18	56	4
Ce	68.75	64	22.85	47	100	4
Pr	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	21.25	17.5	10.05	14	36	4
Cr	-	-	-	-	-	-
Mn	-	-	-	-	-	-
Co	5.5	5.5	0.58	5	6	4
Ni	5.25	5	1.5	4	7	4
Cu	5.75	5	2.22	4	9	4
Zn	20	20	9.8	8	32	4
Sn	1.75	2	0.5		2	4
W	2.75	3	0.5	2	3	4
Mo	9.75	9.5	7.5	2	18	4
Ga	12.75	12	1.5	12	15	4
As	1.75		1.5		4	4
S	225	250	95.74	100	300	4
F	420	325	250.2	250	780	4
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Fenton Granite (Tennysons Suite)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	73.3	73.4	1.01	71.57	74.3	6
TiO2	0.16	0.16	0.05	0.08	0.22	6
Al2O3	13.79	13.72	0.33	13.3	14.22	6
Fe2O3	1.71	1.69	0.21	1.48	1.94	6
FeO	-	-	-	-	-	-
MnO	0.04	0.04	0.02	0.02	0.08	6
MgO	0.33	0.31	0.1	0.23	0.5	6
CaO	1.06	0.99	0.25	0.82	1.47	6
Na2O	3.4	3.33	0.2	3.25	3.8	6
K2O	4.88	4.95	0.4	4.13	5.21	6
P2O5	0.05	0.04	0.02	0.03	0.07	6
H2O+	-	-	-	-	-	-
H2O-	-	-	-	-	-	-
CO2	-	-	-	-	-	-
LOI	0.64	0.63	0.18	0.43	0.9	6
Ba	753.33	750	153.71	500	940	6
Li	31.33	29.5	15.36	10	49	6
Rb	231.67	250	41.19	170	270	6
Sr	150	115	67.23	100	270	6
Pb	212.67	46.5	410.4	32	1050	6
Th	26	27	9.12	12	36	6
U	10.67	10	3.01	8	16	6
Zr	163.33	155	36.7	110	210	6
Nb	-	-	-	-	-	-
Y	17.5	12.5	9.87	10	30	6
La	60	55	20.98	40	90	6
Ce	95	95	36.19	50	140	6
Pr	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	-	-	-	-	-	-
Cr	-	-	-	-	-	-
Mn	-	-	-	-	-	-
Co	-	-	-	-	-	-
Ni	-	-	-	-	-	-
Cu	4.5	4	3.21		8	6
Zn	37	37	6.48	27	47	6
Sn	2.67		1.03		4	6
W	-	-	-	-	-	-
Mo	3.67	4	1.51		6	6
Ga	-	-	-	-	-	-
As	-	-	-	-	-	-
S	50	d	-	d	d	6
F	466.67	450	252.56	100	820	6
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Fingerpost Granodiorite (Hornblende dominated)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	67.95	67.41	1.95	66.03	73.51	12
TiO2	0.37	0.38	0.08	0.17	0.47	12
Al2O3	14.39	14.52	0.58	12.73	14.95	12
Fe2O3	0.79	0.77	0.21	0.37	1.21	12
FeO	2.84	2.9	0.43	1.73	3.36	12
MnO	0.06	0.06	0.02	0.02	0.08	12
MgO	1.47	1.55	0.35	0.61	1.87	12
CaO	2.89	2.94	0.55	1.38	3.42	12
Na2O	3.12	3.11	0.17	2.85	3.4	12
K2O	4.21	4.24	0.3	3.7	4.66	12
P2O5	0.12	0.13	0.03	0.05	0.14	12
H2O+	1.19	1.14	0.12	1.1	1.33	3
H2O-	0.05	0.05	-	10	0.05	2
CO2	0.15	0.15	0.06	0.11	0.19	2
LOI	1.51	1.45	0.29	1.09	1.91	9
Ba	810	801	243.47	344	1302	11
Li	19.45	19	4.8	13	27	11
Rb	150	163	47.32	6	187	12
Sr	282.17	298.5	67.74	100	362	12
Pb	25.08	24	4.34	19	34	12
Th	33.33	32.5	4.44	28	43	12
U	8.38	7.75	2.48	5	13	12
Zr	143.75	147	22.65	87	179	12
Nb	8.25	8	1.48	5	10	12
Y	17.08	18	2.5	12	20	12
La	54.83	55	9.87	33	67	12
Ce	101.08	104.5	14.95	69	126	12
Pr	11	11	-	11	11	1
Nd	38	38	-	38	38	2
Sc	6.5	6.5	0.71	6	7	2
V	68.58	71	15.97	34	94	12
Cr	36.5	36.5	7.78	31	42	2
Mn	-	-	-	-	-	-
Co	11.73	12	2.65	6	15	11
Ni	14.25	15	2.99	7	18	12
Cu	9.83	6.5	11.66	4	46	12
Zn	31.67	31.5	12.23	12	56	12
Sn	2.42	2.5	1.31		5	12
W	2.32		1.98		7	11
Mo	13.68	6	24.36		86	11
Ga	16.55	16	2.02	14	21	11
As	1.05		0.15		1.5	11
S	144.44	100	72.65	100	300	9
F	768.89	760	94.93	660	920	9
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	1		-			1
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	1		-			1

Foelsche Leucogranite (Saunders Suite)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	76.31	76.31	-	76.31	76.31	1
TiO2	0.05	0.05	-	0.05	0.05	1
Al2O3	12.49	12.49	-	12.49	12.49	1
Fe2O3	0.42	0.42	-	0.42	0.42	1
FeO	0.48	0.48	-	0.48	0.48	1
MnO	0.01	0.01	-	0.01	0.01	1
MgO	0.2	0.2	-	0.2	0.2	1
CaO	0.71	0.71	-	0.71	0.71	1
Na2O	3.87	3.87	-	3.87	3.87	1
K2O	4.45	4.45	-	4.45	4.45	1
P2O5	0.01	0.01	-	0.01	0.01	1
H2O+	0.61	0.61	-	0.61	0.61	1
H2O-	-	-	-	-	-	-
CO2	-	-	-	-	-	-
LOI	-	-	-	-	-	-
Ba	66	66	-	66	66	1
Li	5	5	-	5	5	1
Rb	162	162	-	162	162	1
Sr	52	52	-	52	52	1
Pb	25	25	-	25	25	1
Th	29	29	-	29	29	1
U	13	13	-	13	13	1
Zr	48	48	-	48	48	1
Nb	5	5	-	5	5	1
Y	7	7	-	7	7	1
La	25	25	-	25	25	1
Ce	54	54	-	54	54	1
Pr	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	5	5	-	5	5	1
Cr	-	-	-	-	-	-
Mn	-	-	-	-	-	-
Co	-	-	-	-	-	-
Ni	3	3	-	3	3	1
Cu	3	3	-	3	3	1
Zn	6	6	-	6	6	1
Sn	1		-			1
W	3	3	-	3	3	1
Mo	-	-	-	-	-	-
Ga	-	-	-	-	-	-
As	-	-	-	-	-	-
S	-	-	-	-	-	-
F	-	-	-	-	-	-
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Frances Creek Leucogranite (Burnside Suite)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	73.14	73.35	1.6	70.93	76.08	10
TiO2	0.21	0.16	0.09	0.12	0.39	10
Al2O3	13.24	13.36	0.7	11.52	14.1	10
Fe2O3	0.44	0.39	0.2	0.26	0.97	10
FeO	1.51	1.47	0.32	1.03	2.03	10
MnO	0.05	0.03	0.06	0.02	0.2	10
MgO	0.34	0.27	0.23	0.12	0.88	10
CaO	1.16	1.06	0.32	0.86	1.79	10
Na2O	3.17	3.16	0.19	2.83	3.46	10
K2O	5.26	5.23	0.24	4.94	5.62	10
P2O5	0.07	0.06	0.03	0.03	0.12	10
H2O+	0.64	0.64	0.02	0.63	0.66	2
H2O-	0.03	05	0.03	10	01	2
CO2	0.22	0.22	0.11	0.14	0.29	2
LOI	0.86	0.83	0.15	0.64	1.13	8
Ba	461.8	442	198.43	155	745	10
Li	26.6	23	11.56	15	53	10
Rb	276.9	285.5	42.87	213	324	10
Sr	99.6	82	47.9	56	203	10
Pb	34.3	32.5	7.1	24	47	10
Th	50	47.5	10.45	38	73	10
U	10.1	10.5	5.09	3	21	10
Zr	172.4	157.5	70.94	106	357	10
Nb	13.6	13	4.09	7	21	10
Y	27.2	27.5	4.54	20	34	10
La	73.2	60.5	35.43	51	169	10
Ce	149.4	121.5	65.67	97	302	10
Pr	-	-	-	-	-	-
Nd	41.5	41.5	0.71	41	42	2
Sc	3	3	1.41	2	4	2
V	26.4	23	14.49	5	50	10
Cr	26	26	26.87	7	45	2
Mn	-	-	-	-	-	-
Co	4.8	5	1.48	2	7	10
Ni	4.1	3.5	2.23		8	10
Cu	3.8	4	0.92	2	5	10
Zn	20.7	20	5.4	14	31	10
Sn	2.5	3	1.18		4	10
W	2.6	2	1.78		5	10
Mo	4.9	3	4.35		13	10
Ga	16.6	17	2.46	11	20	10
As	1.3		0.67		3	10
S	112.5	100	35.36	100	200	8
F	856.25	805	446.92	440	1700	8
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Margaret Granite (Hornblende/biotite equal)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	73.9	73.9	-	73.9	73.9	1
TiO2	0.22	0.22	-	0.22	0.22	1
Al2O3	13.27	13.27	-	13.27	13.27	1
Fe2O3	0.61	0.61	-	0.61	0.61	1
FeO	1.21	1.21	-	1.21	1.21	1
MnO	0.03	0.03	-	0.03	0.03	1
MgO	0.55	0.55	-	0.55	0.55	1
CaO	1.35	1.35	-	1.35	1.35	1
Na2O	3.08	3.08	-	3.08	3.08	1
K2O	5.1	5.1	-	5.1	5.1	1
P2O5	0.07	0.07	-	0.07	0.07	1
H2O+	0.67	0.67	-	0.67	0.67	1
H2O-	0.05	0.05	-	0.05	0.05	1
CO2	0.21	0.21	-	0.21	0.21	1
LOI	-	-	-	-	-	-
Ba	410	410	-	410	410	1
Li	23	23	-	23	23	1
Rb	242	242	-	242	242	1
Sr	238	238	-	238	238	1
Pb	35	35	-	35	35	1
Th	42	42	-	42	42	1
U	25	25	-	25	25	1
Zr	147	147	-	147	147	1
Nb	24	24	-	24	24	1
Y	37	37	-	37	37	1
La	45	45	-	45	45	1
Ce	75	75	-	75	75	1
Pr	-	-	-	-	-	-
Nd	28	28	-	28	28	1
Sc	5	5	-	5	5	1
V	21	21	-	21	21	1
Cr	15	15	-	15	15	1
Mn	-	-	-	-	-	-
Co	-	-	-	-	-	-
Ni	5	5	-	5	5	1
Cu	1		-			1
Zn	20	20	-	20	20	1
Sn	2	2	-	2	2	1
W	-	-	-	-	-	-
Mo	1.5		-			1
Ga	19	19	-	19	19	1
As	0.5	0.5	-	0.5	0.5	1
S	14	14	-	14	14	1
F	-	-	-	-	-	-
Be	8	8	-	8	8	1
Ag	-	-	-	-	-	-
Bi	1		-			1
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

McCarthys Granite (Hornblende dominated)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	70.77	69.91	2.99	67.15	75.12	9
TiO2	0.29	0.34	0.13	0.07	0.43	9
Al2O3	13.82	14.02	0.94	12.49	15.01	9
Fe2O3	0.57	0.65	0.21	0.19	0.81	9
FeO	2.27	2.38	0.79	1.04	3.15	9
MnO	0.05	0.05	0.02	0.01	0.07	9
MgO	0.82	1.1	0.45	0.25	1.27	9
CaO	1.92	2.14	0.81	0.9	2.95	9
Na2O	3.18	3.23	0.11	3.01	3.32	9
K2O	4.62	4.71	0.52	3.69	5.27	9
P2O5	0.09	0.11	0.05	0.03	0.14	9
H2O+	0.82	0.81	0.17	0.66	1.02	4
H2O-	0.02	0.1	0.03	0.1	0.07	4
CO2	0.17	0.17	0.11	0.1	0.3	4
LOI	1.04	0.87	0.37	0.65	1.56	5
Ba	819.78	911	319.79	333	1241	9
Li	17	17	5.24	8	23	9
Rb	168.78	163	40.59	129	250	9
Sr	227.56	248	95.36	106	349	9
Pb	27	30	4.8	18	32	9
Th	37.44	36	7.94	30	56	9
U	6.11	6	3.22	3	14	9
Zr	165.78	171	58.62	29	232	9
Nb	9.78	9	2.82	4	14	9
Y	19.67	21	8.19	6	35	9
La	68.89	68	23.41	27	103	9
Ce	123.89	117	37.29	61	188	9
Pr	-	-	-	-	-	-
Nd	47.75	50	8.34	36	55	4
Sc	5.75	6.5	2.63	2	8	4
V	39.44	45	19.15	15	66	9
Cr	21.5	22	11.47	7	35	4
Mn	-	-	-	-	-	-
Co	8.38	9.5	2.62	5	11	8
Ni	8.22	8	3.46	4	14	9
Cu	4.67	5	1.66	3	8	9
Zn	32.78	40	15.83	13	52	9
Sn	1.67	2	0.5	-	2	9
W	2.56	2	1.72	-	6	8
Mo	3.89	2	4.33	-	15	9
Ga	16.33	17	1.73	13	18	9
As	0.92	-	0.25	-	50	9
S	119.33	100	94.67	16	300	6
F	668	570	295.25	320	1000	5
Be	2	2	-	2	2	1
Ag	-	-	-	-	-	-
Bi	1	-	-	-	-	1
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

McKinlay Granite (Hornblende/biotite equal)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	67.38	67.38	0.48	67.04	67.72	2
TiO2	0.49	0.49	0.01	0.48	0.5	2
Al2O3	15.97	15.97	0.64	15.51	16.42	2
Fe2O3	0.63	0.63	0.47	0.29	0.96	2
FeO	2.59	2.59	0.02	2.58	2.61	2
MnO	0.09	0.09	0.01	0.09	0.1	2
MgO	1.02	1.02	0.09	0.96	1.09	2
CaO	1.71	1.71	0.28	1.51	1.91	2
Na2O	3.06	3.06	0.01	3.05	3.07	2
K2O	5.34	5.34	0.04	5.31	5.37	2
P2O5	0.2	0.2	0.02	0.19	0.22	2
H2O+	1.24	1.24	0.23	1.08	1.4	2
H2O-	0.02	0.02	0.01	0.02	0.03	2
CO2	-	-	-	-	-	-
LOI	-	-	-	-	-	-
Ba	-	-	-	-	-	-
Li	-	-	-	-	-	-
Rb	-	-	-	-	-	-
Sr	-	-	-	-	-	-
Pb	-	-	-	-	-	-
Th	-	-	-	-	-	-
U	-	-	-	-	-	-
Zr	-	-	-	-	-	-
Nb	-	-	-	-	-	-
Y	-	-	-	-	-	-
La	-	-	-	-	-	-
Ce	-	-	-	-	-	-
Pr	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	-	-	-	-	-	-
Cr	-	-	-	-	-	-
Mn	-	-	-	-	-	-
Co	-	-	-	-	-	-
Ni	-	-	-	-	-	-
Cu	-	-	-	-	-	-
Zn	-	-	-	-	-	-
Sn	-	-	-	-	-	-
W	-	-	-	-	-	-
Mo	-	-	-	-	-	-
Ga	-	-	-	-	-	-
As	-	-	-	-	-	-
S	50	d	-	d	d	2
F	-	-	-	-	-	-
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

