



GEOCHEMICAL VARIABILITY IN SURFICIAL MATERIALS BASED ON CANADA-WIDE AND NEW BRUNSWICK DATASETS

Eric C. Grunsky

Natural Resources Canada-Geological Survey
of Canada





Canada-Wide Study



Data from Geochemical Surveys

Earth Sciences Sector

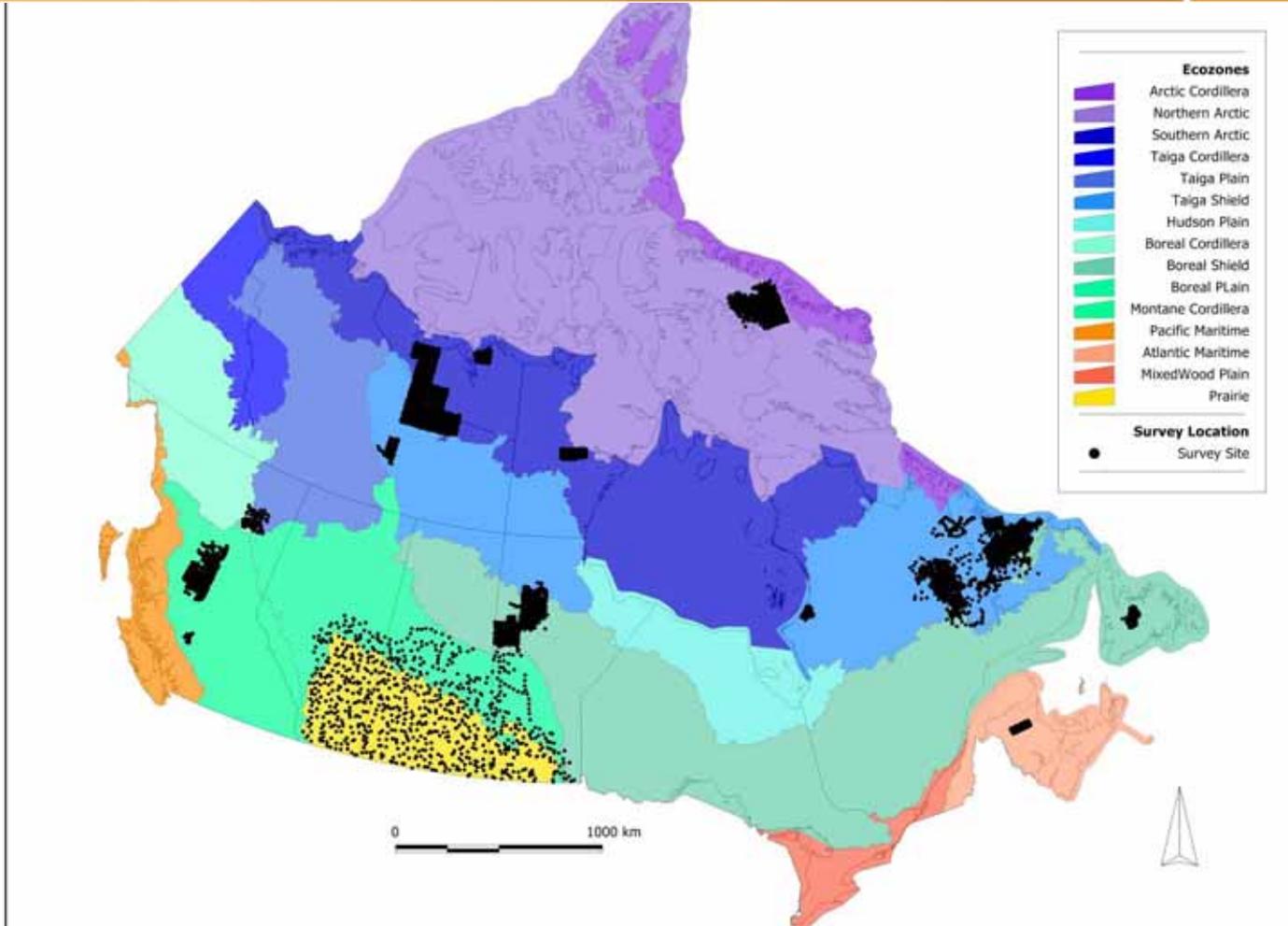


- As part of a project set up to estimate background concentrations in surficial media, geochemical data were taken from till surveys undertaken across Canada and merged.
- 17 surveys were used where raw data were directly comparable – i.e. collected from till, sieved to <63 micron, and analyzed using same or similar Aqua Regia variants. Results of study were released as Geological Survey of Canada, Open File 5084 (Rencz et al., 2006). This merged data set is the basis of the analyses that follow.
- Eco-classification system used is the State of the Environment Reporting spatial framework maintained by the CANSIS group at Agriculture and Agri-Food Canada (Ecological Stratification Working Group. 1996) .
- Geological provinces from Atlas of Canada
<http://atlas.nrcan.gc.ca/site/english/maps/environment/geology/geologicalprovinces>





Sites by Ecozone



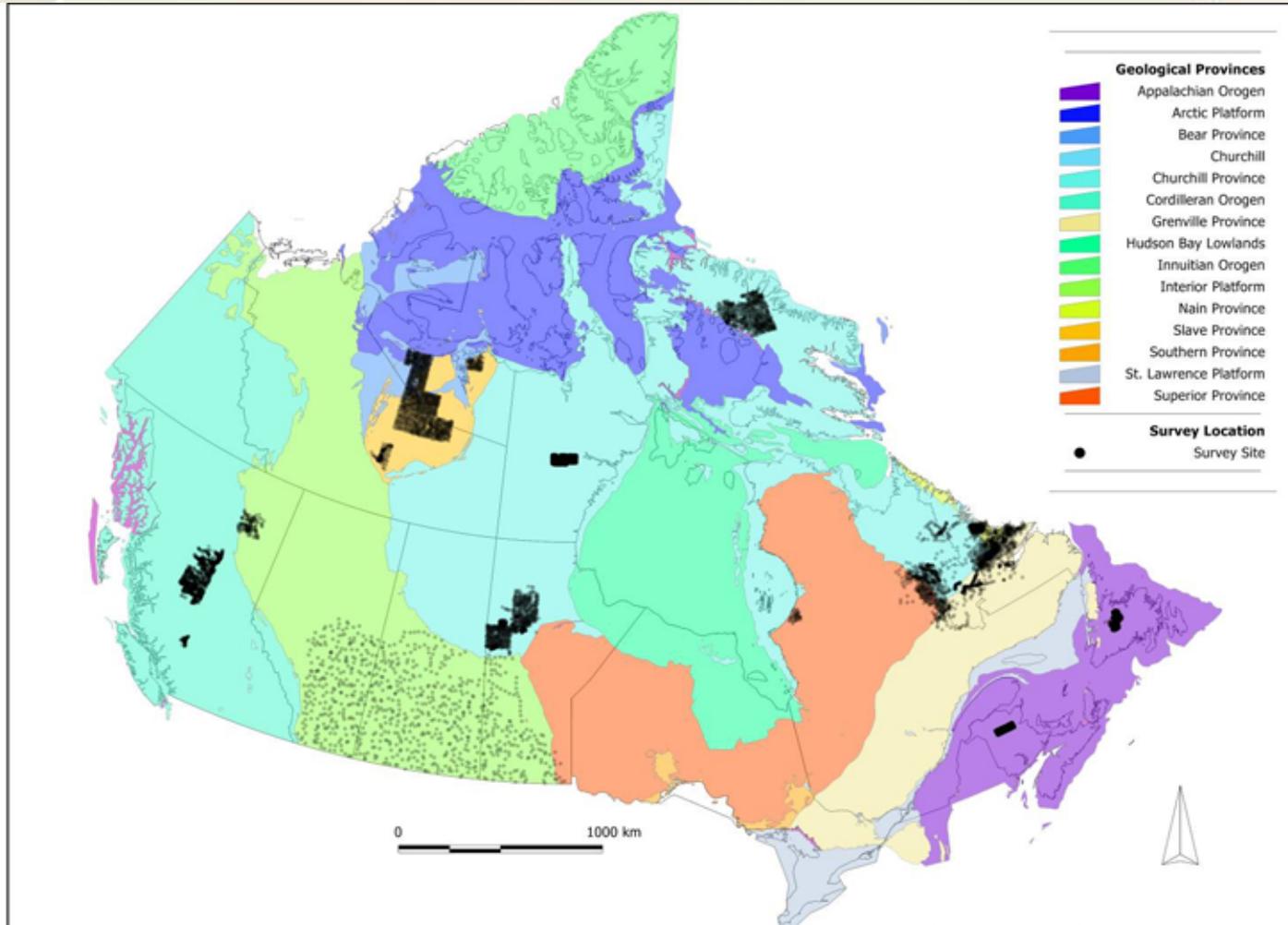
EcoZones

Lambert Conformal Conic
Lon: 87°57'19" W
Lat: 63°18'09" N
Printed at: 2010-02-02





Sites by Geology



Geology

Lambert Conformal Conic
Lon: 86°46'56" W
Lat: 63°14'20" N
Printed at: 2010-02-02

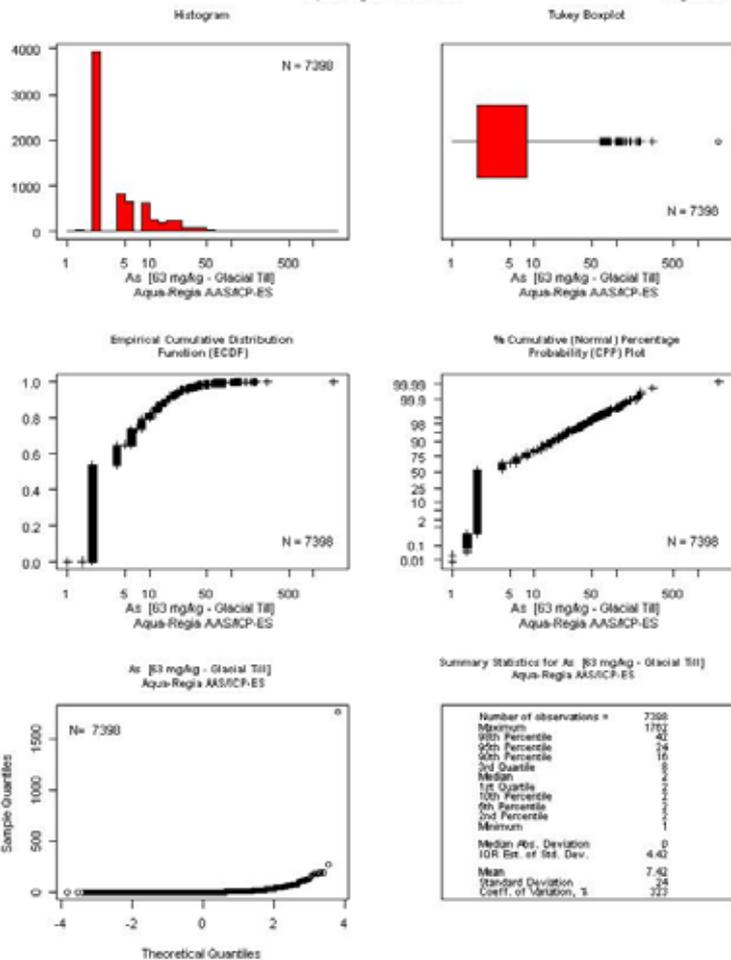


As and Cr Across Canada Aqua Regia



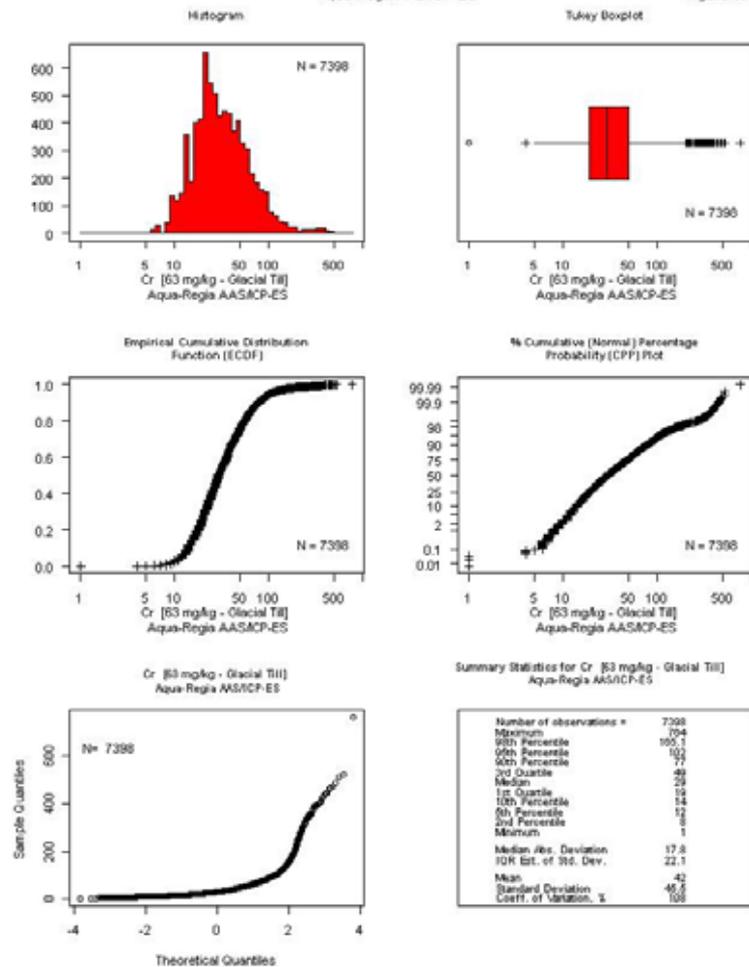
Till Surveys Across Canada
As [63 mg/kg - Glacial Till]
Aqua-Regia AASACP-ES

Figure 64



Till Surveys Across Canada
Cr [63 mg/kg - Glacial Till]
Aqua-Regia AASACP-ES

Figure 66

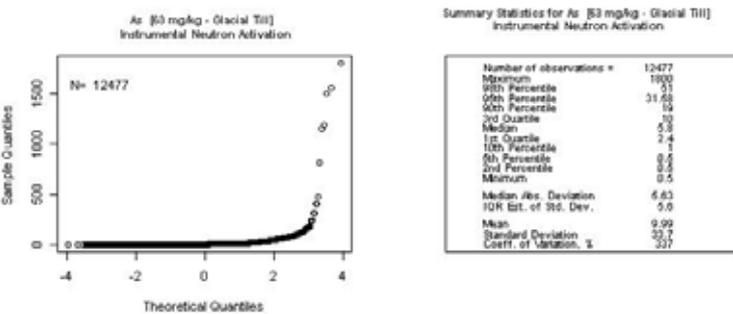
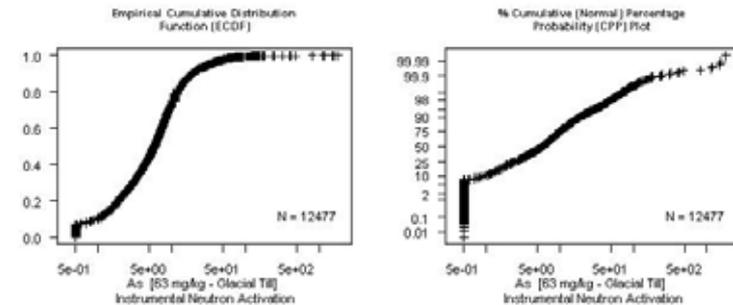
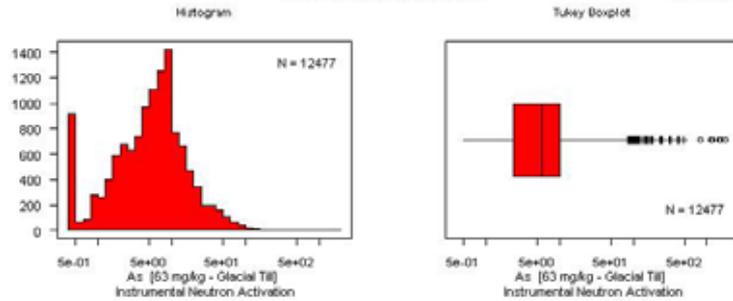


