BWMining

# QUEST Project: Geoscience BC
# A Short Note on the Distribution of Geochemical Elements in Geological Formations of the QUEST Project Area

Colin T Barnett* Peter M Williams†

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## Introduction

In an earlier report on the QUEST Project stream and lake sediment geochemistry [1], we presented the idea of using a neural network to model the geochemistry in areas where the geology is known from outcrop mapping, and then to apply this model to infer the bedrock geology in non-outcropping areas. The resulting inferred geology, wherever geochemistry was known, was almost identical to mapped geology in areas of outcrop, and blended well with mapped geology along the margins, where there was no geochemistry. These results show that geochemistry combined with neural networks can provide a powerful tool for mapping bedrock geology concealed by a veneer of glacial overburden in the QUEST project area.

The results have been reviewed by geologists at the BC Geological Survey, and have generally been found to hold up well in the light of their surface mapping. In a few places, however, there were some obvious discrepancies, where the inferred bedrock geology conflicted with the known surface geology. One of these places, for example, was in the north-centre of the QUEST Project area, midway between Fort St James and Prince George (see Figure 4). In this place, the neural network appears to be confusing the presence of Triassic to Jurassic age Takla Group rocks with older Mississipian to Jurassic age Cache Creek rocks (see legend on Page 8).

To understand how the neural network is making its predictions, we therefore decided to examine the distributions of the 42 leveled elements for each of the 48 principal formations that outcrop in the QUEST Project area. The results are shown as a set of classical "box and whisker" plots, as explained in the next section.

*BW Mining, Boulder, Colorado, USA
†BW Mining, Brighton, Sussex, UK

## Box plots

The plots on Pages 13–36 give summary statistics of the distributions of 42 geochemical elements over each of the 48 principal formations. Consider, for example, the Endako Group shown on Page 14 and reproduced here in Figure 1. Each column comprises a vertical box

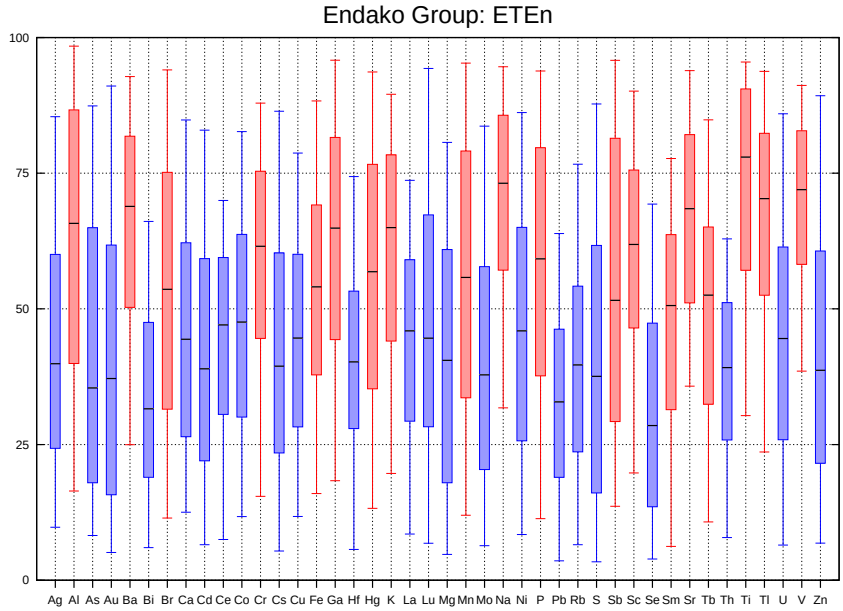



Figure 1: Plot showing the distributions of the various elements for the Endako Group.

and whisker plot of the distribution of the assays for a given element over the formation in question. The box consists of values lying between the lower and upper quartiles of the distribution. It is shaded red or blue depending on whether the median, indicated by a central divider within the box, lies above or below the median for that element over the region as a whole. The whiskers, marked below and above the box, extend from the 5th to the 95th percentiles which, in view of outliers, are more informative than minimum and maximum.

Assay values for the various elements typically occupy very different ranges. If each box and whisker diagram were plotted using the same units for all elements, it would be unclear which elements were elevated, and which depressed, relative to their background values. To solve this problem, the units for each vertical column have been transformed independently by applying the inverse cumulative distribution function of the regional population for the element in question. The resulting dimensionless numbers between 0 and 100, as percents, can then all be plotted on a common vertical scale for each element. In Figure 1, for example, the median value for Ti falls just above 75. This means that the median for Ti, within the Endako Group, lies in the upper quartile for Ti over the region as a whole, implying that Ti is significantly elevated for this formation.

The region used to determine the background distribution was the full geologic map of Figure 4, excluding the pale yellow areas representing the overburden. The relevant percentiles for this background distribution of the various elements are shown in Table 1. The rows of this table can be used, for the various elements, to translate ordinates such as 25, 50, 75 into actual abundances.

## Conclusions

Careful examination of these box and whisker plots reveals that the majority of the 48 geological formations have distinctive geochemical distributions. Since the neural network also takes account of the full multivariate statistics of the 42 elements, it should have little difficulty distinguishing most of these formations. However, a few of the plots are remarkably similar. Two of these happen to be the Nicola and Takla Groups, shown at the top of Page 19, and the Cache Creek Complex, shown at the bottom of Page 20, and reproduced here in Figure 2. It would not be surprising if the neural network had difficulty

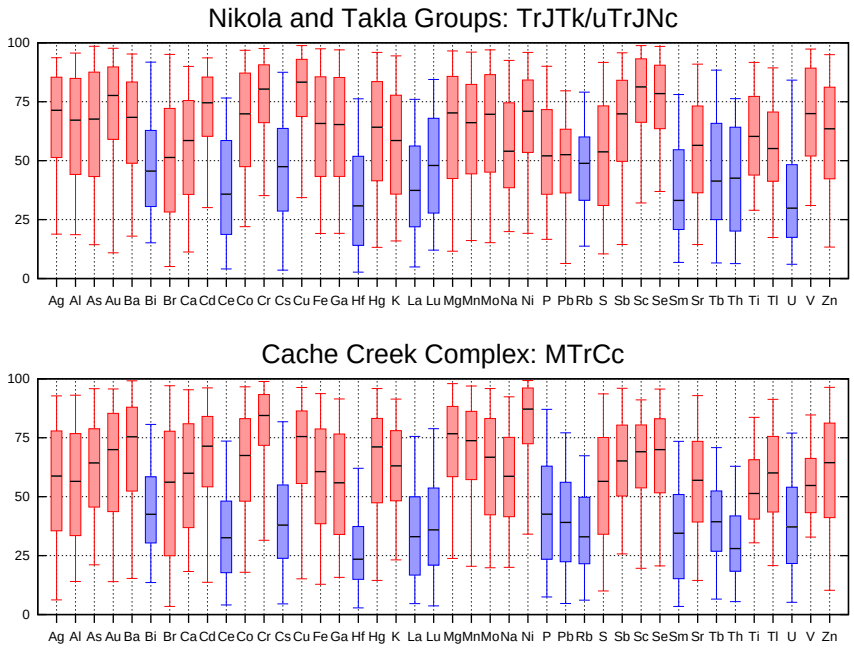



Figure 2: Comparison of the distributions of the various elements for the Nicola and Takla Groups and the Cache Creek Complex.

separating these formations. Geological knowledge and understanding may therefore be required to assess the inferred bedrock geology map in places where the neural network is predicting one or other of these two formations.

It is not the intention of this short note to analyze each of the 48 principal formations in the QUEST Project area in detail. The observant reader will, however, notice other groups

that have similar geochemistry. The late Cretaceous to early Jurassic Kootenay Group and Fernie Formation, for example, closely resemble the Triassic Spray River Group, as shown below in Figure 3. Despite the spread in ages, these different geological formations consist

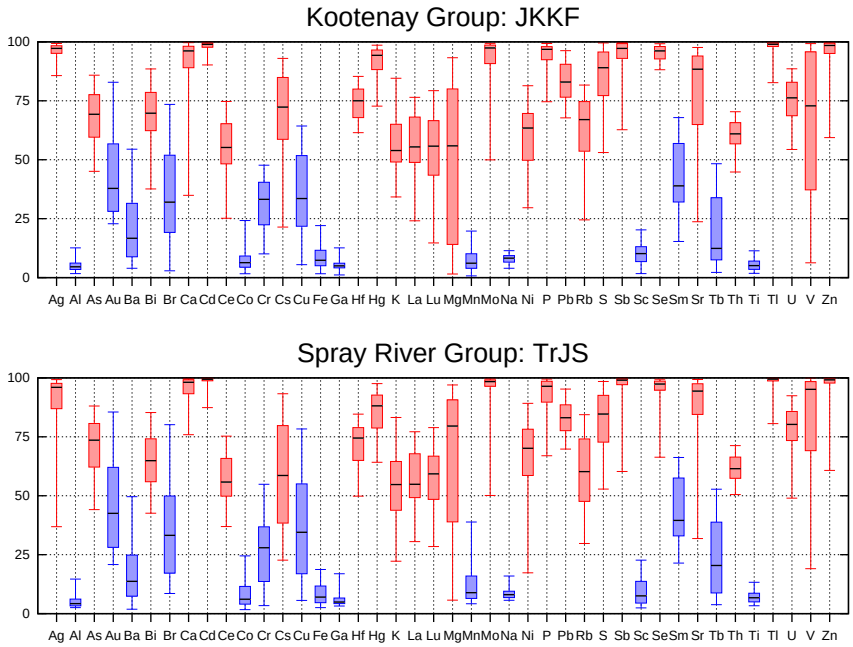



Figure 3: Comparison of the distributions of the various elements for the Kootenay Group and the Spray River Group.

of limestones, shales and sandstones, which were probably derived from the same, older source rocks and deposited under much the same sedimentary conditions.

## Acknowledgements

The authors would like to acknowledge the expertise and assistance provided by Wayne Jackaman of Noble Exploration Services Ltd, firstly in assembling the geochemical samples and secondly in advising on the selection of elements used in this study. They would also like to thank Stephen Williams, private GIS contractor, for compiling the surface geological map of the QUEST Project area. Both are members of the Geoscience BC Project Team.

## References

[1] Barnett, C. T. and Williams, P. M., 2009: Using geochemistry and neural networks to map geology under glacial cover. Final Report for Geoscience Project 2008-003. Geoscience BC Report 2009-003.

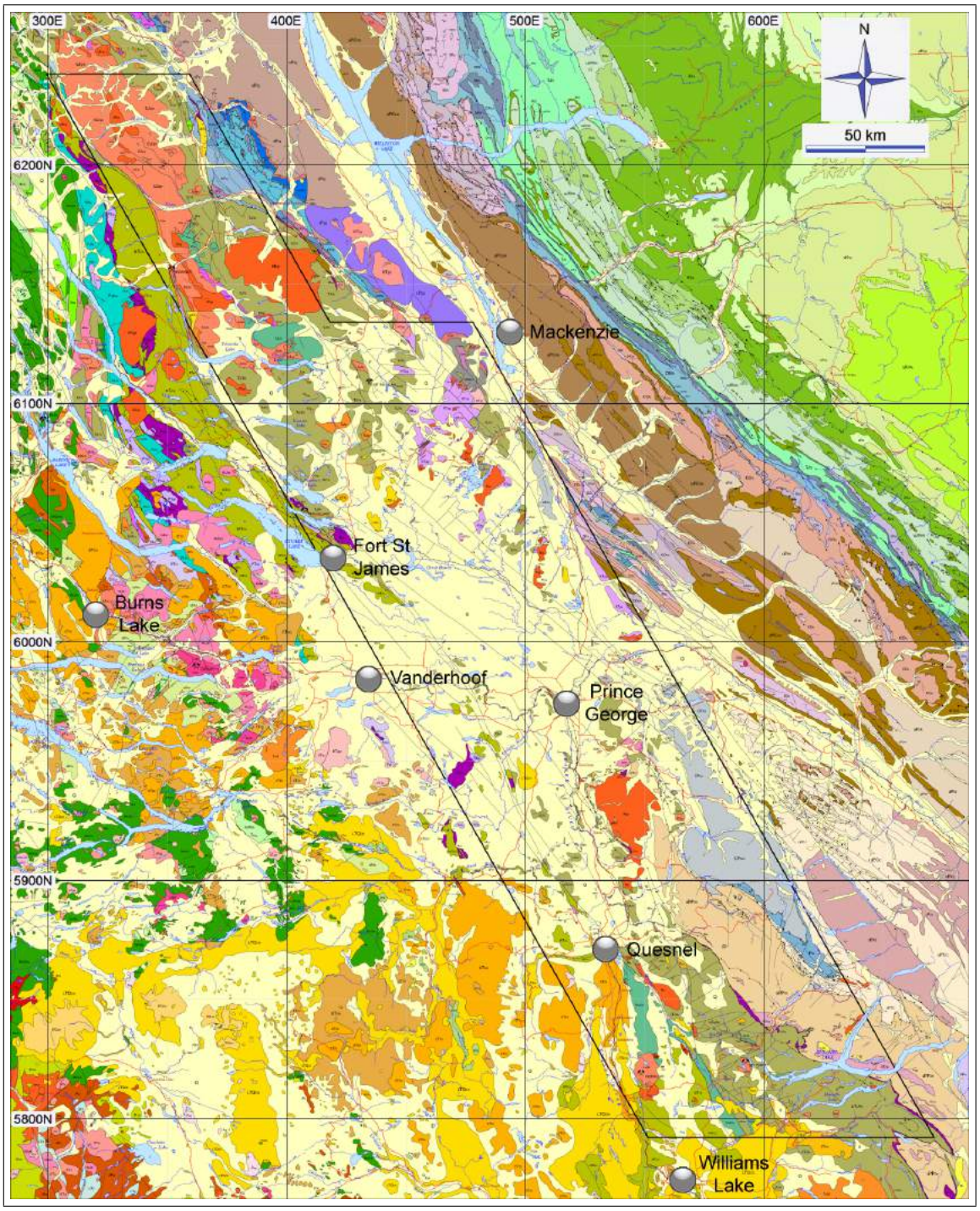



Figure 4: Surficial geological map of the QUEST project area, showing a few of the towns. The pale yellow areas represent the Quaternary overburden. The outline of the airborne gravity and electromagnetic surveys is marked in black. The map projection is UTM Zone 10 in NAD83.

## SEDIMENTARY AND VOLCANIC ROCKS

### CENOZOIC

Neogene to Quaternary

| | |
|---|---|
| Q | *Quaternary cover: Alluvium, glaciofluvial gravels and sand, till. (Note: the extensive Quaternary deposits of the Rocky Mountain foothills and the Peace River area have been omitted.)* |
| Qv | *Quaternary volcanics including Blue Lake Volcanics, Lambly Creek Basalt, Lake Island and Big Raven Formations: Basalt, olivine basalt, unconsolidated ash, scoria, agglomerate and breccia.* |
| LTQAn | *Anahim Volcanics, Bella Bella Formation and equivalents: Basalt, andesite, trachyte and rhyolite flows; andesite and dacite breccia, tuff, minor greywacke, slate and conglomerate.* |
| LTQCh | *Chilcotin Group: Vesicular, columnar jointed basalt, olivine basalt; minor andesite, rhyolite breccia, obsidian, tuff, breccia, conglomerate, sandstone, siltstone, shale and diatomite.* |

Oligocene to Pliocene

| | |
|---|---|
| OPFr | *Poorly consolidated Tertiary sediments (includes the Fraser Bend and Australian Creek Formations): Poorly consolidated to unconsolidated conglomerate, sandstone and mudstone; minor diatomite, lignite, basalt.* |

Paleogene

| | |
|---|---|
| ETs | *Paleogene sediments including Chuckanut, Kitsilano, Slatechuck, Tanzilla Canyon, Kishehn and Sophie Mountain Formations: Conglomerate, sandstone, siltstone, shale, marl, minor coal; minor tuffs and tuffaceous siltstone; basalt.* |
| ETKm | *Kamloops Group: Sandstone, conglomerate, shale, argillite, coal; basalt, andesite, dacite, trachyte, rhyolite, related tuffs and breccias.* |
| ETEn | *Endako Group: Andesite, basalt, minor dacite; flows, breccia and tuff, vesicular, amygdaloidal, locally hyaloclastic, minor picritic basalt and rhyolite; conglomerate, sandstone, shale, lignite.* |
| ETOo | *Ootsa Lake Group (including Newman Formation) and unnamed equivalents: Rhyolite, dacite, trachyte flows; related tuff and breccia; andesite and basalt; minor conglomerate, grit, greywacke and tuffaceous shale.* |

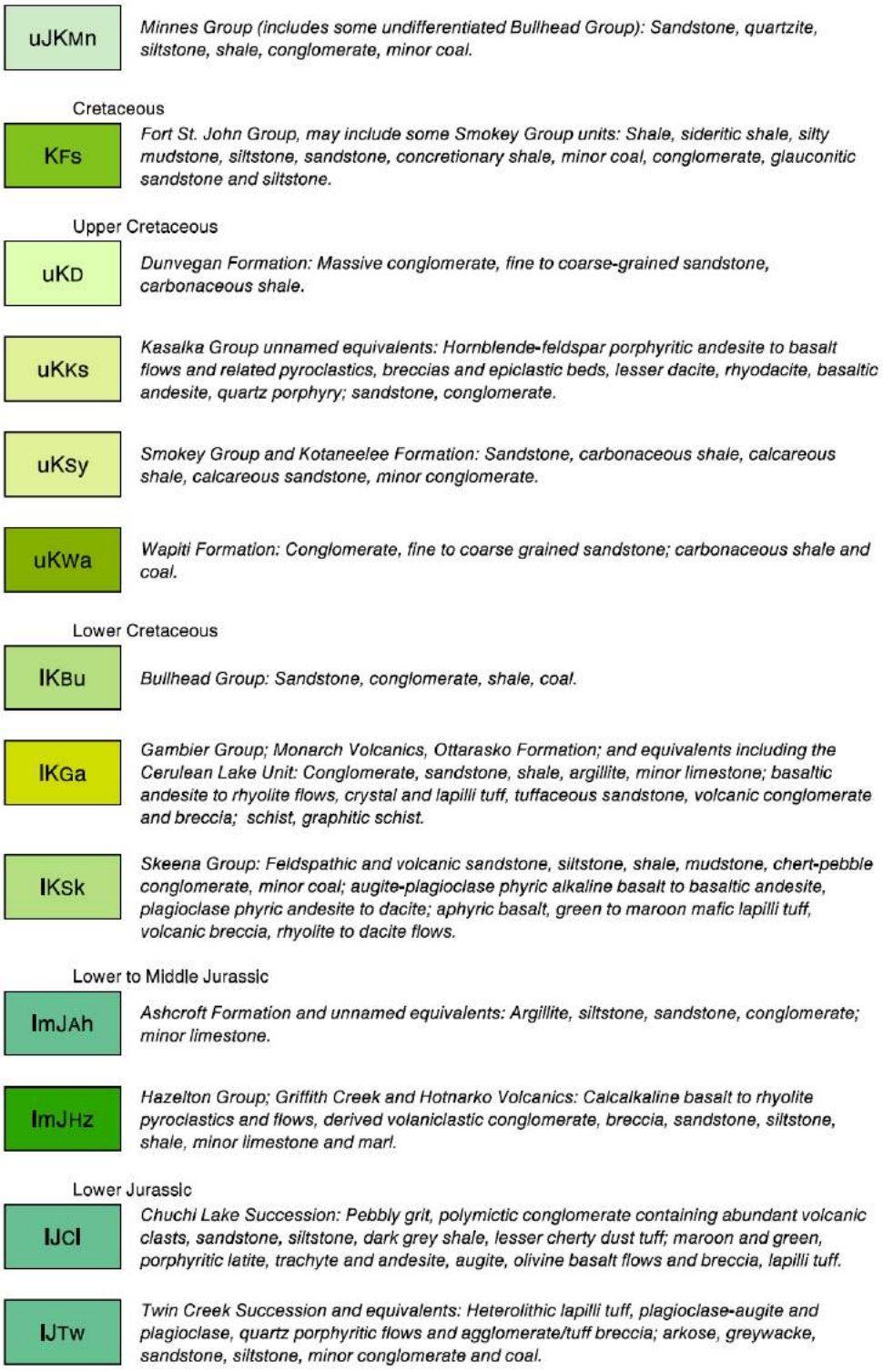
### MESOZOIC

Cretaceous to Tertiary

| | |
|---|---|
| uKTS | *Sifton and Usilika Formations. Bowron River Coal Beds and Reynolds Creek Succession: Pebble to boulder conglomerate, sandstone, siltstone, shale, minor coal.* |
| KSu | *Sustut Group and unnamed equivalents: Sandstone, siltstone, mudstone, chert and quartz-pebble conglomerate, felsic ash-tuff, minor coal.* |

Jurassic to Cretaceous

| | |
|---|---|
| JKKF | *Kootenay Group and Fernie Formation: Shale, sandstone; limestone, phosphatic and sideritic shales.* |
| mJKBo | *Bowser Lake Group: Heterolithic conglomerate, sandstone, siltstone, mudstone, shale, feldspathic wacke, minor coal; minor basalt and andesite flows, breccia and tuff, dacitic lava flows, lapilli tuff.* |


uJKMn
Minnes Group (includes some undifferentiated Bullhead Group): Sandstone, quartzite, siltstone, shale, conglomerate, minor coal.
Cretaceous
KFs
Fort St. John Group, may include some Smokey Group units: Shale, sideritic shale, silty mudstone, siltstone, sandstone, concretionary shale, minor coal, conglomerate, glauconitic sandstone and siltstone.
Upper Cretaceous
uKD
Dunvegan Formation: Massive conglomerate, fine to coarse-grained sandstone, carbonaceous shale.
uKKs
Kasalka Group unnamed equivalents: Hornblende-feldspar porphyritic andesite to basalt flows and related pyroclastics, breccias and epiclastic beds, lesser dacite, rhyodacite, basaltic andesite, quartz porphyry; sandstone, conglomerate.
uKSy
Smokey Group and Kotaneelee Formation: Sandstone, carbonaceous shale, calcareous shale, calcareous sandstone, minor conglomerate.
uKWa
Wapiti Formation: Conglomerate, fine to coarse grained sandstone; carbonaceous shale and coal.
Lower Cretaceous
lKBu
Bullhead Group: Sandstone, conglomerate, shale, coal.
lKGa
Gambier Group; Monarch Volcanics, Ottarasko Formation; and equivalents including the Cerulean Lake Unit: Conglomerate, sandstone, shale, argillite, minor limestone; basaltic andesite to rhyolite flows, crystal and lapilli tuff, tuffaceous sandstone, volcanic conglomerate and breccia; schist, graphitic schist.
lKSk
Skeena Group: Feldspathic and volcanic sandstone, siltstone, shale, mudstone, chert-pebble conglomerate, minor coal; augite-plagioclase phyric alkaline basalt to basaltic andesite, plagioclase phyric andesite to dacite; aphyric basalt, green to maroon mafic lapilli tuff, volcanic breccia, rhyolite to dacite flows.
Lower to Middle Jurassic
lmJAh
Ashcroft Formation and unnamed equivalents: Argillite, siltstone, sandstone, conglomerate; minor limestone.
lmJHz
Hazelton Group; Griffith Creek and Hotnarko Volcanics: Calcalkaline basalt to rhyolite pyroclastics and flows, derived volaniclastic conglomerate, breccia, sandstone, siltstone, shale, minor limestone and marl.
Lower Jurassic
lJCl
Chuchi Lake Succession: Pebbly grit, polymictic conglomerate containing abundant volcanic clasts, sandstone, siltstone, dark grey shale, lesser cherty dust tuff; maroon and green, porphyritic latite, trachyte and andesite, augite, olivine basalt flows and breccia, lapilli tuff.
lJTw
Twin Creek Succession and equivalents: Heterolithic lapilli tuff, plagioclase-augite and plagioclase, quartz porphyritic flows and agglomerate/tuff breccia; arkose, greywacke, sandstone, siltstone, minor conglomerate and coal.