McMinns Bluff Granite (Biotite dominated)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	70.39	71.74	3.43	62.81	74.31	32
TiO2	0.43	0.37	0.22	0.16	0.99	32
Al2O3	14.05	13.98	0.66	12.62	15.73	32
Fe2O3	1.12	0.66	1.05	0.29	4.07	32
FeO	2.47	2.18	1.19	1.07	5.67	26
MnO	0.04	0.04	0.02	0.02	0.1	32
MgO	0.71	0.69	0.35	0.26	1.61	32
CaO	1.72	1.45	0.68	0.87	3.2	32
Na2O	3.06	3.11	0.25	2.5	3.53	32
K2O	4.99	5.01	0.49	3.82	6.89	32
P2O5	0.12	0.1	0.07	0.05	0.27	32
H2O+	0.71	0.71	0.19	0.34	1.17	18
H2O-	0.06	0.07	0.03	10	0.12	16
CO2	0.19	0.17	0.11	10	0.45	17
LOI	0.99	0.85	0.39	0.51	1.72	14
Ba	838.23	818	268.55	161	1450	31
Li	32.1	29	18.46	9	90	20
Rb	212.58	207	45.27	140	360	31
Sr	171.23	166	59.87	65	290	31
Pb	25.16	24	4.16	18	36	31
Th	30.48	30	8.08	17	59	31
U	6.63	6	3.93		18	31
Zr	228.9	220	74.29	125	436	31
Nb	14.96	15	3.86	8	24	25
Y	25.45	25	8.06	10	44	31
La	78.97	74	27.05	40	133	31
Ce	134.45	130	46.21	69	234	31
Pr	9.64	9	3.29	6	18	11
Nd	39.88	32.5	13.91	27	69	16
Sc	3.5	2	3.31		11	16
V	34	26	28.68	8	136	25
Cr	10.19	7	6.13	5	22	16
Mn	-	-	-	-	-	-
Co	9.31	10	2.46	6	14	13
Ni	4.04	4	2.23		10	25
Cu	4.55	4	2.62		13	31
Zn	44.29	40	17.83	18	86	31
Sn	2.97	2	1.71		7	30
W	2.12	2	1.08		4	13
Mo	3.48		3.55		19	30
Ga	18.79	19	2.43	11	24	24
As	1.35	1	0.54		3	24
S	120.06	85.5	90.15	d	300	16
F	1259.29	1190	589.27	460	2550	14
Be	2	2	-	2	2	1
Ag	-	-	-	-	-	-
Bi	1		-			12
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	1		-			11

Minglo Granite (Hornblende dominated)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	76.02	74.31	7.37	70.95	99.99	13
TiO2	0.18	0.16	0.07	0.07	0.33	13
Al2O3	12.98	12.91	0.56	12.14	13.94	13
Fe2O3	0.53	0.5	0.19	0.22	0.88	13
FeO	1.26	1.14	0.44	0.66	1.91	13
MnO	0.03	0.03	0.01	0.02	0.04	13
MgO	0.3	0.27	0.1	0.16	0.53	13
CaO	1.15	1.16	0.29	0.61	1.67	13
Na2O	3.23	3.23	0.26	2.73	3.76	13
K2O	5.13	5.03	0.21	4.89	5.51	13
P2O5	0.05	0.05	0.02	0.02	0.1	13
H2O+	-	-	-	-	-	-
H2O-	-	-	-	-	-	-
CO2	-	-	-	-	-	-
LOI	0.76	0.77	0.09	0.63	0.89	13
Ba	414.62	382	200.52	116	818	13
Li	25.92	25	9.06	17	50	13
Rb	262.92	249	58.48	167	394	13
Sr	113.54	108	49.71	44	234	13
Pb	37.62	33	12.84	26	70	13
Th	55	51	13.42	39	82	13
U	12.19	11	3	9	19.5	13
Zr	153.77	155	46.95	98	243	13
Nb	14.92	13	5.09	8	26	13
Y	26.85	25	8.94	12	43	13
La	83.15	63	58.33	33	237	13
Ce	150	112	96.73	68	413	13
Pr	18.14	13	13.01	7	42	7
Nd	60.29	40	38.79	27	133	7
Sc	3.14	3	1.35	1	5	7
V	17.15	15	11.12	3	39	13
Cr	3.64	4	2.25		7	7
Mn	194.57	195	58.51	132	282	7
Co	43.85	67	37.43	4	90	13
Ni	2.54	2	1.39	1	5	13
Cu	2.35		2.14		6	13
Zn	18.85	18	5.52	11	28	13
Sn	1.38		0.65		3	13
W	3.08	3	1.66		6	13
Mo	4		5.26		16	13
Ga	16.54	16	1.51	14	19	13
As	1.81	2	0.69		2.5	13
S	73.08	d	25.94	d	100	13
F	921.67	890	398.72	520	1550	6
Be	4	4	1.41	3	7	7
Ag	2.29	2	0.76	1	3	7
Bi	1		-			7
Cs	3.36	3	1.95		6	7
Ge	1.29	1	0.39	1	2	7
Se	0.5		-			7

Mount Bunday Granite

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	71.54	71.54	1.51	70.47	72.6	2
TiO2	0.31	0.31	0.04	0.28	0.33	2
Al2O3	13.76	13.76	0.21	13.61	13.91	2
Fe2O3	1.26	1.26	0.11	1.18	1.34	2
FeO	0.9	0.9	0.11	0.82	0.98	2
MnO	0.02	0.02	-	0.02	0.02	2
MgO	0.74	0.74	0.23	0.57	0.9	2
CaO	1.49	1.49	0.06	1.45	1.53	2
Na2O	3.67	3.67	0.13	3.58	3.77	2
K2O	5.2	5.2	0.21	5.06	5.35	2
P2O5	0.13	0.13	0.03	0.11	0.15	2
H2O+	0.43	0.43	0.03	0.41	0.45	2
H2O-	0.1	0.1	0.04	0.08	0.13	2
CO2	0.15	0.15	0.03	0.13	0.17	2
LOI	-	-	-	-	-	-
Ba	1095.5	1095.5	243.95	923	1268	2
Li	9	9	7.07	4	14	2
Rb	266.5	266.5	10.61	259	274	2
Sr	534.5	534.5	174.66	411	658	2
Pb	29.5	29.5	0.71	29	30	2
Th	54.5	54.5	0.71	54	55	2
U	14.5	14.5	0.71	14	15	2
Zr	219.5	219.5	21.92	204	235	2
Nb	22	22	2.83	20	24	2
Y	15.5	15.5	0.71	15	16	2
La	79.5	79.5	2.12	78	81	2
Ce	123	123	1.41	122	124	2
Pr	-	-	-	-	-	-
Nd	32.5	32.5	4.95	29	36	2
Sc	5.5	5.5	0.71	5	6	2
V	19	19	4.24	16	22	2
Cr	18.5	18.5	6.36	14	23	2
Mn	-	-	-	-	-	-
Co	-	-	-	-	-	-
Ni	11.5	11.5	6.36	7	16	2
Cu	4	4	1.41	3	5	2
Zn	15.5	15.5	3.54	13	18	2
Sn	2	2	1.41	-	3	2
W	-	-	-	-	-	-
Mo	1.5	-	-	-	-	2
Ga	19	19	-	19	19	2
As	0.5	0.5	-	0.5	0.5	2
S	34.5	34.5	4.95	31	38	2
F	-	-	-	-	-	-
Cl	264.5	264.5	40.31	236	293	2
Be	5.5	5.5	0.71	5	6	2
Ag	-	-	-	-	-	-
Bi	1	-	-	-	-	2
Hf	-	-	-	-	-	-
Ta	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Mount Davis Granite (Zoned, hornblende dominated)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	69.47	69.47	0.23	69.31	69.64	2
TiO2	0.38	0.38	0.01	0.37	0.39	2
Al2O3	13.98	13.98	-	13.97	13.98	2
Fe2O3	0.65	0.65	0.02	0.64	0.67	2
FeO	3.14	3.14	0.04	3.12	3.17	2
MnO	0.03	0.03	-	0.03	0.03	2
MgO	0.81	0.81	0.06	0.77	0.85	2
CaO	2.05	2.05	0.2	1.91	2.19	2
Na2O	3.27	3.27	0.21	3.12	3.42	2
K2O	4.44	4.44	0.23	4.28	4.6	2
P2O5	0.13	0.13	0.02	0.11	0.14	2
H2O+	-	-	-	-	-	-
H2O-	-	-	-	-	-	-
CO2	-	-	-	-	-	-
LOI	1.48	1.48	0.14	1.38	1.58	2
Ba	759	759	1.41	758	760	2
Li	22.5	22.5	2.12	21	24	2
Rb	218	218	11.31	210	226	2
Sr	215.5	215.5	9.19	209	222	2
Pb	25	25	4.24	22	28	2
Th	41.5	41.5	0.71	41	42	2
U	7.5	7.5	0.71	7	8	2
Zr	210	210	9.9	203	217	2
Nb	10.5	10.5	0.71	10	11	2
Y	26.5	26.5	2.12	25	28	2
La	78.5	78.5	4.95	75	82	2
Ce	144	144	9.9	137	151	2
Pr	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	59.5	59.5	2.12	58	61	2
Cr	-	-	-	-	-	-
Mn	-	-	-	-	-	-
Co	9	9	-	9	9	2
Ni	5.5	5.5	0.71	5	6	2
Cu	12.5	12.5	0.71	12	13	2
Zn	27.5	27.5	0.71	27	28	2
Sn	4	4	-	4	4	2
W	3.5	3.5	2.12	2	5	2
Mo	6	6	-	6	6	2
Ga	16.5	16.5	0.71	16	17	2
As	1	-	-	-	-	2
S	350	350	70.71	300	400	2
F	1250	1250	-	1250	1250	2
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Mount Porter Granite (Hornblende/biotite equal)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	72.86	73.05	2.98	69.78	75.74	3
TiO2	0.18	0.18	0.13	0.05	0.31	3
Al2O3	13.62	13.77	0.58	12.98	14.11	3
Fe2O3	0.46	0.52	0.15	0.29	0.58	3
FeO	1.54	1.23	0.87	0.87	2.52	3
MnO	0.04	0.04	0.02	0.02	0.06	3
MgO	0.46	0.43	0.14	0.34	0.61	3
CaO	1.15	1.26	0.52	0.58	1.6	3
Na2O	3.69	3.68	0.2	3.5	3.9	3
K2O	4.73	4.68	0.24	4.52	5	3
P2O5	0.07	0.07	0.03	0.05	0.1	3
H2O+	-	-	-	-	-	-
H2O-	-	-	-	-	-	-
CO2	-	-	-	-	-	-
LOI	0.86	0.83	0.35	0.53	1.22	3
Ba	487.33	570	386.69	66	826	3
Li	20	23	11.79	7	30	3
Rb	295	290	22.91	275	320	3
Sr	153.33	169	116.29	30	261	3
Pb	43.33	40	14.29	31	59	3
Th	42.33	40	4.04	40	47	3
U	20	16	8.72	14	30	3
Zr	146.33	130	59.21	97	212	3
Nb	16	16	3	13	19	3
Y	30	29	3.61	27	34	3
La	40	41	27.51	12	67	3
Ce	81	84	42.58	37	122	3
Pr	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	17.67	18	16.5		34	3
Cr	-	-	-	-	-	-
Mn	-	-	-	-	-	-
Co	3.67	4	0.58	3	4	3
Ni	4	4	-	4	4	3
Cu	5.67	5	2.08	4	8	3
Zn	32.67	38	11.93	19	41	3
Sn	2.33	2	0.58	2	3	3
W	1.67		1.15		3	3
Mo	3.67	3	1.15	3	5	3
Ga	17.67	18	1.53	16	19	3
As	1.67		1.15		3	3
S	133.33	100	57.74	100	200	3
F	1316.67	1450	709.46	550	1950	3
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Prices Springs Granite (Hornblende/biotite equal)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	70.66	70.04	1.97	67.9	73.98	8
TiO2	0.34	0.36	0.09	0.19	0.45	8
Al2O3	14.27	14.15	0.88	12.85	15.81	8
Fe2O3	0.71	0.67	0.33	0.2	1.23	8
FeO	2.28	2.3	0.64	1.22	3.2	8
MnO	0.05	0.05	0.02	0.02	0.08	8
MgO	0.67	0.68	0.28	0.22	1.14	8
CaO	1.66	1.71	0.33	0.96	2	8
Na2O	3.03	3.05	0.28	2.65	3.41	8
K2O	5.1	5.22	0.44	4.19	5.54	8
P2O5	0.11	0.11	0.05	0.05	0.18	8
H2O+	0.83	0.81	0.11	0.69	0.95	5
H2O-	0.07	0.07	0.04	0.02	0.12	4
CO2	0.15	0.11	0.12	0.05	0.29	3
LOI	1.06	1.07	0.12	0.94	1.17	3
Ba	836.25	775.5	167.3	712	1082	4
Li	25.5	24	13.63	12	42	4
Rb	255.75	245	33.27	231	302	4
Sr	269.5	251	71.91	212	364	4
Pb	33.75	33.5	2.75	31	37	4
Th	37.83	41.5	18.86	2	53	6
U	10	10	3.22	6	14	6
Zr	210.75	214.5	58.21	150	264	4
Nb	11.25	11	1.5	10	13	4
Y	23	20.5	8.52	16	35	4
La	67.5	64	14.55	54	88	4
Ce	123.25	118.5	28.58	96	160	4
Pr	-	-	-	-	-	-
Nd	34	34	-	34	34	1
Sc	6	6	-	6	6	1
V	48	54	24.77	14	70	4
Cr	8	8	-	8	8	1
Mn	-	-	-	-	-	-
Co	6.67	7	0.58	6	7	3
Ni	6.5	6.5	1.29	5	8	4
Cu	4.5	4	1.73	3	7	4
Zn	31.5	31	2.65	29	35	4
Sn	2.75	2.5	1.71		5	4
W	2.67	3	1.53		4	3
Mo	6.63	4.5	6.42		16	4
Ga	17.5	17	1.91	16	20	4
As	1.75	1	1.5		4	4
S	102	33	97.85	d	300	8
F	1266.67	1500	404.15	800	1500	3
Be	3	3	-	3	3	1
Ag	-	-	-	-	-	-
Bi	1		-			1
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Saunders Leucogranite (Saunders Suite)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	72.94	73.34	1.64	70.51	75.15	8
TiO2	0.26	0.23	0.13	0.12	0.48	8
Al2O3	13.53	13.45	0.31	13.22	13.92	8
Fe2O3	0.55	0.57	0.22	0.23	1	8
FeO	1.42	1.31	0.53	0.8	2.42	8
MnO	0.03	0.03	0.01	0.02	0.04	8
MgO	0.45	0.42	0.21	0.14	0.86	8
CaO	1.36	1.32	0.29	1.02	1.81	8
Na2O	2.81	2.83	0.16	2.58	3.01	8
K2O	5.48	5.54	0.26	4.9	5.78	8
P2O5	0.08	0.07	0.05	0.02	0.19	8
H2O+	0.79	0.81	0.17	0.48	1	7
H2O-	0.04	10	0.02	10	0.05	7
CO2	0.18	0.14	0.11	0.1	0.43	7
LOI	1.16	1.16	-	1.16	1.16	1
Ba	734.63	721	128.23	498	894	8
Li	21.17	21	5.67	14	28	6
Rb	225.5	229	14.6	196	240	8
Sr	196.75	197	32.05	146	248	8
Pb	33.63	34	5.53	26	40	8
Th	46.25	47	4.74	38	54	8
U	8.25	8	2.76	5	13	8
Zr	187.38	183	56.93	130	305	8
Nb	13.25	13.5	1.83	11	16	8
Y	19.63	19.5	5.1	12	26	8
La	86.13	86.5	11.73	64	104	8
Ce	143.5	141	24.71	104	187	8
Pr	14.5	14.5	2.12	13	16	2
Nd	48.57	49	7	39	56	7
Sc	2.71	3	1.25		5	7
V	19.75	11	23.02	2	73	8
Cr	10.71	10	7.78	2	25	7
Mn	-	-	-	-	-	-
Co	5.5	5	1.22	4	7	6
Ni	3.88	4	1.73		7	8
Cu	4	3	3.46		12	8
Zn	20.88	20.5	7.08	10	33	8
Sn	1.25		0.46		2	8
W	3.17	2	2.29		6	6
Mo	1.69		0.53		3	8
Ga	16.25	17	2.6	11	19	8
As	1.56		0.82		3	8
S	100	100	-	100	100	1
F	1650	1650	-	1650	1650	1
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	1		-			2
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	1		-			2