As and Cr Across Canada Neutron Activation



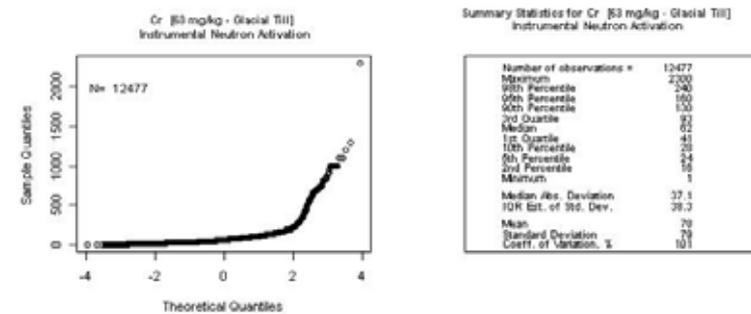
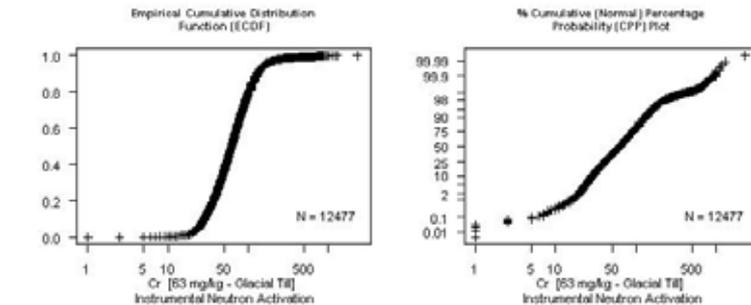
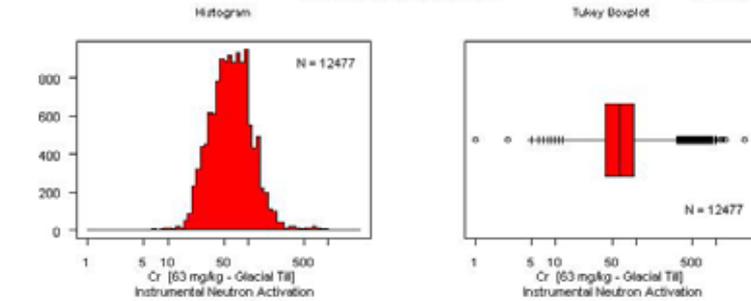
Till Surveys Across Canada
As [63 mg/kg - Glacial Till]
Instrumental Neutron Activation

Figure 73



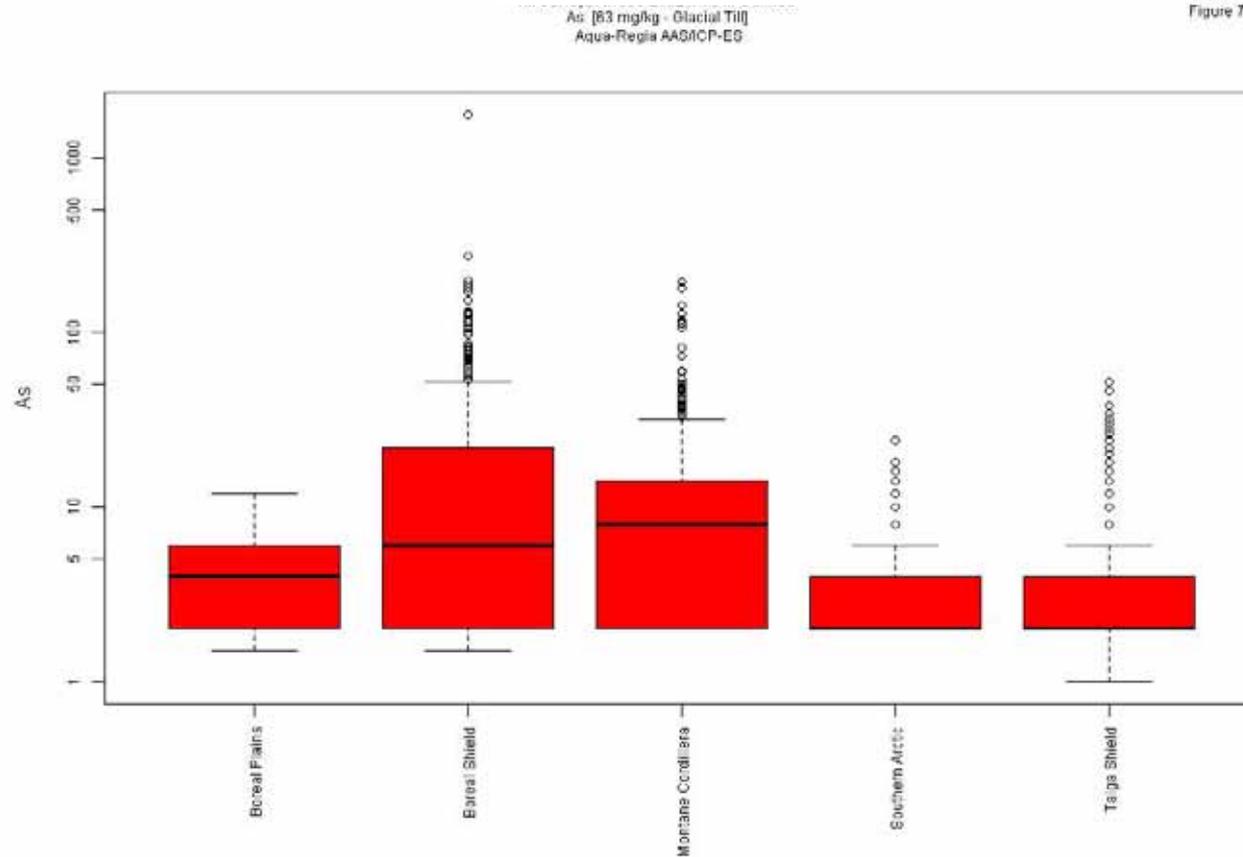
Till Surveys Across Canada
Cr [63 mg/kg - Glacial Till]
Instrumental Neutron Activation

Figure 75





As – Aqua regia – Till by Ecozone

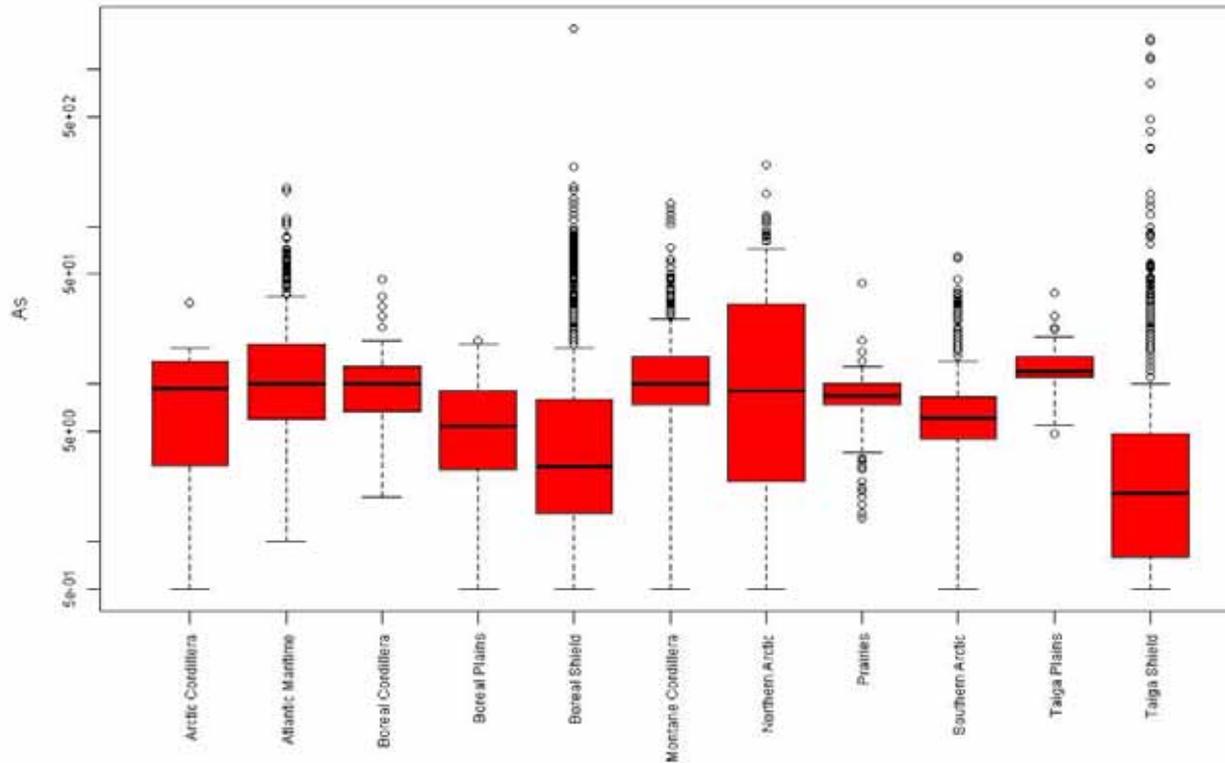




As – Neutron Activation – Till by Ecozone

Till Surveys Across EcoZones in Canada
As (63 mg/kg - Glacial Till)
Instrumental Neutron Activation

Figure 16

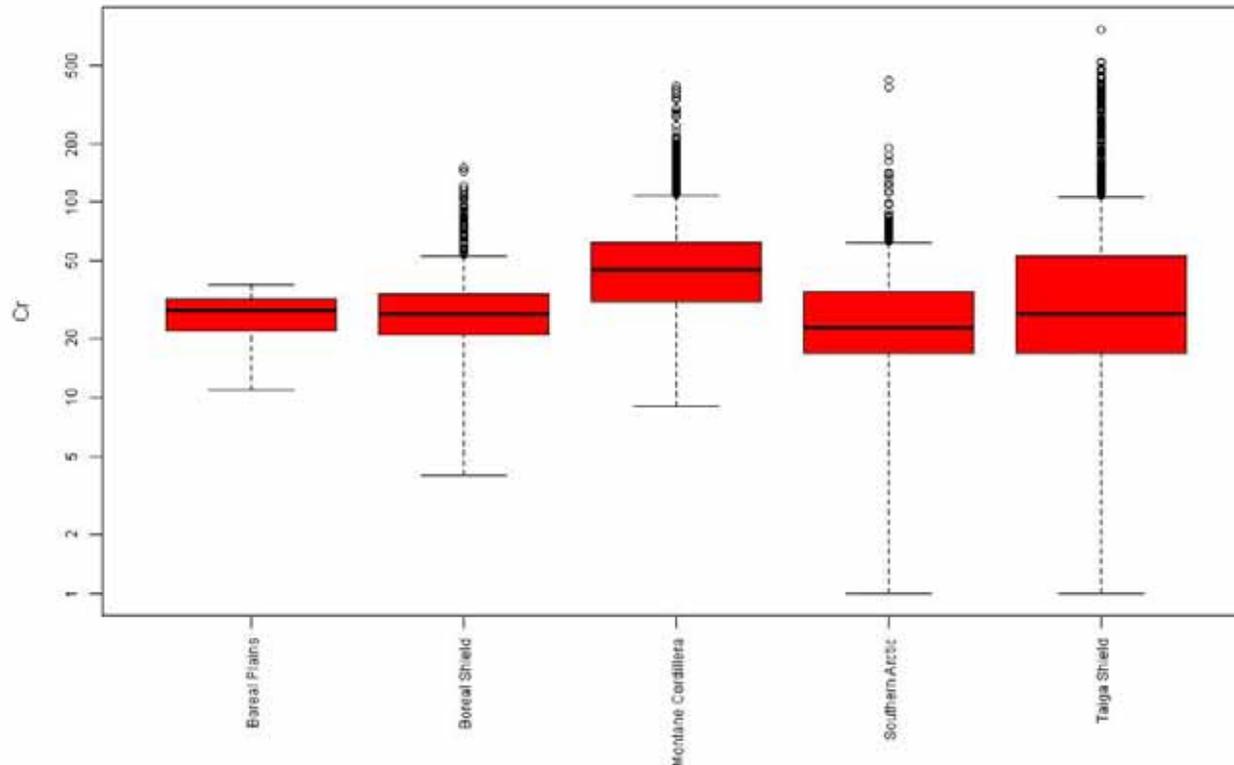




Cr – Aqua regia – Till by Ecozone

Till Surveys Across EcoZones in Canada
Cr [63 mg/kg - Glacial Till]
Aqua-Regia AAS/CP-ES

Figure 9

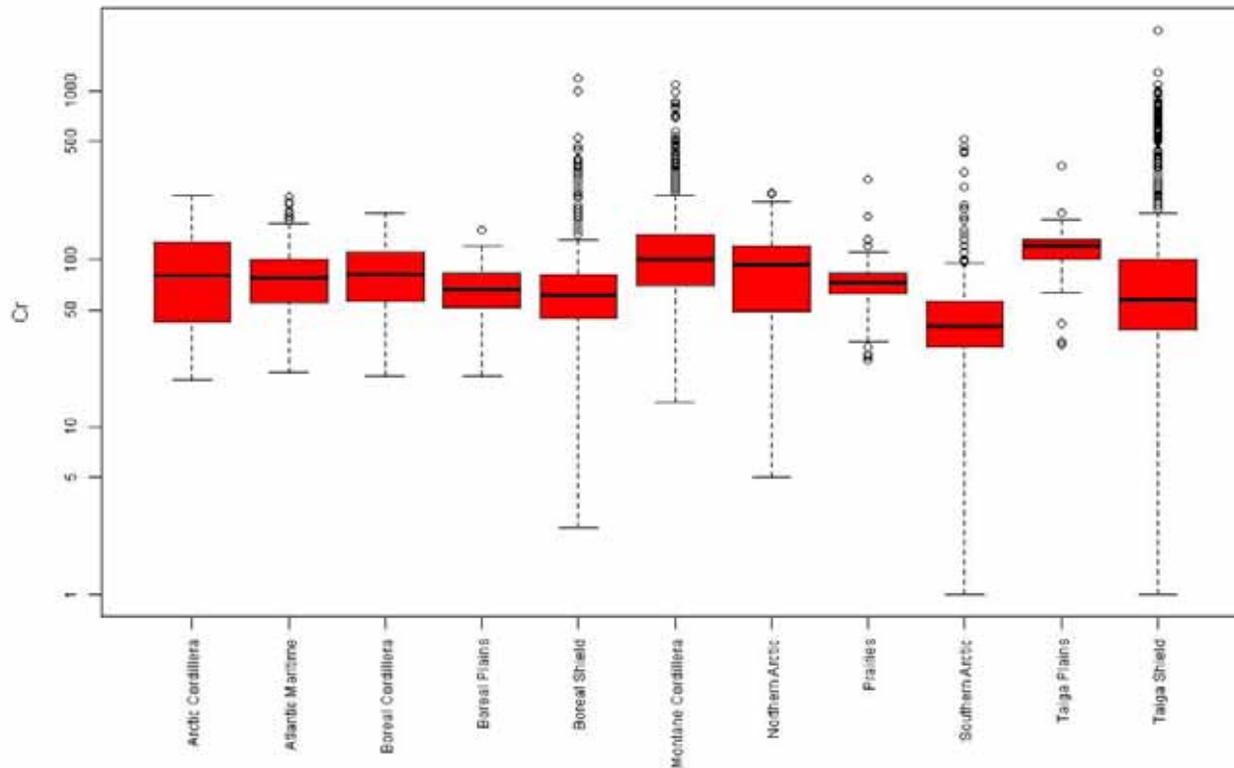




Cr – Neutron Activation – Till by Ecozone

Till Surveys Across EcoZones in Canada
Cr (63 mg/kg - Ofacial Till)
Instrumental Neutron Activation