Triassic to Jurassic

uTJNc — *Nicola Group: Undifferentiated mafic to felsic flows and volcaniclastic rocks, including augite-phyric flows, tuffs and breccias; feldspathic sandstone and siltstone, argillite, shale, polymict conglomerate; minor limestone and calcareous siltstone.*

TJTK — *Takla Group (may include deformed Asitka Group); Tezzaron Sequence; and unnamed equivalents: Augite-phyric and aphyric basalt breccia, agglomerate, tuff, pillowed and massive flows; mafic to felsic tuff, ash tuff, lapilli tuff, breccia and conglomerate; tuffaceous argillite and siltite, greywacke, conglomerate, sandstone, siltstone and chert; phyllite, phyllitic schist; limestone, minor skarn.*

Triassic

TJS — *Spray River Group; Halfway, Liard, Charlie Lake, Baldonnel, Pardonet, Ludington, Toad and Grayling Formations; unnamed equivalents: Limestone, dolomite, carbonaceous - argillaceous limestone, calcareous and dolomitic siltstone, calcareous sandstone; shale, sandstone, orthoquartzite and minor gypsum.*

Upper Triassic

uTS — *Stuhini Group; Mosley and Mount Moore Formations; and unnamed equivalents; Mafic to intermediate lapilli tuff, ash, breccia and tuffite; massive aphyric to plagioclase and augite-phyric flows and sills; felsic tuff; tuffaceous siltstone, wacke, argillite, polymict conglomerate, limestone, shale; graphitic shale, rare black chert, ribbon chert.*

PALEOZOIC TO MESOZOIC

Permian to Jurassic

PJKu — *Kutcho Formation, Sitlika Assemblage and possible equivalents: Basaltic to rhyolitic schist, greenstone, pillowed metabasalt, heterolithic breccia; slate, phyllite; banded siltstone, sandstone and conglomerate; minor limestone, marble, chert and green chloritic phyllite.*

Mississippian to Jurassic

MTCc — *Cache Creek Complex and equivalents: Greenstone, amphibolite, mafic pillow lavas, volcanic breccia, agglomerate, tuff, rare felsic flows and tuff; phyllite, siliceous phyllite, metachert, ribbon chert, chlorite schist, sandstone; micritic to clastic limestone, argillite, marble, dolomite; minor serpentinite and mafic intrusions.*

PALEOZOIC

PBl — *Black Stuart Group: Chert, limestone, dolostone and derived conglomerate and breccia; black shale and argillite, cherty argillite, quartzite, siltite and slate; some pillow basalt, schistose calcareous basaltic tuff and volcaniclastics.*

Devonian to Permian

DPAs — *Asitka Group: Massive, grey, bioclastic limestone; argillaceous, thin bedded, recrystallized limestone with chert nodules; slate, slaty siltstone and chert; sericite and chlorite phyllite and schist; metagabbro, basalt, rhyolite, tuff; minor serpentinite and listwanite.*

DPBc — *Big Creek Group: Basalt breccia, tuff and pillows; dacitic and rhyolite tuff; shale, argillite, slate, calcareous argillite, limestone, tuffaceous argillite, sandstone, wacke.*

CPSm — *Slide Mountain Complex and Antler Formation: Massive and pillowed basalt, breccia, tuff, diabase, minor diorite, gabbro and serpentinite; chert, argillite, lithic sandstone, limestone, dacitic tuff and agglomerate, black argillite, quartz-chert sandstone, variocoloured chert, rhodonite, calcarenite, phyllite, chlorite schist.*

Carboniferous to Permian

CPNl — *Nina Creek Group: Cherty argillite, chert, argillite, massive and pillowed basalt, volcanic breccia, gabbro, siltstone, wacke, dacite.*

CPSd — *Stoddart Group, Fantasque and Kindle Formations: Limestone, dolomite, conglomerate, bedded chert, quartz sandstone, calcareous sandstone, siltstone, shale, locally phosphatic; dark grey chert.*

CPLy — *Lay Range Assemblage, Evans Creek Limestone: Massive and pillowed basalt, chert, fine to medium-grained gabbro and rare serpentinite; crystal and lapilli tuff, siliceous tuff, volcanic sandstone, minor agglomerate, siltstone, siliceous argillite, limestone, quartz sandstone, minor conglomerate.*

Devonian to Mississippian

OMEa — *Earn Group: Argillite, slate, shale, locally carbonaceous and pyritic; chert, cherty mudstone; chert arenite and pebble conglomerate, polymictic conglomerate; limestone; nodular and bedded barite +/- sulphides.*

DMB — *Besa River Formation: Black, siliceous shale, calcareous siltstone, minor dolomite, limestone, sandstone and pebble conglomerate, barite.*

DMBe — *Banff and Exshaw Formations: Carbonate, black shale, brown calcareous shale.*

Mississippian

MRu — *Rundle Group; Prophet and Flett Formations; unnamed equivalents: Dolomite, limestone, crinoidal and skeletal limestone, cherty limestone, calcareous mudstone, spiculite, chert, argillite, siltstone, rare amygdaloidal basalt.*

Cambrian to Devonian

ЄDER — *Razorback and Echo Lake Groups: Thinly layered and interbedded argillaceous limestone and dolomite, shale and slate; dolomite, sandy dolomite, sandstone to quartizite, massive to poorly bedded limestone and dolomite; equivalent to the Kechika and Road River Groups and the Tapioca Sandstone of the Sandpile Group.*

Ordovician to Devonian

ODRo — *Road River Group (may include some undifferentiated Earn Group): Shale, slate, siltstone, chert, minor coarse clastics, limestone, dolomite, rare tuffs.*

Silurian to Devonian

SDs — *Silurian to Devonian strata of the Rockies including Cedared, Burnais, Harrogate, Mount Forster, Muncho-McConnell, Wokkpash, Stone, Dunedin, Nonda, Pine Point Formations and Tapioca Sandstone: Dolomite, limestone, silty limestone and dolostone, sandstone, quartzite, argillite, shale, siltstone, chert, greenstone, minor gypsum.*

Devonian

DFa — *Fairholme Group, Flume, Mount Hawk, Palliser, Pendrix Formations and unnamed equivalents: Argillaceous limestone, nodular limestone, calcareous shale, dolomite; shale, siltstone, orthoquartzite.*

Cambrian to Ordovician

ЄOKe — *Kechika Group; may include some undifferentiated Road River Group, Skoki Formation or Gog Group: Limestone, argillaceous limestone, pale calcareous slate, phyllitic limestone, calcareous phyllite, pyritic and carbonaceous slate and shale; minor conglomerate, sandstone, greenstone and green tuff.*

ЄOOs — *Cambrian to Ordovician strata of the Rockies: includes McKay Group, Monkman Quartzite, Active, Chushina, Mount Wilson, Skoki, Tipperary, Glenogle, Survey Peak, Beaverfoot, Arctomys, Waterfowl, Cathedral, Tanglefoot, Elko, Gordon, Chancellor, Eldon, Flathead, Gull Lake, Jubilee, Lyell, Sullivan, Lynx, Mistaya, Bison Creek, Nelway, Ottertail, Pika, Snake, Indian, Stephen, Mount White and Tsar Creek Formations, Kinbasket unit and several unnamed units: Limestone, dolomite, shale, calcareous shale, slate, sandstone, red beds, quartzite, minor conglomerate and chert.*

Cambrian

| | |
|---|---|
| €At | *Atan Group: Orthoquartzite, siltstone, shale, sandstone; limestone; minor dolostone, phyllite and conglomerate.* |

PROTEROZOIC TO PALEOZOIC

| | |
|---|---|
| uPPSn | *Snowshoe Group: Micaceous quartzite, quartzite, phyllite, slate and schist; lesser siltite, limestone and limestone or quartzite-clast conglomerate; minor amphibolite, metatuff, marble and diabase.* |

Upper Proterozoic to Cambrian

| | |
|---|---|
| uP€Ms | *Misinchinka Group (may include some undifferentiated Miette Group): Phyllite, siltite, slate, diamictite, quartzite, feldspathic quartzite, minor iron formation; limestone, dolomite, sandy limestone and dolomite, minor argillite; quartz chlorite schist, chloritic phyllite, garnet-mica schist, calcareous sericite schist, amphibolite.* |
| uP€c | *Cariboo Group: Shale, siltstone, limestone, argillite, phyllite, schist, quartzite; minor feldspathic sandstone and conglomerate.* |
| uP€Go | *Gog and Boulder Creek Groups; Badshot (may include some undifferentiated Index Formation), Hota, Mohican, Marsh Adams and Mount Garnier Formations, and unnamed equivalents: Limestone, siltstone, dolomite; quartzite, pebble conglomerate; alkalic to calc-alkalic basalt, andesite and dacite; mica schist, marble amphibolite.* |

PROTEROZOIC

Upper Proterozoic

| | |
|---|---|
| uPIg | *Ingenika Group: Quartzite, micaceous quartzite, pebble conglomerate, limestone, dolomite, oolitic and pisolitic limestone, shale, sandstone, wacke, sandy limestone, phyllite, schist, gneiss, chlorite-muscovite schist, slate, argillite, micaceous crystalline limestone, marble, calcsilicate rock, amphibolite.* |
| uPKz | *Kaza Group: Phyllite, greywacke, grit, argillite, schist and micaceous feldspathic quartzite; minor pebble conglomerate, amphibolite, limestone and marble.* |
| uPMi | *Miette Group: Grit, conglomerate, quartzite; phyllite, argillite, slate, pelitic schist, metasandstone; dolomite, marble and minor calcsilicate rock.* |

INTRUSIVE ROCKS

CENOZOIC

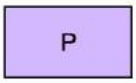
| | |
|---|---|
| LT | *Late Tertiary: granite (gr).* |
| ET | *Early Tertiary: monzodiorite (dg), gabbro (gb), granodiorite (gd), granite (gr), quartz diorite (qd), quartz monzonite (qm), quartz porphyry (qp), feldspar porphyry (fp), migmatite (mi) and undifferentiated intrusive rocks (g).* |

MESOZOIC

| | |
|---|---|
| KT | *Cretaceous to Tertiary: diorite (dr), granodiorite (gd), granite (gr), syenite (sy), feldspar porphyry (fp), pegmatite (pe) and undifferentiated intrusive rocks (g).* |
| LK | *Late Cretaceous: diorite (dr), granodiorite (gd), granite (gr), quartz monzonite (qm), quartz porphyry (qp), tonalite (to) and feldspar porphyry (fp).* |

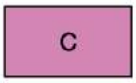

mK
Middle Cretaceous: monzodiorite (dg), gabbro (gb), granodiorite (gd) and granite (gr).
EK
Early Cretaceous: diorite (dr), monzodiorite (dg), granodiorite (gd), granite (gr), quartz diorite (qd) and quartz monzonite (qm).
K
Cretaceous: granite (gr), pegmatite (pe), orthogneiss (og), migmatite (mi) and undifferentiated intrusive rocks (g).
JK
Jurassic to Cretaceous: granite (gr), quartz monzonite (qm), tonalite (to), quartz porphyry (qp), orthogneiss (og) and undifferentiated intrusive rocks (g).
J
Jurassic: granodiorite (gd).
LJ
Late Jurassic: diorite (dr), granodiorite (gd), granite (gr), quartz diorite (qd) and quartz monzonite (qm).
MJ
Middle Jurassic: Diorite (dr), granodiorite (gd), granite (gr), quartz diorite (qd), quartz monzonite (qm), syenite (sy), feldspar porphyry (fp) and undifferentiated intrusive rocks (g).
MLJ
Middle to Late Jurassic: diorite (dr), gabbro (gb), granodiorite (gd), granite (gr) and quartz diorite (qd).
EMJ
Early to Middle Jurassic: diorite (dr), granodiorite (gd) and diabase (db).
EJ
Early Jurassic: diorite (dr), monzodiorite (dg), gabbro (gb), granodiorite (gd), quartz diorite (qd), quartz monzonite (qm), syenite (sy).
ŦJ
Triassic to Jurassic: diorite (dr), gabbro (gb), granodiorite (gd), quartz monzonite (qm), syenite (sy) and feldspar porphyry (fp)
Ŧ
Triassic: diorite (dr), gabbro (gb) and granodiorite (gd).
Mesozoic: ultramafics (um) and serpentinites (us); Ŧum, Ŧus, ŦJum, ŦJus and ƐJum.
PALEOZOIC
PJ
Permian to Jurassic: tonalite (to) and orthogneiss (og).


*Permian to Triassic: diorite (dr), gabbro (gb), tonalite (to) and diabase (db).*




*Permian: gabbro (gb).*


*Carboniferous to Permian: diorite (dr) and gabbro (gb).*




*Carboniferous: diorite (dr).*


*Mississippian: diorite (dr) and syenite (sy).*


*Devonian to Carboniferous: orthogneiss (og).*


*Devonian: Syenite (sy).*

*Paleozoic: Syenite (sy);* Ssy.

*Paleozoic: ultramafics (um) and serpentinites (us);* CPum, CPus, CTrum, CTus, Cus, DTum and Pum.

AGE UNKNOWN

*Age unknown or poorly constrained: granite (gr) and orthogneiss (og).*

METAMORPHIC ROCKS

MESOZOIC

*Mesozoic (includes* KT*): greenschist to mid-amphibolite facies rocks (gs), calcsilicates (mc) and paragneiss (pg);* Jgs, KTmc and KTpg.

PALEOZOIC

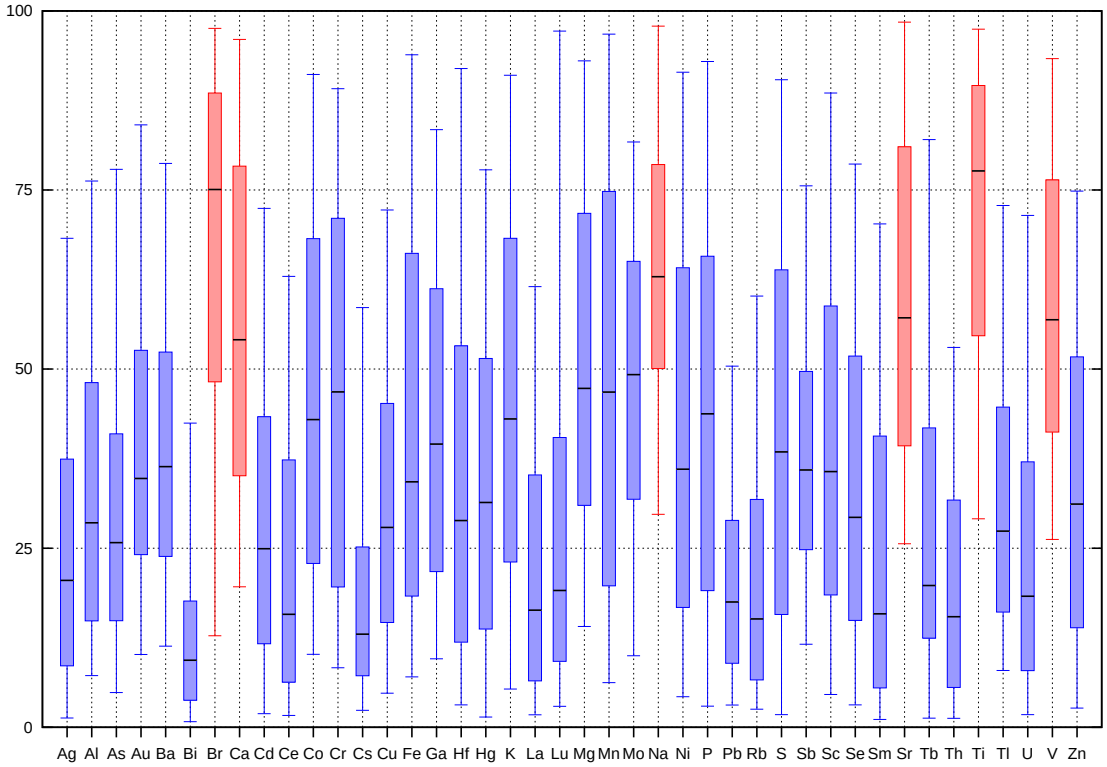
*Paleozoic (includes* PJ*): greenschist to lower-amphibolite facies rocks (ml) and undifferentiated metamorphic rocks (m);* DTrml, PJml and PPm.

PROTEROZOIC

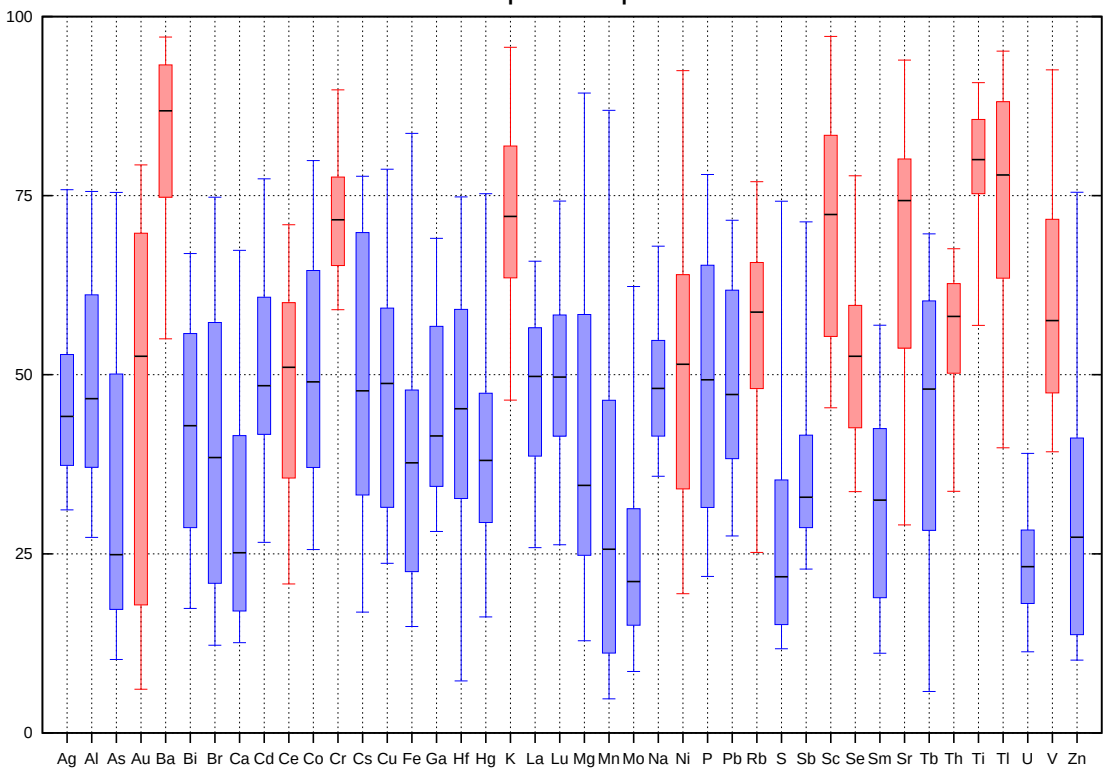
*Proterozoic: Paragneiss (pg);* LPpg.