Shoobridge Granite (Zoned, hornblende dominated)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	66.75	65.21	4.66	59.61	72.98	17
TiO2	0.4	0.46	0.19	0.08	0.68	17
Al2O3	15.08	15.01	0.72	14.02	16.65	17
Fe2O3	2.78	1.91	2.12	0.43	6.11	17
FeO	2.08	1.65	1.1	0.89	3.58	6
MnO	0.05	0.07	0.03	0.01	0.09	17
MgO	1.66	2.14	1.02	0.17	3.52	17
CaO	2.2	2.08	0.94	0.7	3.92	17
Na2O	3.32	3.29	0.29	2.72	3.8	17
K2O	4.98	5.16	0.59	3.35	6.06	17
P2O5	0.2	0.22	0.13	0.03	0.38	17
H2O+	0.94	0.93	0.24	0.57	1.41	15
H2O-	0.07	0.07	0.02	0.02	0.09	14
CO2	0.38	0.33	0.2	0.16	0.91	13
LOI	0.61	0.61	0.36	0.35	0.86	2
Ba	1318	1100	409.16	1064	1790	3
Li	24.67	26	3.21	21	27	3
Rb	186.23	185	28.59	134	235	13
Sr	615.54	733	278.75	180	954	13
Pb	63	37	87.08	31	352	13
Th	34.07	34	7.34	16	46	15
U	10	10	1.77	7	14	15
Zr	234.46	261	64.37	112	308	13
Nb	17.5	19	3.71	10	21	12
Y	13.15	15	3.98	6	18	13
La	79.67	70	27.79	58	111	3
Ce	133	101	56.29	100	198	3
Pr	-	-	-	-	-	-
Nd	25	25	-	25	25	1
Sc	10.5	10.5	7.78	5	16	2
V	42.5	42.5	36.06	17	68	2
Cr	12	12	-	12	12	1
Mn	-	-	-	-	-	-
Co	15	15	-	15	15	1
Ni	11	11	8.49	5	17	2
Cu	4	5	2.65		6	3
Zn	29.33	28	17.04	13	47	3
Sn	2		1		3	3
W	1		-			1
Mo	2.17		0.76		3	3
Ga	19	19	-	19	19	2
As	17	17	22.63		33	2
S	59.06	d	36.33	d	200	17
F	1040	1040	650.54	580	1500	2
Be	4	4	-	4	4	2
Ag	-	-	-	-	-	-
Bi	1		-			1
Cs	5	5	-	5	5	1
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Tabletop Granite (Zoned, hornblende dominated)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	71.82	74.07	6.35	46.52	78.46	25
TiO2	0.22	0.2	0.15	0.03	0.67	25
Al2O3	13.24	13.07	1.1	11.4	16.43	25
Fe2O3	0.52	0.46	0.33	0.08	1.7	25
FeO	1.72	1.51	0.98	0.27	4.57	25
MnO	0.04	0.03	0.02	0.01	0.1	25
MgO	0.5	0.38	0.35	0.08	1.25	25
CaO	1.39	1.43	0.69	0.45	2.67	25
Na2O	3.14	3.13	0.2	2.83	3.59	25
K2O	4.98	4.92	0.47	4.13	6.1	25
P2O5	0.07	0.06	0.05	0.01	0.25	25
H2O+	0.64	0.53	0.27	0.31	1.3	18
H2O-	0.02	0.1	0.02	0	0.1	18
CO2	0.16	0.14	0.13	0	0.55	20
LOI	0.8	0.82	0.24	0.46	1.07	7
Ba	482.42	415	500.74	11	2349	24
Li	21.08	21	10.33	4	43	25
Rb	224.28	217	41.03	173	318	25
Sr	171.48	166	137.73	13	602	25
Pb	27.8	27	6.16	19	39	25
Th	38.88	38	8.91	22	57	25
U	9.76	10	4.14	4	24	25
Zr	133.76	127	56.88	38	319	25
Nb	10.64	10	2.27	6	15	25
Y	24.8	23	7.97	13	52	25
La	57.72	58	22.84	16	95	25
Ce	102.24	108	37.76	39	167	25
Pr	-	-	-	-	-	-
Nd	39.67	38.5	11.49	21	61	18
Sc	2.78	2	2.6		11	18
V	21.44	17	20.18		63	25
Cr	8.17	7	5.38	3	24	18
Mn	-	-	-	-	-	-
Co	5.16	5	2.37	2	9	25
Ni	3.68	4	1.82		8	25
Cu	3.64	3	1.7	2	9	25
Zn	23.8	21	11.56	9	55	25
Sn	2		1.29		5	25
W	3.68	4	1.9		7	25
Mo	5.08		7.76		33	25
Ga	14.72	14	2.44	9	20	25
As	1.08		0.28		2	25
S	157.14	100	113.39	100	400	7
F	958.57	1000	367.08	320	1500	7
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Tennysons Leucogranite (Tennysons Suite)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	73.94	74.1	1.24	72.08	75.94	12
TiO2	0.19	0.17	0.08	0.09	0.3	12
Al2O3	12.86	12.69	0.46	12.28	13.57	12
Fe2O3	0.41	0.4	0.11	0.21	0.57	12
FeO	1.84	1.76	0.4	1.16	2.35	12
MnO	0.03	0.03	0.01	0.01	0.05	12
MgO	0.37	0.39	0.14	0.2	0.57	12
CaO	0.76	0.75	0.17	0.53	1.1	12
Na2O	2.95	3.01	0.19	2.66	3.27	12
K2O	5.28	5.27	0.14	5.05	5.51	12
P2O5	0.08	0.08	0.02	0.04	0.11	12
H2O+	0.71	0.71	-	0.71	0.71	1
H2O-	-	-	-	-	-	-
CO2	0.03	05	-	05	05	1
LOI	1.01	1.06	0.15	0.81	1.21	11
Ba	318.5	321	172.9	61	560	12
Li	48.17	53	18.36	12	70	12
Rb	329.25	322.5	32.26	278	389	12
Sr	60	69.5	24.2	19	86	12
Pb	34.42	34	5.02	28	45	12
Th	32.08	32	3.85	25	37	12
U	13.5	11.5	6.26	6	28	12
Zr	123.92	122.5	30.27	74	169	12
Nb	11.25	11.5	1.29	8	13	12
Y	43.58	44	10.11	27	64	12
La	38.33	38	12.18	19	56	12
Ce	86.25	88.5	18.91	57	110	12
Pr	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	21	14.5	12.55	10	43	12
Cr	-	-	-	-	-	-
Mn	-	-	-	-	-	-
Co	5.25	5	1.14	4	7	12
Ni	4.25	4.5	1.22	3	6	12
Cu	6.08	5	4.81	3	21	12
Zn	20.5	19.5	6.9	6	31	12
Sn	5.08	5	1.24	3	7	12
W	6.83	6	3.16	4	14	12
Mo	10	6	6.02	4	19	11
Ga	16.82	17	1.25	14	18	11
As	2.18		1.78		6	11
S	113.64	100	45.23	d	200	11
F	2095.45	1950	324.39	1700	2850	11
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Umbrawarra Leucogranite (Tennysons Suite)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	75.5	75.63	0.74	74.59	76.13	4
TiO2	0.12	0.11	0.03	0.09	0.15	4
Al2O3	12.69	12.67	0.25	12.43	13	4
Fe2O3	0.28	0.31	0.13	0.1	0.4	4
FeO	1.17	1.21	0.21	0.88	1.37	4
MnO	0.03	0.03	-	0.03	0.04	4
MgO	0.22	0.22	0.08	0.13	0.3	4
CaO	0.61	0.61	0.05	0.55	0.66	4
Na2O	3.1	3.1	0.29	2.8	3.4	4
K2O	5.32	5.28	0.13	5.21	5.51	4
P2O5	0.05	0.05	0.02	0.03	0.07	4
H2O+	0.67	0.7	0.06	0.61	0.71	3
H2O-	0.06	10	0.02	10	0.08	3
CO2	0.18	0.22	0.12	10	0.28	3
LOI	0.71	0.71	-	0.71	0.71	1
Ba	191.25	174.5	96.02	93	323	4
Li	50.33	42	28.43	27	82	3
Rb	363	362.5	27.75	335	392	4
Sr	44.5	44.5	14.75	27	62	4
Pb	31.25	31	6.08	26	37	4
Th	31.25	33	6.18	23	36	4
U	14.75	14.5	2.06	13	17	4
Zr	83.25	101.5	38.24	26	104	4
Nb	9.5	10.5	3.87	4	13	4
Y	43.25	43	16.01	24	63	4
La	31	31	9.83	19	43	4
Ce	64.5	59	14.01	55	85	4
Pr	9	9	-	9	9	1
Nd	27	26	4.58	23	32	3
Sc	1.33		0.58		2	3
V	6	5.5	2.16	4	9	4
Cr	4.33	5	2.08	2	6	3
Mn	-	-	-	-	-	-
Co	4	3	1.73	3	6	3
Ni	2.5	2.5	1.29		4	4
Cu	2.5	2	1	2	4	4
Zn	16	16	3.46	13	19	4
Sn	4.25	4.5	0.96	3	5	4
W	6	6	1	5	7	3
Mo	7.25	6.75	6.69		14	4
Ga	17.25	17.5	2.5	14	20	4
As	3.13	3.25	1.75		5	4
S	100	100	-	100	100	1
F	1900	1900	-	1900	1900	1
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	1		-			1
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	1		-			1

Wandie Granite (Burnside Suite)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	74.77	74.77	-	74.77	74.77	1
TiO2	0.1	0.1	-	0.1	0.1	1
Al2O3	12.53	12.53	-	12.53	12.53	1
Fe2O3	0.27	0.27	-	0.27	0.27	1
FeO	1.56	1.56	-	1.56	1.56	1
MnO	0.02	0.02	-	0.02	0.02	1
MgO	0.11	0.11	-	0.11	0.11	1
CaO	0.75	0.75	-	0.75	0.75	1
Na2O	3.26	3.26	-	3.26	3.26	1
K2O	5.33	5.33	-	5.33	5.33	1
P2O5	0.02	0.02	-	0.02	0.02	1
H2O+	-	-	-	-	-	-
H2O-	-	-	-	-	-	-
CO2	-	-	-	-	-	-
LOI	0.68	0.68	-	0.68	0.68	1
Ba	112	112	-	112	112	1
Li	30	30	-	30	30	1
Rb	258	258	-	258	258	1
Sr	60	60	-	60	60	1
Pb	24	24	-	24	24	1
Th	49	49	-	49	49	1
U	12	12	-	12	12	1
Zr	138	138	-	138	138	1
Nb	10	10	-	10	10	1
Y	31	31	-	31	31	1
La	77	77	-	77	77	1
Ce	148	148	-	148	148	1
Pr	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	10	10	-	10	10	1
Cr	-	-	-	-	-	-
Mn	-	-	-	-	-	-
Co	1		-			1
Ni	4	4	-	4	4	1
Cu	85	85	-	85	85	1
Zn	20	20	-	20	20	1
Sn	2	2	-	2	2	1
W	5	5	-	5	5	1
Mo	19	19	-	19	19	1
Ga	15	15	-	15	15	1
As	1		-			1
S	200	200	-	200	200	1
F	1600	1600	-	1600	1600	1
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Wolfram Hill Granite (Tennysons Suite)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	68.41	68.41	-	68.41	68.41	1
TiO2	0.33	0.33	-	0.33	0.33	1
Al2O3	17.26	17.26	-	17.26	17.26	1
Fe2O3	1.32	1.32	-	1.32	1.32	1
FeO	2.15	2.15	-	2.15	2.15	1
MnO	0.05	0.05	-	0.05	0.05	1
MgO	0.96	0.96	-	0.96	0.96	1
CaO	0.56	0.56	-	0.56	0.56	1
Na2O	3.31	3.31	-	3.31	3.31	1
K2O	4.37	4.37	-	4.37	4.37	1
P2O5	0.09	0.09	-	0.09	0.09	1
H2O+	0.85	0.85	-	0.85	0.85	1
H2O-	-	-	-	-	-	-
CO2	-	-	-	-	-	-
LOI	-	-	-	-	-	-
Ba	-	-	-	-	-	-
Li	-	-	-	-	-	-
Rb	-	-	-	-	-	-
Sr	-	-	-	-	-	-
Pb	-	-	-	-	-	-
Th	-	-	-	-	-	-
U	-	-	-	-	-	-
Zr	-	-	-	-	-	-
Nb	-	-	-	-	-	-
Y	-	-	-	-	-	-
La	-	-	-	-	-	-
Ce	-	-	-	-	-	-
Pr	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	-	-	-	-	-	-
Cr	-	-	-	-	-	-
Mn	-	-	-	-	-	-
Co	-	-	-	-	-	-
Ni	-	-	-	-	-	-
Cu	-	-	-	-	-	-
Zn	-	-	-	-	-	-
Sn	-	-	-	-	-	-
W	-	-	-	-	-	-
Mo	-	-	-	-	-	-
Ga	-	-	-	-	-	-
As	-	-	-	-	-	-
S	50	d	-	d	d	1
F	-	-	-	-	-	-
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Yenberrie Leucogranite (Tennysons Suite)

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	75.23	75.23	-	75.23	75.23	1
TiO2	0.05	0.05	-	0.05	0.05	1
Al2O3	12.21	12.21	-	12.21	12.21	1
Fe2O3	0.36	0.36	-	0.36	0.36	1
FeO	1.71	1.71	-	1.71	1.71	1
MnO	0.03	0.03	-	0.03	0.03	1
MgO	0.18	0.18	-	0.18	0.18	1
CaO	0.54	0.54	-	0.54	0.54	1
Na2O	2.8	2.8	-	2.8	2.8	1
K2O	5.1	5.1	-	5.1	5.1	1
P2O5	0.06	0.06	-	0.06	0.06	1
H2O+	-	-	-	-	-	-
H2O-	-	-	-	-	-	-
CO2	-	-	-	-	-	-
LOI	1.23	1.23	-	1.23	1.23	1
Ba	71	71	-	71	71	1
Li	17	17	-	17	17	1
Rb	359	359	-	359	359	1
Sr	18	18	-	18	18	1
Pb	20	20	-	20	20	1
Th	26	26	-	26	26	1
U	11	11	-	11	11	1
Zr	66	66	-	66	66	1
Nb	8	8	-	8	8	1
Y	48	48	-	48	48	1
La	22	22	-	22	22	1
Ce	62	62	-	62	62	1
Pr	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	-	-	-	-	-	-
V	8	8	-	8	8	1
Cr	-	-	-	-	-	-
Mn	-	-	-	-	-	-
Co	4	4	-	4	4	1
Ni	5	5	-	5	5	1
Cu	6	6	-	6	6	1
Zn	20	20	-	20	20	1
Sn	3	3	-	3	3	1
W	6	6	-	6	6	1
Mo	4	4	-	4	4	1
Ga	18	18	-	18	18	1
As	7	7	-	7	7	1
S	100	100	-	100	100	1
F	2900	2900	-	2900	2900	1
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

5 JIM JIM SUITE

5.1 Timing 1825 Ma

5.2 Individual Ages **Primary Ages:**

1. Grace Creek Granite ¹	1863 ± 5 Ma, U-Pb [#]
2. Plum Tree Creek Volcanics ¹	1858 ± 25 Ma, U-Pb [#]
3. Ironbark Member ¹	1857 ± 61 Ma, U-Pb [#]
4. Jim Jim Granite ¹	1838 ± 7 Ma, SHRIMP
5. Plum Tree Creek Volcanics ¹	1833 ± 43 Ma, U-Pb
6. Gimbat Formation ²	1827 ± 5 Ma, SHRIMP
7. Gimbat Formation ²	1827 ± 4 Ma, SHRIMP
8. Plum Tree Creek Volcanics ¹	1825 ± 4 Ma, SHRIMP
9. Malone Creek Granite ¹	1823 ± 9 Ma, SHRIMP
10. Malone Creek Granite ¹	1808 ± 20 Ma, SHRIMP*
11. Tin Camp Granite ^{1, 3}	1758 ± 20 Ma, Rb-Sr init. 0.708 ± .003 ⁺
12. Malone Creek Granite ¹	1736 ± 5 Ma, SHRIMP*

Sources: [1] OZCHRON, [2] Jagodzinski (unpublished data), [3] Page *et al.*, (1980).