Figure 18

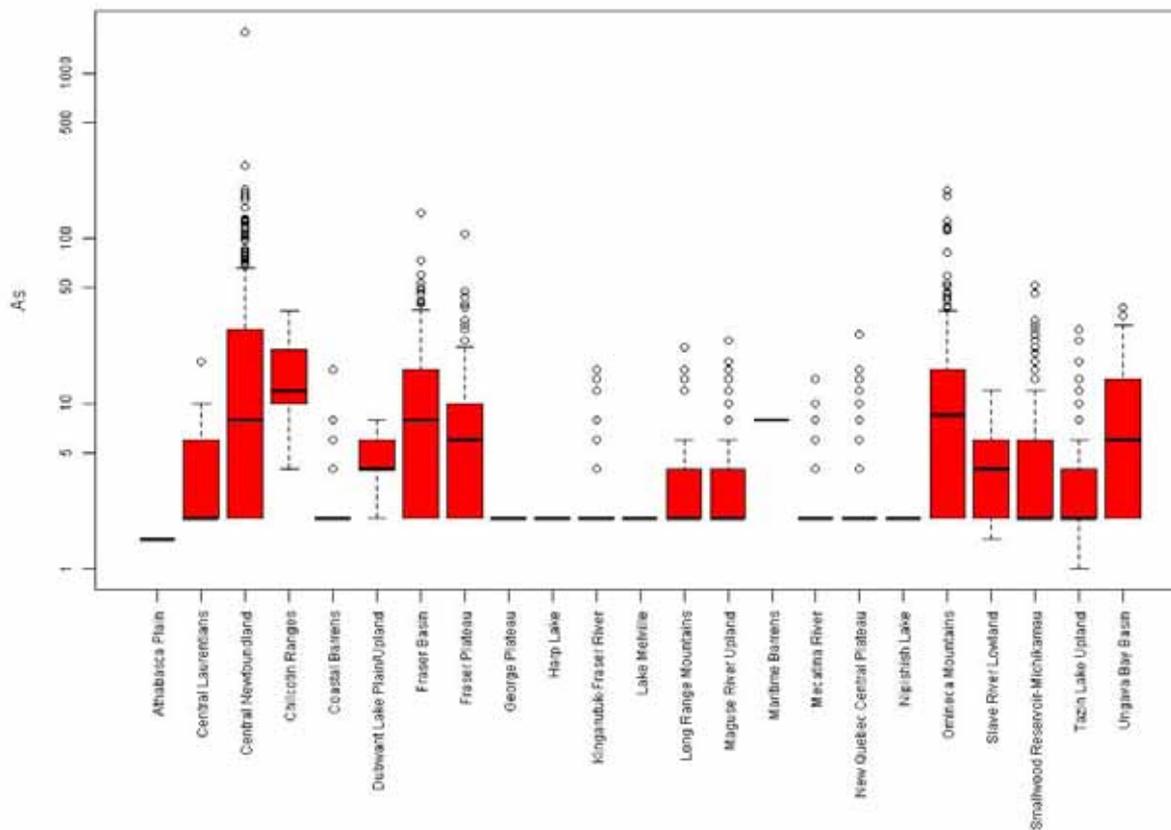


As – Aqua Regia – Till by EcoRegion



Till Surveys Across EcoRegions in Canada
As [63 mg/kg - Glacial Till]
Aqua-Regia AAS/ICP-ES

Figure 26

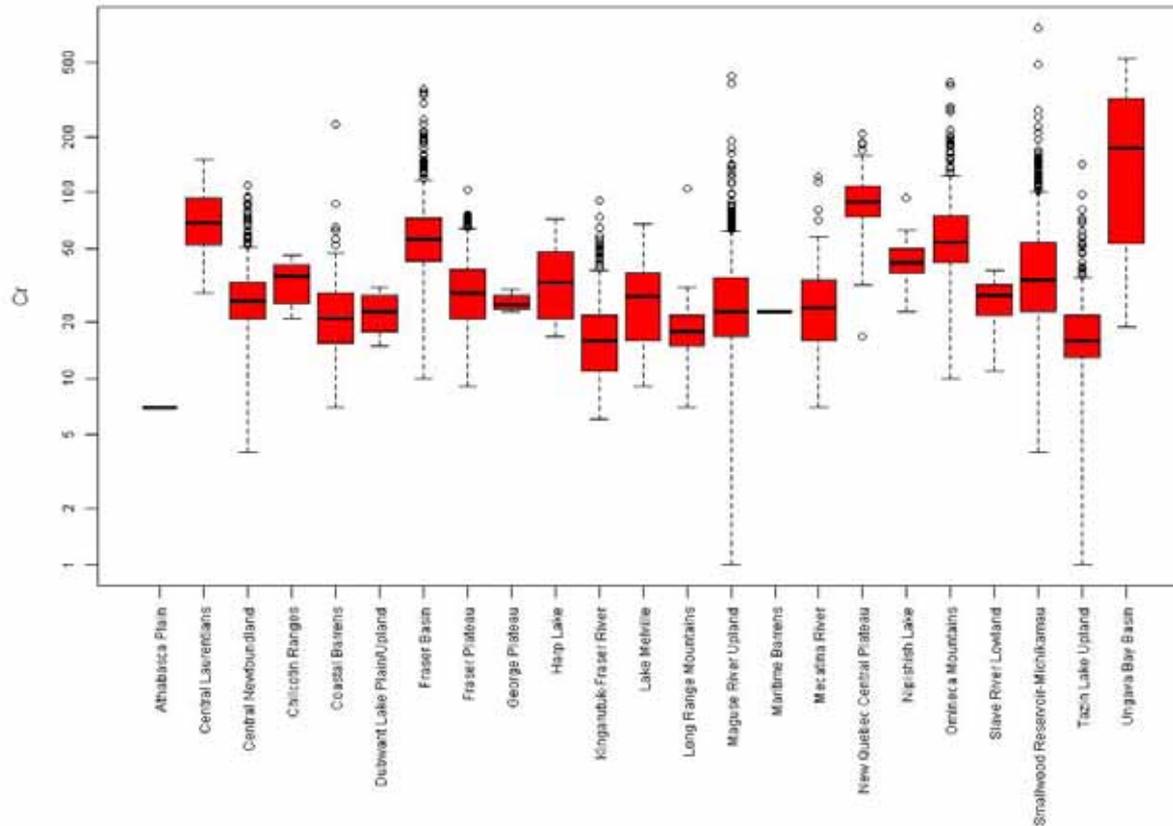


Cr – Aqua Regia – Till by EcoRegion



Till Surveys Across EcoRegions in Canada
Cr (63 mg/kg - Glacial Till)
Aqua-Regia AAS/ICP-ES

Figure 28

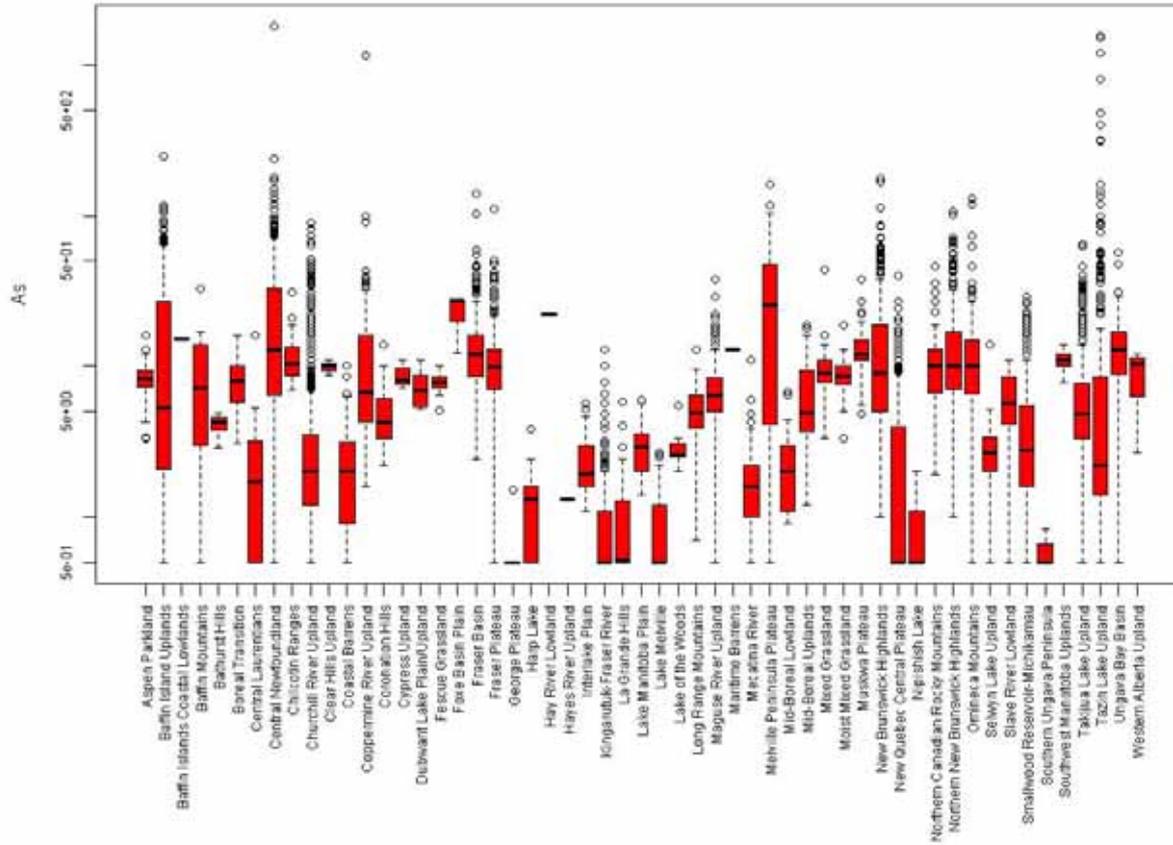




As – Neutron Activation – Till by Ecoregion

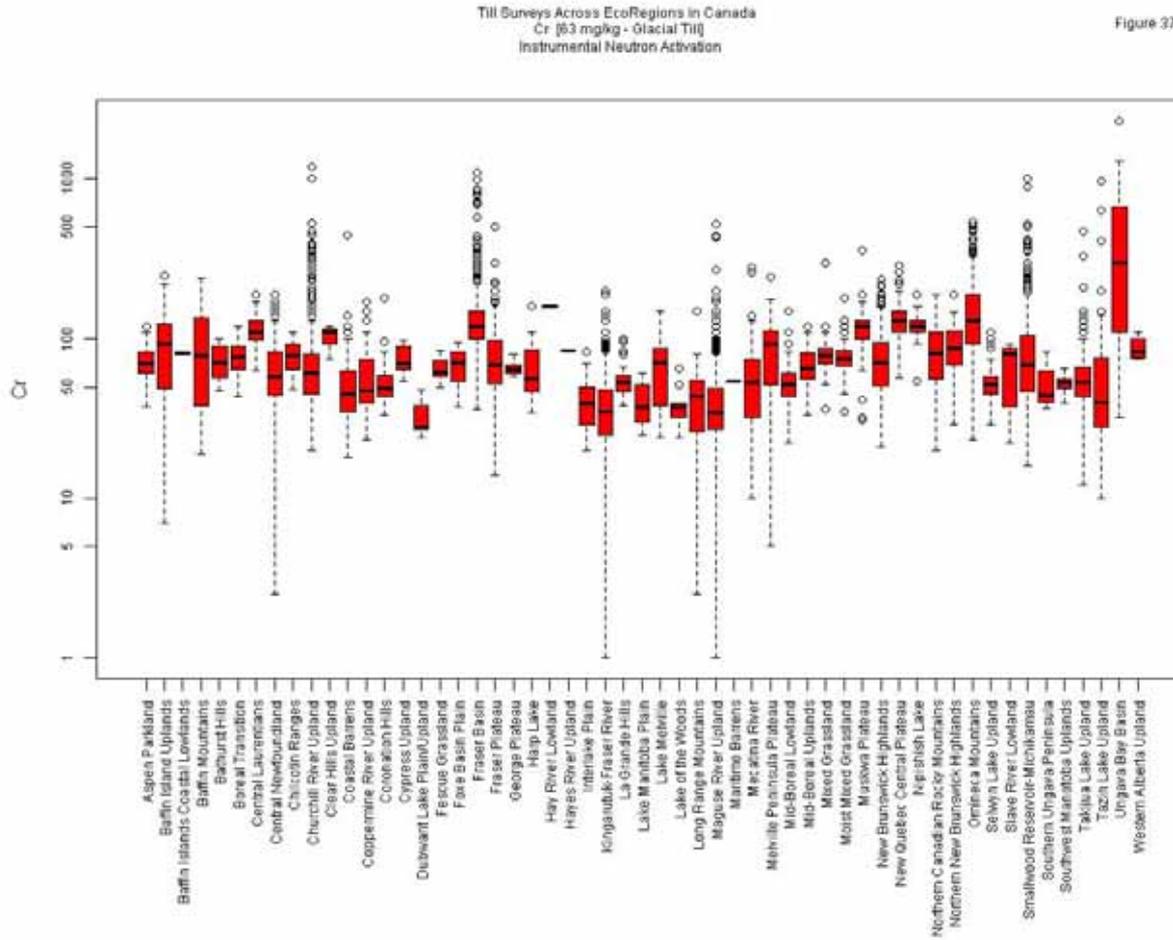
Till Surveys Across EcoRegions in Canada
As [63 mg/kg - Glacial Till]
Instrumental Neutron Activation