BWMining

Chilcotin Group: LTQCh




Kamloops Group: ETKm



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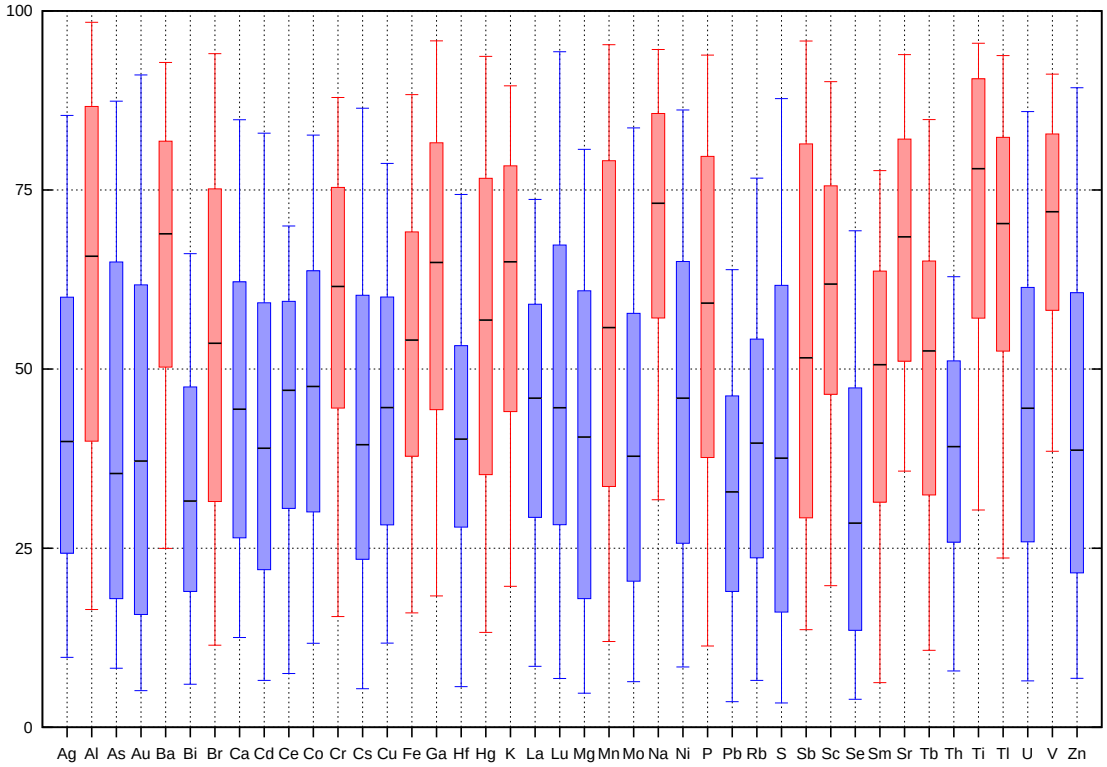
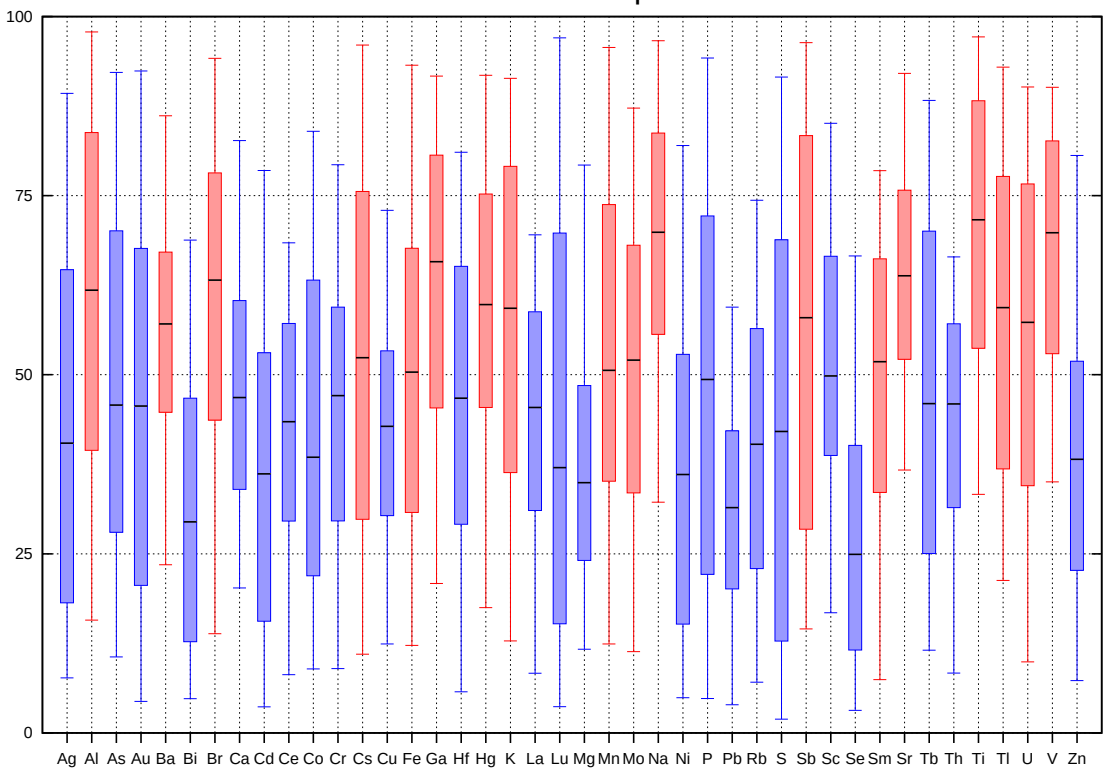
Endako Group: ETEn




Ootsa Lake Group: ETOo



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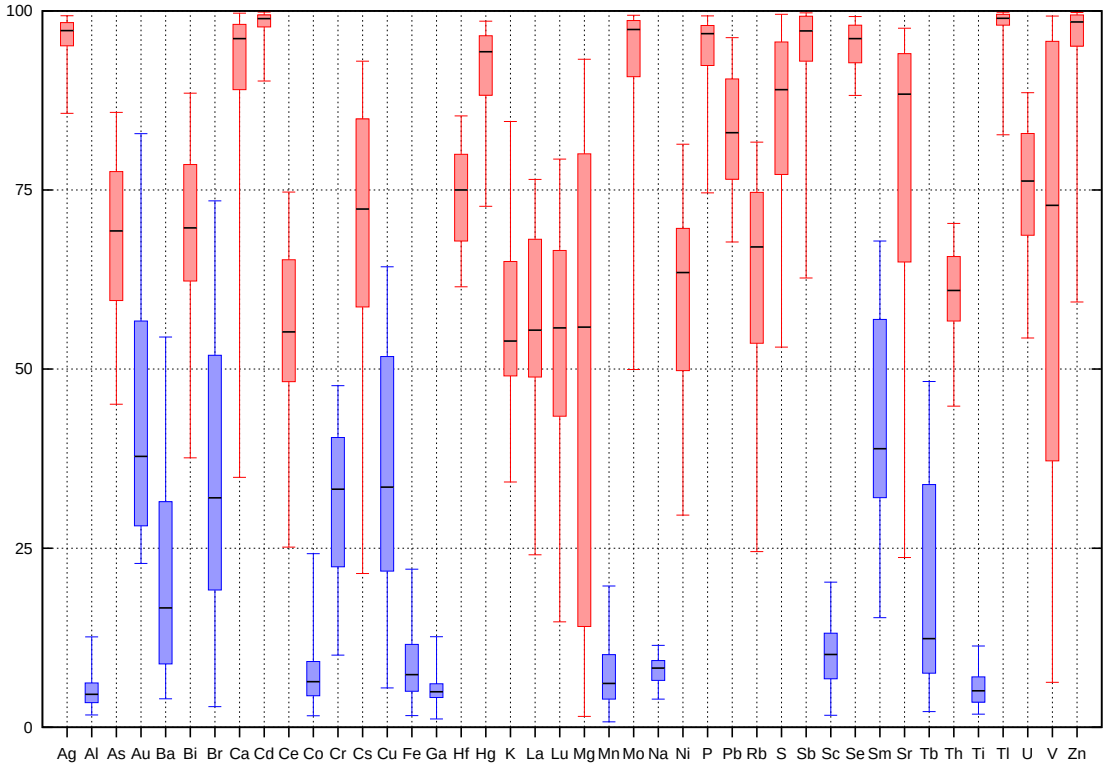
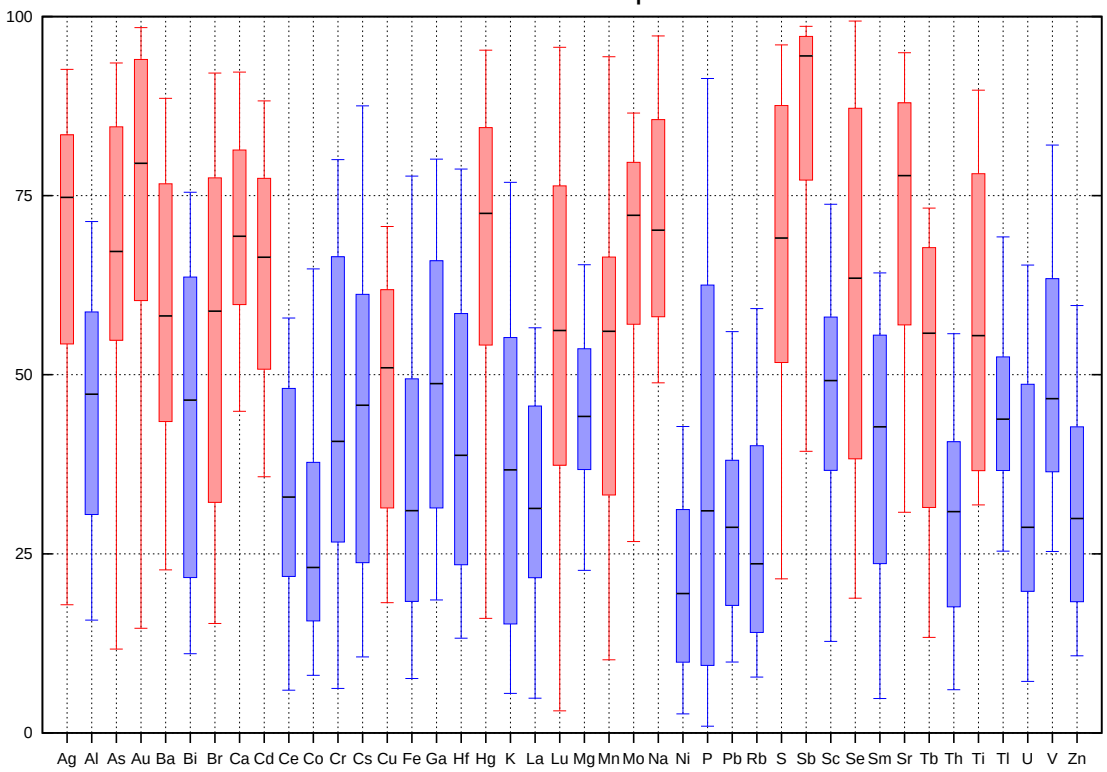
Kootenay Group: JKKF




Bowser Lake Group: mJKBo

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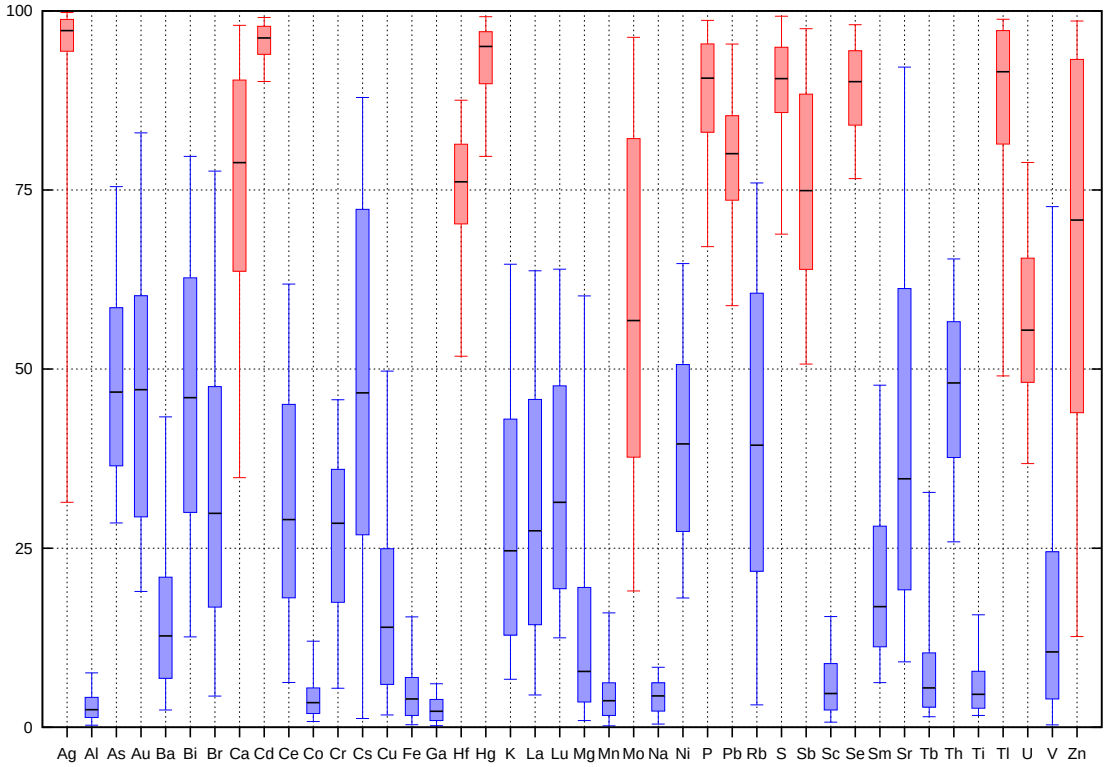
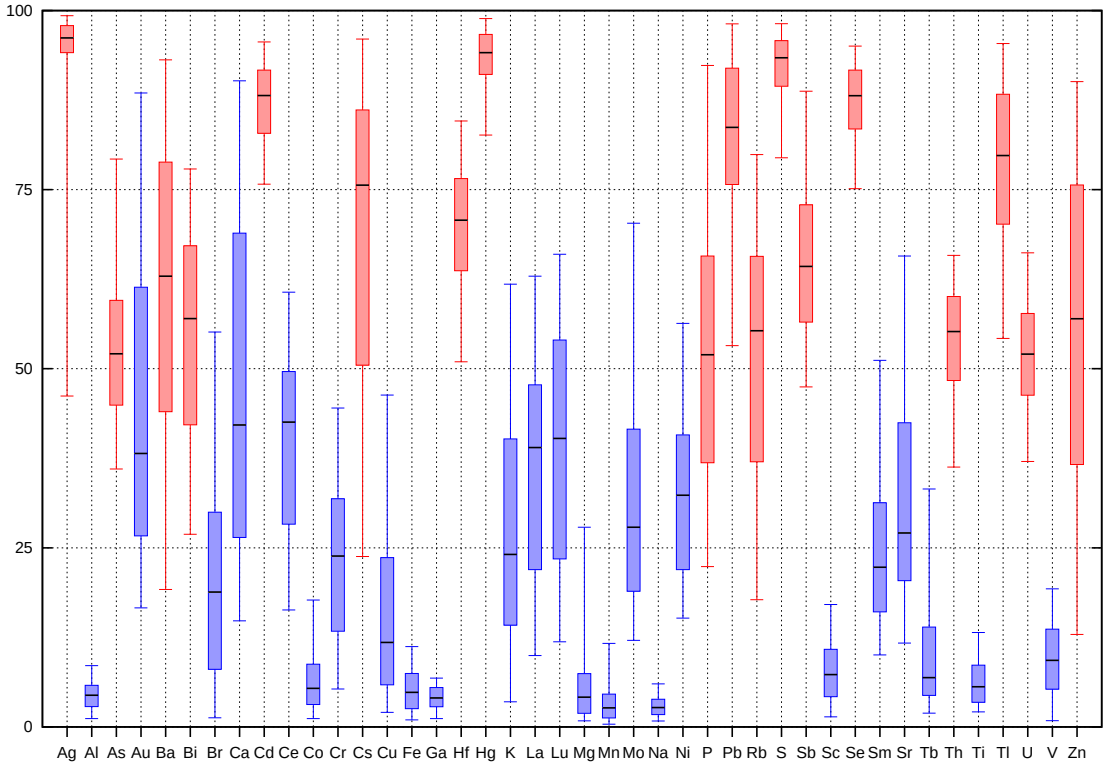
Minnes Group: uJKMn




Fort St John Group: KFs



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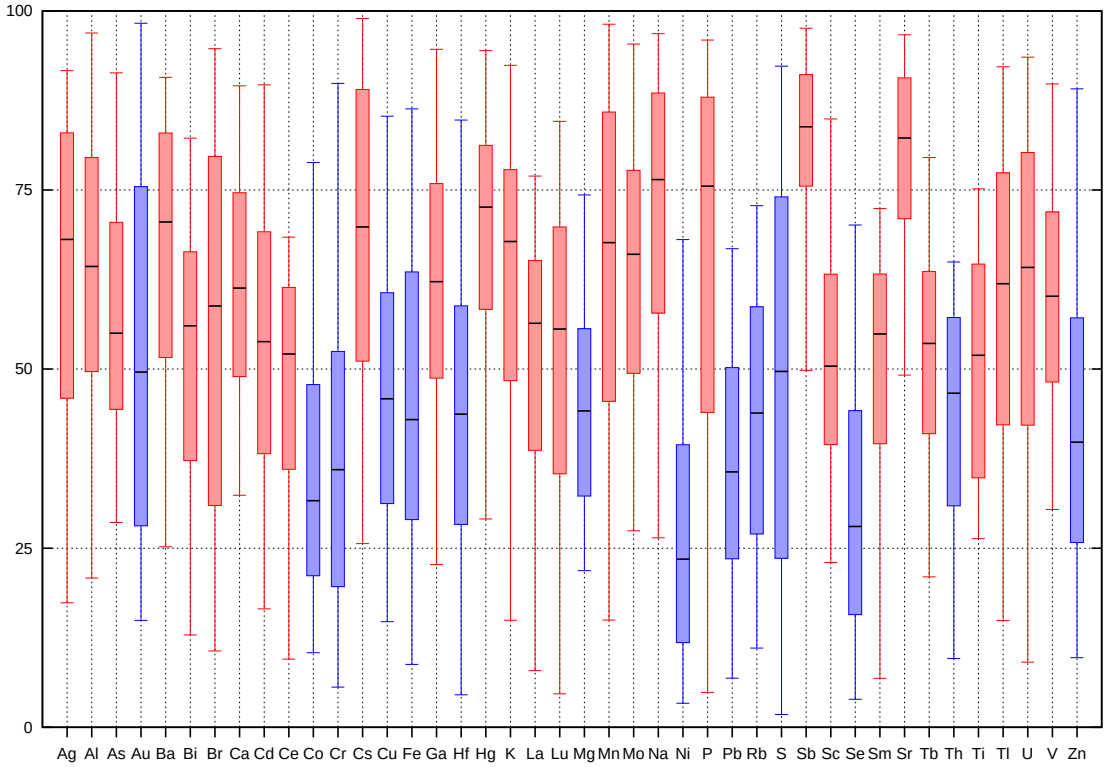
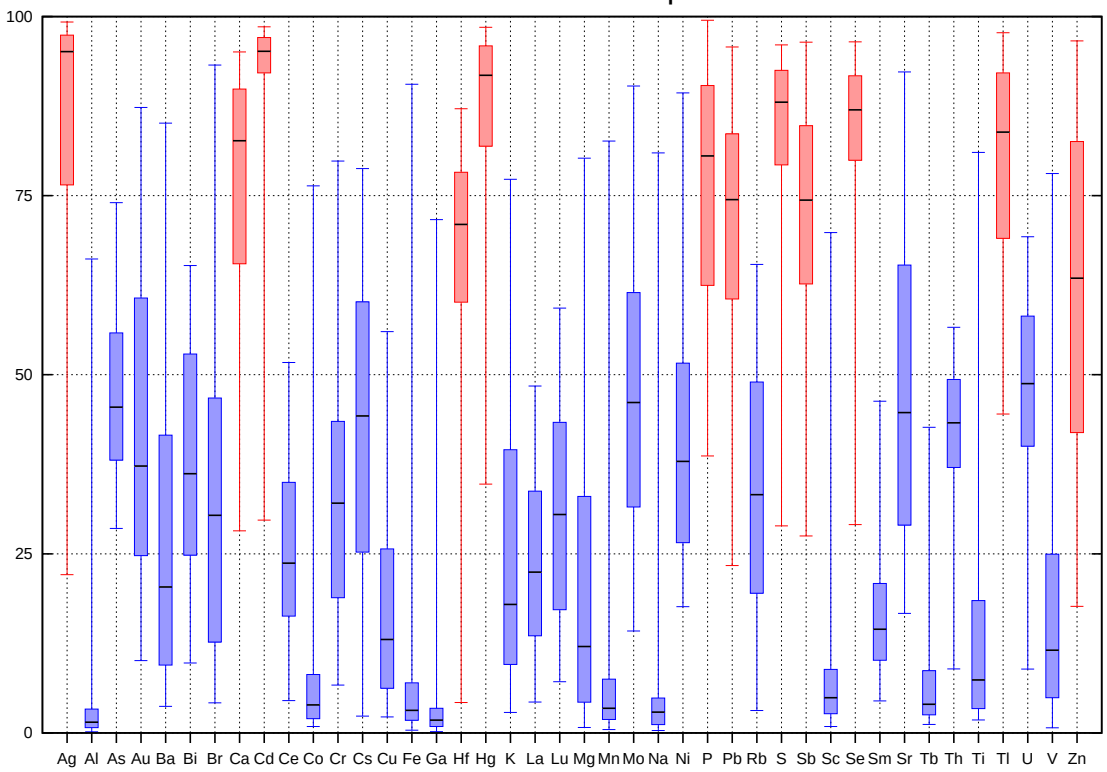
Kasalka and Smokey Groups: uKKs/uKSy