[#] samples have a significant proportion of inherited zircon

* samples are plagued by discordance due to lead loss

⁺ Rb-Sr age which has been reset).

5.3 Regional Setting

This suite occurs in the eastern part of the Pine Creek Inlier mainly along the western border of Arnhem Land. The suite appears coeval with the Cullen Supersuite, but has some distinctive characteristics. The Jim Jim Suite contains both granites and volcanics and represents a significant felsic magmatic episode. All plutons show evidence of a shallow level of emplacement, with some grading into volcanics and others showing evidence of faulted contacts that are filled with quartz breccia. The volcanics are subaerial proximal ignimbrites, and interbedded with braidplain and lacustrine sediments. They fill rift valleys which formed on the older basin sediments during reactivation of pre-existing basement structures (Jagodzinski 1991, 1992). In the more mafic phases, the Jim Jim Suite appears to be restite-dominant. However, after restite separation, the remaining liquid fractionated significantly to produce greisen and abundant late-stage alteration. Because of the high level of emplacement, only minor hornfelsing has been recorded at the contact.

5.4 Summary

The suite is dominated by felsic end-members. Significant fractionation took place at about 74 wt% SiO₂, and the values of Rb, U, Y and F increase exponentially to relatively high levels with increasing SiO₂. Compared with other felsic igneous suites in the Pine Creek Inlier, the Jim Jim suite is predominantly oxidised. Although there is evidence of late-stage magmatic fluids, there is little interaction with the adjacent country rocks. Another significant difference between the Cullen Suite and the Jim Jim Suite is that the country rocks surrounding the Jim Jim suite do not appear to contain the abundance of graphitic sediments or banded iron formations that are commonly proximal to the plutons of the Cullen Supersuite and host significant Au mineralisation.

5.5 Potential

Some mineralisation appears to be related to late-stage fractionation, after separation of the restite. The main commodities associated with this suite are Sn, W and minor Au.

Although there is evidence of fractionation and the presence of late magmatic fluids, the limited silica range over which the fractionation has occurred, combined with the presence of fluorite lowers the potential of this suite and helps explain the limited associated mineralisation. However, because it occurs in fairly remote and rugged terrains, it could well be argued that this suite has not been fully explored.

Cu:	Low
Au:	Mod
Pb/Zn:	None
Sn:	High
Mo/W:	High
Confidence Level:	322

5.6 Descriptive Data

Location: Eastern Pine Creek Inlier, straddling the border between Arnhem Land and the Kakadu National Park. Crops out predominantly on the ALLIGATOR RIVER, MOUNT EVELYN, and KATHERINE 1:250 000 Sheet areas.

Dimensions and area: The Jim Jim Suite extends in a northerly direction for at least 240 km and has a maximum preserved width of 120 km. Much of the outcrop is covered by sandstone of the Kombolgie Formation or Cainozoic sediments. Total area of outcrop is 2400 km².

5.7 Intrusives

Component plutons: Nabarlek Granite, Tin Camp Granite, Jim Jim Granite, Malone Creek Granite, Grace Creek Granite, Eva Valley Granite and Yeuralba Granite.

Form: Circular plutons (Malone Creek Granite, Jim Jim Granite). Most plutons, however, are covered to varying degrees by sandstone of the Kombolgie Formation. Concentric zoning has been mapped in the Grace Creek, Eva Valley and the Malone Creek Granites.

Metamorphism and Deformation: Not much information available. However, as the granites are all supposedly later than the main regional metamorphic episode, any metamorphic effects would be minor. Many of the plutons have fault-bounded margins reflecting their shallow level of emplacement, possibly as resurgent domes. Specifically: Nabarlek Granite - emplaced after the main regional metamorphic event. Jim Jim Granite - some breccia zones and shear zones recorded.

Dominant intrusive rock types: Granite and leucogranite predominate, and the less felsic varieties are usually porphyritic. *Specifically:* Nabarlek Granite - granite. Tin Camp Granite - biotite granite, trondhjemitic, porphyritic granite. Jim Jim Granite - granite, leucogranite, porphyritic granite, granophyric granite. Malone Creek Granite - porphyritic alkali-feldspar granite, even-grained granite. Grace Creek Granite - porphyritic microgranite, medium-grained granite, porphyritic granophyre. Eva Valley Granite - biotite leucogranite, porphyritic biotite leucogranite. Yeuralba Granite - coarse even-grained leucogranite.

Colour: The dominant colour is pink, reflecting the oxidised nature of this suite. Specifically: Nabarlek Granite - pink to green. Tin Camp Granite - pale pink to green. Jim Jim Granite - white to pink. Malone Creek Granite - pink to white. Grace Creek Granite - grey to pink. Eva Valley Granite - pink to green. Yeuralba Granite - pink.

Veins, Pegmatites, Aplites, Greisens: Late-stage greisen are commonly recorded. *Specifically:* Malone Creek Granite - aplite and pegmatite veins emanate into the country rock, greisen also occur. Eva Valley Granite - greisen zones recorded. Yeuralba Granite - greisen noted.

Distinctive mineralogical characteristics: Biotite is the dominant ferromagnesian mineral, whilst hornblende is recorded only in the more mafic plutons. Fluorite is commonly recorded. *Specifically:* Nabarlek Granite - plagioclase, quartz, orthoclase, biotite and rare opaques: accessory allanite, apatite, zircon and fluorite. Tin Camp Granite - plagioclase, quartz, orthoclase, biotite and rare opaques. Jim Jim Granite - biotite, hornblende, plagioclase, K-feldspar, quartz, allanite, apatite, and zircon. Malone Creek Granite - quartz, K-feldspar, plagioclase, biotite, allanite, titanite, fluorite and zircon. Grace Creek Granite - hornblende, biotite, K-feldspar, plagioclase, quartz, magnetite and zircon. Eva Valley Granite - quartz, K-feldspar, plagioclase, biotite, allanite, titanite, fluorite and zircon. Yeuralba Granite - quartz, K-feldspar, plagioclase, biotite, muscovite, tourmaline.

Breccias: Quartz-filled breccias have been noted in many of the intrusions. This may reflect their emplacement at shallow crustal levels, although some may be related to later deformation.

Specifically: Nabarlek Granite - cut by numerous quartz breccia-filled fault zones. Tin Camp Granite - cut by meridionally trending quartz breccia zones each about 0.5 to 1 m wide. Malone Creek Granite - some breccias locally developed. Eva Valley Granite - quartz breccias fill in faults and shear zones.

Xenoliths: Fine grained xenoliths of 'syenitic' composition have been noted in the Grace Creek Granite.

Alteration in the granite: Alteration is pervasive throughout most plutons. Some of this alteration is related to late-stage magmatic processes, and some is younger and has been dated at 1560 Ma (Page *et al.* 1980). This young alteration presumably relates to nearby unconformity uranium deposits/prospects including Narbarlek (Nabarlek Granite) and Caramal (Tin Camp Granite). *Specifically:* Nabarlek Granite - extensively altered, with zones of overprinting hematite-chlorite and chlorite-sericite: some calcite. Orthoclase is commonly sericitised, plagioclase saussuritised, and biotite altered to chlorite. Tin Camp Granite - pervasively altered with orthoclase altered to brown sericite, plagioclase to sericite, and biotite to chlorite. Jim Jim Granite - biotite altered to chlorite, feldspars to sericite. Malone Creek Granite - alteration minerals include epidote, sericite and carbonate. Grace Creek Granite - hornblende is chloritised; calcite and kaolinite also observed. Eva Valley Granite - fluorite, chlorite, sericite, epidote. Yeuralba Granite - sericite, chlorite.

5.8 Extrusives

The Plum Tree Creek Volcanics of the Edith River Group and the Gimbat Formation are the two main felsic volcanic units (other units being the Edith River Volcanics and the Big Sunday Formation). The Plum Tree Creek Volcanics are about 500 m thick and consist of red to purple massive rhyodacitic ignimbrite with minor rhyolite. Phenocrysts consist of K-feldspar and plagioclase with minor quartz and chloritised amphibole/biotite. Stewart (1965) reported clear laths in the groundmass which he interpreted to be formed by inversion of tridymite. Tridymite is usually formed by precipitation from hot gases (Deer *et al.* 1963). The Gimbat Formation is dominated by quartz-feldspar-bearing rhyolitic ignimbrites with minor rhyolitic lava.

5.9 Country Rock

Contact metamorphism: Most contacts are either faulted, or gradational into the comagmatic felsic volcanics. Some local hornfelsing has been noted. *Specifically:* Nabarlek Granite - none recorded as exposed contacts are faulted. Tin Camp Granite - none recorded. Jim Jim Granite - no evidence preserved, may have been obliterated by faulting and/or alteration, metamorphism. Malone Creek Granite - contact aureole about 200 m wide, pelitic rocks have cordierite porphyroblasts, greywackes are silicified. Grace Creek Granite - gradational contact into Plum Tree Creek Volcanics. Eva Valley Granite - local hornfelsing. Yeuralba Granite - local hornfelsing

Reaction with country rock: None recorded. All alteration appears to have been contained within the granites.

Units the granite intrudes: Myra Falls Metamorphics, Nimbuwah Complex, Nourlangie Schist, Cahill Formation, Burrell Creek Formation, Zamu Dolerite, Coronation Sandstone, Gimbat Formation, Plum Tree Creek Volcanics, Tollis Formation.

Dominant rock types: Schist, granodioritic migmatite, feldspathic sandstone, dolerite, ignimbrite, felsic volcanic.

Potential hosts: Schists and mafic volcanics.

5.10 Mineralisation

Most of this suite occurs in Arnhem Land and it has probably not been all that systematically explored. Sn ± W ± Au mineralisation is associated with some members of this suite. The Maranboy tin field produced ~1340 t of tin, 0.07 t of W and 249 g of Au between 1915 and 1956. Most of the tin is in quartz-tourmaline lodes. In the Yeuralba Mineral Field, Sn and W mineralisation is associated with tourmaline and topaz-bearing greisens. Total production is 19.6 t W, 8.2 t of Sn and 110 g Au. Most of the mineralisation is along the western greisenised contact with the Yeuralba Granite. Cassiterite veins have also been noted near the Tin Camp Granite, and a minor Au-Ag-U prospect is located just east of the Malone Creek Granite.

5.11 Geochemical Data

Data source: The samples were collected as part of the AGSO 1:100 000 mapping program, as part of the AGSO projects in the South Alligator and Kakadu Conservation Zones from 1988 to 1990 and samples from E. Jagodzinski's PhD thesis area. All data are held in the AGSO OZCHEM database.

Data quality: All samples have been analysed within the AGSO laboratory for consistency.

Are the data representative? No. Only the Malone Creek Granite and the Gimbat Formation have been sampled properly. There are no samples of the Yeuralba Granite and the other units have only been sampled on an opportunistic basis.

Are the data adequate? Although for the most part the sampling has not been systematic, what data exist do tend to give a consistent story.

SiO₂ range (Fig. 5.1): The dominant silica range is from 63 to 79 wt%. The anomalous peak at 76 wt% reflects in part the detailed sampling by E. Jagodzinski of the rhyolitic ignimbrites of

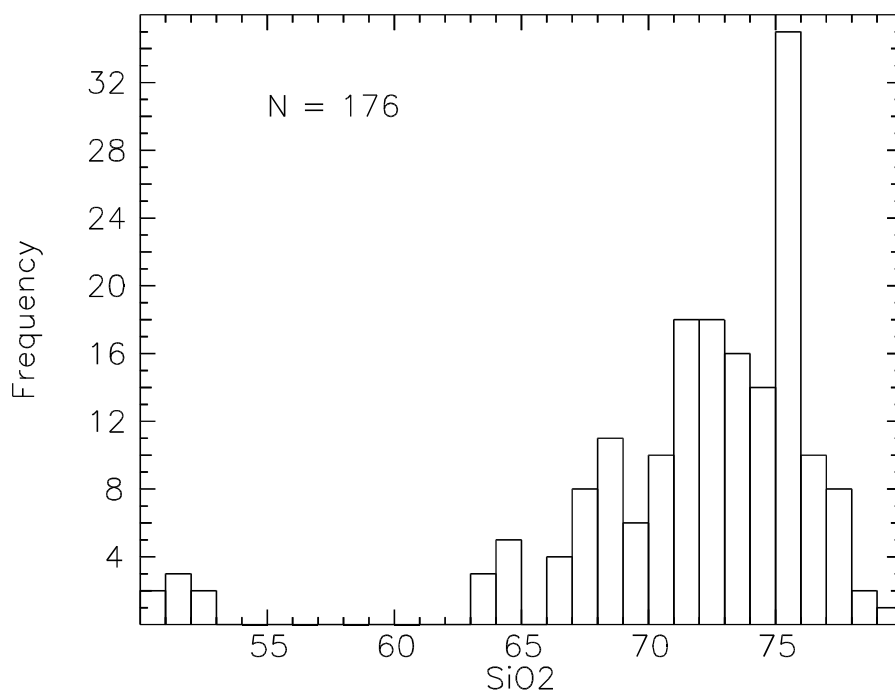


Figure 5.1. Frequency Histogram of the Jim Jim Suite

the Gimbat Formation; it is also due to the fact that once the granites started fractionating the SiO₂ levels remained fairly constant.

Alteration (Figs. 5.1 & 5.2):

- **SiO₂:** Silicification appears minor.
- **K₂O/Na₂O:** The dominant sericite alteration is reflected in the samples with low to moderate K₂O and very low values of Na₂O. Some samples have been albitised.
- **Th/U:** Despite the degree of mineralogical alteration, the Th/U ratios have been only weakly affected.
- **Fe₂O₃/(FeO+Fe₂O₃):** Some samples have been strongly oxidised, particularly the volcanic members. This oxidation could be related to the palaeoweathering profiles described by Needham and Stuart-Smith (1985) or to oxidised fluids associated with the nearby unconformity uranium deposits (Mernagh *et al.* 1994).

Fractionation Plots (Fig. 5.3):

- **Rb:** Rb values increase rapidly and exponentially to very high values with increasing SiO₂. The increase does not start until about 74 wt.% SiO₂.
- **U:** U values increase rapidly and exponentially to very high values with increasing SiO₂. The increase does not start until about 74 wt.% SiO₂.
- **Y:** Y values increase rapidly and exponentially to very high values with increasing SiO₂. The increase does not start until about 74 wt.% SiO₂.
- **P₂O₅:** P₂O₅ values are low and decrease with increasing SiO₂.
- **Th:** Th values increase exponentially with increasing SiO₂.
- **K/Rb:** The K/Rb ratio decreases rapidly with increasing SiO₂, particularly for the granites.
- **Rb-Ba-Sr:** Most samples plot in the strongly differentiated field.
- **Sr:** Sr values are very low.

- **Rb/Sr:** The Rb/Sr ratio increases rapidly and exponentially with increasing SiO₂. The increase does not start until about 74 wt.% SiO₂.
- **Ba:** Ba decreases with increasing SiO₂. The Ba values for ignimbrite in the Gimbat Formation are noticeably lower than for any other members of this suite.
- **F:** F values increase to very high levels with increasing SiO₂.

Metals (Fig. 5.4):

- **Cu:** Values are low for all members of this suite.
- **Pb:** Values are generally low to moderate.
- **Zn:** Zn values are high, particularly for ignimbrite in the Gimbat Formation.
- **Sn:** Sn values increase exponentially to moderate values with increasing SiO₂.

High field strength elements (Fig 5.5):

- **Zr:** Zr values decrease with increasing SiO₂. The anomalously high values in the Gimbat Formation may reflect heavy mineral concentration during winnowing associated with eruptive processes.
- **Nb:** Nb values increase exponentially with increasing SiO₂.
- **Ce:** Ce values are low to moderate.