Figure 35

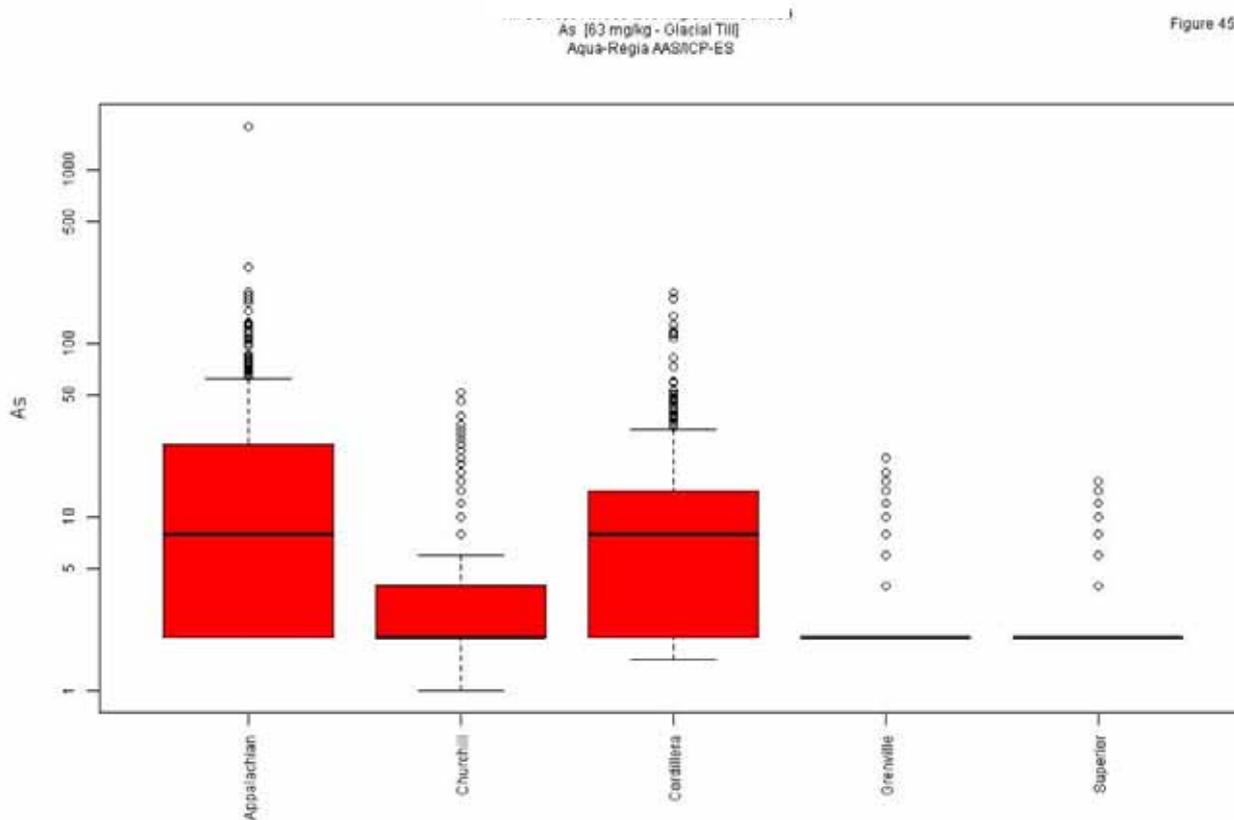




Cr – Neutron Activation – Till by Ecoregion

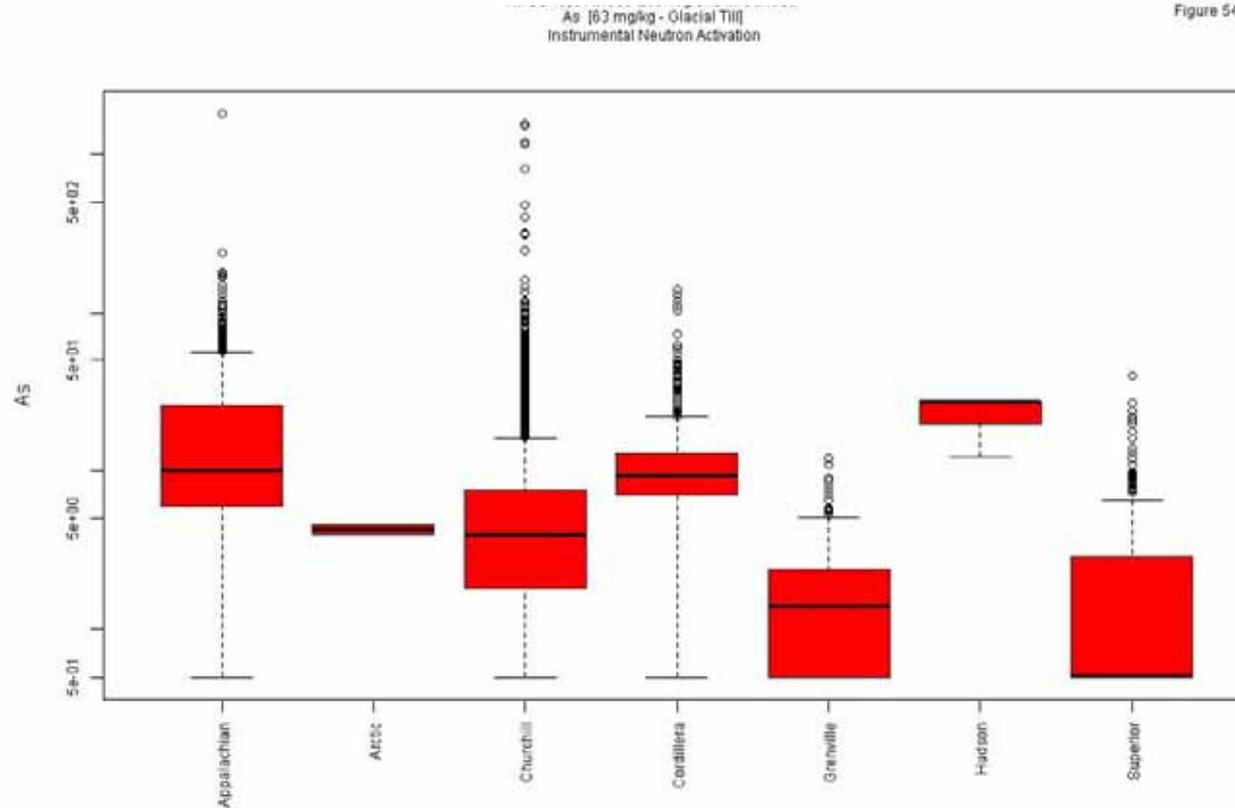


As – Aqua Regia – Till by Geologic Province





As – Neutron Activation – Till by Geologic Province





New Brunswick Study



Till Sampling Surveys in New Brunswick



- Till sampling surveys were undertaken in New Brunswick in the 1980s to the 2000s.
- Data for the <63 micron fraction obtained using an Aqua Regia or variants were used for the analyses that follow.
- The Natural Resource Canada - Geoscience Data Repository links for the surveys used are listed below.
- Eco-classification system used for the analyses that follow is the State of the Environment Reporting spatial framework maintained by the CANSIS group at Agriculture and Agri-Food Canada (Ecological Stratification Working Group. 1996).





Till Sampling Surveys in New Brunswick

Site Count	Title and online link
218	Till sampling survey, NTS 21O/2, north central New Brunswick, 1990-91. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=050004
145	Till sampling survey, NTS 21O/1, north central New Brunswick, 1990-1991. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=050005
124	Till sampling survey, NTS 21P/4, northern New Brunswick, 1993. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130027
264	Till and soil sampling survey, NTS 21O/7 (Nepisiguit Lakes), north central New Brunswick, 1989. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130002
265	Till sampling survey, NTS 21O/3, northwestern New Brunswick, 1989. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130003
292	Till sampling survey, NTS 21G/12 (Forest City), 13 (Fosterville), southwest New Brunswick, 1990-1995. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130004
265	Till sampling survey, Canterbury area, NTS 21G/14 southwest New Brunswick, 1990-1991. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130005
278	Till sampling survey, NTS 21O/15, 22B/1, 2, northern New Brunswick, 1987-1988. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130007
193	Till sampling survey, NTS 21H/11 (Waterford), southern New Brunswick, 1993-1994. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130008
171	Till sampling survey, NTS 21O/15 (Atholville), 21O/16 (Charlo), north central New Brunswick, 1998-1999. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130009





Till Sampling Surveys in New Brunswick

Earth Sciences Sector

499	Till sampling survey, NTS 21G/6, 7, southwestern New Brunswick, 2001-2002. http://qdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130010
48	Till sampling survey, NTS 21H/6 (Salmon River), 21H/10 (Alma), southeastern New Brunswick, early 1990s. http://qdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130011
299	Till sampling survey, NTS 21J/10 (Hayesville), central New Brunswick, 2004. http://qdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130012
1129	Till sampling Survey, NTS 21O/11, 12, 13, 14, northwestern New Brunswick, 1999-2004. http://qdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130013
51	Till sampling survey, NTS 21H/15 (Hillsborough), 21I/3 (Salisbury), 21I/4 (Chipman), Fundy Model Forest area, New Brunswick. http://qdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130014
312	Till sampling survey, McAdam area, NTS 21G/11, southwest New Brunswick, 1991-1994. http://qdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130015
248	Till sampling survey, NTS 21O/10, northern New Brunswick, 1986. http://qdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130016
86	Till sampling survey, NTS 21G/3, southwest New Brunswick, 2002. http://qdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130017
119	Till sampling survey, NTS 21G/10, southwest New Brunswick, 2002. http://qdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130018
300	Till sampling survey, NTS 21H/12 (Sussex), 21G/9 (Hampstead, E½), southern New Brunswick, 1995-1996. http://qdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130019





Till Sampling Surveys in New Brunswick

265	Till sampling survey, NTS 21O/9, northern New Brunswick, 1985. http://gdr.nrcan.gc.ca/geochem/metadatasvy_e.php?key=130020
41	Till sampling survey, Canterbury, NTS 21G/14, southwest New Brunswick, 1995. http://gdr.nrcan.gc.ca/geochem/metadatasvy_e.php?key=130023
135	Till sampling survey, NTS 21H/10, 11, 15, southeast New Brunswick, 1988. http://gdr.nrcan.gc.ca/geochem/metadatasvy_e.php?key=130024
81	Till sampling survey, NTS 21H/6, 11, southeast New Brunswick, 1989. http://gdr.nrcan.gc.ca/geochem/metadatasvy_e.php?key=130025
189	Till sampling survey, NTS 21P/5, northern New Brunswick, 1996. http://gdr.nrcan.gc.ca/geochem/metadatasvy_e.php?key=130026
110	Till sampling survey, NTS 21G/2 (St. George), southwest New Brunswick, 2003. http://gdr.nrcan.gc.ca/geochem/metadatasvy_e.php?key=130028
336	Till sampling, NTS 21J/3, (Millville), southwest New Brunswick, 1995-1998. http://gdr.nrcan.gc.ca/geochem/metadatasvy_e.php?key=130029
114	Till sampling survey, NTS 21J/4 (Woodstock), southwest New Brunswick, 1999. http://gdr.nrcan.gc.ca/geochem/metadatasvy_e.php?key=130030
270	Till sampling, NTS 21H/14 (Petitcodiac), southeastern New Brunswick, 1993 and 1997. http://gdr.nrcan.gc.ca/geochem/metadatasvy_e.php?key=130034
270	Till sampling, NTS 21H/13 (Codys), southern New Brunswick. http://gdr.nrcan.gc.ca/geochem/metadatasvy_e.php?key=130039
306	Till and soil sampling survey, NTS 21O/8 (California Lake), north central New Brunswick, 1990-1991. http://gdr.nrcan.gc.ca/geochem/metadatasvy_e.php?key=130042





Till Sampling Surveys in New Brunswick

341	Till sampling, NTS 21J/6 (Coldstream), 21J/7 (Napadogan), west central New Brunswick, 1998, 2000-2002. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130043
264	Till sampling survey, NTS 21P/12 (Bathurst), 21P/13 (Pointe Verte), northern New Brunswick, 2004-2005. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130044
292	Till sampling survey, NTS 21O/6 (Sisson Branch Reservoir), northern New Brunswick, 2005. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=130045
40	Overburden drilling and till geochemistry survey, 3 areas in northern and western New Brunswick, 1986-1987. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=210035
281	Till samples from a trenching survey, NTS 21J/10, central New Brunswick, 1986 and 1987. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=210036
978	Till sampling survey, northern Miramichi Zone, NTS 21O, P, New Brunswick, 1985. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=210037
1516	Till sampling survey, central Miramichi Zone, NTS 21O,P, J, New Brunswick, 1985-1987. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=210038
705	Till sampling survey, southern Miramichi Zone, NTS 21J, G, New Brunswick, 1985. http://gdr.nrcan.gc.ca/geochem/metadata_svy_e.php?key=210039
Total - 11840	

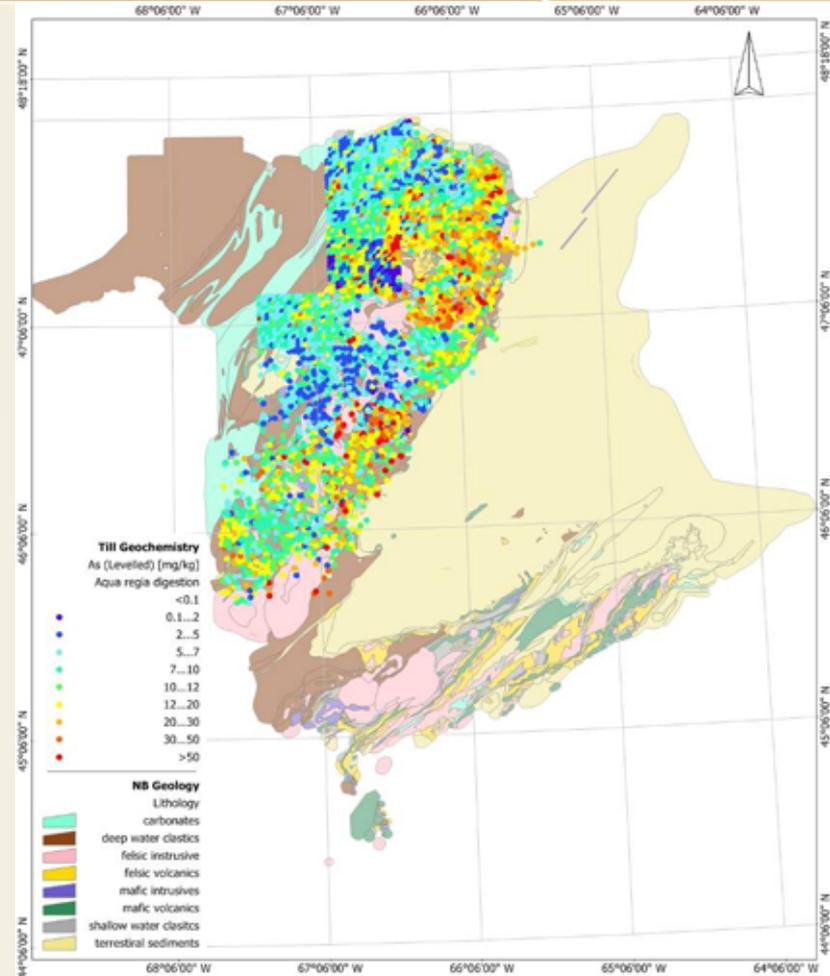
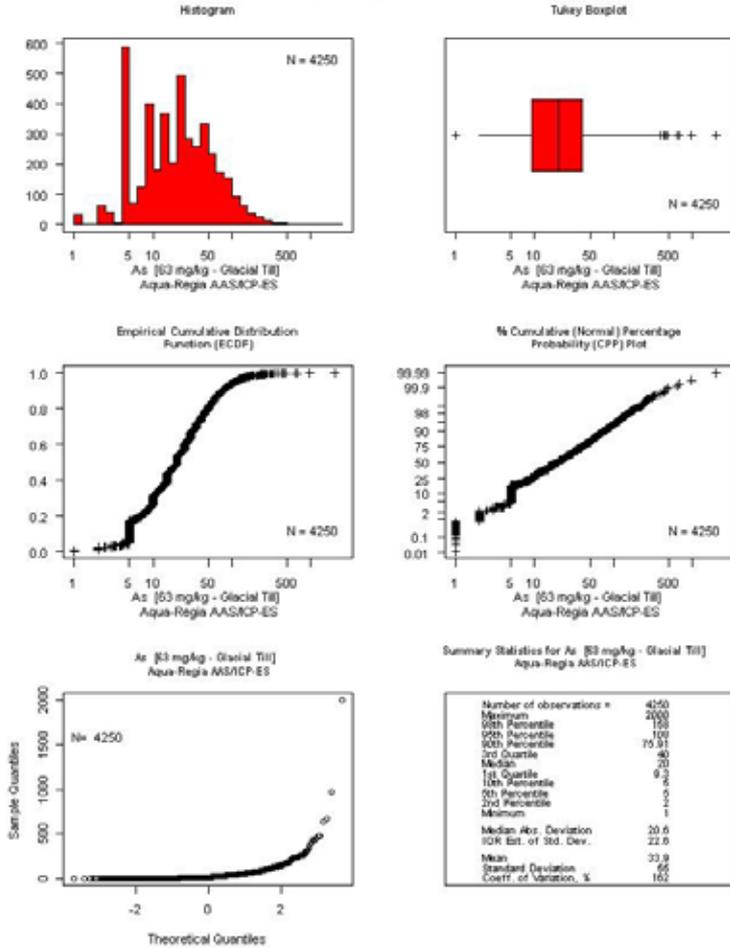