Bullhead and Skeena Groups: lKBu/lKSk

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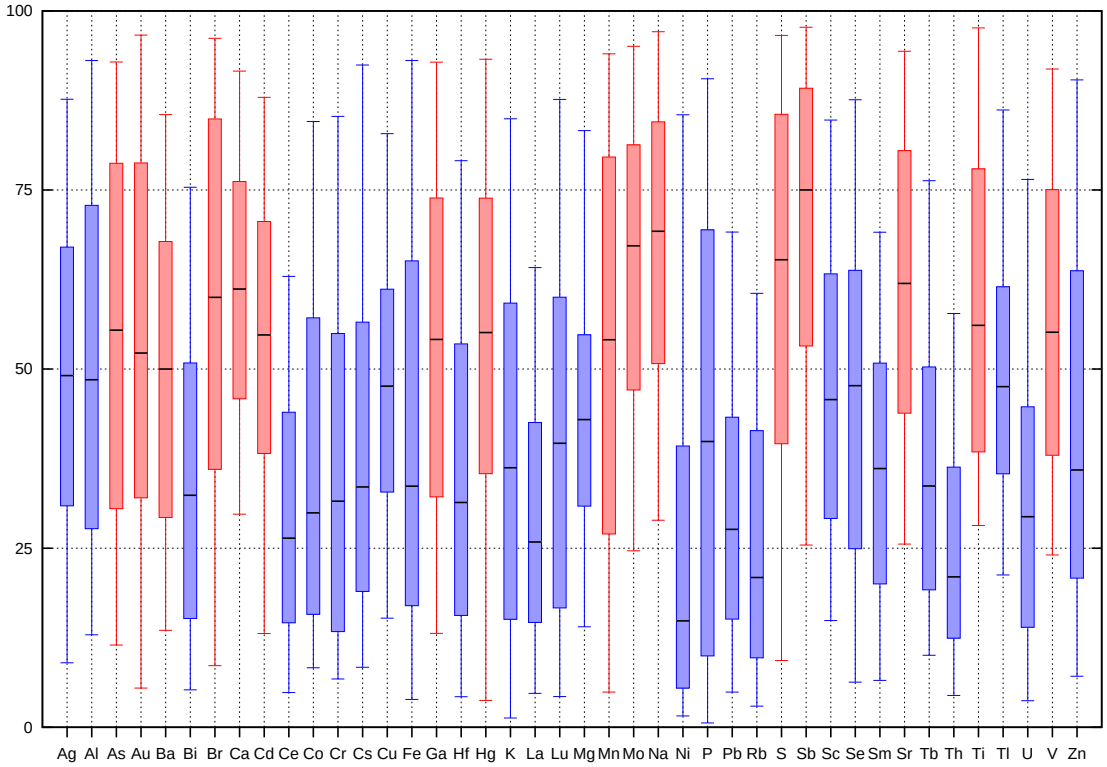
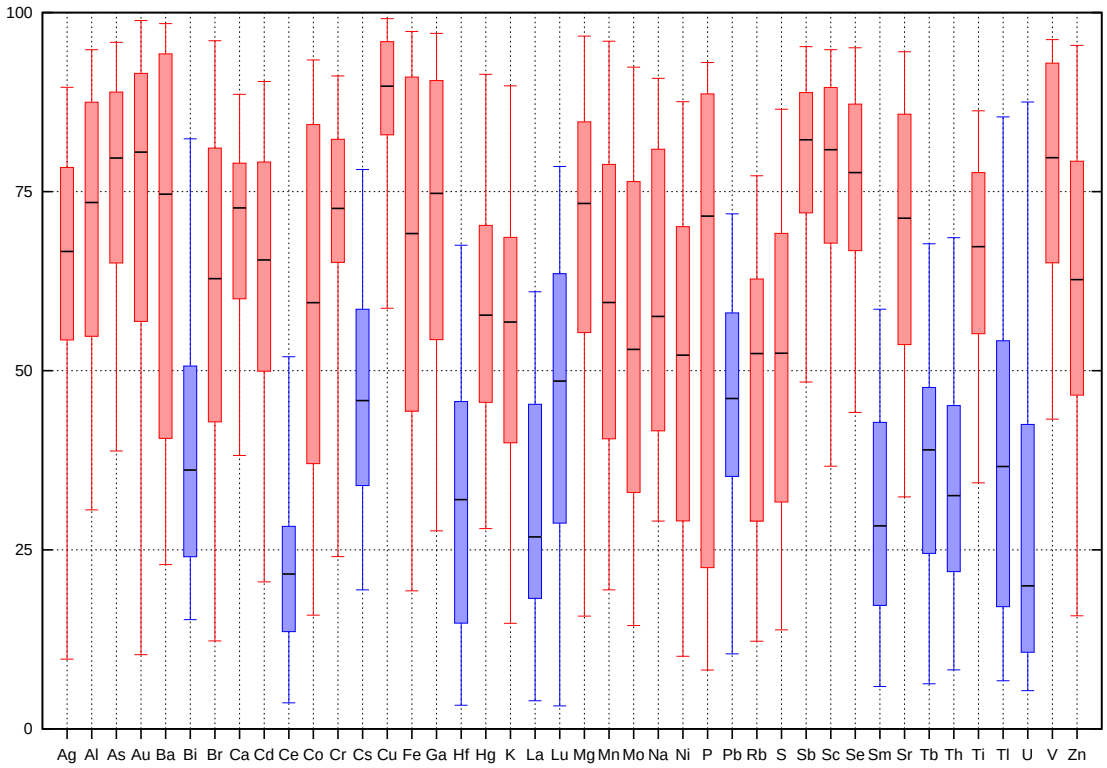
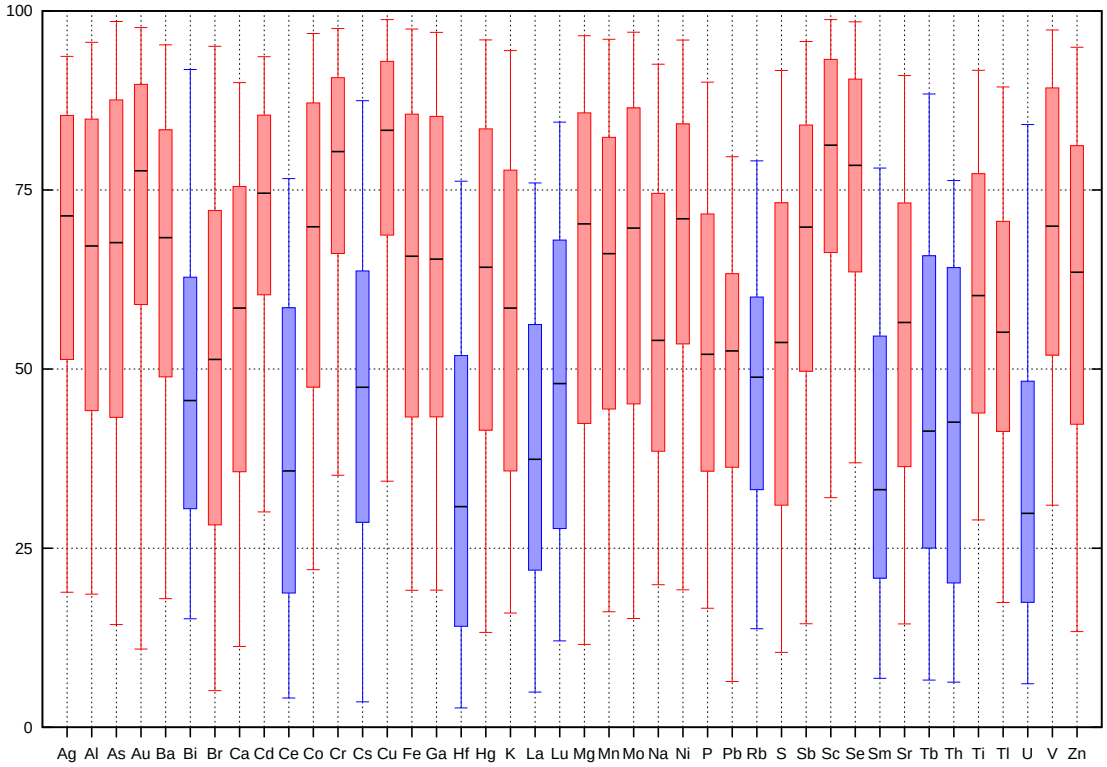
Hazelton Group: lmJHz



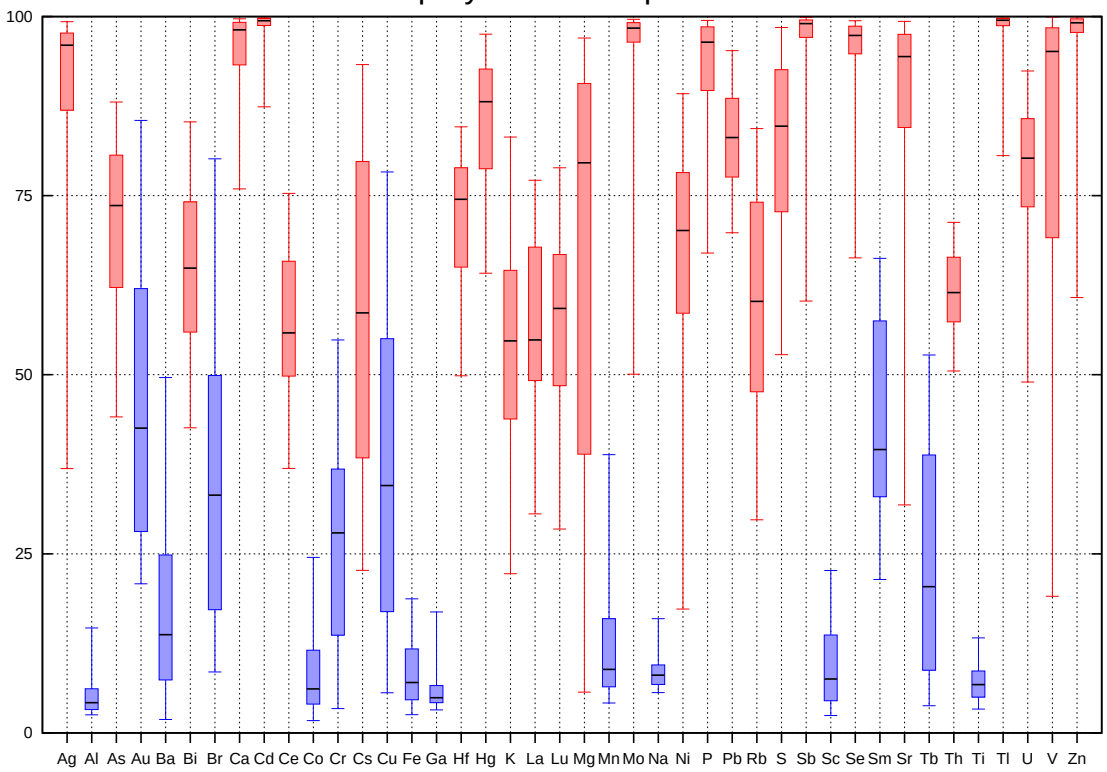

Chuchi Lake, Twin Creek, Ashcroft: lJCl/lJTw/lmJAh



Nikola and Takla Groups: TrJTk/uTrJNc




Spray River Group: TrJS



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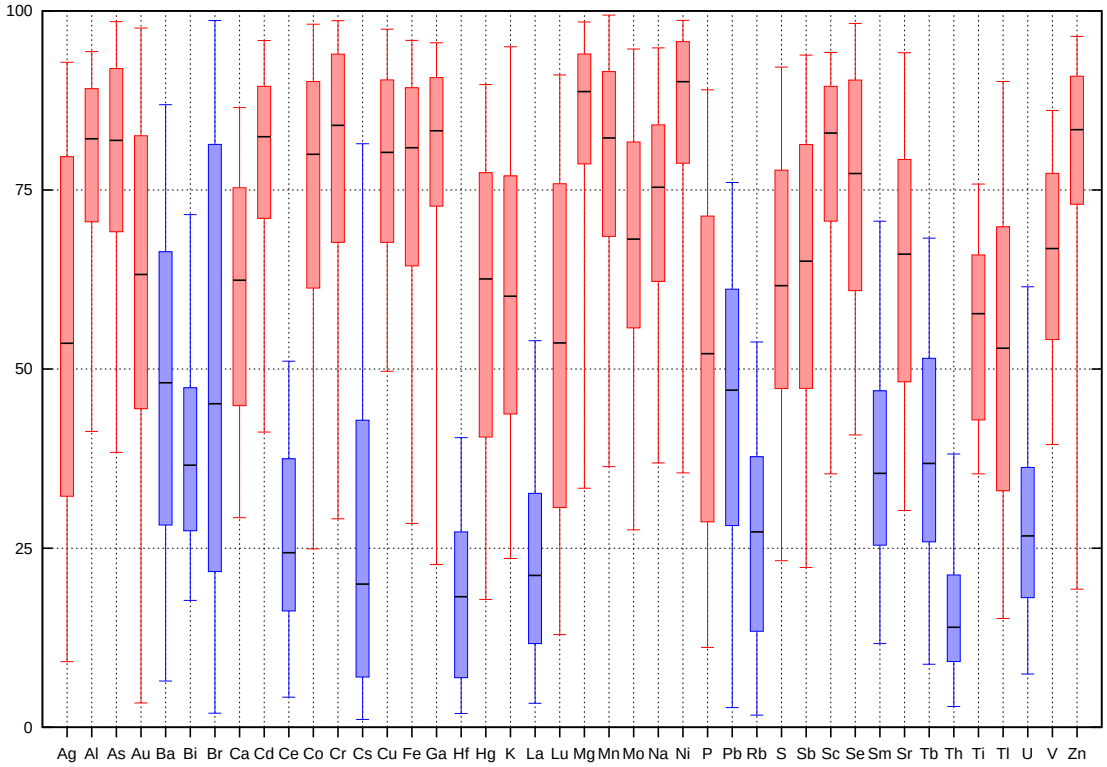
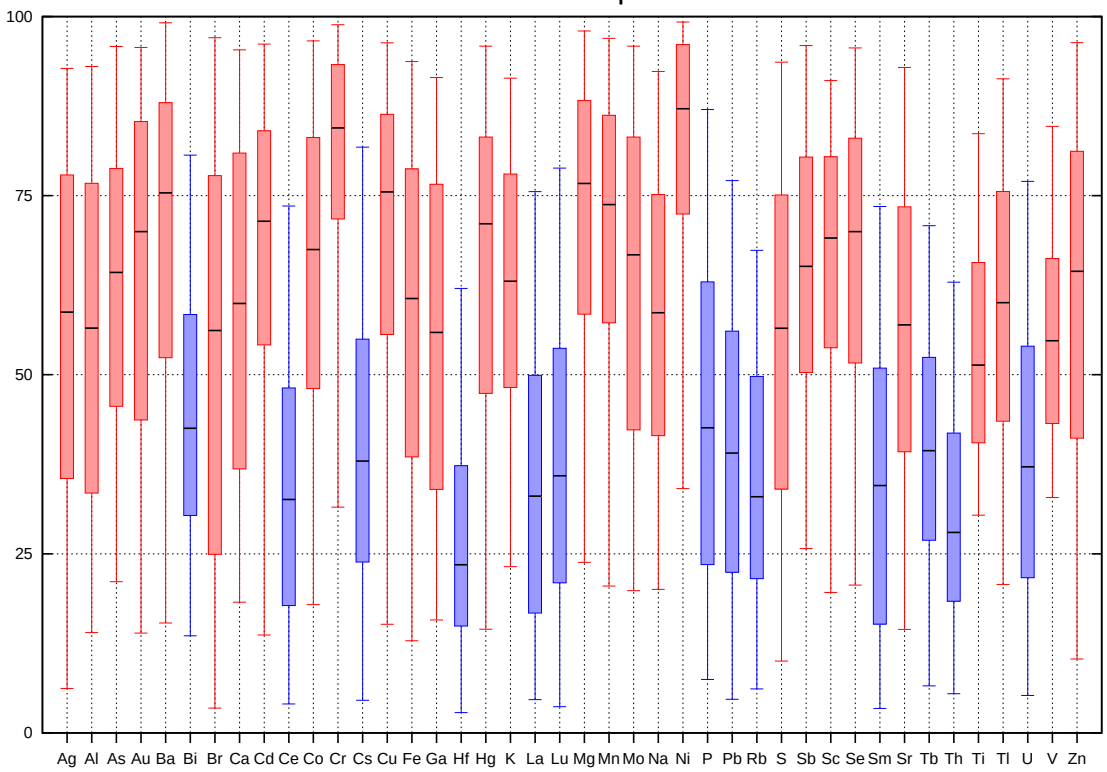
Kutchko Formation: PJKu




Cache Creek Complex: MTrCc

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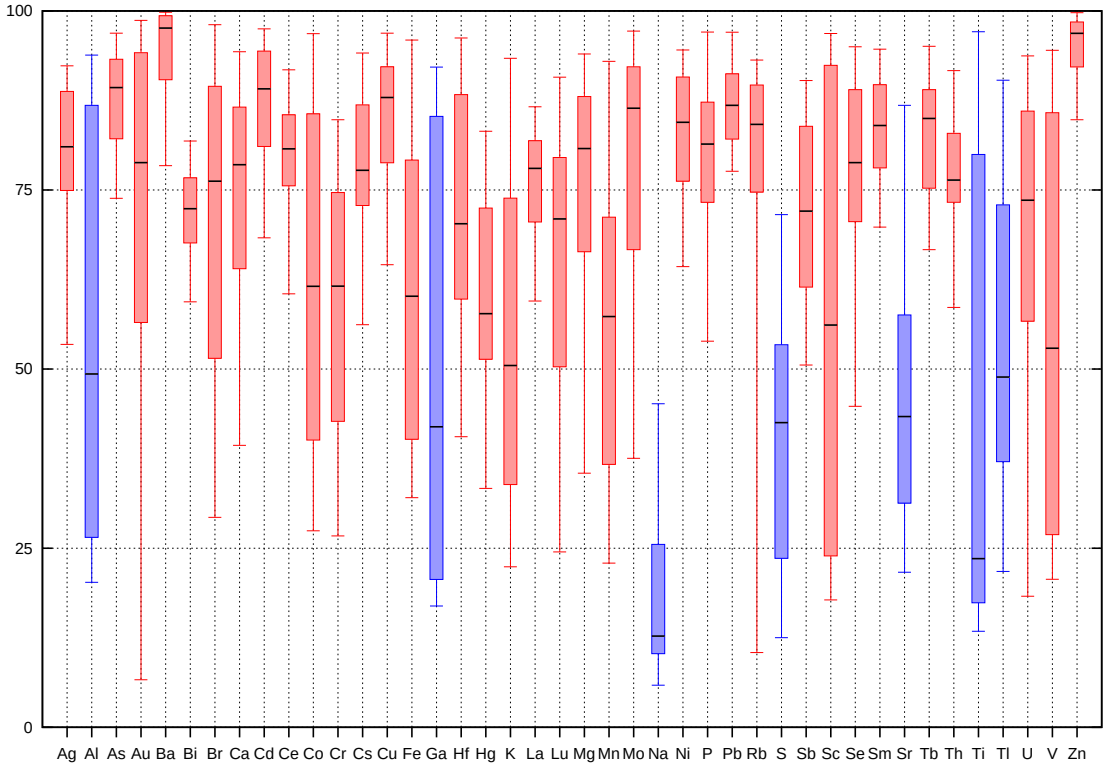
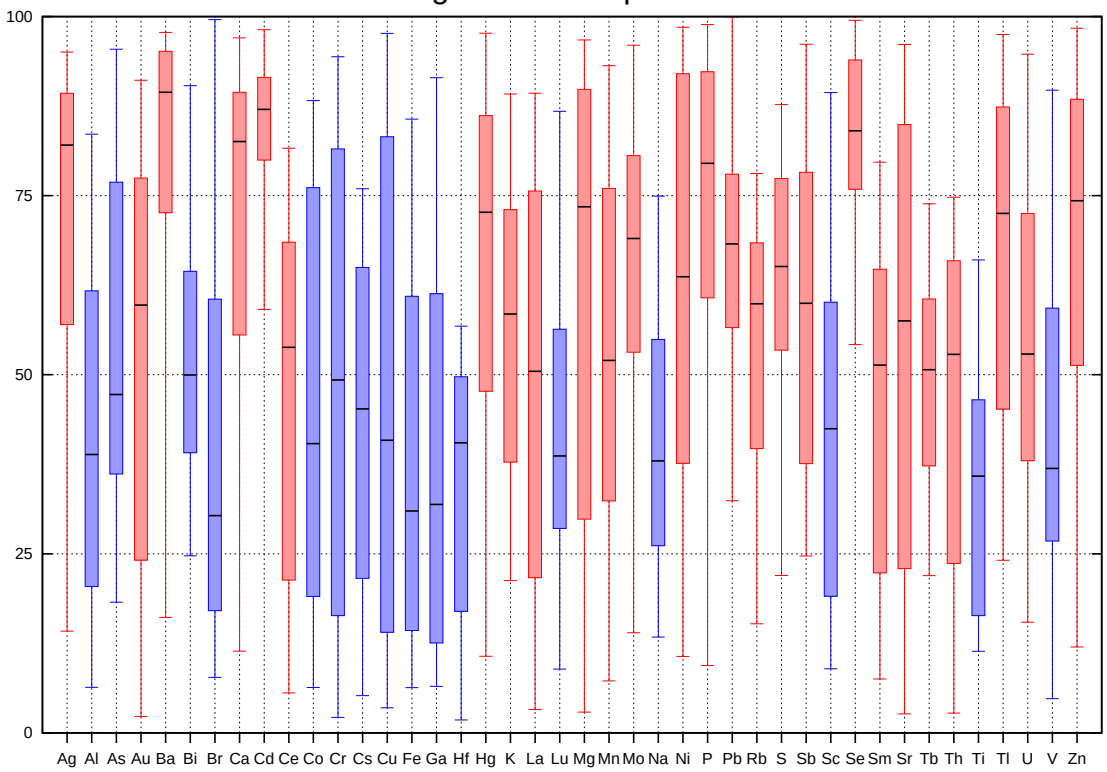
Black Stuart Group: PzBl