Classification (Fig. 5.6):

- **The CaO/Na₂O/K₂O plot of White, quoted in Sheraton and Simons (1992):** Most samples plot in the monzogranite to granite field.
- **Zr/Y vs Sr/Sr*:** All samples plot below 1 indicating that the suite is Sr-depleted.
- **Spidergram:** The spidergram plot is the typical Sr-depleted, Y-undepleted for the Proterozoic of Australia. The most SiO₂-enriched sample shows very strong fractionation, that is not visible in the other two samples at 68 and 72 wt%. This indicates that fractionation occurred fairly late in the magmatic process.
- **Oxidation plot of Champion and Heinemann (1994):** The members of this suite plot predominantly in the oxidised field. Samples which plot in the strongly oxidised and the reduced field are probably altered.
- **ASI:** samples progress from metaluminous to strongly peraluminous.
- **A-type plot of Eby (1990):** Most samples plot in the A-type field as defined by Eby (1990) for Palaeozoic granites.

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

Australian Proterozoic granite type: Nicholson.

5.12 Geophysical Signature

Radiometrics (Fig. 5.7): Most samples plot above the Proterozoic median for all three elements and hence would appear white in a RGB image.

Gravity: The AGSO regional gravity data are rather coarse. Most of the plutons appear as gravity lows and some lows coincident with the Kombolgie Formation are interpreted to be plutons of the Jim Jim Suite.

Magnetics: On the regional aeromagnetic image, the magnetic signatures are variable, but there is a weak correlation, with the more mafic units having a variable signature which ranges from high to low values, whilst the more felsic units are all magnetic lows.

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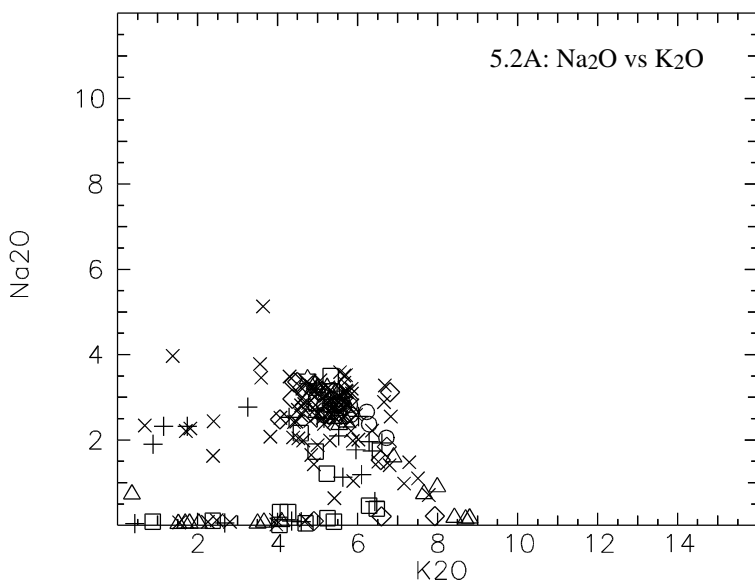
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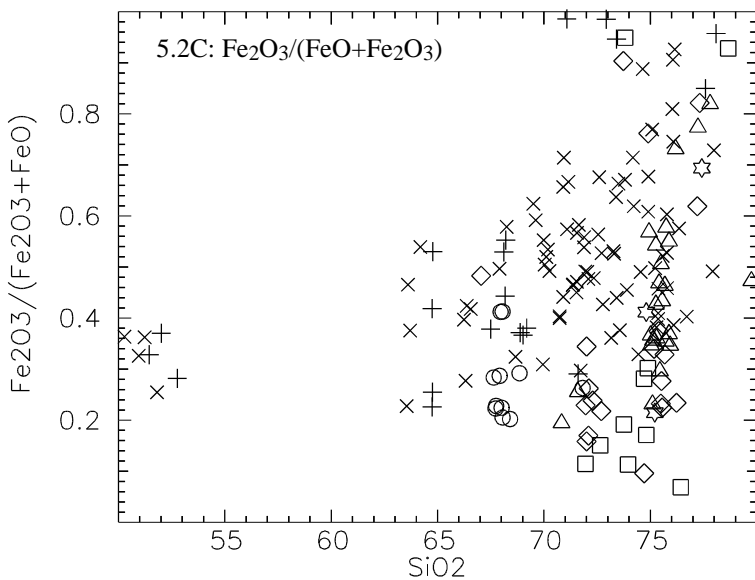
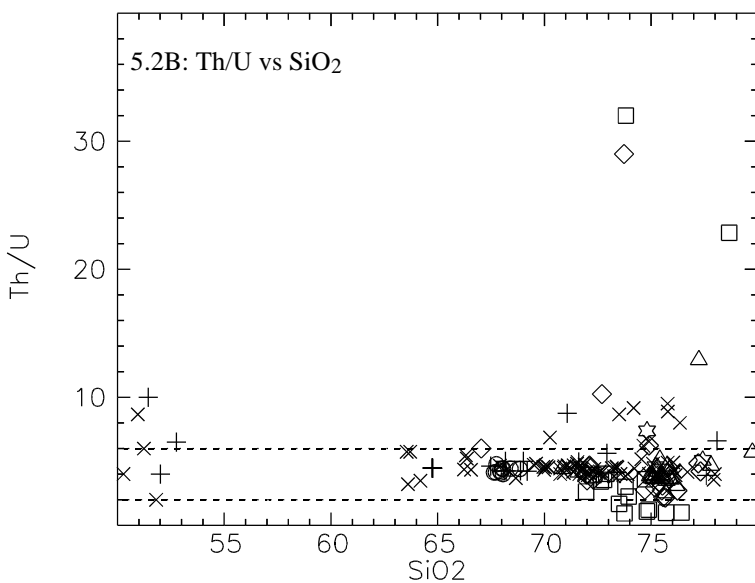
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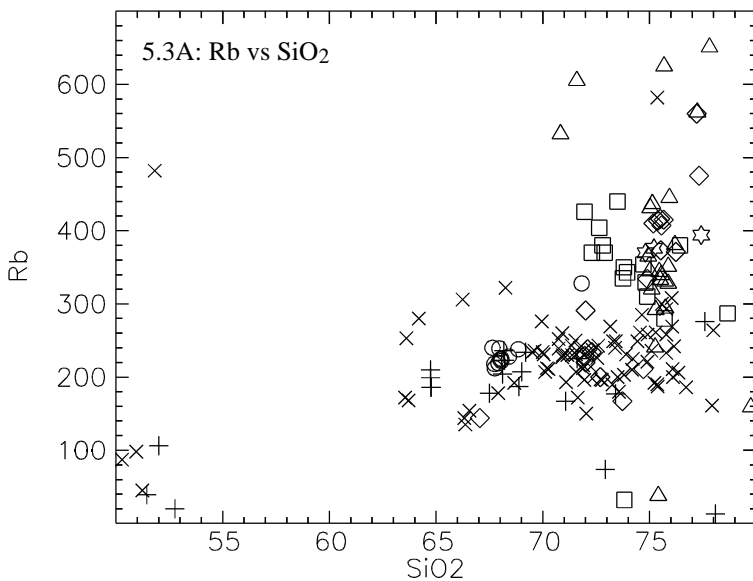
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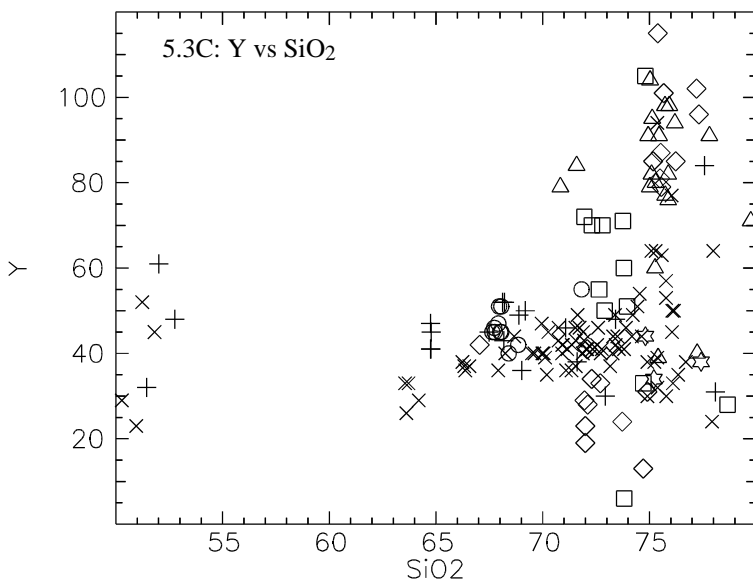
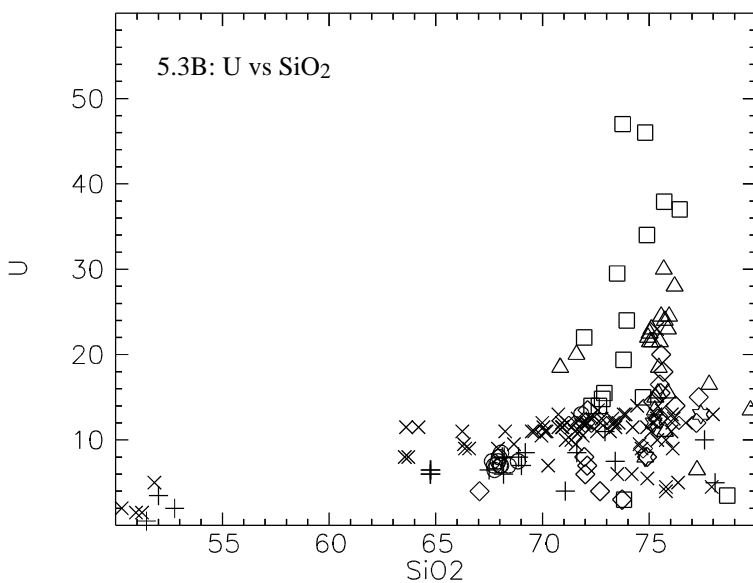
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- + Edith River Group