As – Till – Aqua Regia New Brunswick

New Brunswick Till Surveys
As [63 mg/kg - Glacial Till]
Aqua-Regia AAS/CP-ES

Figure 64



As - Till - Aqua Regia
< 63 micron

Universal Transverse Mercator - Zone 19
Lon: 66°22'48" W
Lat: 46°17'10" N
Printed at: 2010-01-22

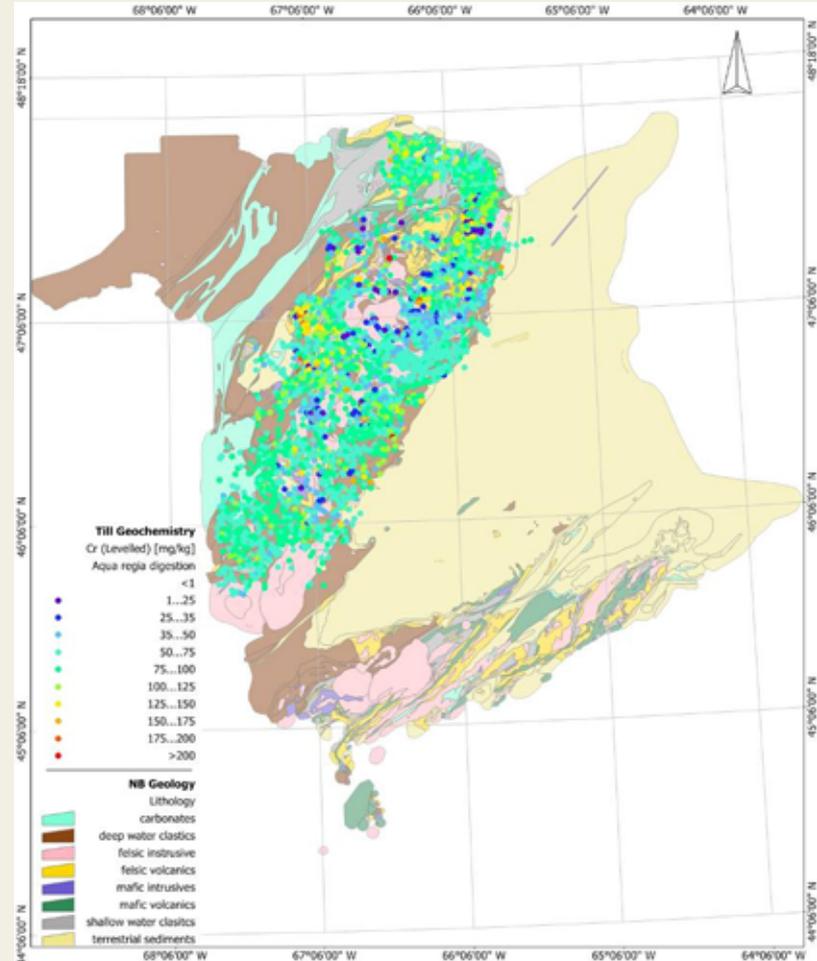
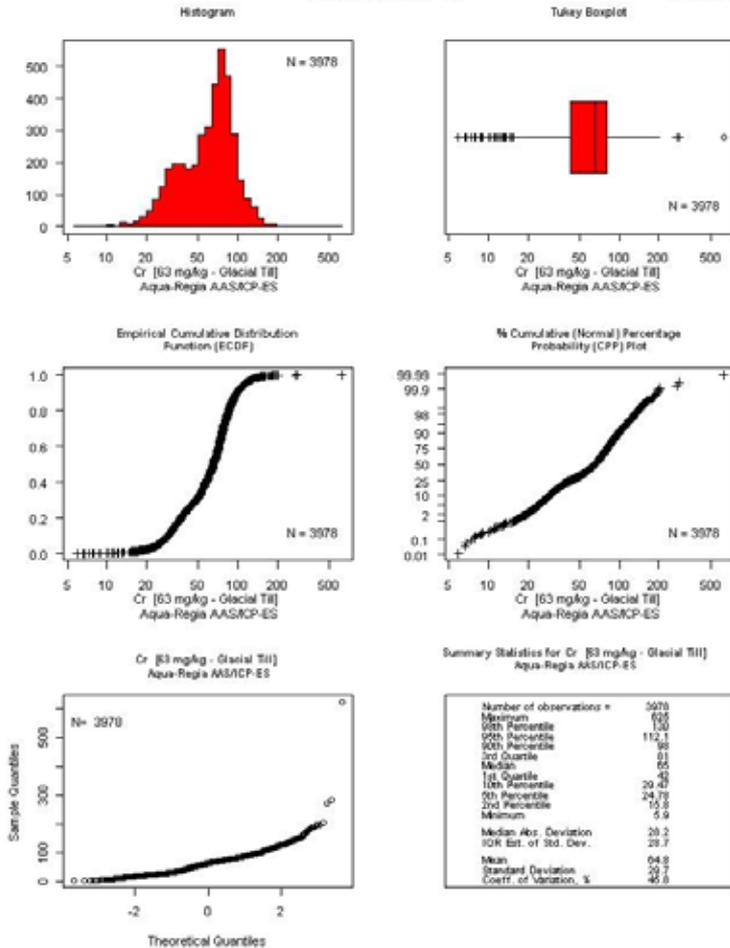




Cr – Till – Aqua Regia New Brunswick

New Brunswick Till Surveys
Cr [63 mg/kg - Glacial Till]
Aqua-Regia AAS/CP-ES

Figure 69



Cr - Till - Aqua Regia
< 63 micron

Universal Transverse Mercator - Zone 19
Lon: 66°22'48" W
Lat: 46°17'10" N
Printed at: 2010-01-22

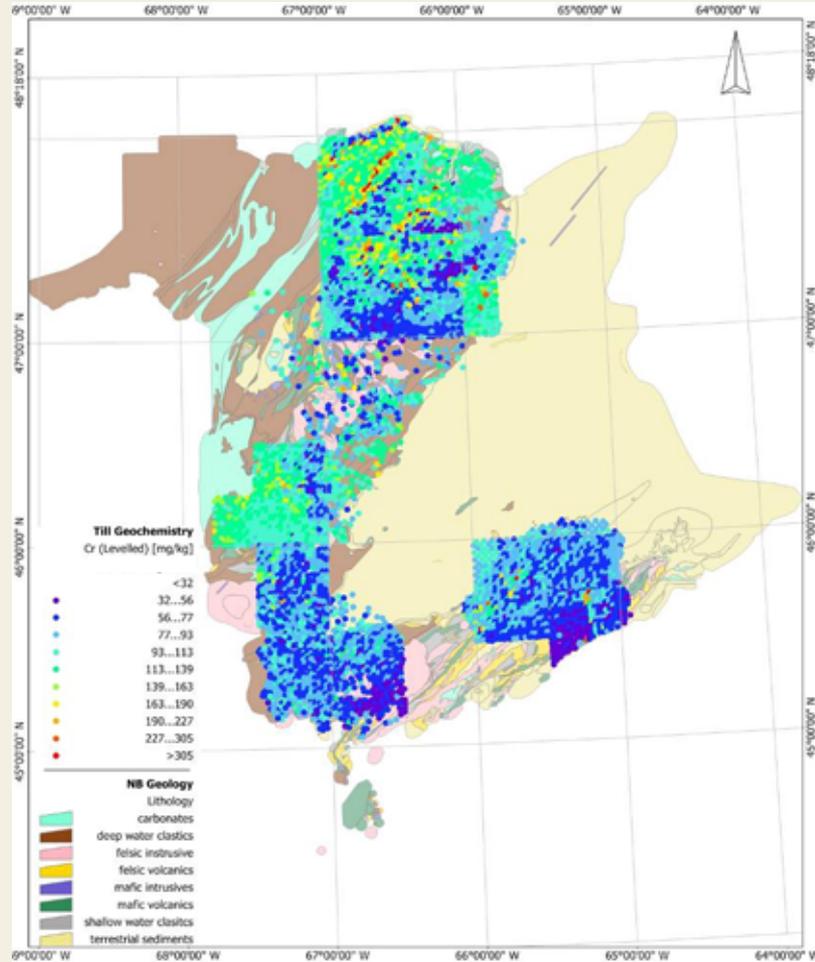
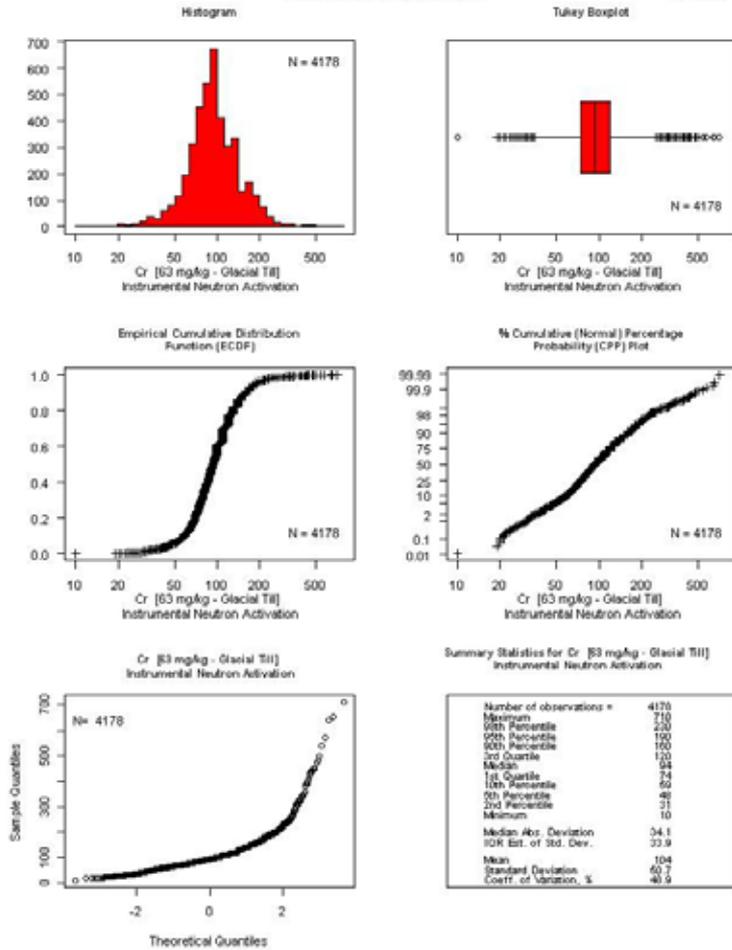




Cr – Till – Neutron Activation New Brunswick

New Brunswick Till Surveys
Cr [63 mg/kg - Glacial Till]
Instrumental Neutron Activation

Figure 04



Cr - Till

< 63 micron

Universal Transverse Mercator - Zone 19
Lon: 66°22'48" W
Lat: 46°17'10" N
Printed at: 2010-01-22

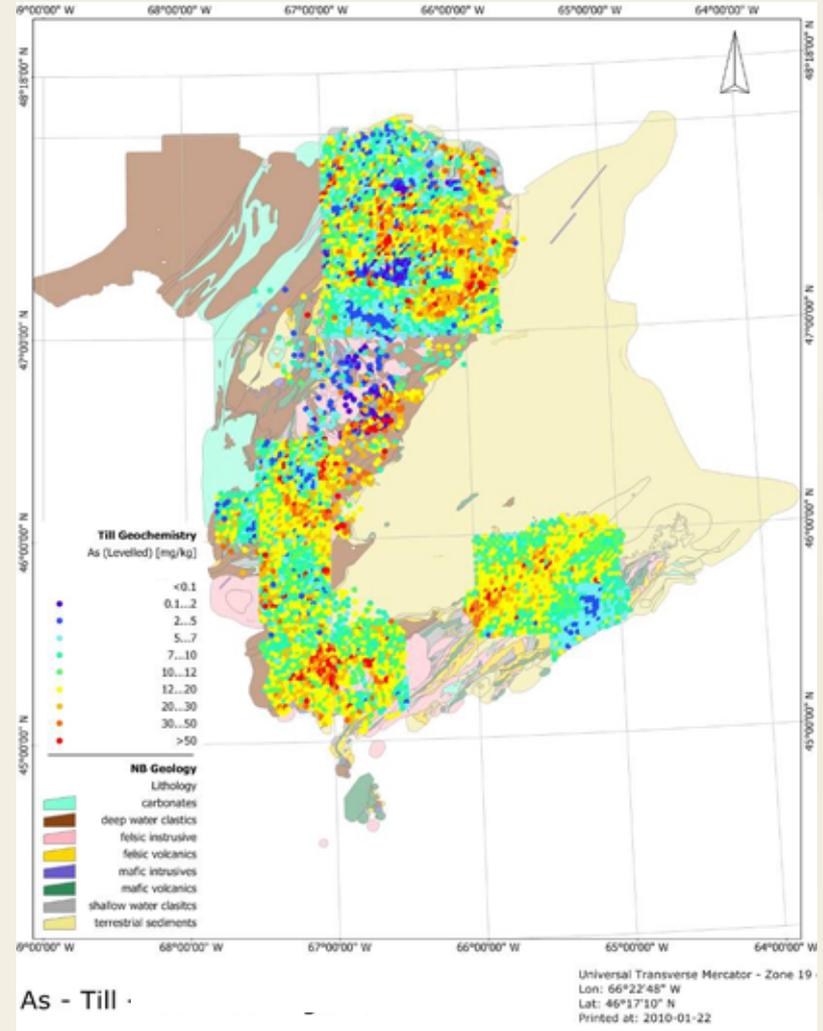
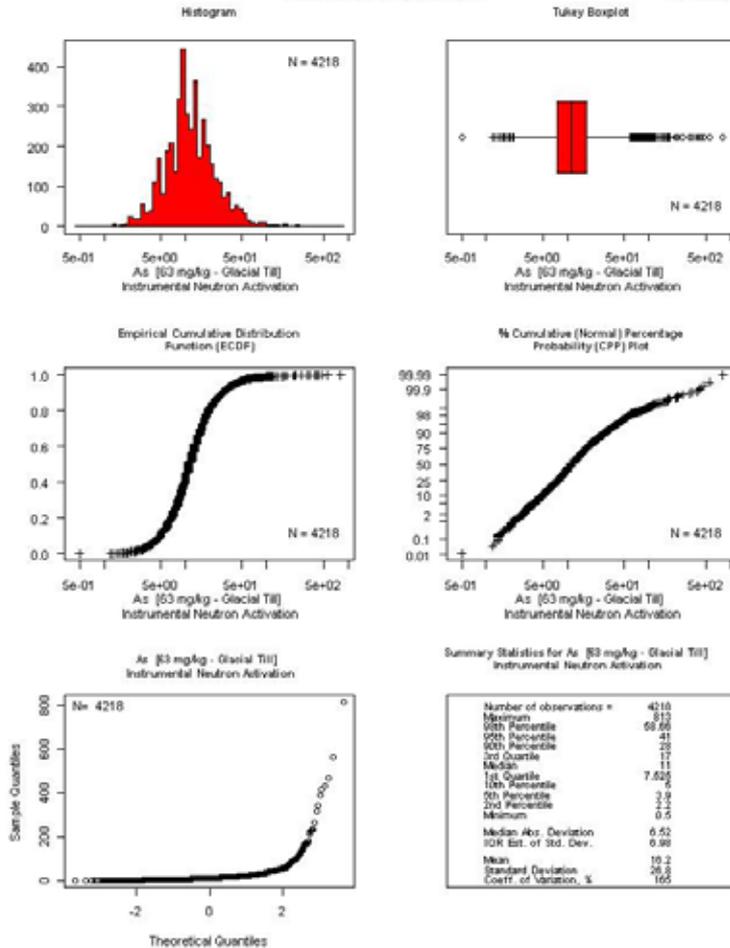