Big Creek Group: DPBc

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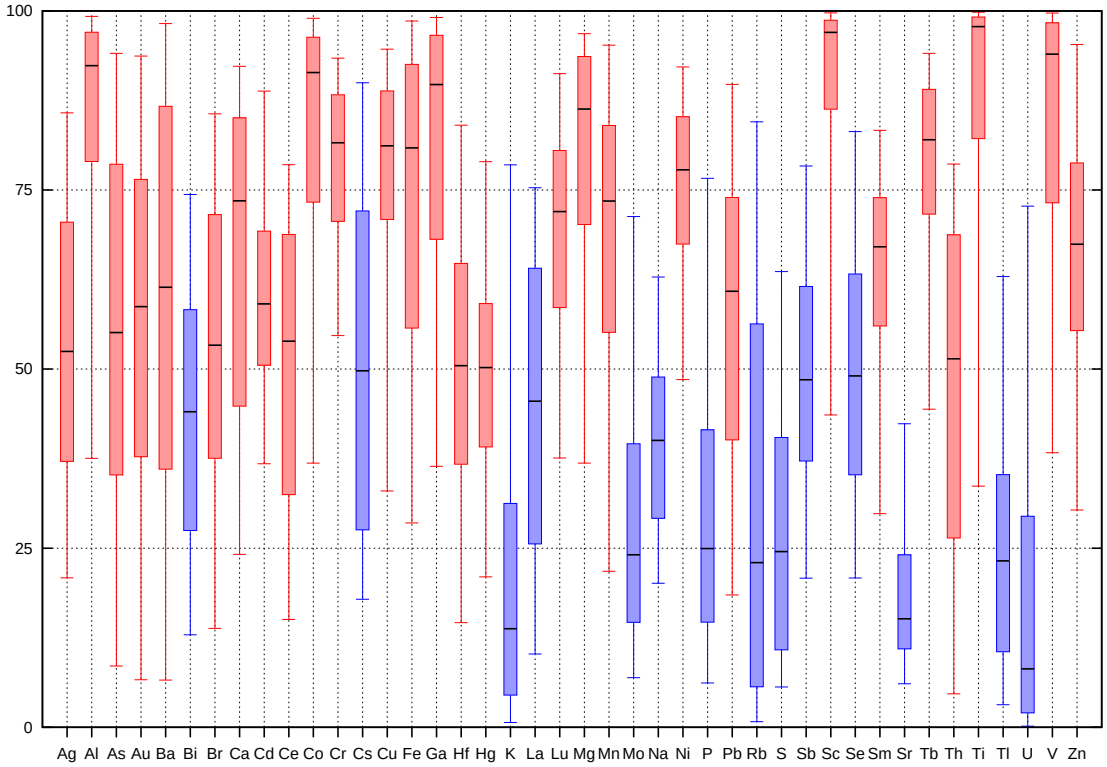
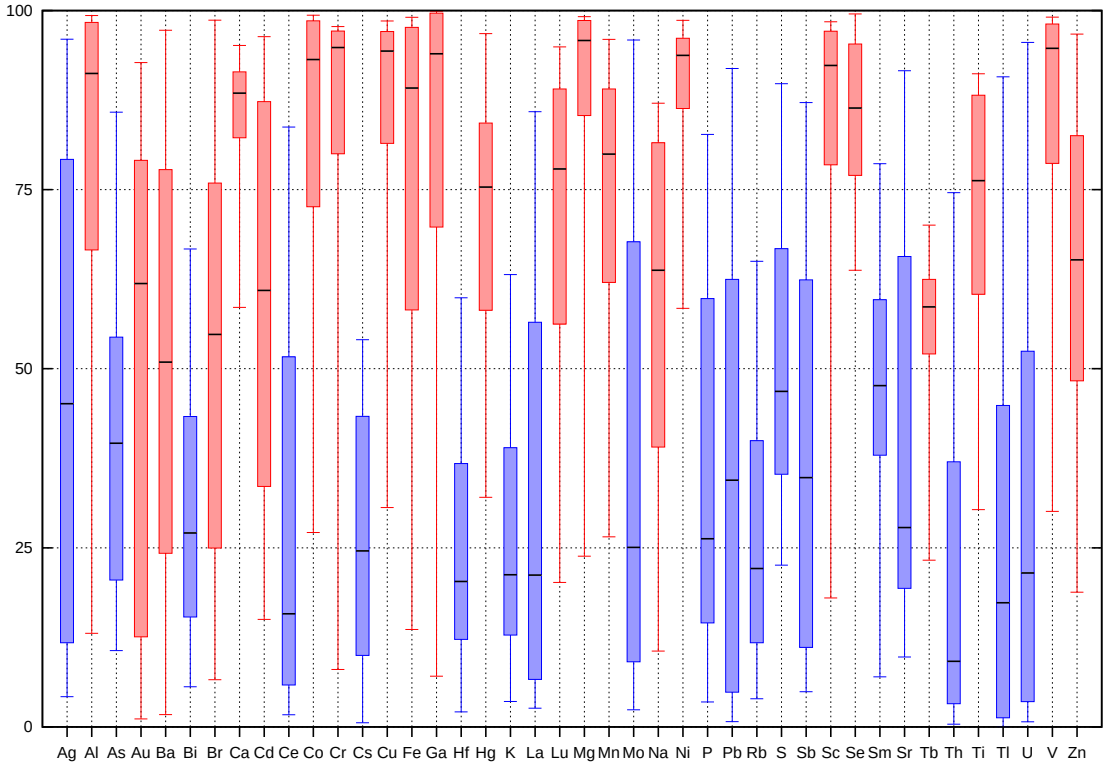
Slide Mountain Complex: CPSm




Nina Creek Group: CPNi

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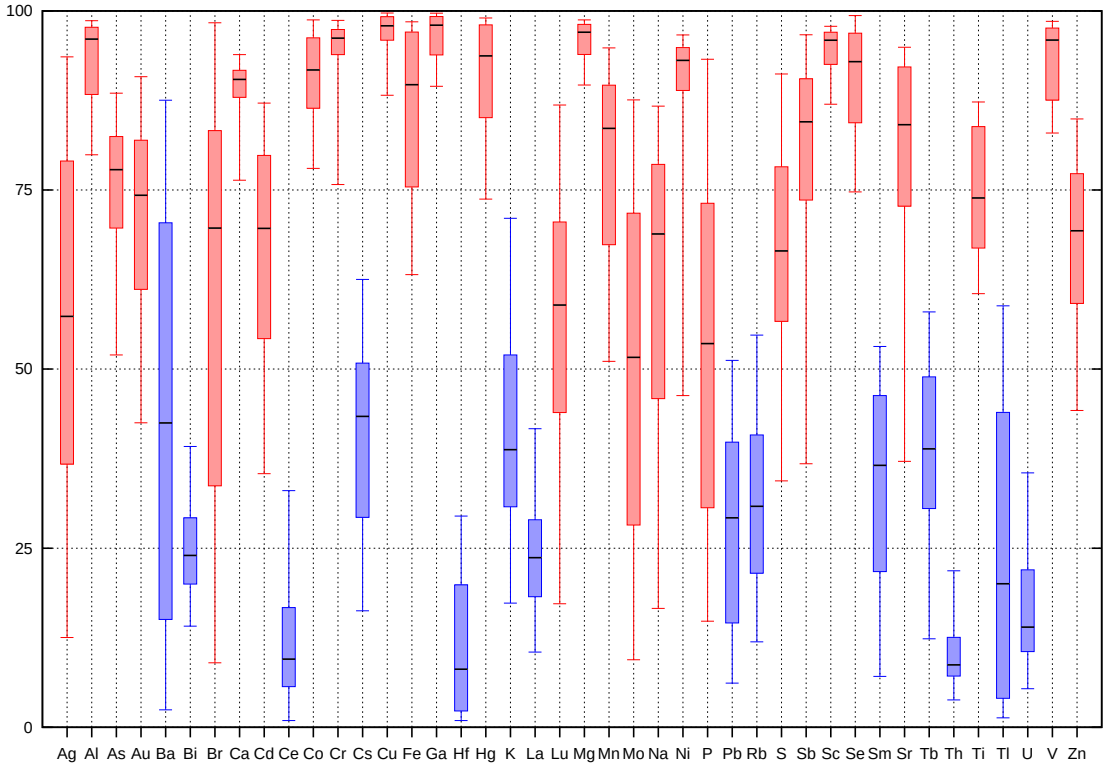
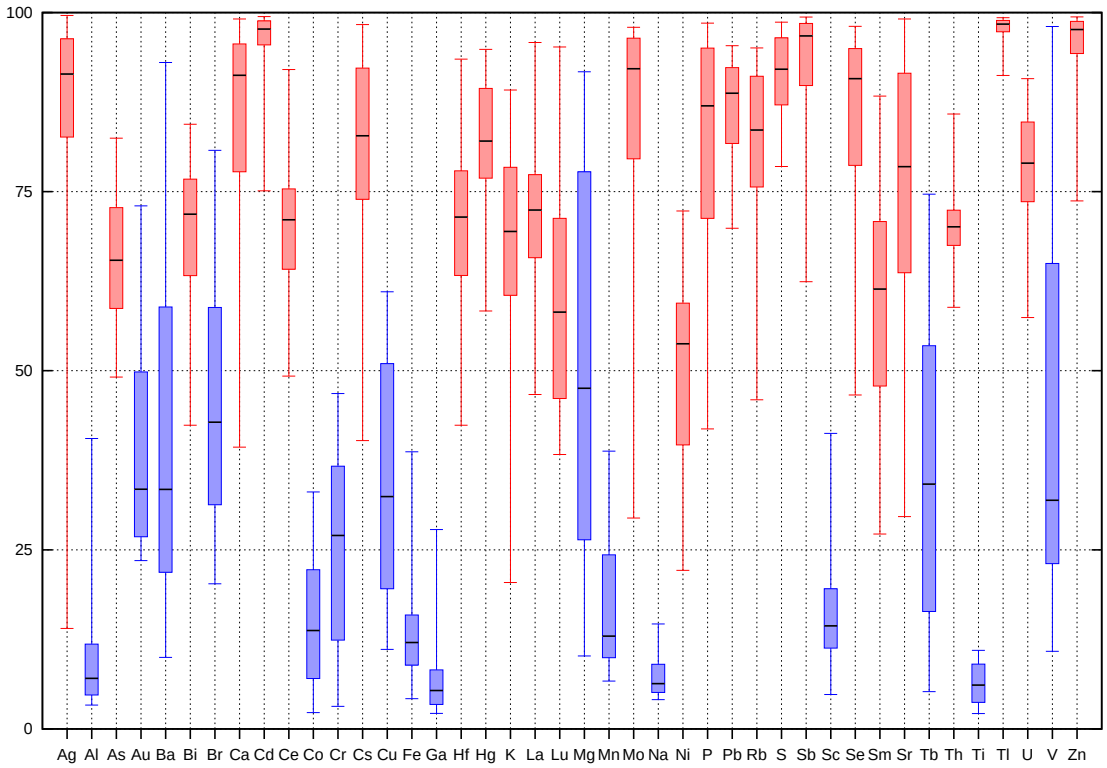
Lay Range Assemblage: CPLy




Base River/Banf and Exshaw: DMB/DMBe

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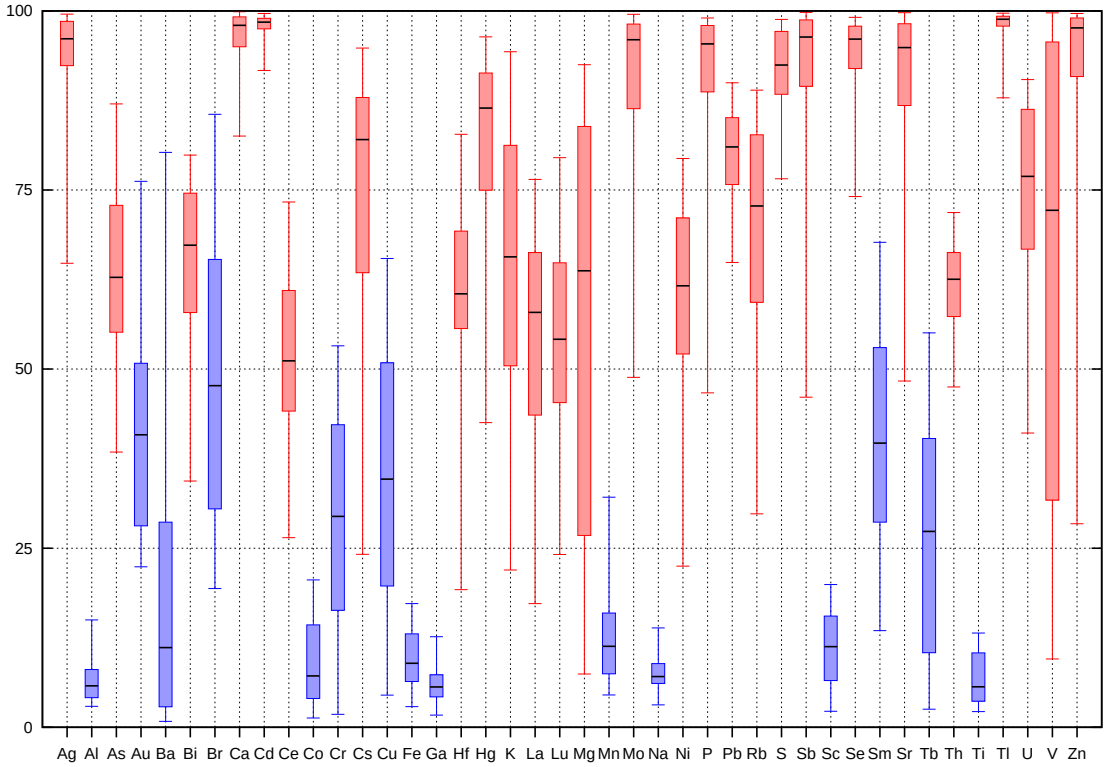
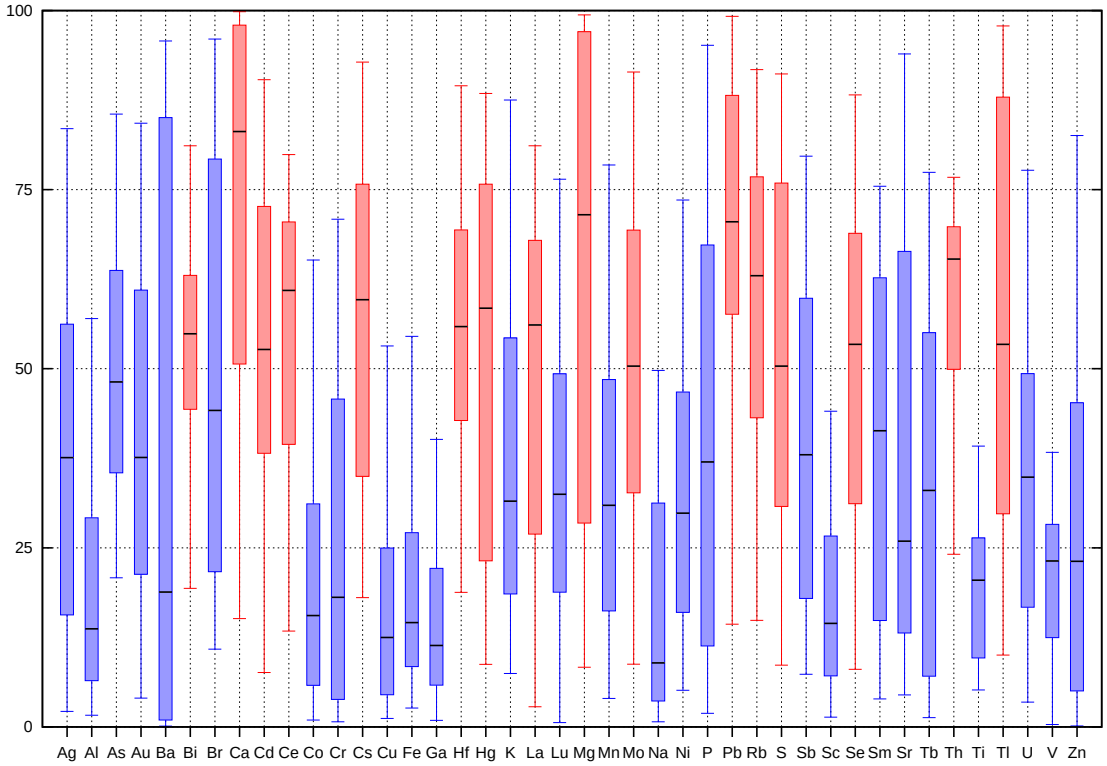
Rundle Group: MRu




Road River Group: ODRo/SDs

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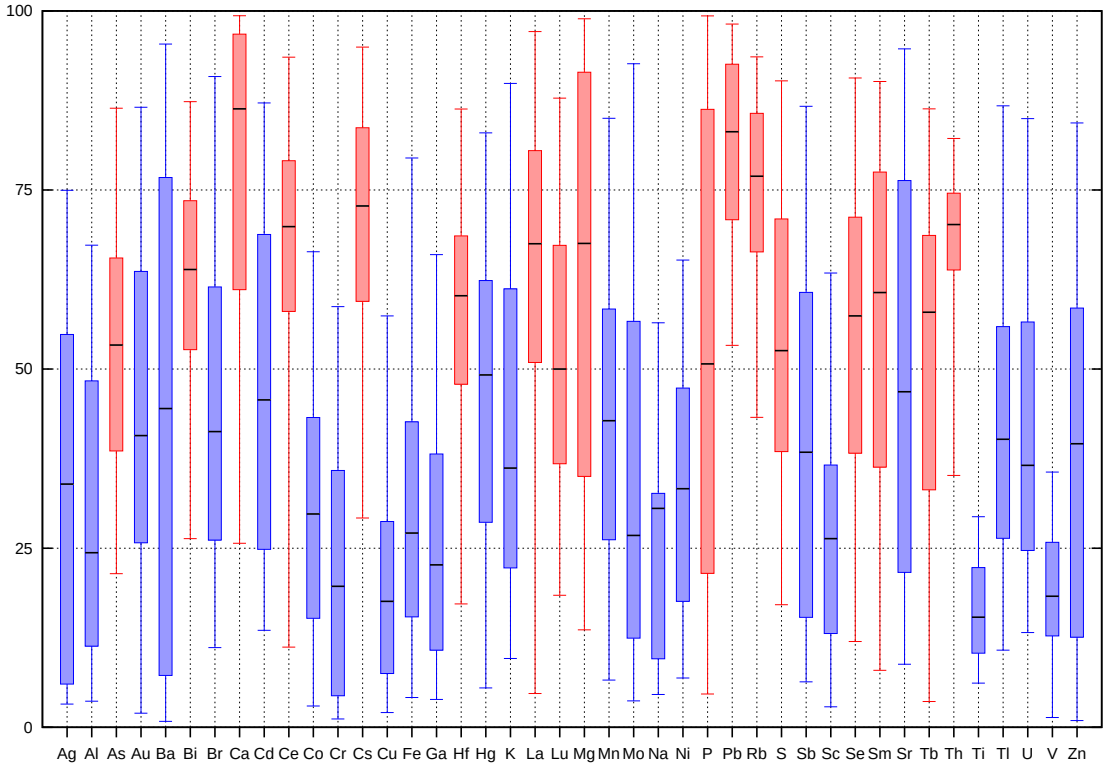
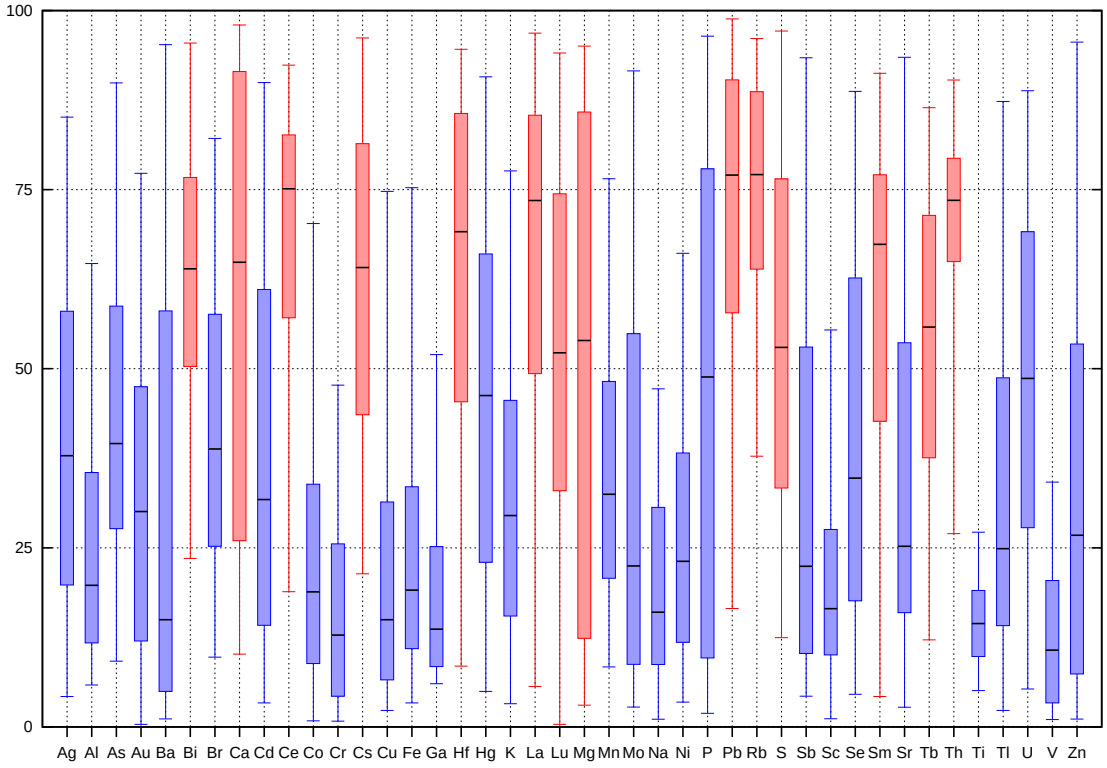
Kechika Group: CmOKe