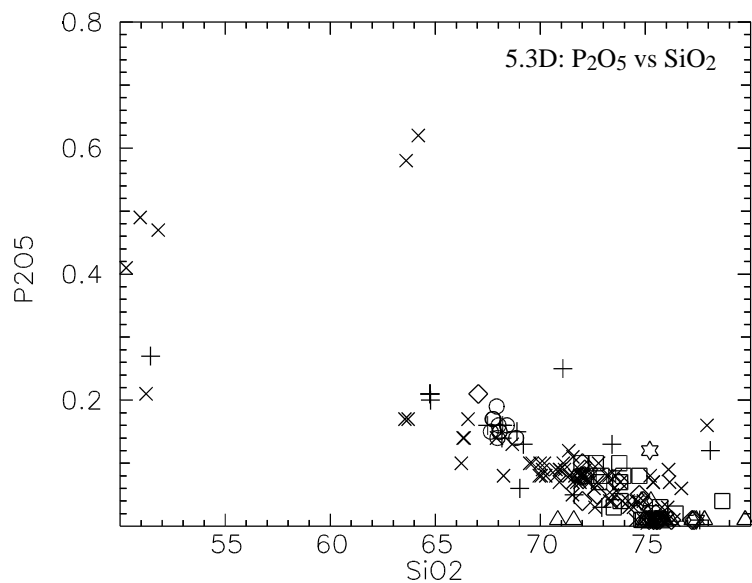
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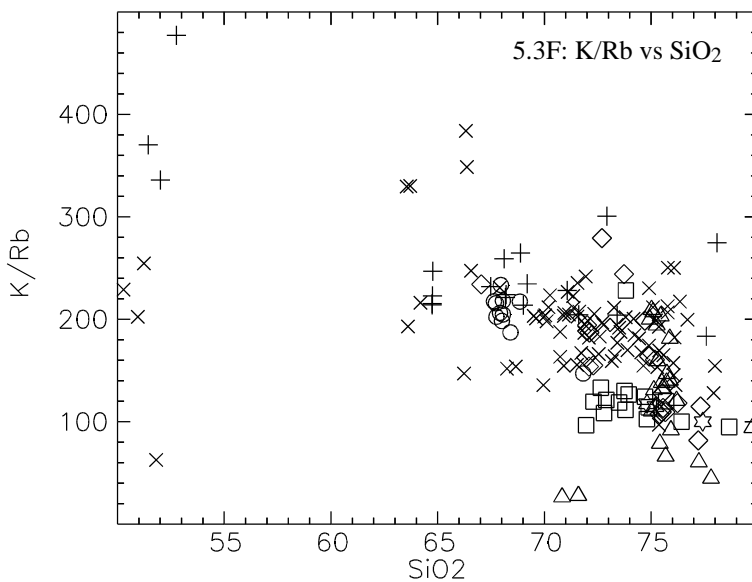
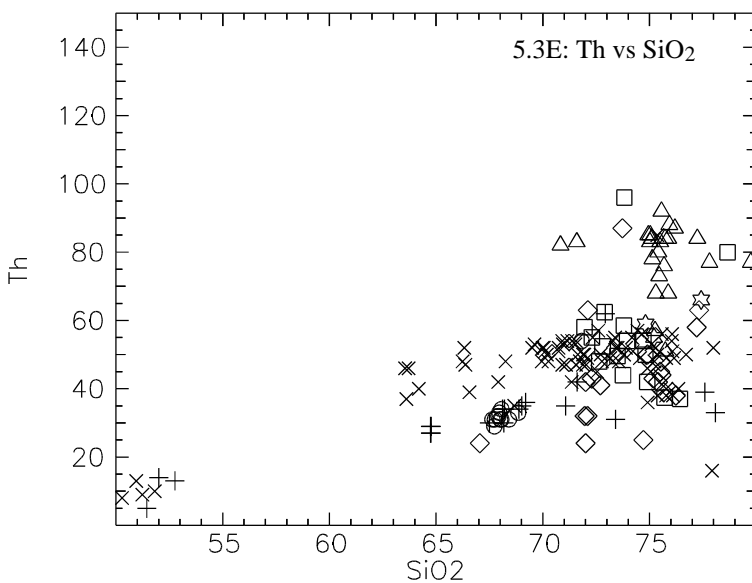
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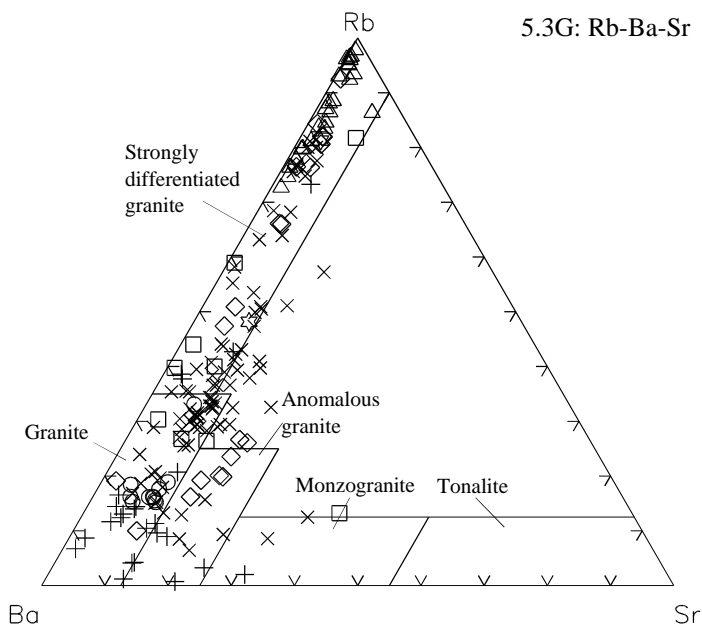
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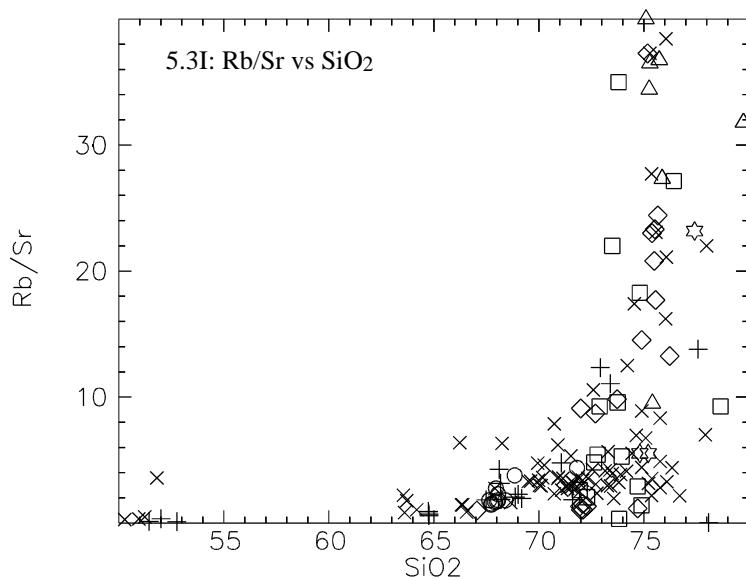
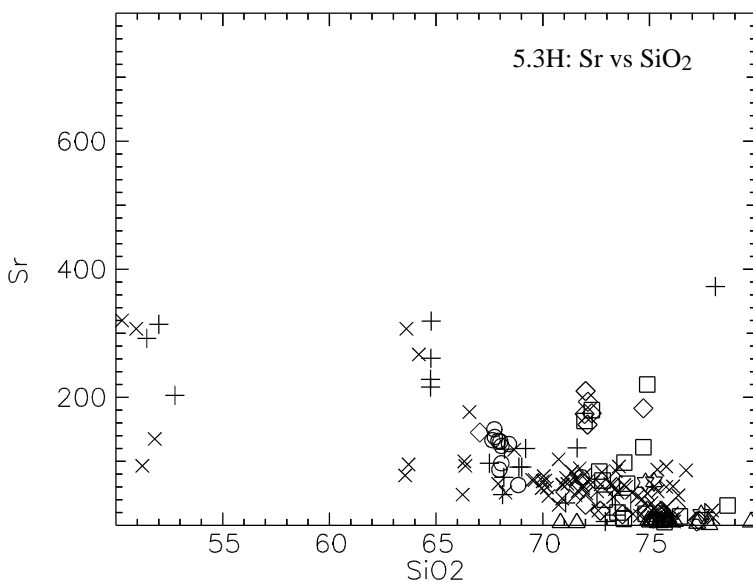
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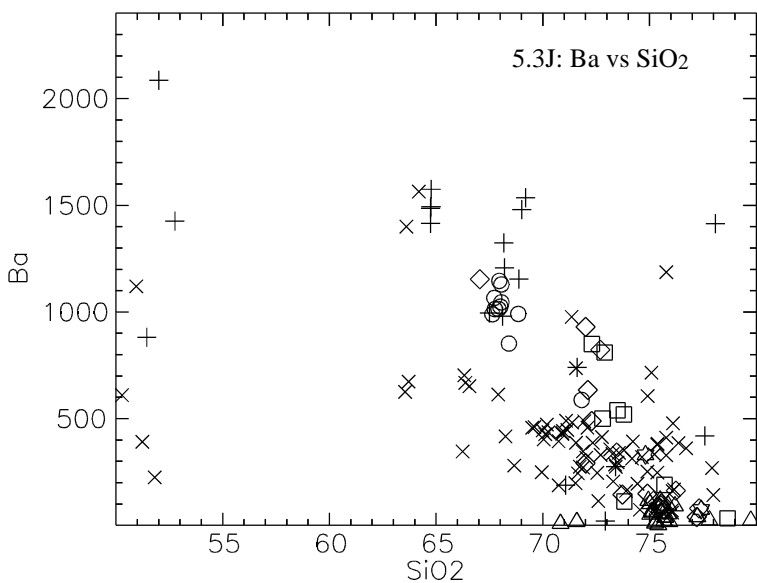
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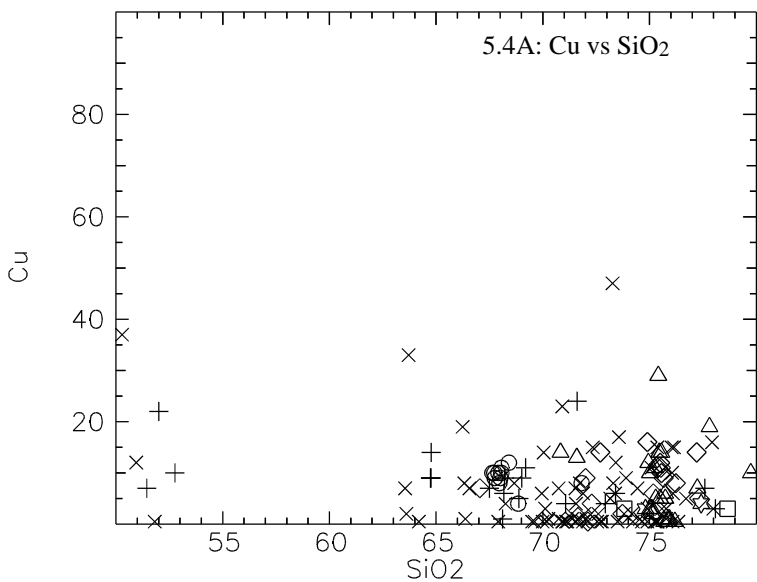
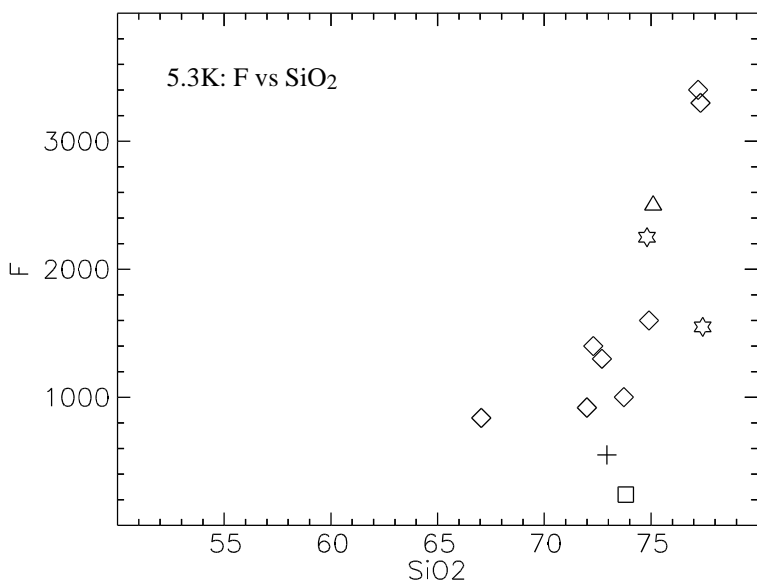
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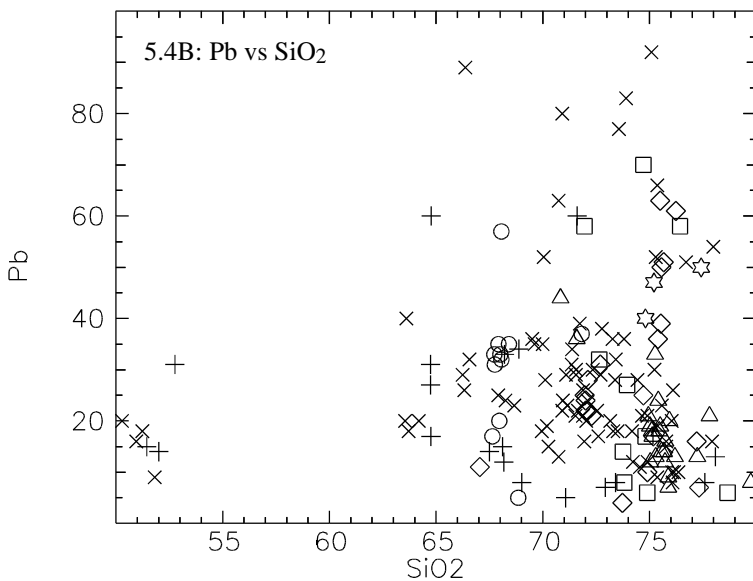
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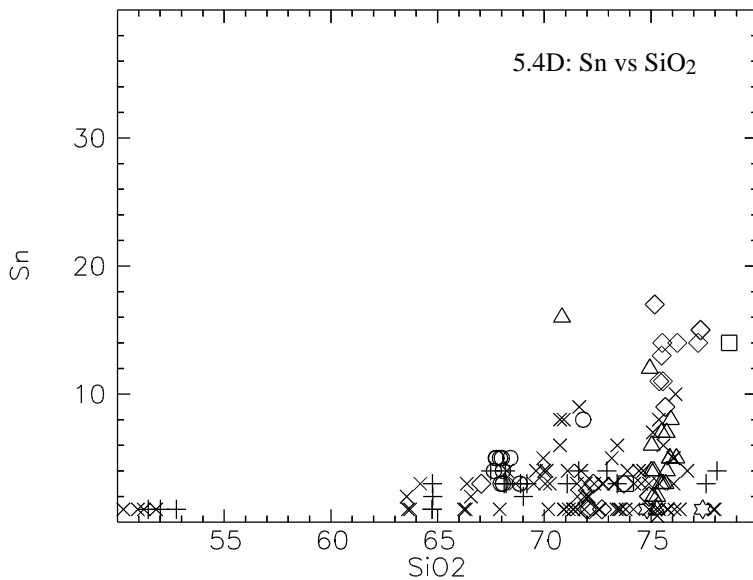
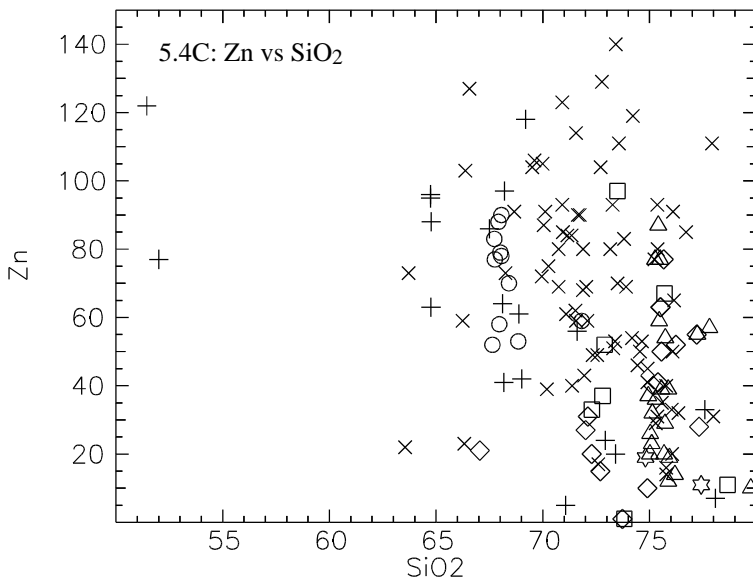
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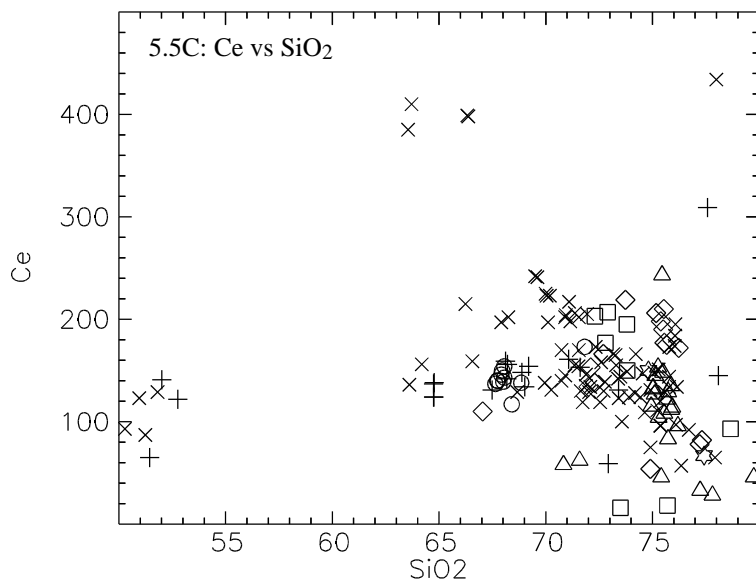
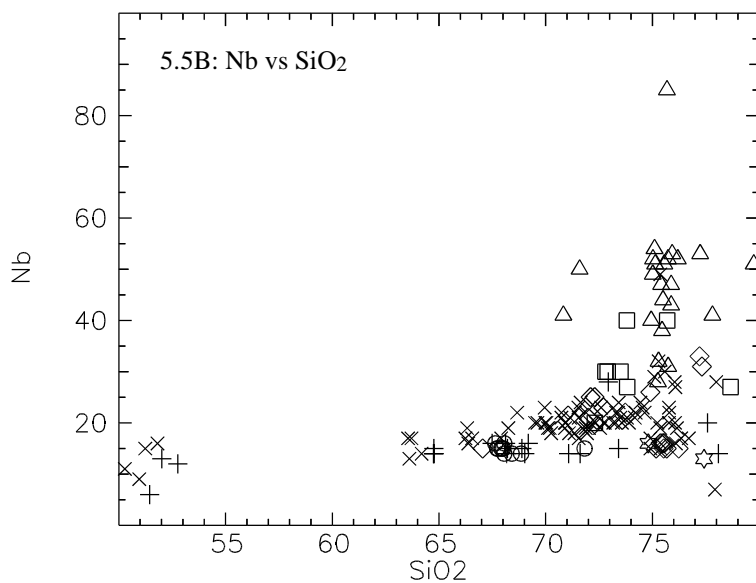
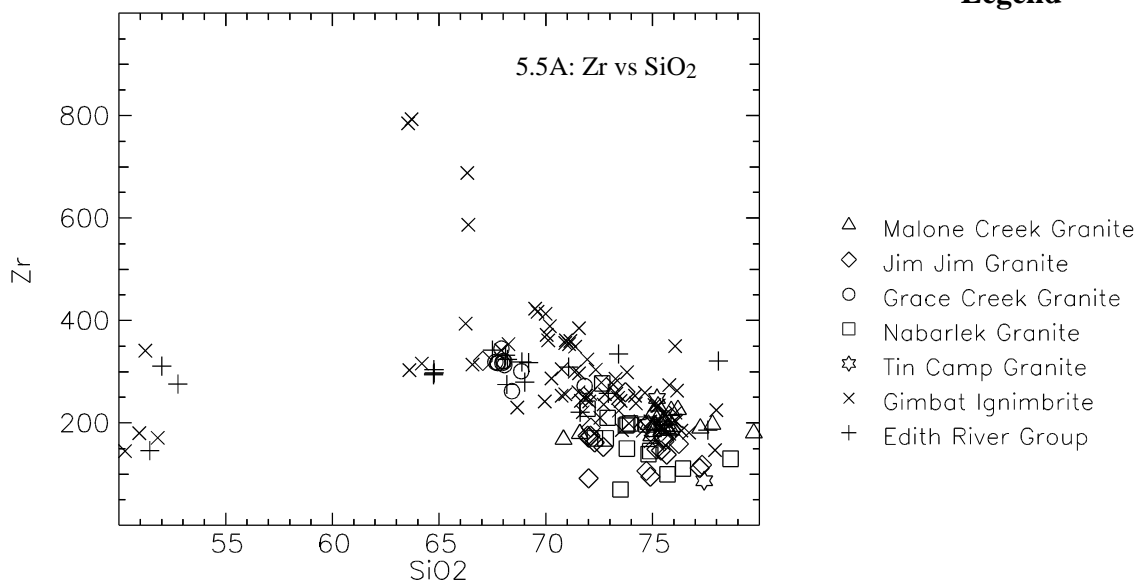
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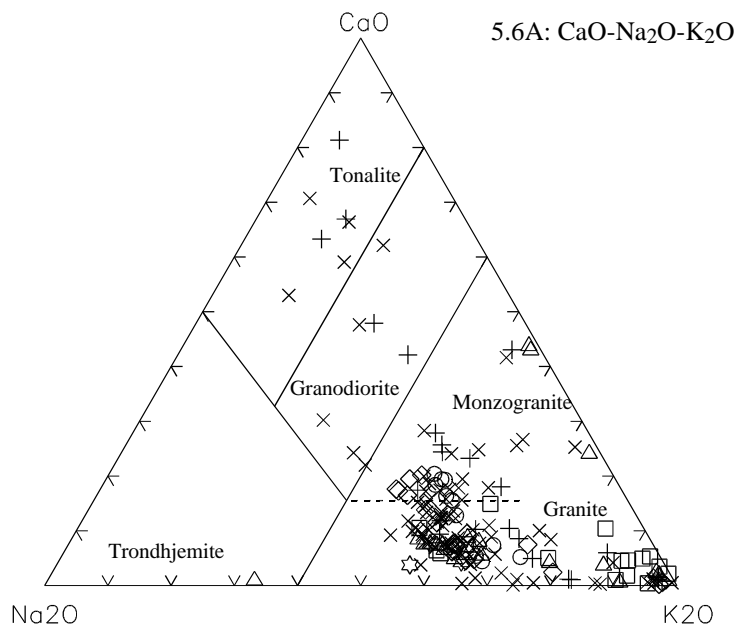
- △ Malone Creek Granite
- ◇ Jim Jim Granite
- Grace Creek Granite
- Nabarlek Granite
- ☆ Tin Camp Granite
- × Gimbat Ignimbrite
- + Edith River Group