As – Till – Neutron Activation New Brunswick

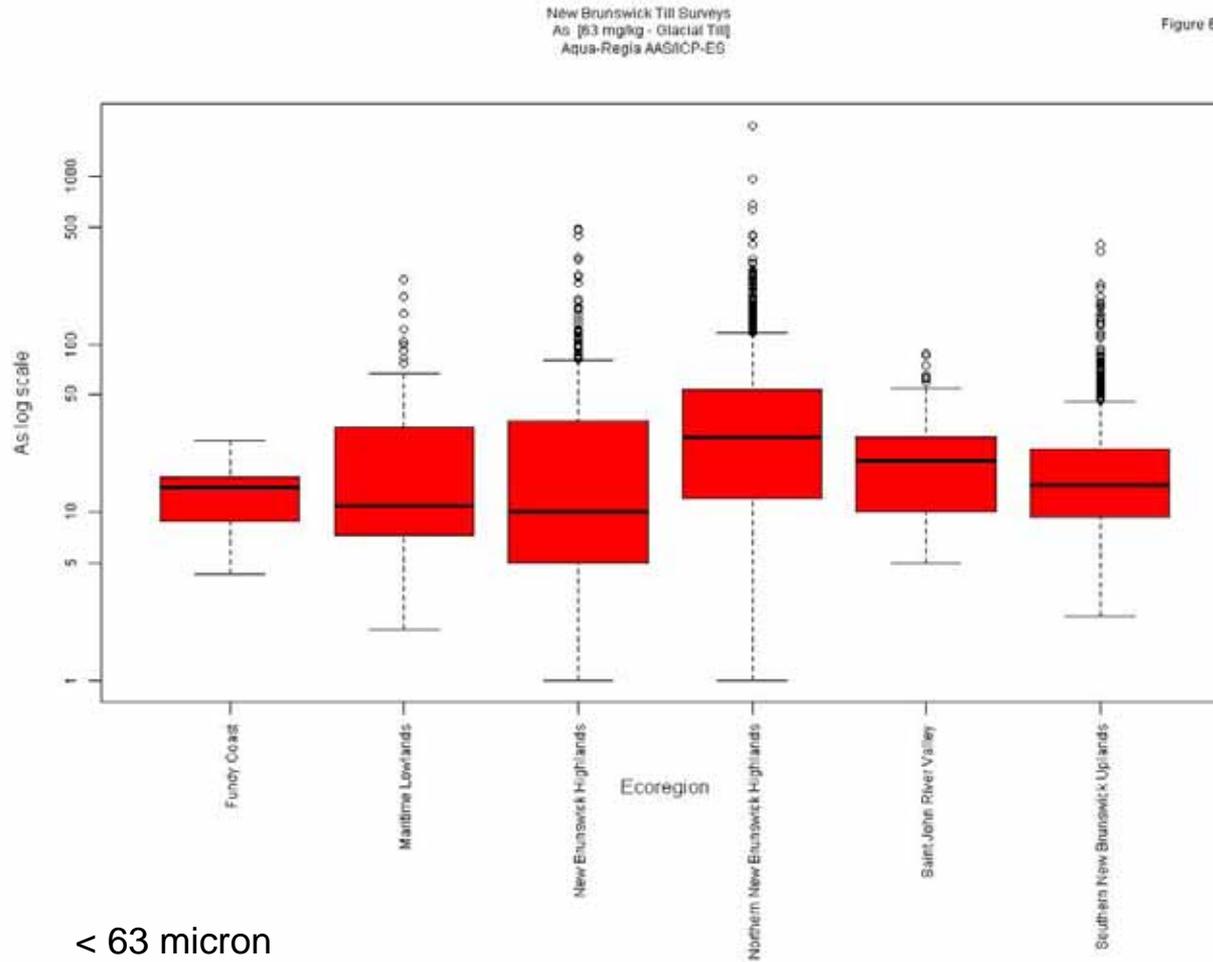
New Brunswick Till Surveys
As [63 mg/kg - Glacial Till]
Instrumental Neutron Activation

Figure 01



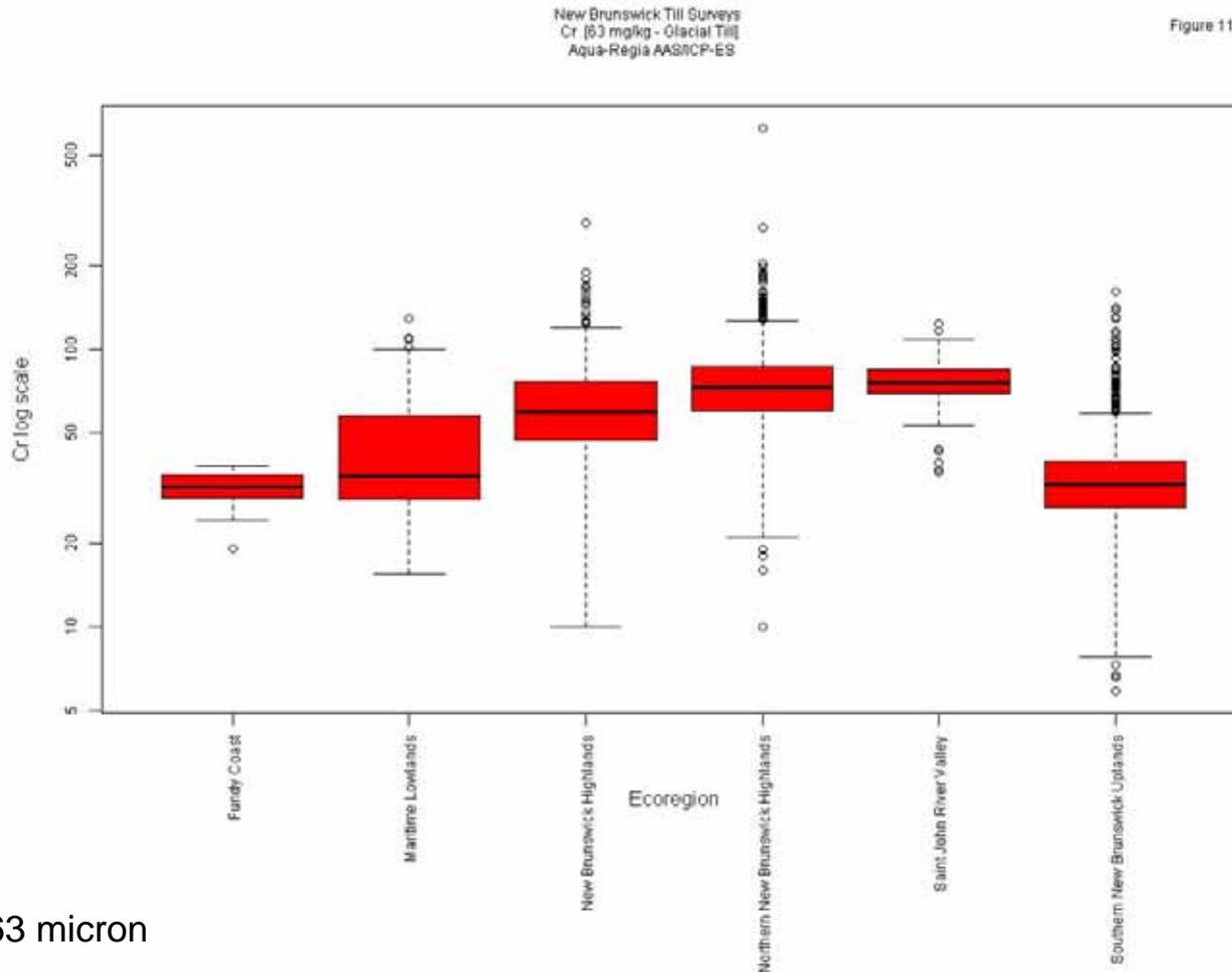


As – Aqua regia – Till by Ecoregion



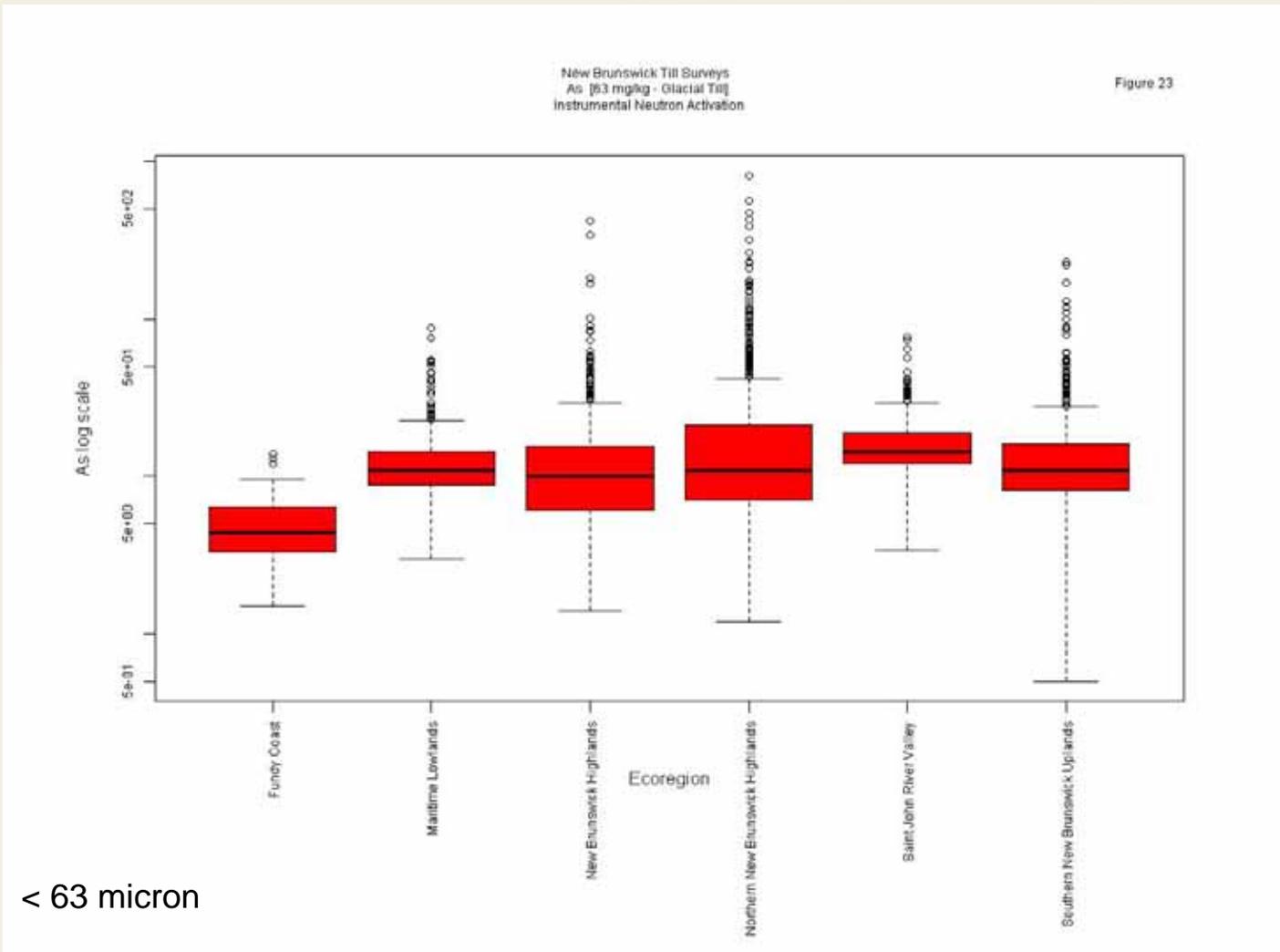


Cr – Aqua regia – Till by Ecoregion





As – Neutron Activation – Till by Ecoregion

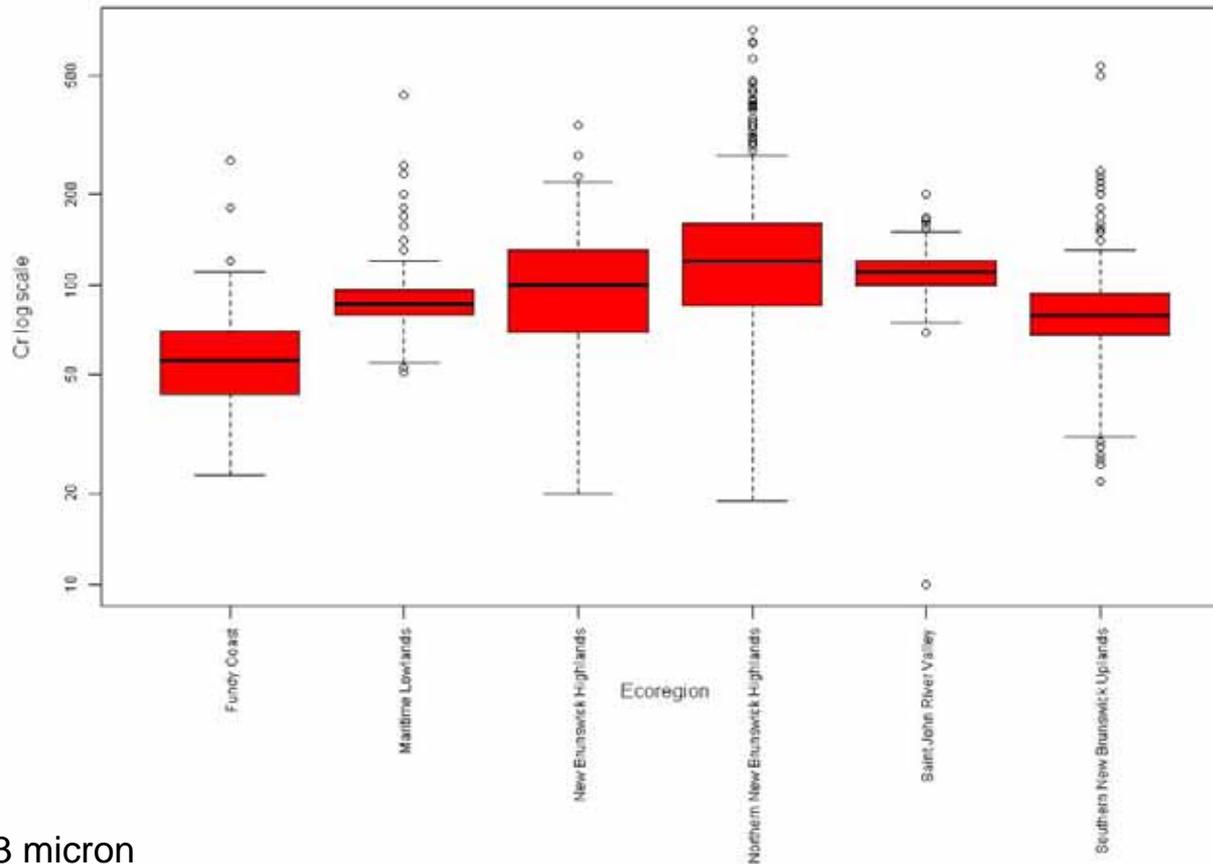




Cr – Neutron Activation – Till by Ecoregion

New Brunswick Till Surveys
Cr [63 mg/kg - Glacial Till]
Instrumental Neutron Activation