Cambrian-Ordovician: CmOs

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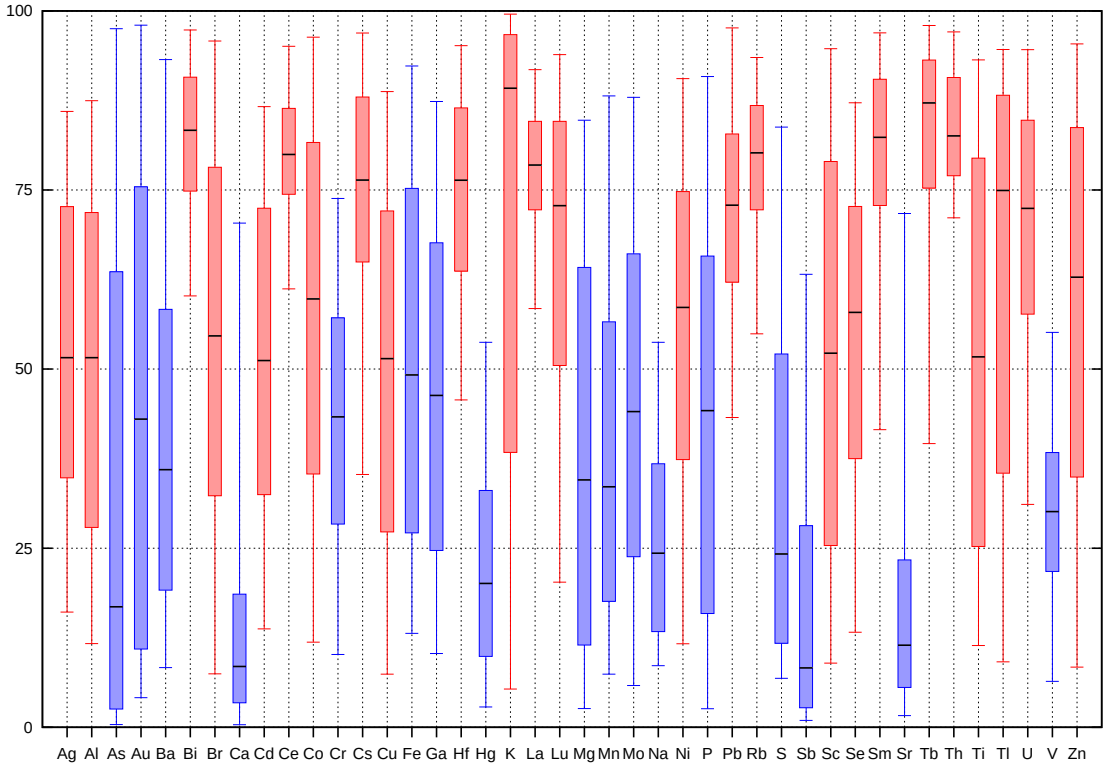
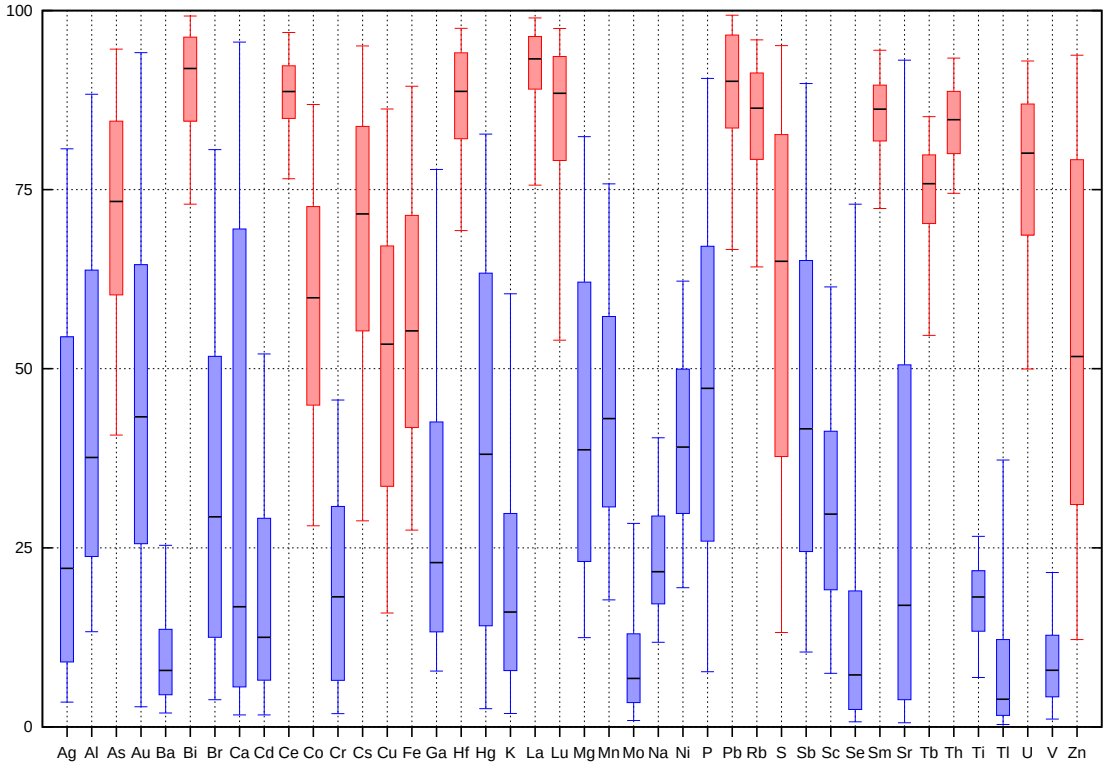
Snowshoe Group: uPrPzSn




Misinchinka Group: uPrCmMs

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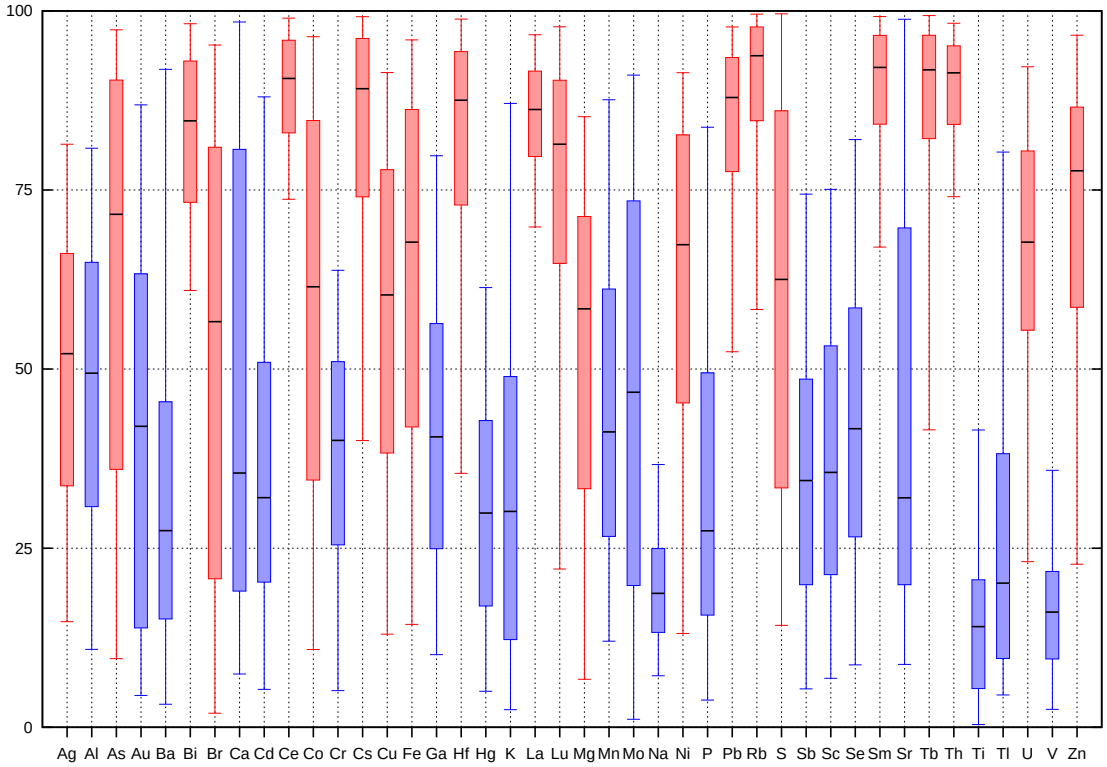
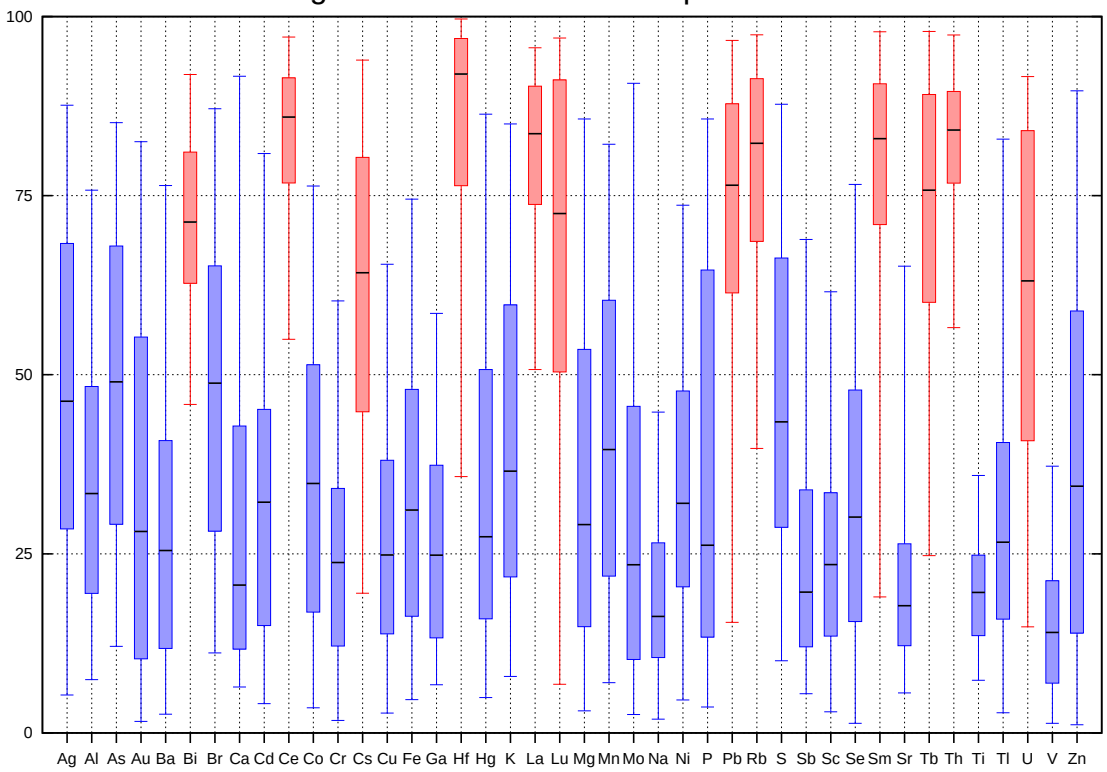
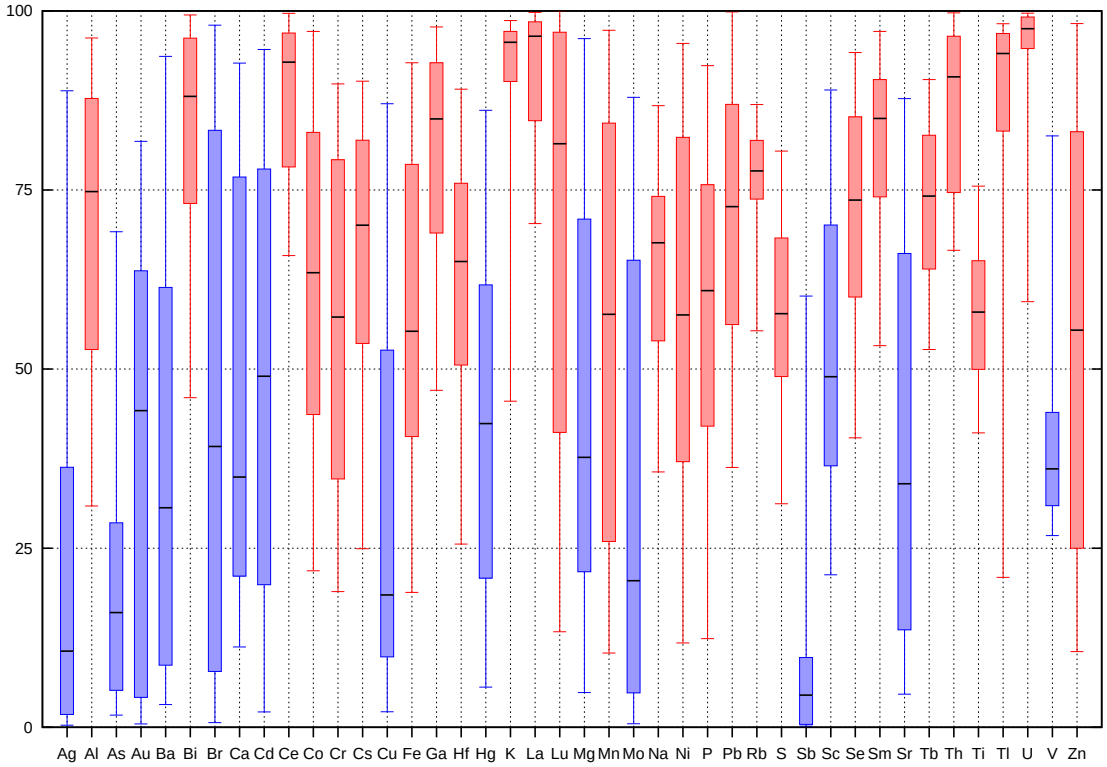
Cariboo Group: uPrCmC



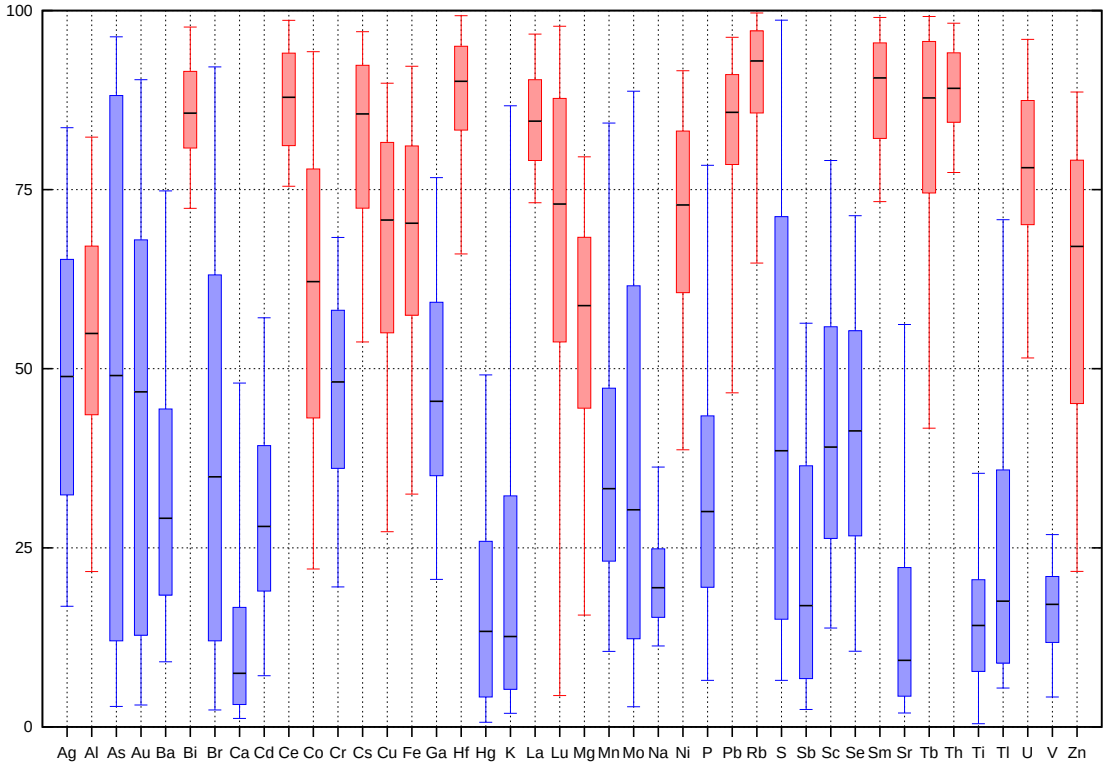

Gog and Boulder Creek Groups: uPrCmGo



Ingenika Group: uPrIg




Kaza Group: uPrKz



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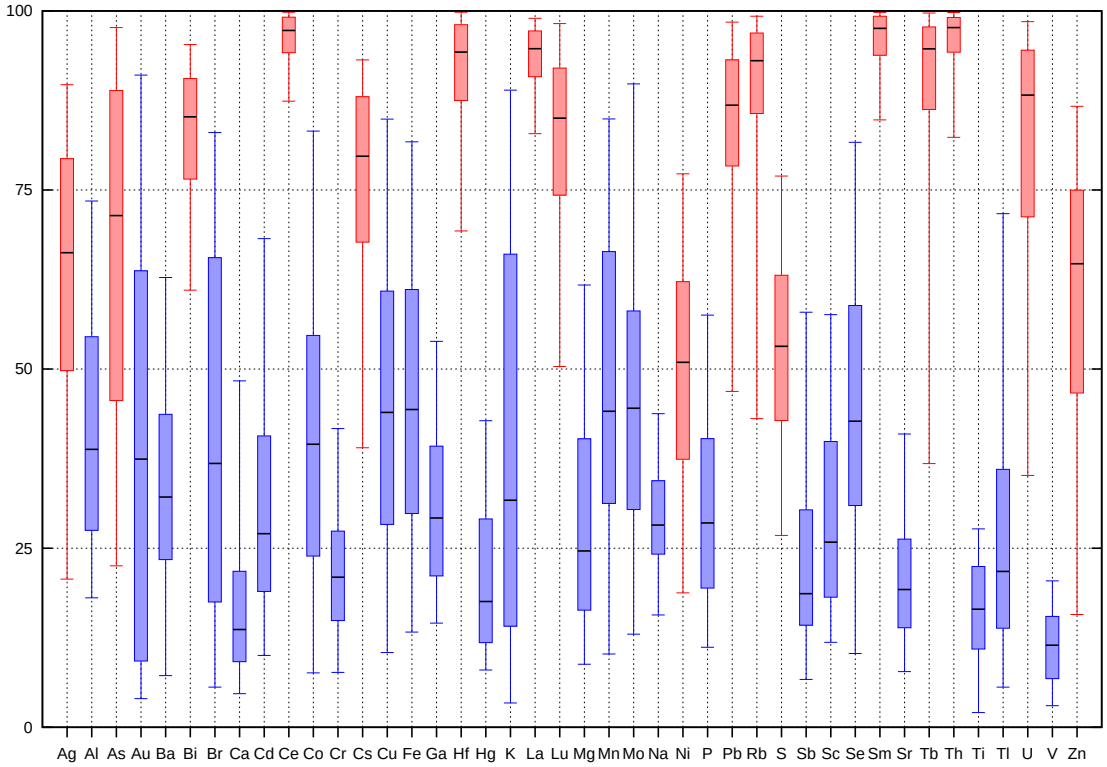
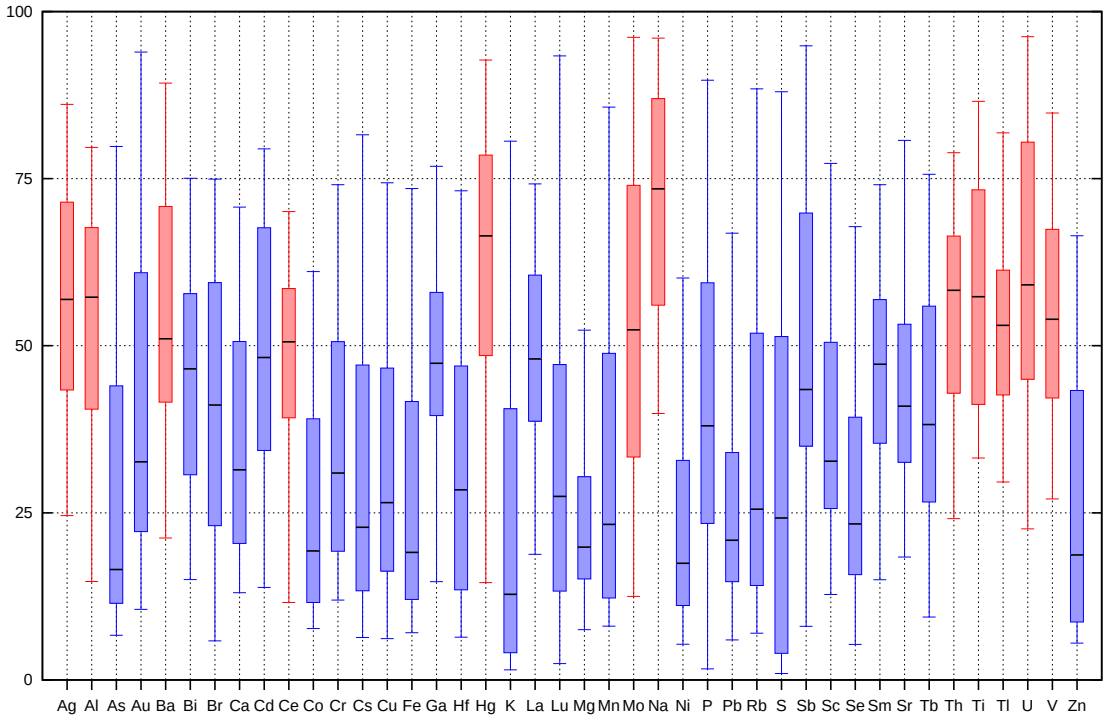
Miette Group: uPrMi