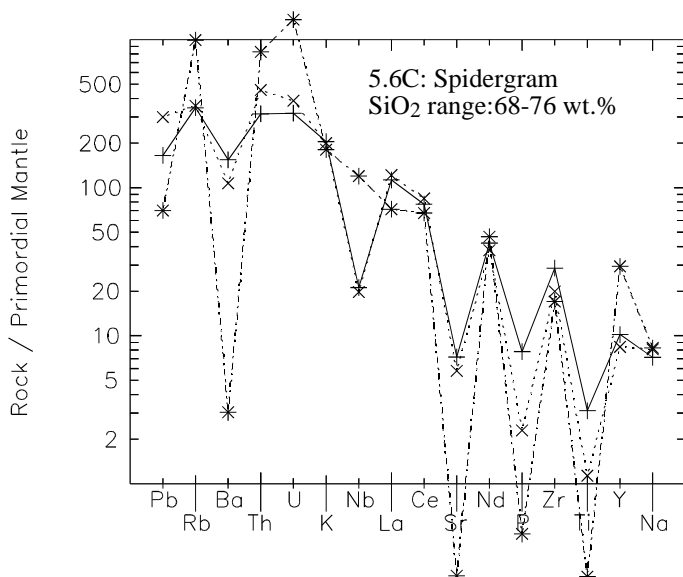
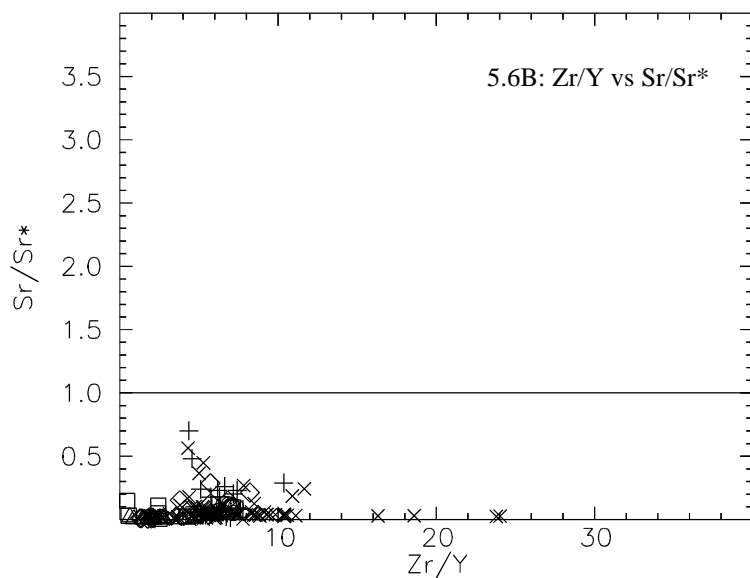
Legend



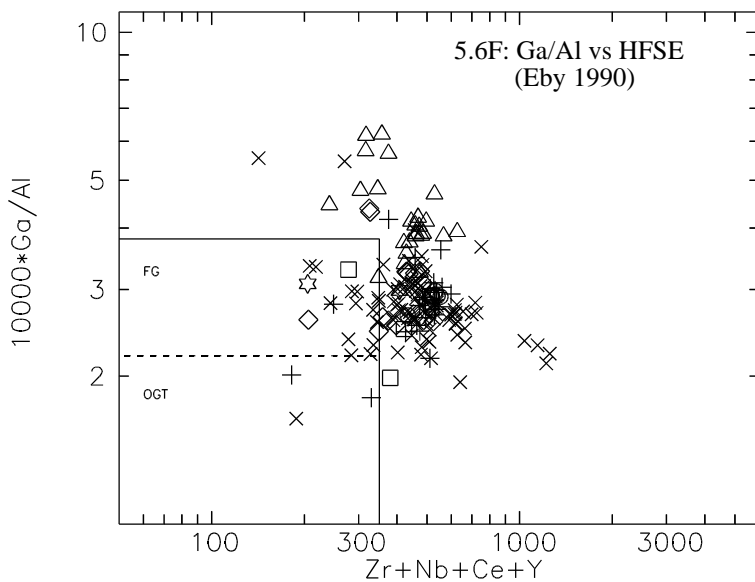
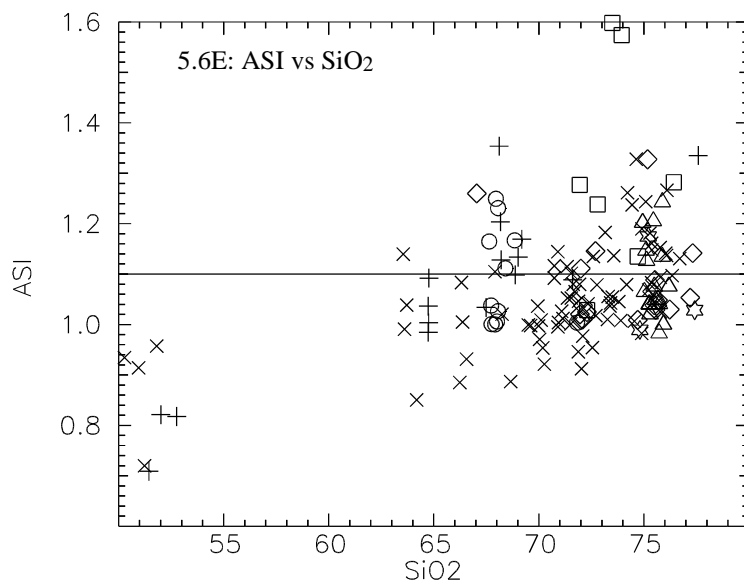
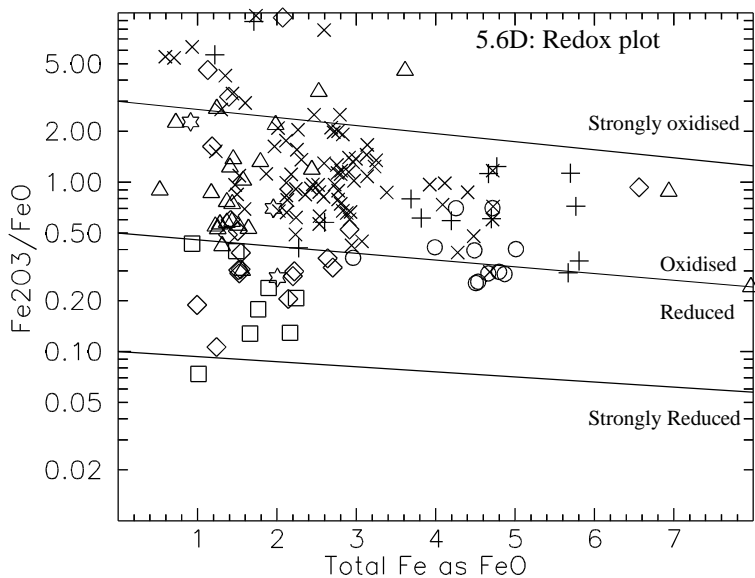
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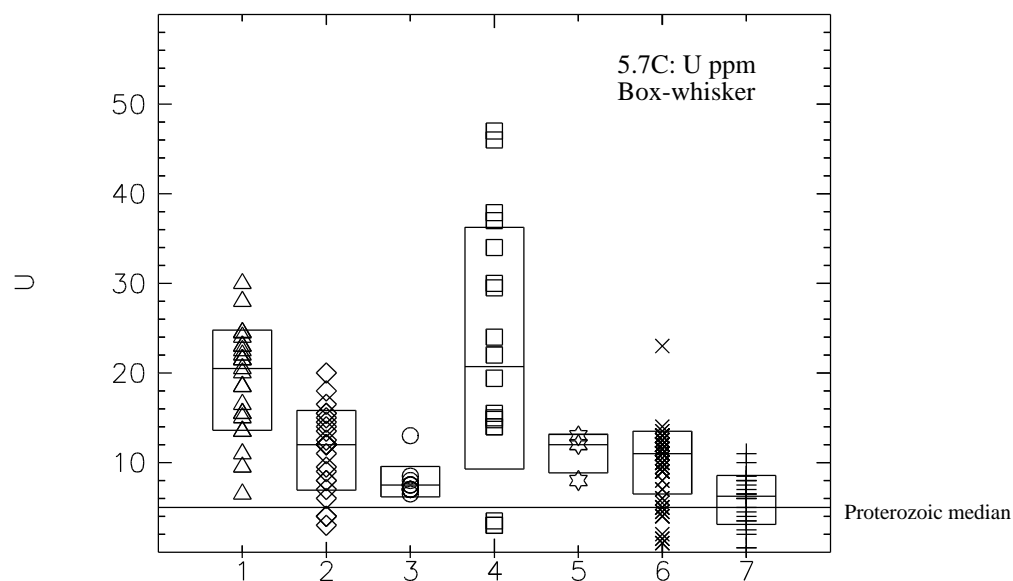
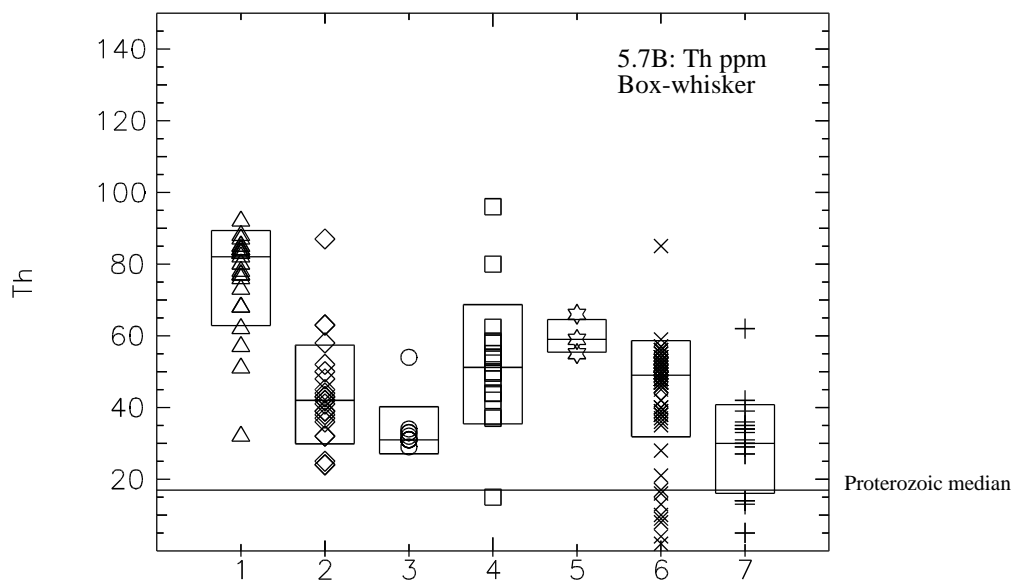
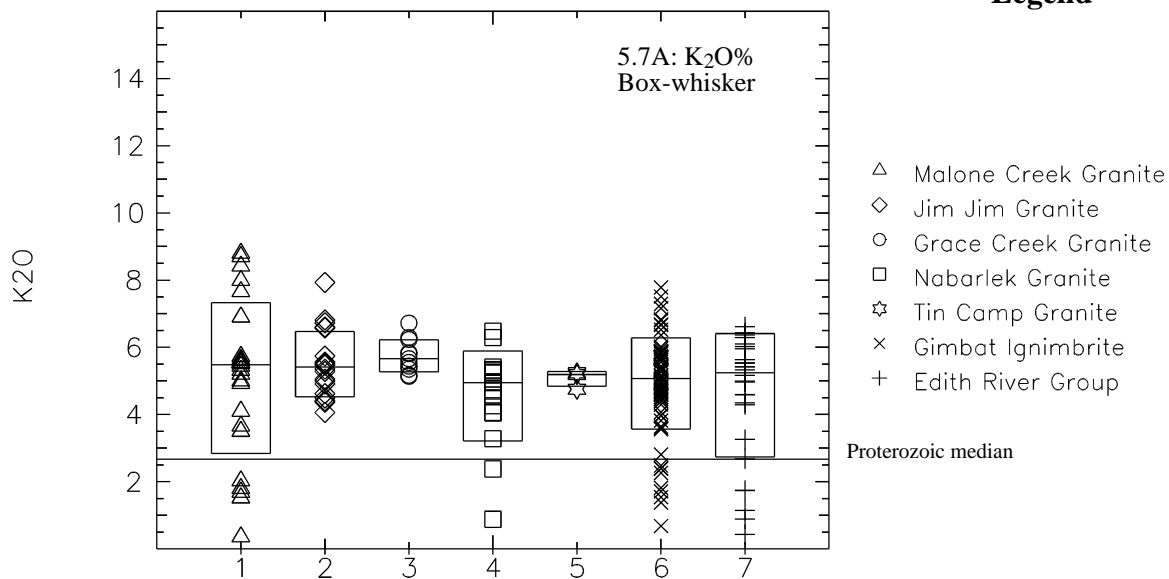
- △ Malone Creek Granite
- ◇ Jim Jim Granite
- Grace Creek Granite
- Nabarlek Granite
- ☆ Tin Camp Granite
- × Gimbat Ignimbrite
- + Edith River Group



Legend



Legend



Malone Creek Granite

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	76.24	75.53	3.52	70.83	90.91	26
TiO2	0.05	0.05	0.02	0.02	0.1	26
Al2O3	11.89	12.14	1.46	5.09	13.38	26
Fe2O3	1.04	0.63	0.85	0.26	3.41	26
FeO	1.34	0.84	1.65	0.24	6.55	26
MnO	0.02	0.02	0.01	0.01	0.07	25
MgO	0.29	0.21	0.2	0.07	0.8	26
CaO	0.57	0.6	0.35	0.01	1.44	21
Na2O	1.49	1.25	1.33	0.04	3.3	26
K2O	5.08	5.48	2.29	0.36	8.8	26
P2O5	0.01	0.01	0.01	0.01	0.04	24
H2O+	0.5	0.5	0.02	0.48	0.51	2
H2O-	0.07	0.07	-	0.07	0.07	1
CO2	0.04	0.04	0.02	0.05	0.05	2
LOI	1.54	1.29	0.55	0.79	3.07	24
Ba	46.84	38	35.66		118	25
Li	23.12	17	16.57	3	59	25
Rb	383.92	345	151.86	38	651	25
Sr	5.84	6	2.37	1	12	25
Pb	18.32	17	8.93	7	44	25
Th	76.12	82	13.54	32	92	25
U	19.2	20.5	5.7	6.5	30	25
Zr	192	193	27.88	84	233	25
Nb	45.92	48	12.53	15	85	25
Y	91.28	84	38.5	39	231	25
La	41.84	44	24.94		105	25
Ce	100.24	112	52.67	8	243	25
Pr	12.87	13	7.49		31	23
Nd	53.42	59	28.77	3	117	24
Sc	1.22		0.78		3	25
V	1.04		0.2		2	25
Cr	1.25		1.21		4	24
Mn	188.4	140	170.15	47	702	15
Co	65.75	72.5	34.73	3	133	12
Ni	1.08		0.92		4	25
Cu	7.82	5	6.86		29	25
Zn	54.32	37	61.72	10	290	25
Sn	54.44	6	160.57		810	25
W	8.03	8	5.42		21	15
Mo	8.66	2	17.47		62	25
Ga	26.92	25	6.29	12	40	25
As	9.48	4	13.66	1.5	51.5	25
S	55.67	d	33.75	d	200	21
F	2500	2500	-	2500	2500	1
Cl	222	222	-	222	222	1
Be	4.2	4	1.66	2	7	25
Ag	1.26	1	0.45	1	2	23
Bi	12		42.2		206	24
Hf	9.63	10	2.52	3	15	19
Ta	2.56	3	1.29		4	18
Cs	5.53	5	3.43		11	15
Ge	2.47	2	1.48	1	6.5	18
Se	0.53		0.12		1	18