Figure 26

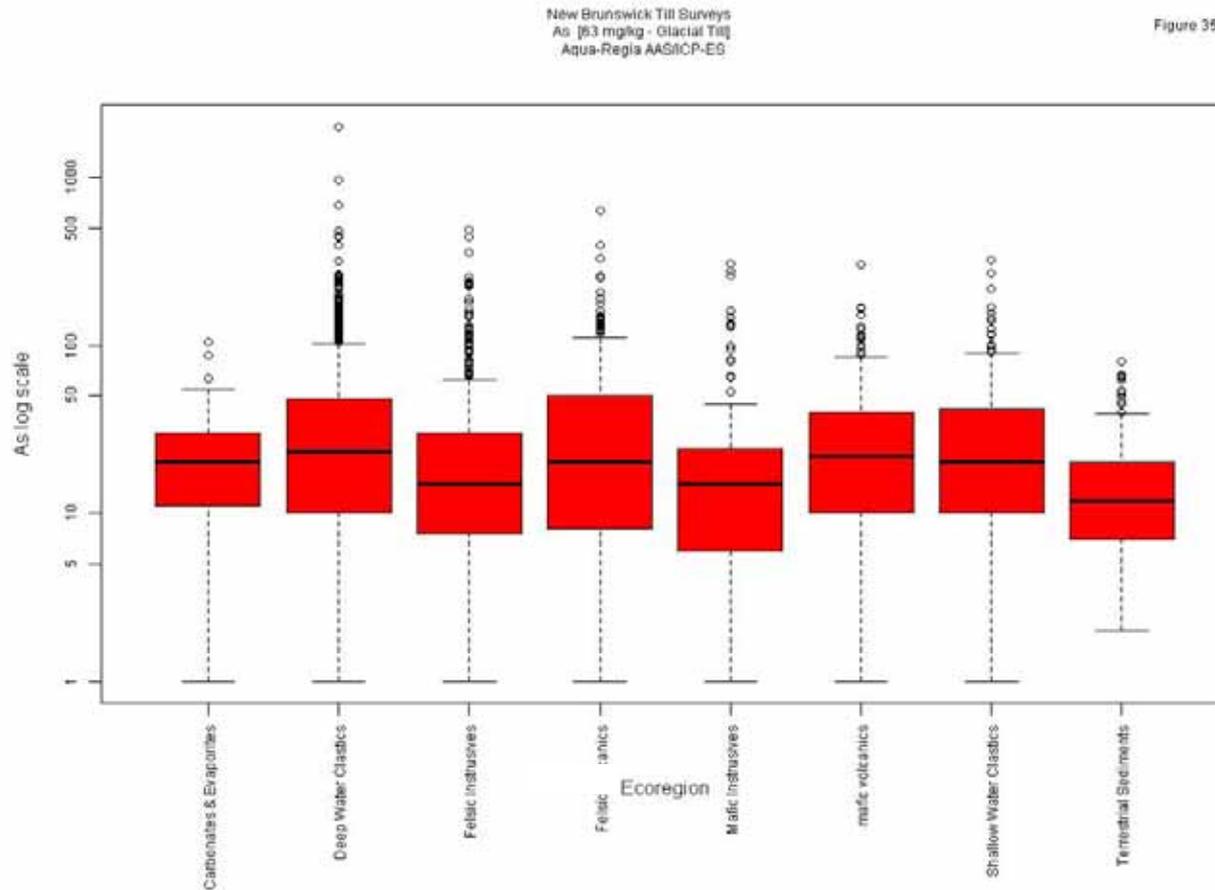


< 63 micron





As – Aqua Regia – Till by Bedrock Lithology



< 63 micron

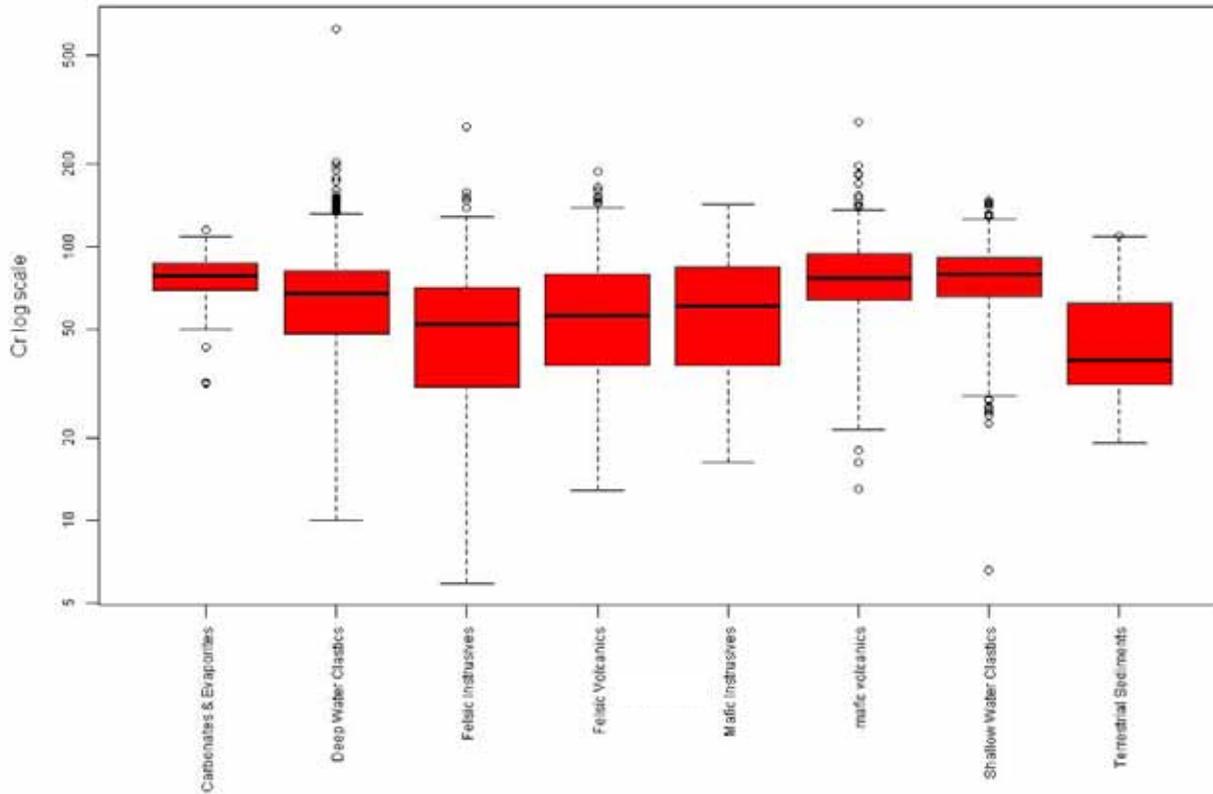




Cr – Aqua regia – Till by Bedrock Lithology

New Brunswick Till Surveys
Cr (63 mg/kg - Glacial Till)
Aqua-Regia AAS(ICP-ES)

Figure 40



< 63 micron

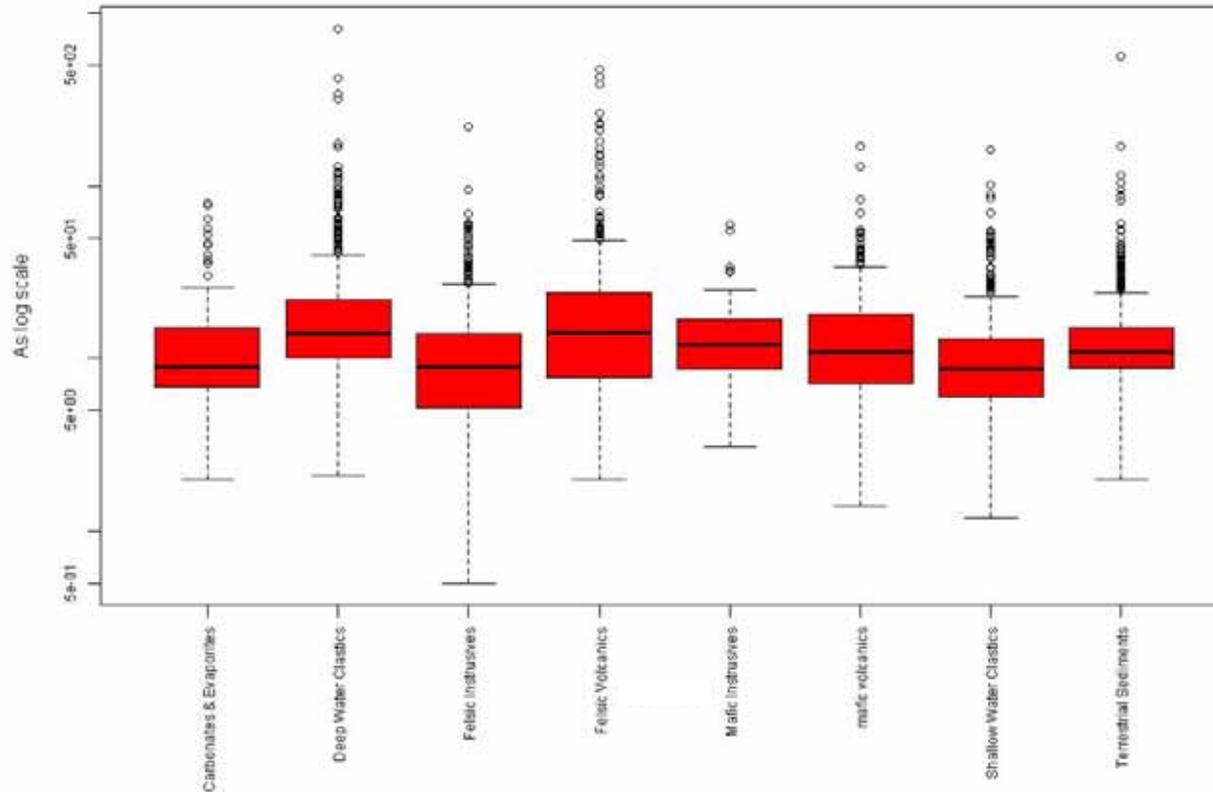




As – Neutron Activation – Till by Bedrock Lithology

New Brunswick Till Surveys
As [63 mg/kg - Glacial Till]
Instrumental Neutron Activation

Figure 52



< 63 micron

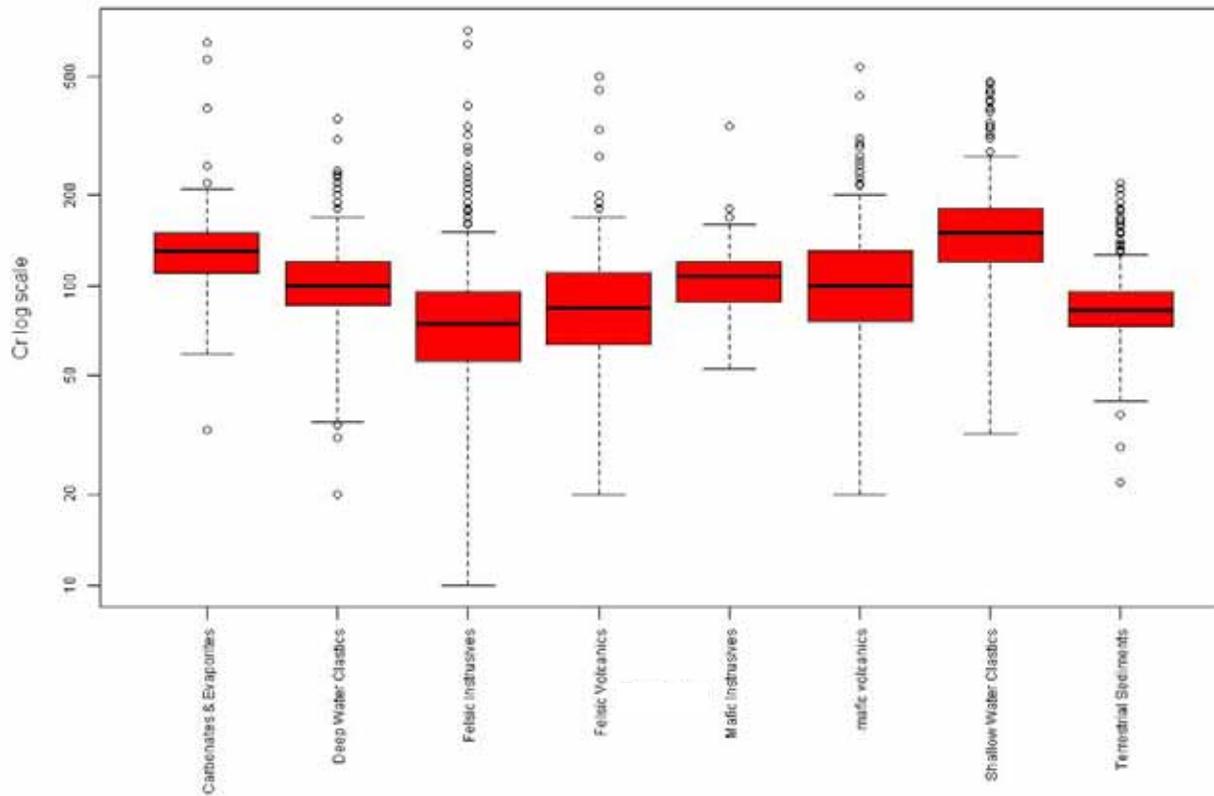




Cr – Neutron Activation – Till by Bedrock Lithology

New Brunswick Till Surveys
Cr [63 mg/kg - Glacial Till]
Instrumental Neutron Activation

Figure 55



< 63 micron



Recommendations

Earth Sciences Sector

Choose a sample density that will suit the purpose of the project.

Determine the influence of bedrock, soil, ecoregion and culture by using graphical tools for the display of element variability (box plots).



Natural Resources
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Ressources naturelles
Canada

Canada



Other Considerations When Using Legacy Data





Interpretation of Geochemical Survey Data

Earth Sciences Sector

- Geochemical data derived from government geochemical surveys are difficult to assemble and integrate due to the use of different spatial resolution, size fractions, and methods of digestion and analytical instrumentation.
- The assembly of these data is a challenge but the results provide opportunities for discovering a wider range of geochemical processes using advanced methods of statistical analysis.
- Many of the topics related to integrating geochemical data sets are covered in Grunsky (2010).