Early Tertiary Intrusives:

ETdg/ETfp/ETg/ETgb/ETgd/ETgr/ETmi/ETqd/ETqm/ETqp



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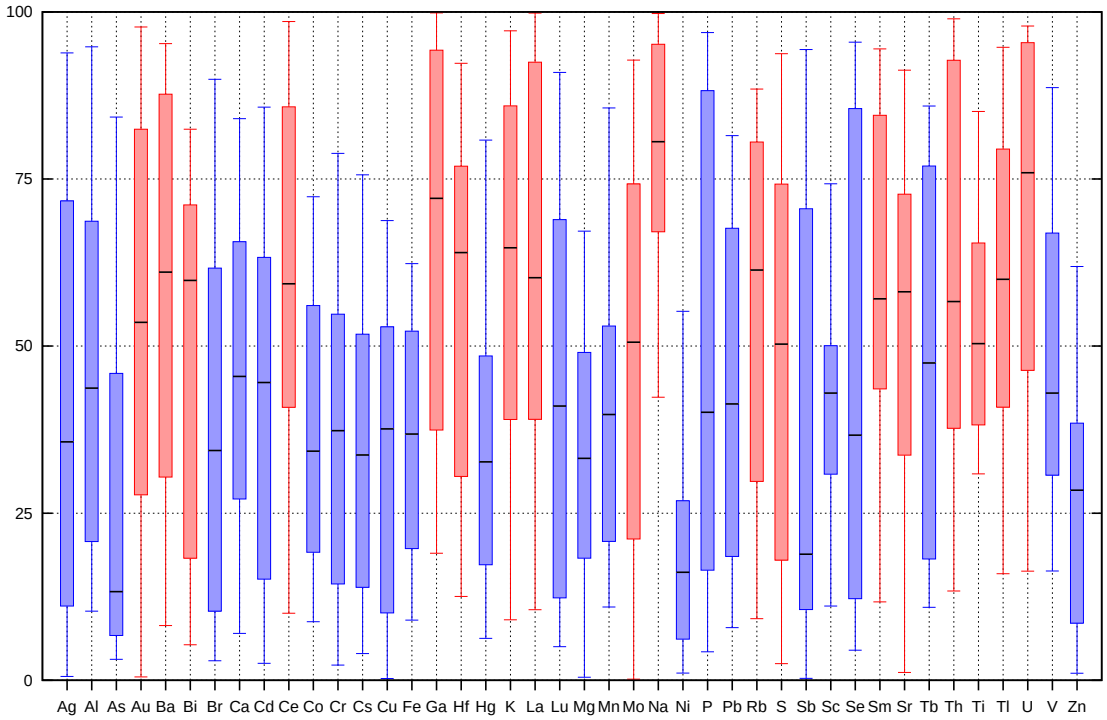
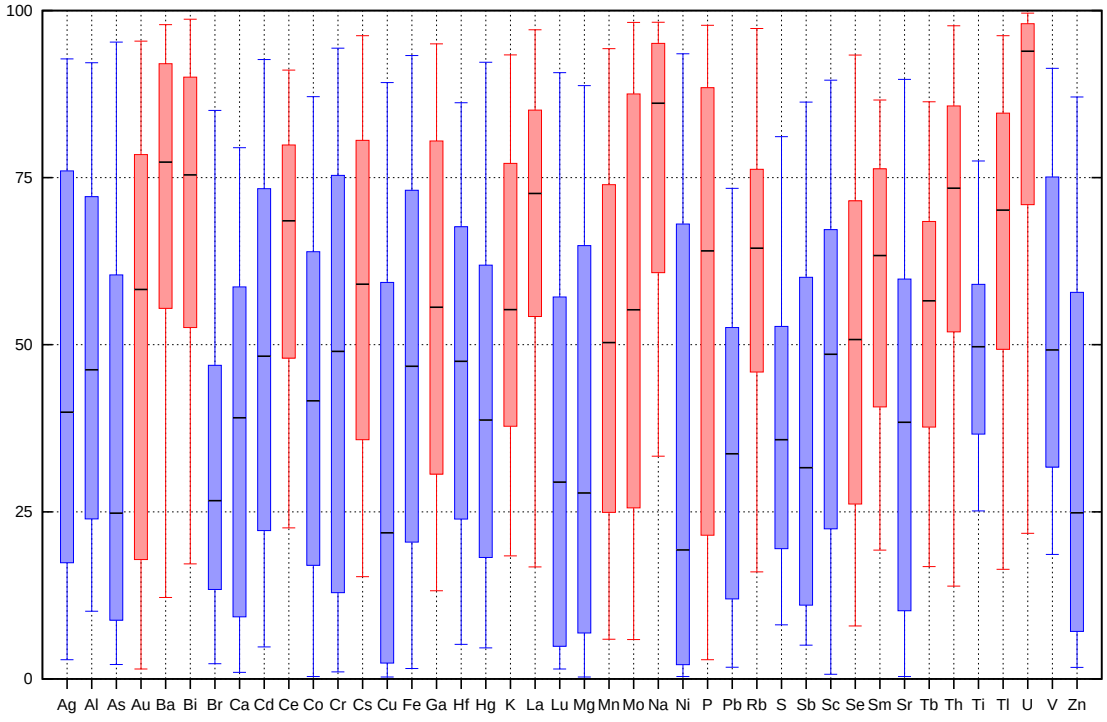
Cretaceous-Tertiary Intrusives:

KTdr/KTfp/KTg/KTgd/KTgr/KTpe/KTsy/LKdr/LKfp/LKgd/LKgr/LKqm/LKqp/LKto




Cretaceous Intrusives:

EKdg/EKdr/EKgd/EKgr/EKqd/EKqm/Kg/Kgr/Kmi/Kog/Kpe/mKdg/mKgb/mKgd/mKgr



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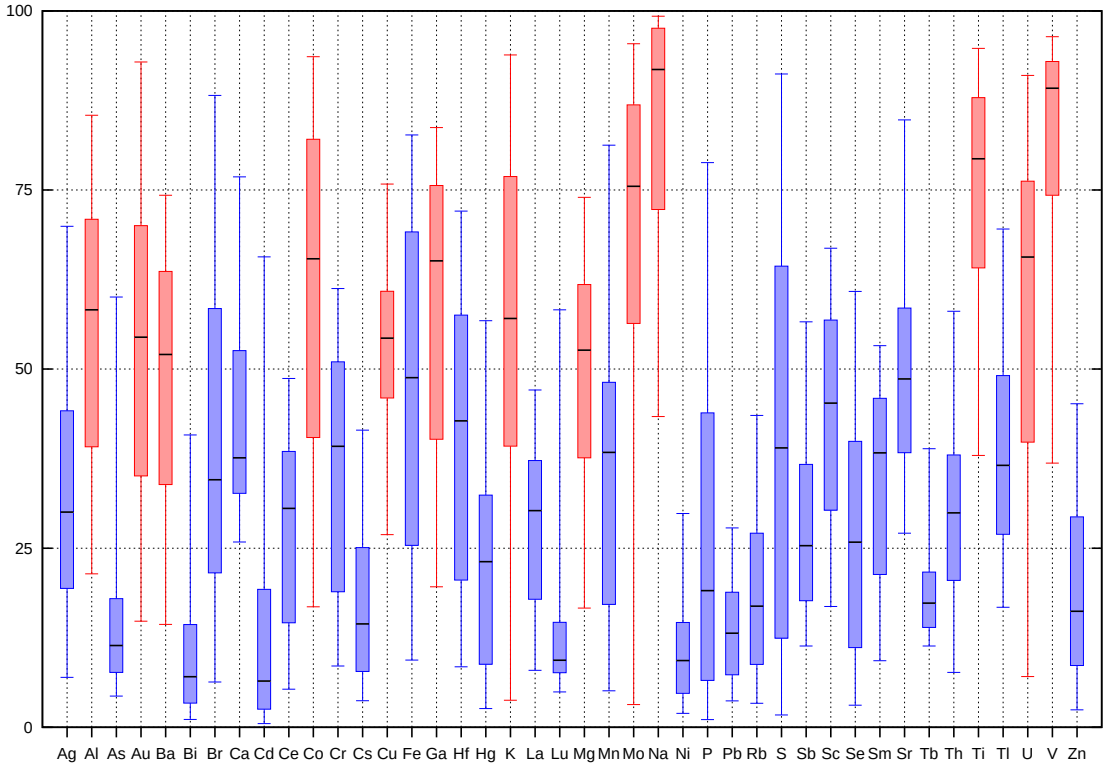
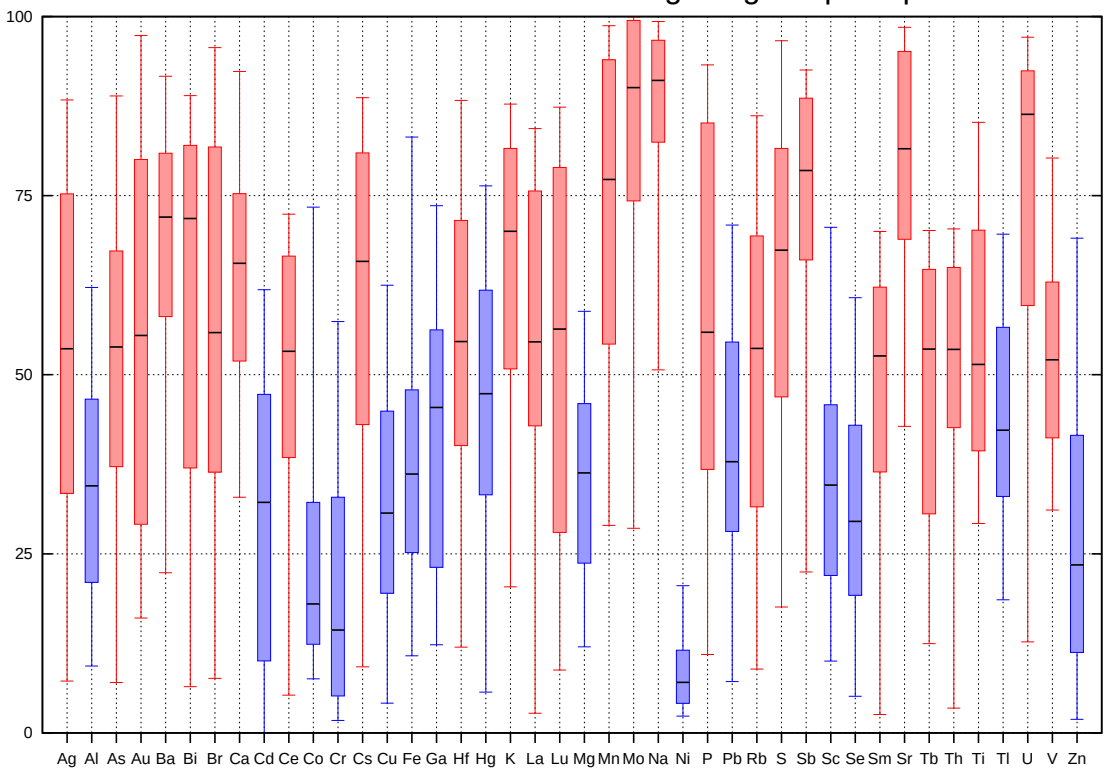
Jurassic-Cretaceous Intrusives: JKg/JKgr/JKog/JKqm/JKqp/JKto




Late Jurassic Intrusives: LJdr/LJgd/LJgr/LJqd/LJqm

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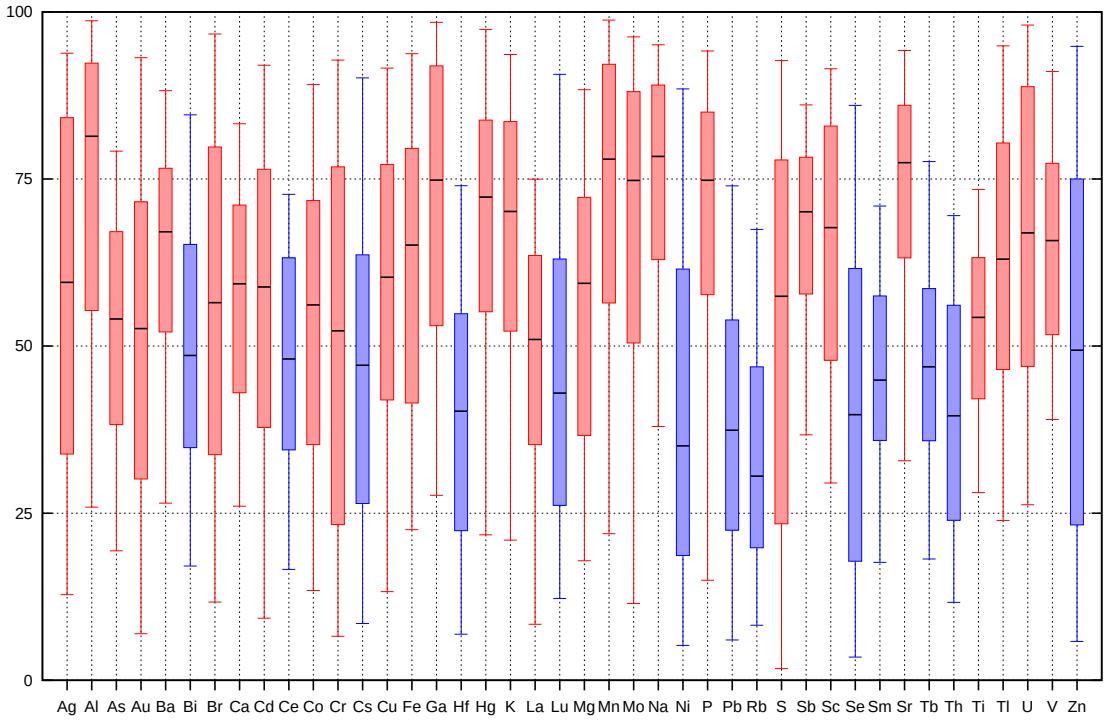
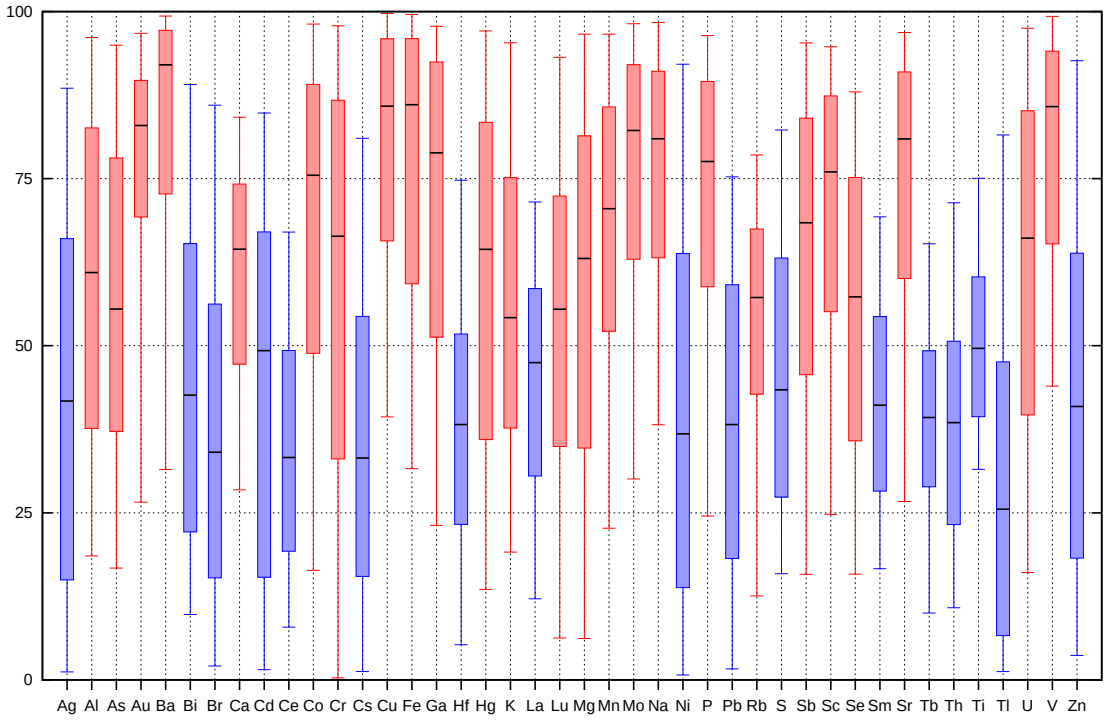
Mid-Late Jurassic Intrusives:

MJdr/MJfp/MJg/MJgd/MJgr/MJqd/MJqm/MJsy/MLJdr/MLJgb/MLJgd/MLJgr/MLJqd




Early-Mid Jurassic Intrusives:

EJdg/EJdr/EJgb/EJgd/EJqd/EJqm/EJsy/EJvl/EMJdb/EMJdr/EMJgd



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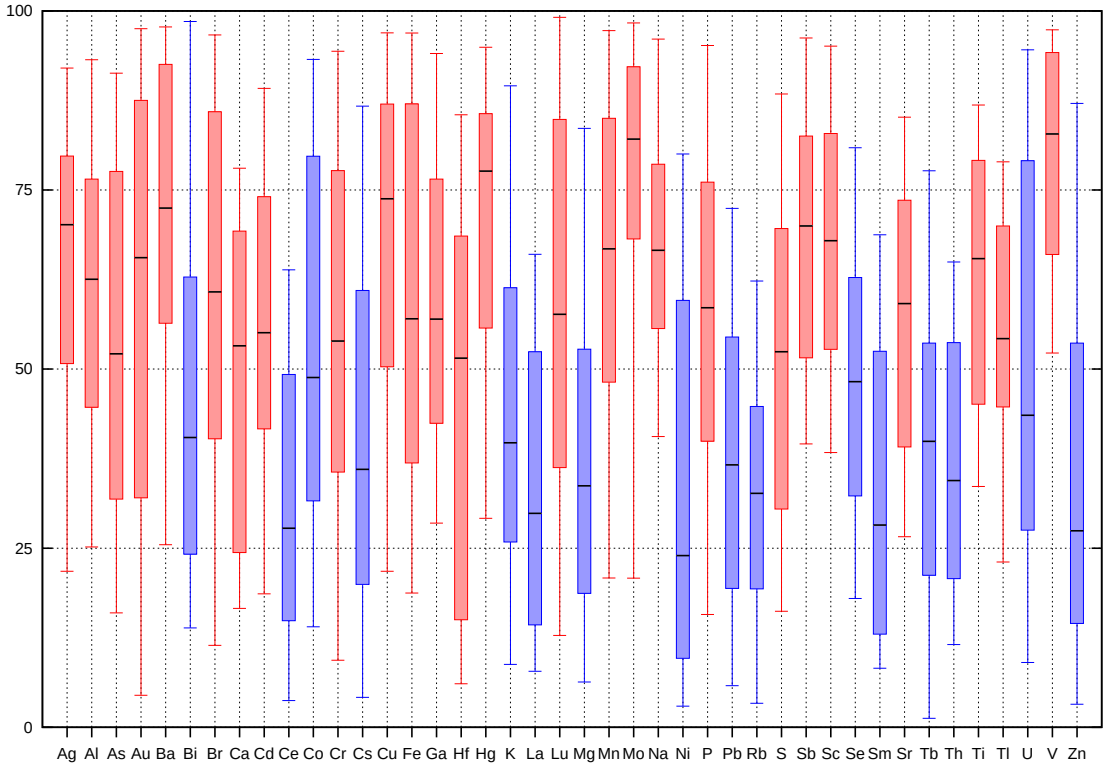
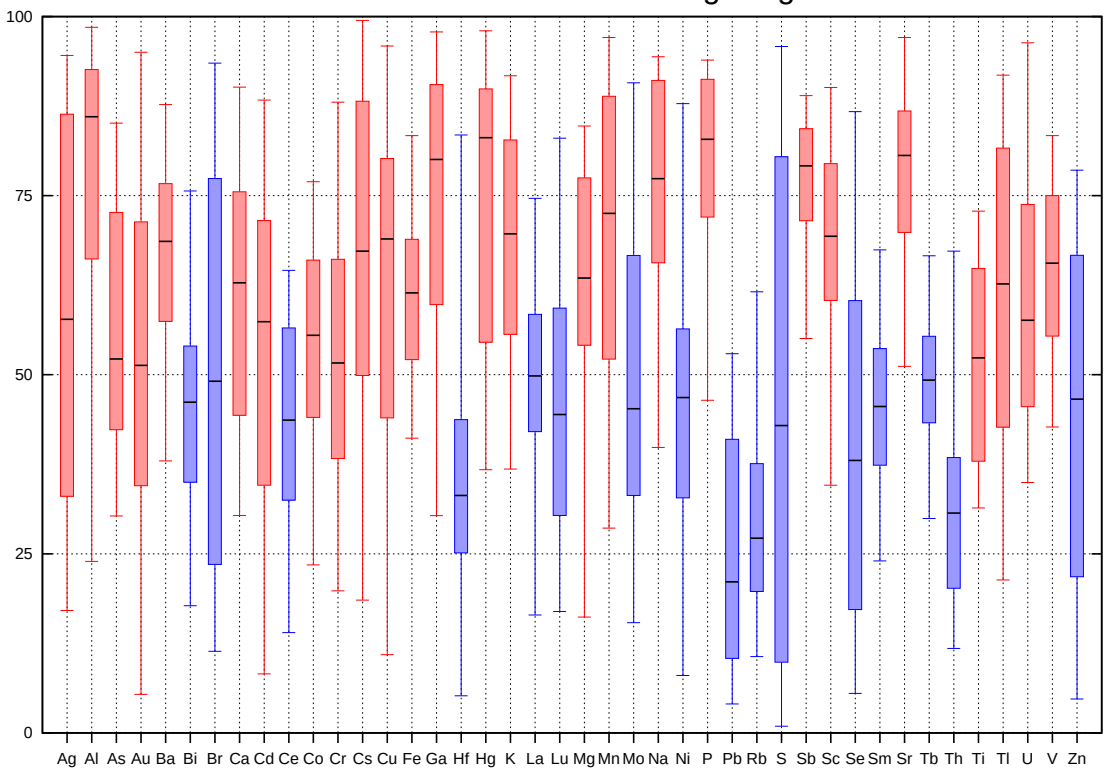
Triassic-Jurassic Intrusives: TrJdr/TrJfp/TrJgb/TrJgd/TrJqm/TrJsy