Jim Jim Granite

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	73.96	74.81	2.44	67.05	77.32	20
TiO2	0.21	0.16	0.17	0.05	0.8	20
Al2O3	12.78	12.63	0.99	11.39	15.35	20
Fe2O3	0.77	0.52	0.74	0.12	3.33	20
FeO	1.3	1.17	0.79	0.22	3.57	20
MnO	0.04	0.04	0.03	01	0.12	20
MgO	0.53	0.49	0.34	0.14	1.19	20
CaO	0.83	0.69	0.59	0.02	1.77	20
Na2O	2.39	2.84	1.05	0.1	3.36	20
K2O	5.5	5.41	0.99	4.06	7.93	20
P2O5	0.05	0.04	0.05	0.01	0.21	20
H2O+	-	-	-	-	-	-
H2O-	-	-	-	-	-	-
CO2	0.07	0.05	0.05	05	0.2	8
LOI	1.3	1.18	0.47	0.85	2.58	20
Ba	378.67	163	343.63	39	1153	21
Li	25.33	25	9.75	10	41	9
Rb	301.17	240.5	110.86	144	560	24
Sr	91.63	30	82.24	6	210	24
Pb	27.96	25	15.62	4	63	24
Th	43.63	42	14.06	24	87	24
U	11.35	12	4.54	3	20	24
Zr	161.79	163	50.78	92	321	24
Nb	20.05	18	6.09	11	33	20
Y	52.83	37.5	32.88	13	115	24
La	73.15	79	25.96	21	125	20
Ce	146.55	159	49.43	54	219	20
Pr	17.17	18	5.22	7	25	12
Nd	61.75	68	18.25	25	83	12
Sc	5.85	5	3.76		17	20
V	23.25	7	31.56		122	20
Cr	9.33	3	19.5	1	71	12
Mn	276.25	251.5	90.78	128	403	12
Co	6.67	7	3.51	3	10	3
Ni	2.13	1	2.24		10	20
Cu	8.27	9	4.19		16	20
Zn	36	30.5	20.25	1	77	20
Sn	7.75	7.5	5.52		17	20
W	4.63	2	7.03	2	22	8
Mo	1.85		1.14		5	20
Ga	19.29	18	2.76	16	27	24
As	2.4	1.75	2.26		9	20
S	60.75	15.5	62.31	d	200	24
F	1720	1350	1038.19	840	3400	8
Cl	229.18	206	84.11	125	390	11
Be	3.75	4	1.5	2	5	4
Ag	2	2	-	2	2	1
Bi	1.25		0.62		3	12
Hf	5.55	5	1.9	3	11	20
Ta	1.5		0.9		4	12
Cs	13.36	12	6.8		24	11
Ge	1.42	1.5	0.42	1	2	12
Se	0.71		0.26		1	12

Grace Creek Granite

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	68.38	68.01	1.19	67.64	71.82	11
TiO2	0.59	0.6	0.08	0.42	0.72	11
Al2O3	13.65	13.64	0.29	13.09	14.23	11
Fe2O3	1.26	1.12	0.38	0.8	2.03	11
FeO	3.3	3.67	0.55	2.24	3.87	11
MnO	0.07	0.07	0.01	0.04	0.09	11
MgO	0.9	0.74	0.34	0.4	1.34	11
CaO	1.3	1.56	0.66	0.41	2.05	11
Na2O	2.66	2.78	0.26	2.05	2.95	11
K2O	5.74	5.66	0.5	5.14	6.72	11
P2O5	0.15	0.15	0.03	0.08	0.19	11
H2O+	1.28	1.29	0.25	0.9	1.64	9
H2O-	0.08	0.07	0.02	0.05	0.12	9
CO2	0.13	0.09	0.09	0.03	0.29	9
LOI	2.21	2.21	0.06	2.17	2.25	2
Ba	987.09	1014	153.41	588	1146	11
Li	32.5	32.5	9.19	26	39	2
Rb	235.73	225	31.95	212	328	11
Sr	114.27	127	28.73	63	150	11
Pb	30.45	33	13.2	5	57	11
Th	33.64	31	6.89	29	54	11
U	7.86	7.5	1.79	6.5	13	11
Zr	309.45	317	23.47	262	345	11
Nb	14.91	15	0.7	14	16	11
Y	46.55	45	4.3	40	55	11
La	77.91	78	7.85	62	96	11
Ce	143.36	140	13.6	117	173	11
Pr	14.5	14.5	0.71	14	15	2
Nd	55.82	56	4.42	46	63	11
Sc	7.64	8	2.06	3	11	11
V	24.64	22	7.57	15	45	11
Cr	10.18	9	4.21	5	22	11
Mn	-	-	-	-	-	-
Co	-	-	-	-	-	-
Ni	3.45	3	1.51	2	6	11
Cu	9.18	10	2.09	4	12	11
Zn	71.55	77	13.92	52	90	11
Sn	4.55	5	1.44	3	8	11
W	-	-	-	-	-	-
Mo	1.77		0.61		3	11
Ga	20.64	21	0.81	19	22	11
As	3.14	2.5	1.82	1	6.5	11
S	-	-	-	-	-	-
F	-	-	-	-	-	-
Cl	-	-	-	-	-	-
Be	2.5	2.5	0.71	2	3	2
Ag	1	1	-	1	1	2
Bi	1		-			2
Hf	-	-	-	-	-	-
Ta	-	-	-	-	-	-
Cs	3.5	3.5	0.71	3	4	2
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Nabarlek Granite

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	74.67	73.82	2.66	71.95	82.76	17
TiO2	0.19	0.23	0.12	0.02	0.42	17
Al2O3	12.92	13.1	1.64	8.34	17.15	17
Fe2O3	0.98	0.37	1.23	0.07	3.24	11
FeO	1.06	1.1	0.67	0.11	1.94	11
MnO	0.03	0.02	0.02	0.01	0.08	17
MgO	1.11	1.01	0.75	0.02	2.5	17
CaO	0.39	0.32	0.33	0.01	1.17	16
Na2O	1.04	0.35	1.23	0.01	3.5	16
K2O	4.55	4.95	1.38	0.88	6.48	17
P2O5	0.06	0.07	0.03	0.01	0.1	17
H2O+	-	-	-	-	-	-
H2O-	-	-	-	-	-	-
CO2	0.03	05	-	05	05	2
LOI	2.35	2.2	1	0.93	4.7	17
Ba	429.56	500	290.77	33	850	9
Li	18	19	12.53	5	30	3
Rb	328.44	352	101.18	32	440	18
Sr	71.59	42	64.96		220	17
Pb	26.92	19.5	23	5	70	12
Th	52.07	51.2	17.12	15	96	18
U	22.76	20.7	13.89	3	47	18
Zr	176.88	170	62.6	70	319	17
Nb	28	30	9.79	8	40	9
Y	81.17	70	51.4	6	180	18
La	74.03	83.9	46.44	10.1	138	9
Ce	125.22	150	77.97	16	207	9
Pr	9	9	-	9	9	1
Nd	42.4	56	28.49	5.7	74	7
Sc	4.82	4.5	2.7	1.4	11	9
V	21.33	11	19.66	9	44	3
Cr	10.86	10	4.3	6	20	7
Mn	-	-	-	-	-	-
Co	3.51	3.2	2.05	1.8	8.3	8
Ni	3.17	4	2.36		5	3
Cu	3	3	-	3	3	3
Zn	74.11	37	112.27	1	362	9
Sn	6	3	7		14	3
W	1.83	2	0.29		2	3
Mo	6.63	7	3.73		12.1	9
Ga	20	20	3.95	11	25	11
As	4.63	1	7.25		15.5	4
S	63.64	d	23.35	d	100	11
F	265	265	35.36	240	290	2
Cl	-	-	-	-	-	-
Be	1.33	1	0.58	1	2	3
Ag	1	1	-	1	1	1
Bi	1		-			1
Hf	7.96	7.2	1.94	6	11	9
Ta	4.31	4.3	2.77	1.2	9.6	7
Cs	4.77	4.6	3.08	1.8	12	9
Ge	3.5	3.5	-	3.5	3.5	1
Se	0.5		-			1

Tin Camp Granite

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	75.81	75.21	1.41	74.81	77.42	3
TiO2	0.18	0.23	0.1	0.06	0.25	3
Al2O3	11.91	12.03	0.21	11.66	12.03	3
Fe2O3	0.65	0.68	0.2	0.44	0.84	3
FeO	1.04	1.2	0.67	0.3	1.61	3
MnO	0.03	0.03	0.02	0.01	0.05	3
MgO	0.22	0.24	0.14	0.08	0.35	3
CaO	0.46	0.35	0.21	0.32	0.7	3
Na2O	3.09	3.23	0.43	2.6	3.43	3
K2O	5.06	5.19	0.27	4.75	5.24	3
P2O5	0.06	0.04	0.06	0.01	0.12	3
H2O+	-	-	-	-	-	-
H2O-	-	-	-	-	-	-
CO2	0.05	0.05	-	0.05	0.05	2
LOI	1.19	1.17	0.16	1.04	1.35	3
Ba	202.5	202.5	181.73	74	331	2
Li	21	21	22.63	5	37	2
Rb	380	376	12.49	370	394	3
Sr	50.67	67	29.16	17	68	3
Pb	45.67	47	5.13	40	50	3
Th	60	59	5.57	55	66	3
U	11	12	2.65	8	13	3
Zr	177.33	197	82.28	87	248	3
Nb	14.5	14.5	2.12	13	16	2
Y	38.67	38	5.03	34	44	3
La	58	58	32.53	35	81	2
Ce	108.5	108.5	58.69	67	150	2
Pr	-	-	-	-	-	-
Nd	-	-	-	-	-	-
Sc	2.5	2.5	0.71	2	3	2
V	9	9	9.9	2	16	2
Cr	-	-	-	-	-	-
Mn	-	-	-	-	-	-
Co	-	-	-	-	-	-
Ni	2.5	2.5	0.71	2	3	2
Cu	3.5	3.5	0.71	3	4	2
Zn	15	15	5.66	11	19	2
Sn	1	-	-	-	-	2
W	2	2	-	2	2	2
Mo	2.5	2.5	0.71	2	3	2
Ga	18.67	19	0.58	18	19	3
As	1	-	-	-	-	2
S	83.33	100	28.87	d	100	3
F	1900	1900	494.97	1550	2250	2
Cl	-	-	-	-	-	-
Be	-	-	-	-	-	-
Ag	-	-	-	-	-	-
Bi	-	-	-	-	-	-
Hf	4	4	1.41	3	5	2
Ta	-	-	-	-	-	-
Cs	-	-	-	-	-	-
Ge	-	-	-	-	-	-
Se	-	-	-	-	-	-

Ignimbrite in the Gimbat Formation

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	70.94	72.09	7.73	43.7	90.46	89
TiO2	0.38	0.29	0.39	0.05	2.38	89
Al2O3	12.41	12.48	1.52	5.45	17.38	89
Fe2O3	1.62	1.44	0.82	0.55	5	89
FeO	1.85	1.35	1.98	0.1	10.27	89
MnO	0.06	0.05	0.05	0.01	0.22	89
MgO	1.34	0.84	1.57	0.13	8.04	89
CaO	1.41	0.94	1.59	0.01	8.08	88
Na2O	2.41	2.58	1	0.02	5.13	89
K2O	4.92	5.07	1.37	0.68	7.78	89
P2O5	0.1	0.08	0.12	0.1	0.62	88
H2O+	-	-	-	-	-	-
H2O-	-	-	-	-	-	-
CO2	-	-	-	-	-	-
LOI	2.36	1.95	1.54	0.8	10.08	89
Ba	400.44	356	273.41	45	1564	89
Li	17.58	14	20.89	3	193	89
Rb	223.48	227	71.19	45	582	89
Sr	72.73	61	65.32	4	320	89
Pb	29.12	23	19.93	8	105	89
Th	45.22	49	13.48	2	85	89
U	9.98	11	3.53	1	23	89
Zr	276.47	253	121.79	82	793	89
Nb	19.56	20	5.8	6	49	89
Y	41.79	41	11.19	14	94	89
La	85.12	75	46.55	6	241	89
Ce	156.28	144	77.91	16	434	89
Pr	16.94	16	7.95	2	47	89
Nd	64.66	61	27.99	7	185	89
Sc	9.04	7	8		40	89
V	32.67	15	61.82		442	89
Cr	48.42	25	91.93		626	89
Mn	582.83	492.5	400.21	25	1965	80
Co	8.57	5	10.15		51	80
Ni	13.6	8	20.67		124	89
Cu	10.66	3	21.07		118	89
Zn	87.81	75	66.02	3	412	89
Sn	2.72	2	2.11		10	89
W	-	-	-	-	-	-
Mo	2.01		5.9		55	89
Ga	18.13	18	3.04	12	31	89
As	4.03	3	4.11	1	35	89
S	145.32	d	357.86	d	2200	72
F	2600	2600	-	2600	2600	1
Cl	88	88	-	88	88	1
Be	3.11	3	1.03	1	6	87
Ag	1.86	2	0.75		4	89
Bi	1.06		0.35		4	89
Hf	8.21	8	2.32	3	17	82
Ta	1.39		0.84		4	82
Cs	7.9	7	6.17		29	43
Ge	2.89	3	0.8	1	4.5	81
Se	0.64		0.64		6	81

Edith River Volcanics

MEANS AND STANDARD DEVIATIONS

Element	Mean	Median	Standard Deviation	Minimum	Maximum	Number of Items
SiO2	64.88	68.14	10.38	43.47	80.3	24
TiO2	0.87	0.59	0.79	0.09	2.67	24
Al2O3	13.45	13.75	1.21	9.41	14.78	24
Fe2O3	3.01	2.49	2.14	0.68	9.84	24
FeO	3.5	2.6	3.12	0.04	9.25	24
MnO	0.09	0.08	0.07	0.01	0.22	24
MgO	1.38	1	1.31	0.01	5.12	24
CaO	2.57	1.4	3.06	0.03	12.18	24
Na2O	1.84	2.03	1.02	0.04	3.19	24
K2O	4.57	5.24	1.88	0.43	6.61	24
P2O5	0.28	0.16	0.31	0.01	0.99	24
H2O+	1.95	1.69	0.88	0.86	3.32	9
H2O-	0.11	0.1	0.04	0.05	0.18	9
CO2	1.25	0.23	2.36	0.05	7.77	10
LOI	3.19	2.35	2.18	1.09	7.86	15
Ba	1171.79	1323	570.96	21	2200	24
Li	18.67	16.5	12.73	5	53	18
Rb	156.21	182	76.64	13	276	24
Sr	154.08	119.5	115.46	6	373	24
Pb	30.5	14	57.2	5	289	24
Th	28.42	30	12.61	5	62	24
U	5.83	6.25	2.78	0.5	11	24
Zr	278.29	301	64.27	109	342	24
Nb	14.33	14	4.24	5	28	24
Y	45.75	45.5	13.06	25	84	24
La	70.33	70.5	36.42	4	212	24
Ce	135.58	137.5	48.06	43	309	24
Pr	14.47	14	6.84	6	39	17
Nd	58.22	55	23.55	22	155	23
Sc	14.48	11	9.52		32	24
V	54.96	28	55.36		192	24
Cr	15.61	10	26.25		117	23
Mn	22	22	-	22	22	1
Co	18.5	18.5	21.92	3	34	2
Ni	4.13	2.5	5.31		27	24
Cu	8.69	8	6.33		24	24
Zn	72.21	70	43.92	5	155	24
Sn	2.38	3	1.21		4	24
W	4	4	-	4	4	1
Mo	3.1	3	1.59		6	24
Ga	20.08	21	3.68	9	29	24
As	4.44	3	6.55	0.5	34	24
S	69	40	74.32	19	200	5
F	550	550	-	550	550	1
Cl	111.8	110	34.11	67	161	5
Be	2.25	2.5	1.11		4	18
Ag	1.73	1	0.97		3	13
Bi	1.05		0.22		2	21
Hf	11.5	11.5	3.54	9	14	2
Ta	1		-			1
Cs	2.77	3	1.49		6	13
Ge	0.5	0.5	-	0.5	0.5	1
Se	0.9		0.22			5