Natural Resources
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Ressources naturelles
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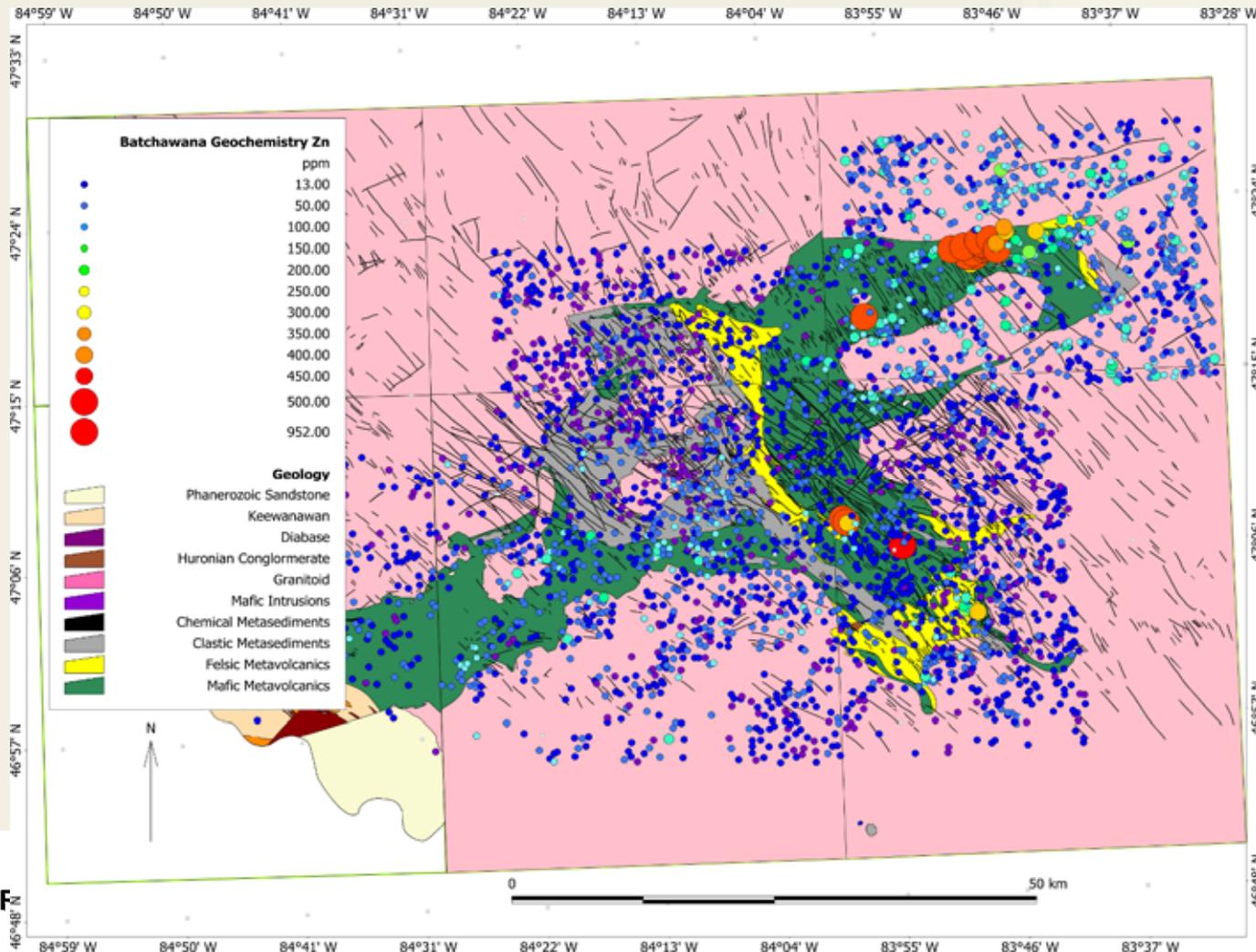


Interpretation of Geochemical Survey Data

Example – Lake sediment data from the Batchawana area (Grunsky, 2010)

Zn

3047 lake sediment samples collected between 1989-1995





Sources of Batchawana Data

Earth Sciences Sector

- FORTESCUE, J.A.C. and VIDA, E.A., 1989, Geochemical Survey of the Trout Lake Area; Ontario Geological Survey, Map 80803.
- FORTESCUE, J.A.C. and VIDA, E.A., 1990, Geochemical Survey, Hanes Lake Area; Ontario Geological Survey, Map 80806.
- FORTESCUE, J.A.C. and VIDA, E.A., 1991a, Geochemical Survey, Montreal River Area; Ontario Geological Survey, Map 80808.
- FORTESCUE, J.A.C. and VIDA, E.A., 1991b, Geochemical Survey, Pancake Lake Area; Ontario Geological Survey, Map 80807.
- HAMILTON, S., 1995, Lake Sediment Geochemistry of the Cow River Area, Ontario Geological Survey, Open File Report 5917.



Natural Resources
Canada

Ressources naturelles
Canada

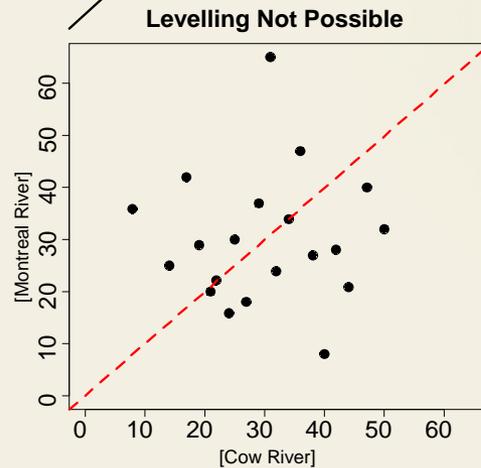
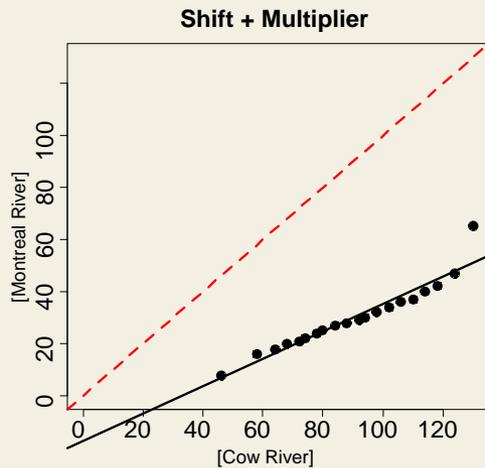
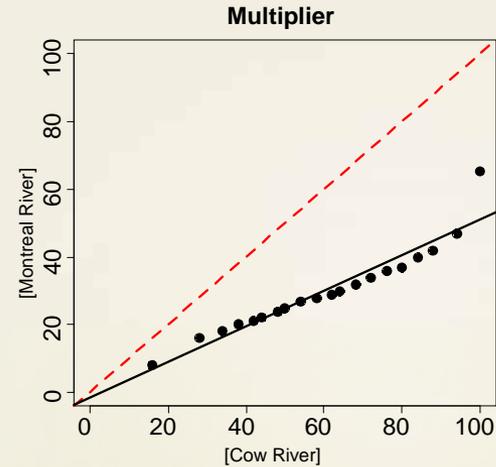
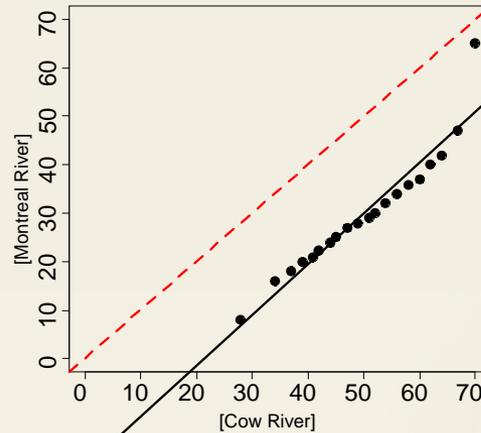
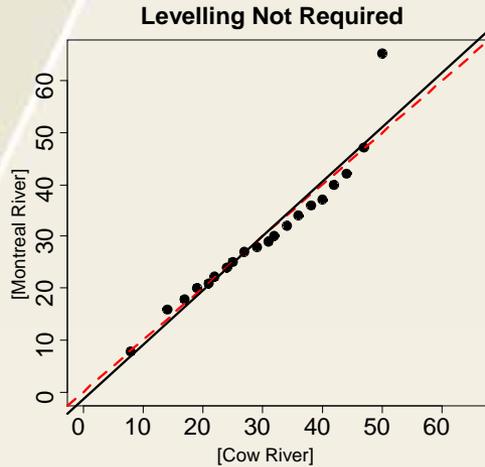
Canada



Parametric Levelling Scenarios

Example - Cr - Lake Sediment Surveys

Cr (mg/kg) in Lake Sediments



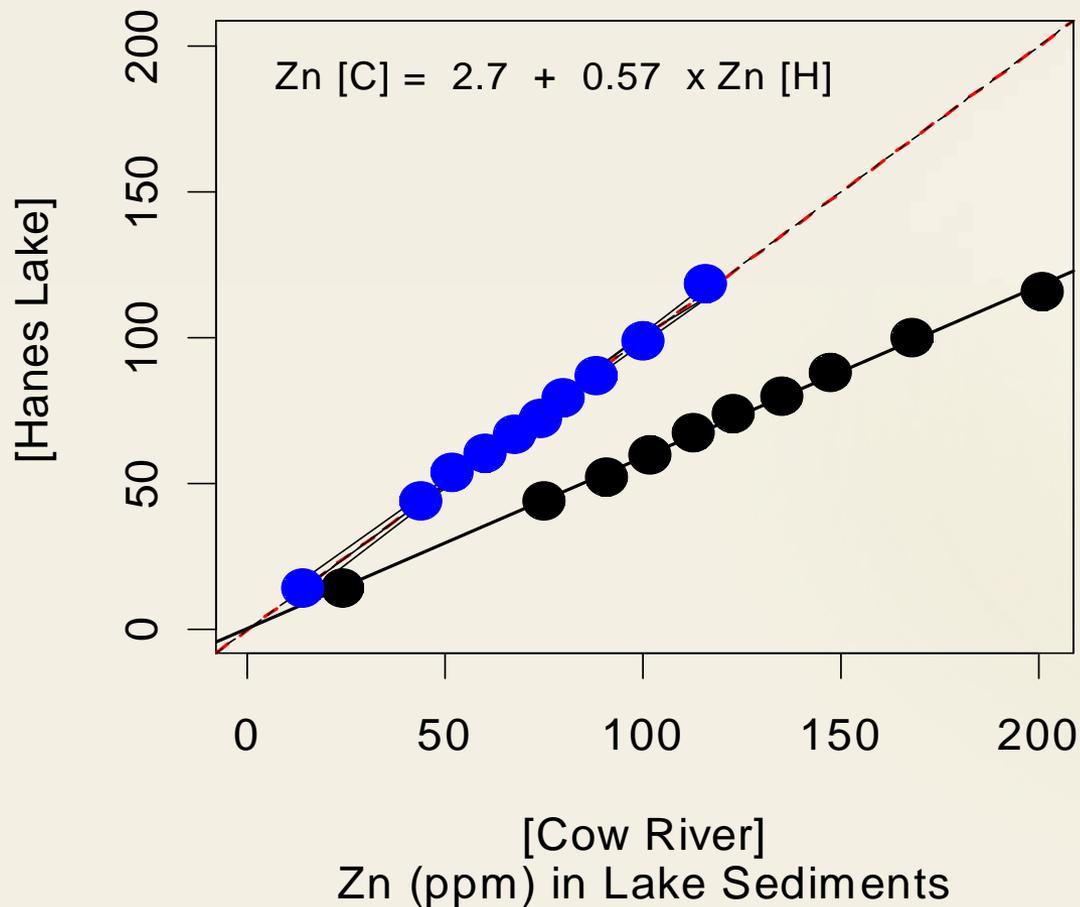
Quantile Interval=0.05



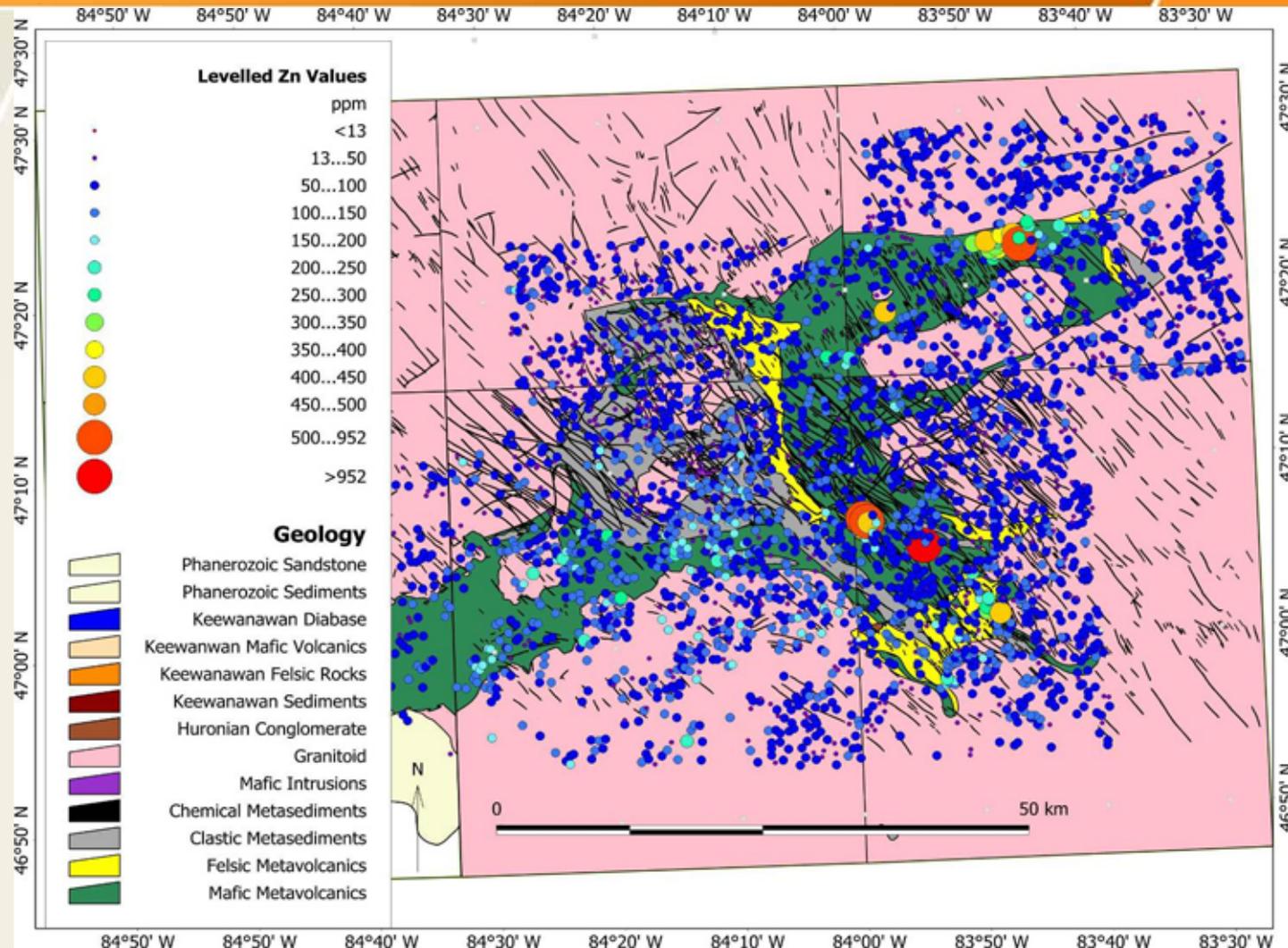


Example of Zn levelling

Shift + Multiplier



Zn in Lake Sediments after Levelling





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