Triassic Intrusives: Trdr/Trgb/Trgd

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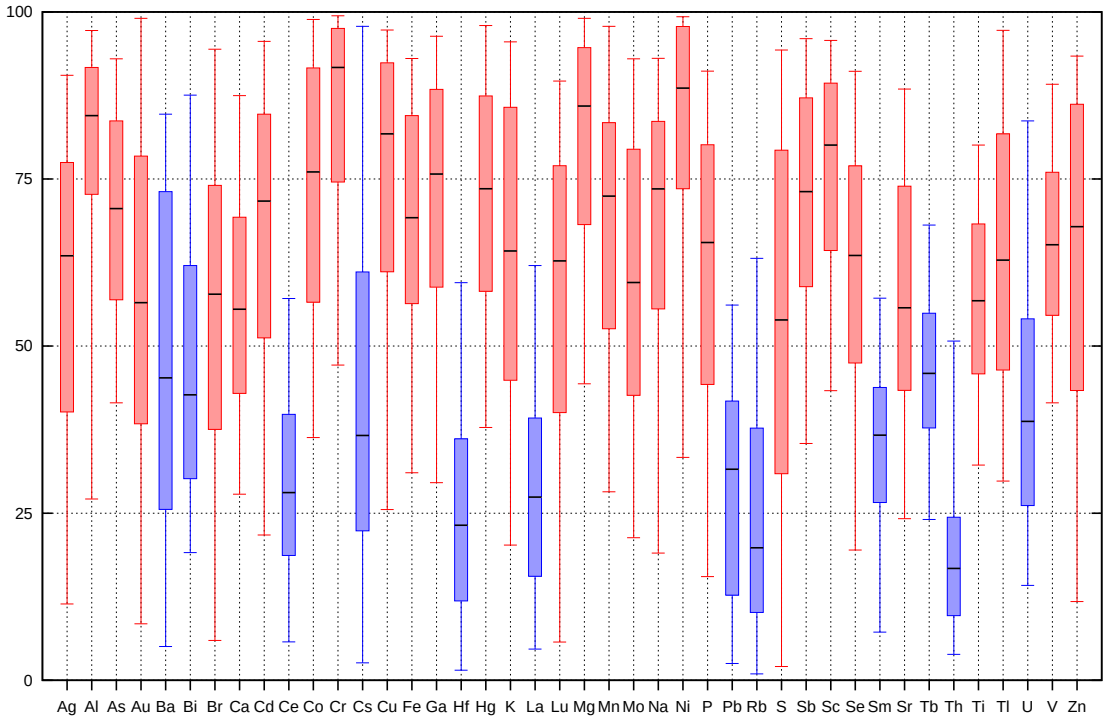
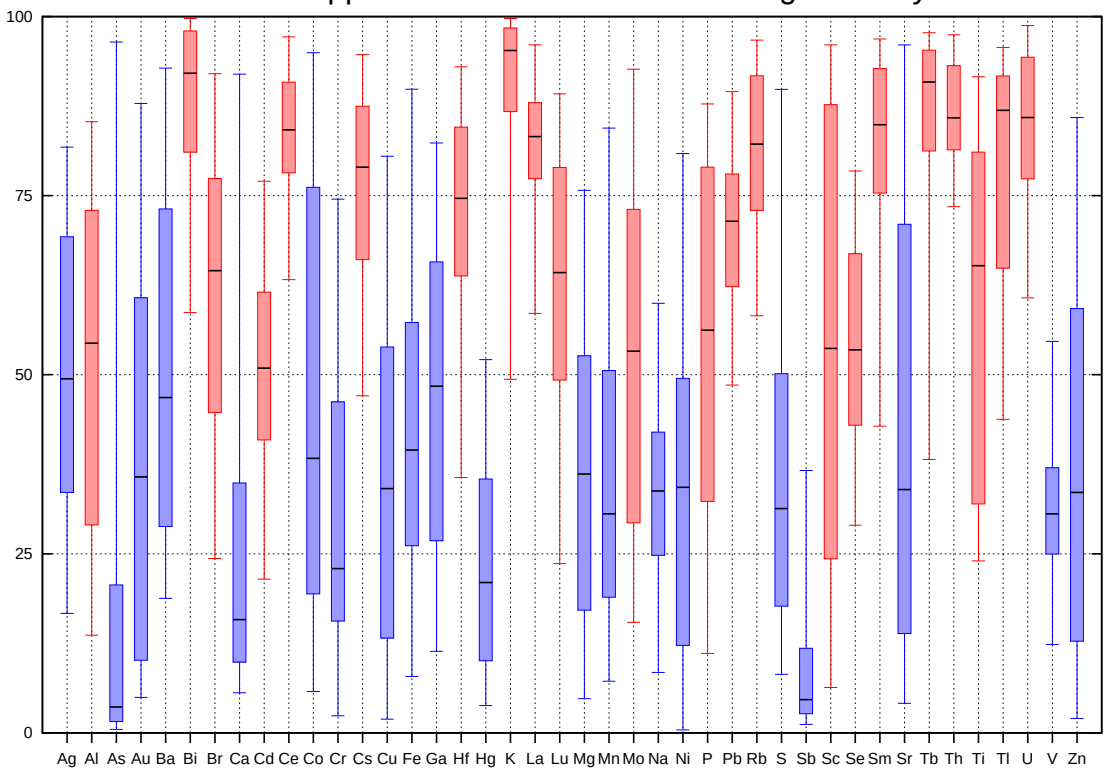
Jurassic to Permian Intrusives:

PJog/PJto/PTrdb/PTrdr/PTrgb/PTrgs/PTrto/Pgb




Mississippian-Devonian Intrusives: DCog/Mdr/Msy

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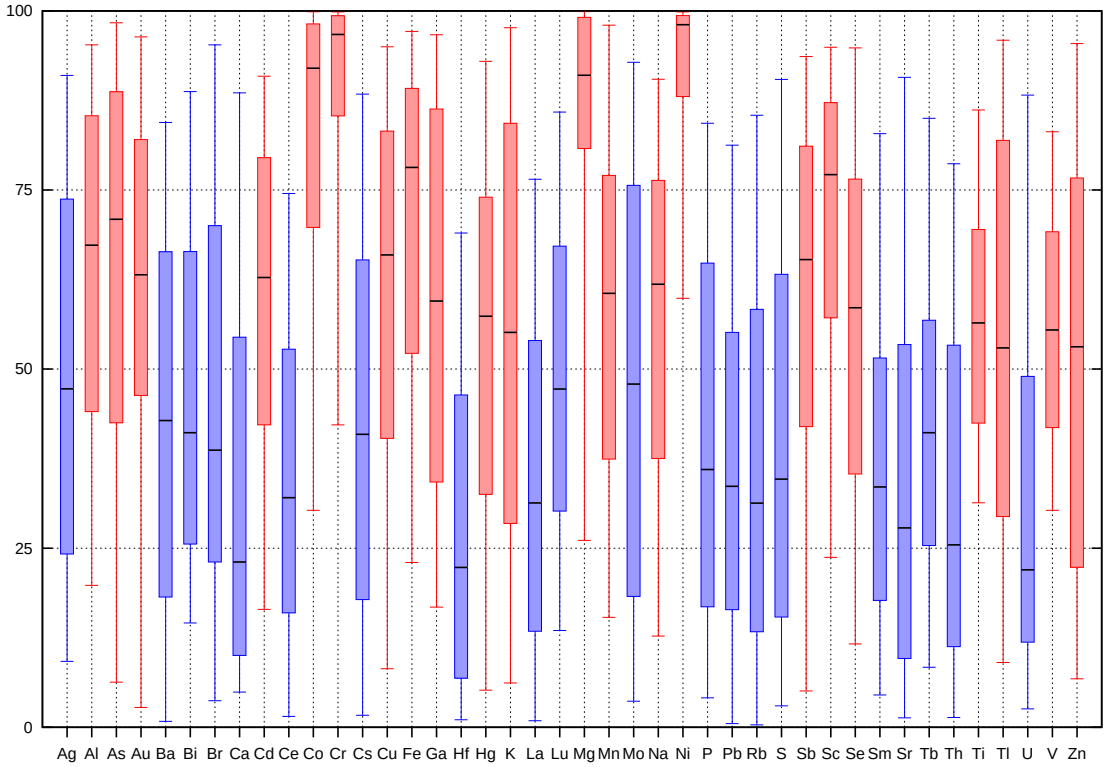
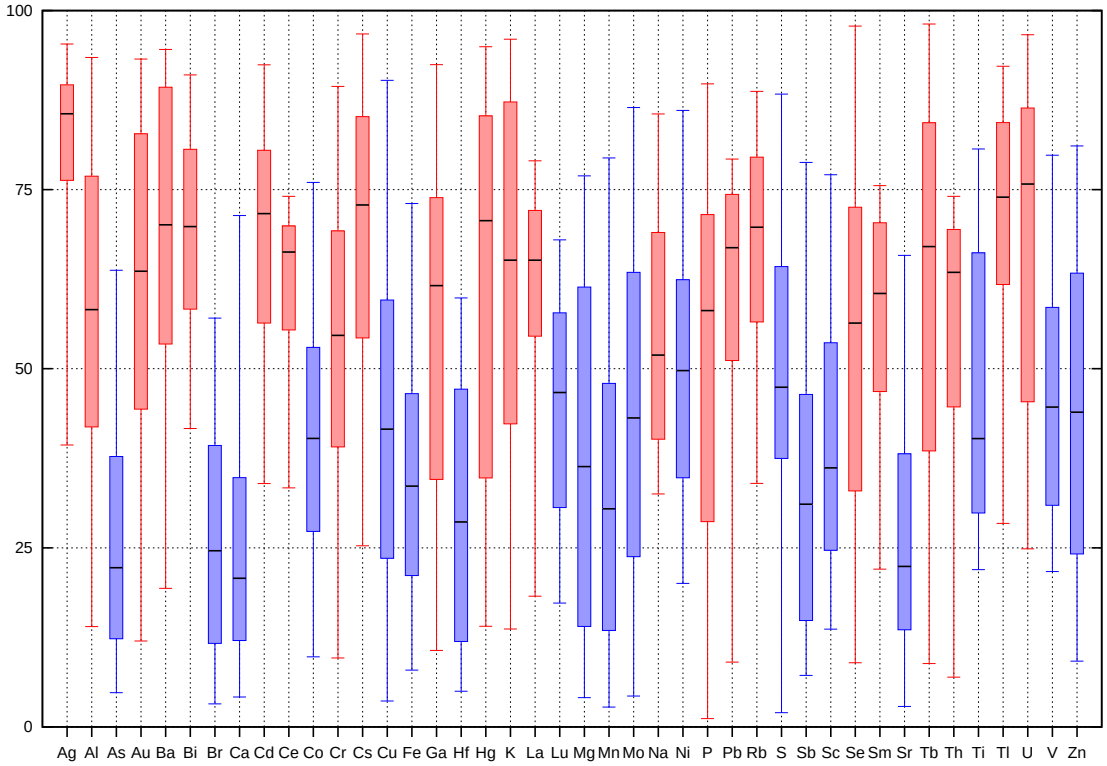
Palaeozoic Ultramafics: CPrum/CPus/CTrum/CTrus/Cus/DTrum/Pzum




Cretaceous-Tertiary Intrusives: Jgs/KTmc/KTpg

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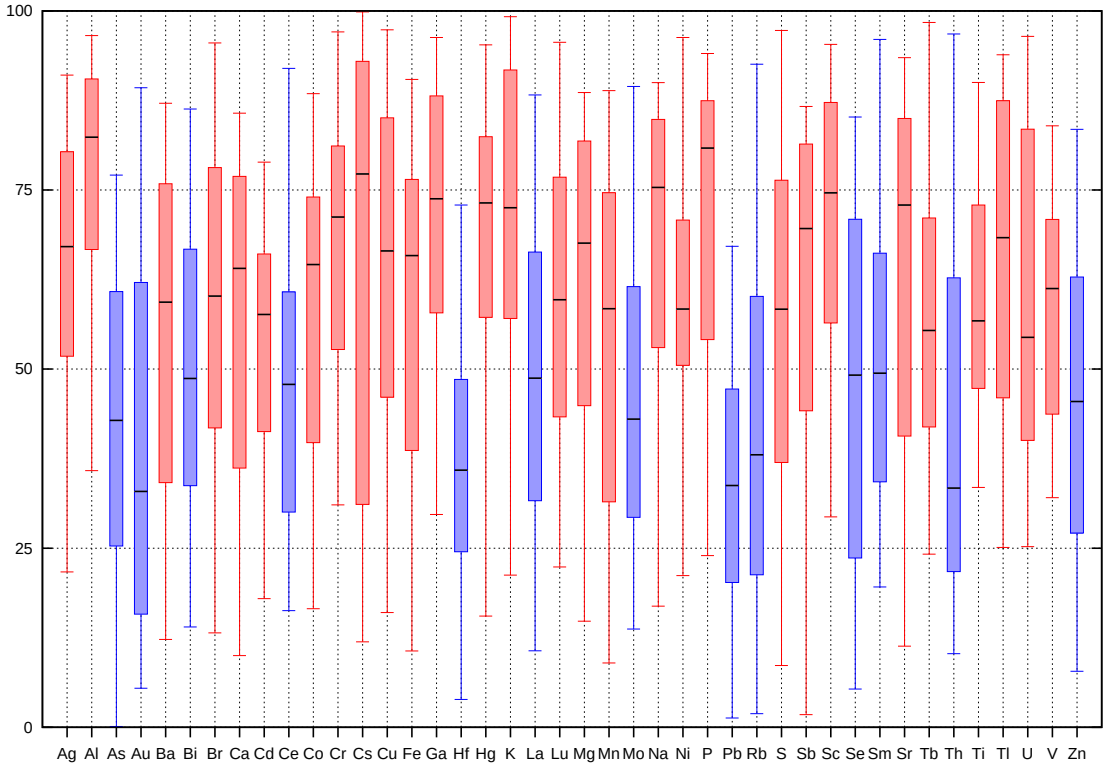
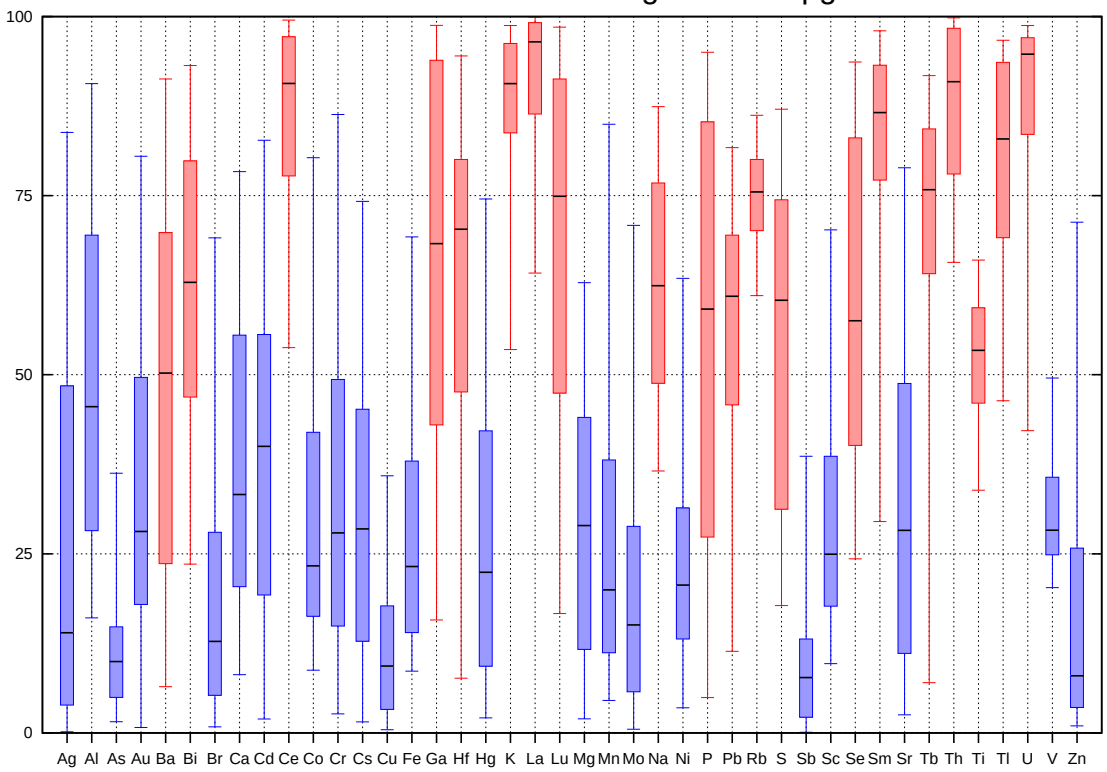
Paleozoic Metamorphics: DTrlm/DTrml/PJml/PrPzm




Lower Proterozoic Paragneiss: LPrpg



| | 5% | 25% | 50% | 75% | 95% | |
|---|---|---|---|---|---|---|
| Ag | 0.0212 | 0.0358 | 0.0497 | 0.0715 | 0.1751 | ppm |
| Al | 0.4464 | 0.8661 | 1.0408 | 1.2265 | 1.6445 | pct |
| As | 1.0652 | 3.3137 | 5.8523 | 9.4393 | 21.665 | ppm |
| Au | 1.7810 | 1.9865 | 2.2241 | 2.9216 | 5.2829 | ppb |
| Ba | 411.53 | 578.46 | 722.50 | 876.89 | 1170.0 | ppm |
| Bi | 0.0334 | 0.0558 | 0.0799 | 0.1259 | 0.2346 | ppm |
| Br | 1.4685 | 3.0673 | 4.8566 | 7.5653 | 13.445 | ppm |
| Ca | 0.1975 | 0.4086 | 0.5780 | 0.8104 | 1.9238 | pct |
| Cd | 0.0701 | 0.1161 | 0.1650 | 0.2676 | 0.7601 | ppm |
| Ce | 25.940 | 39.912 | 52.570 | 93.917 | 216.22 | ppm |
| Co | 6.4368 | 10.559 | 14.501 | 19.138 | 29.210 | ppm |
| Cr | 49.221 | 68.821 | 93.620 | 141.70 | 272.06 | ppm |
| Cs | 1.4297 | 1.7710 | 2.2974 | 3.0417 | 4.4629 | ppm |
| Cu | 8.5960 | 13.636 | 18.430 | 26.170 | 43.554 | ppm |
| Fe | 1.6730 | 3.0109 | 3.8508 | 4.7122 | 6.3217 | pct |
| Ga | 1.7424 | 3.2248 | 3.7379 | 4.2376 | 5.2424 | ppm |
| Hf | 2.9079 | 4.2196 | 6.2628 | 10.000 | 18.806 | ppm |
| Hg | 9.7015 | 15.254 | 21.860 | 35.362 | 65.730 | ppb |
| K | 0.0265 | 0.0435 | 0.0592 | 0.0791 | 0.1362 | pct |
| La | 15.428 | 21.689 | 27.143 | 41.522 | 77.704 | ppm |
| Lu | 0.1831 | 0.2357 | 0.3263 | 0.4526 | 0.7193 | ppm |
| Mg | 0.2080 | 0.3725 | 0.4787 | 0.6417 | 1.3334 | pct |
| Mn | 230.14 | 477.81 | 699.60 | 1034.5 | 1934.8 | ppm |
| Mo | 0.3947 | 0.6700 | 0.9924 | 1.5663 | 3.7627 | ppm |
| Na | 0.2872 | 0.8467 | 1.2836 | 1.7251 | 2.2413 | pct |
| Ni | 8.6300 | 16.561 | 24.500 | 42.077 | 100.05 | ppm |
| P | 0.0484 | 0.0610 | 0.0708 | 0.0872 | 0.1336 | pct |
| Pb | 4.1498 | 5.3856 | 6.7746 | 10.074 | 16.617 | ppm |
| Rb | 27.643 | 39.884 | 52.214 | 71.983 | 109.13 | ppm |
| S | 0.0127 | 0.0174 | 0.0246 | 0.0390 | 0.0747 | pct |
| Sb | 0.1888 | 0.4066 | 0.6043 | 0.8881 | 1.6510 | ppm |
| Sc | 5.9939 | 10.471 | 13.695 | 17.061 | 24.502 | ppm |
| Se | 0.1478 | 0.2778 | 0.4458 | 0.7650 | 1.7014 | ppm |
| Sm | 2.6522 | 4.1519 | 5.3883 | 8.2262 | 18.541 | ppm |
| Sr | 12.621 | 24.319 | 35.785 | 49.469 | 96.237 | ppm |
| Tb | 0.5225 | 0.6438 | 0.8384 | 1.2996 | 3.3183 | ppm |
| Th | 2.2607 | 3.9374 | 5.9132 | 13.700 | 31.815 | ppm |
| Ti | 0.0012 | 0.0136 | 0.0486 | 0.0814 | 0.2115 | pct |
| Tl | 0.0328 | 0.0466 | 0.0636 | 0.0866 | 0.1405 | ppm |
| U | 1.0246 | 1.7574 | 2.5305 | 3.7660 | 7.6317 | ppm |
| V | 12.096 | 26.312 | 49.643 | 65.940 | 99.243 | ppm |
| Zn | 41.389 | 54.190 | 63.085 | 75.104 | 106.30 | ppm |

Table 1: Table showing percentiles of the distributions of 42 elements over the region of the geologic map of Figure 4 that excludes the pale yellow areas representing the overburden.