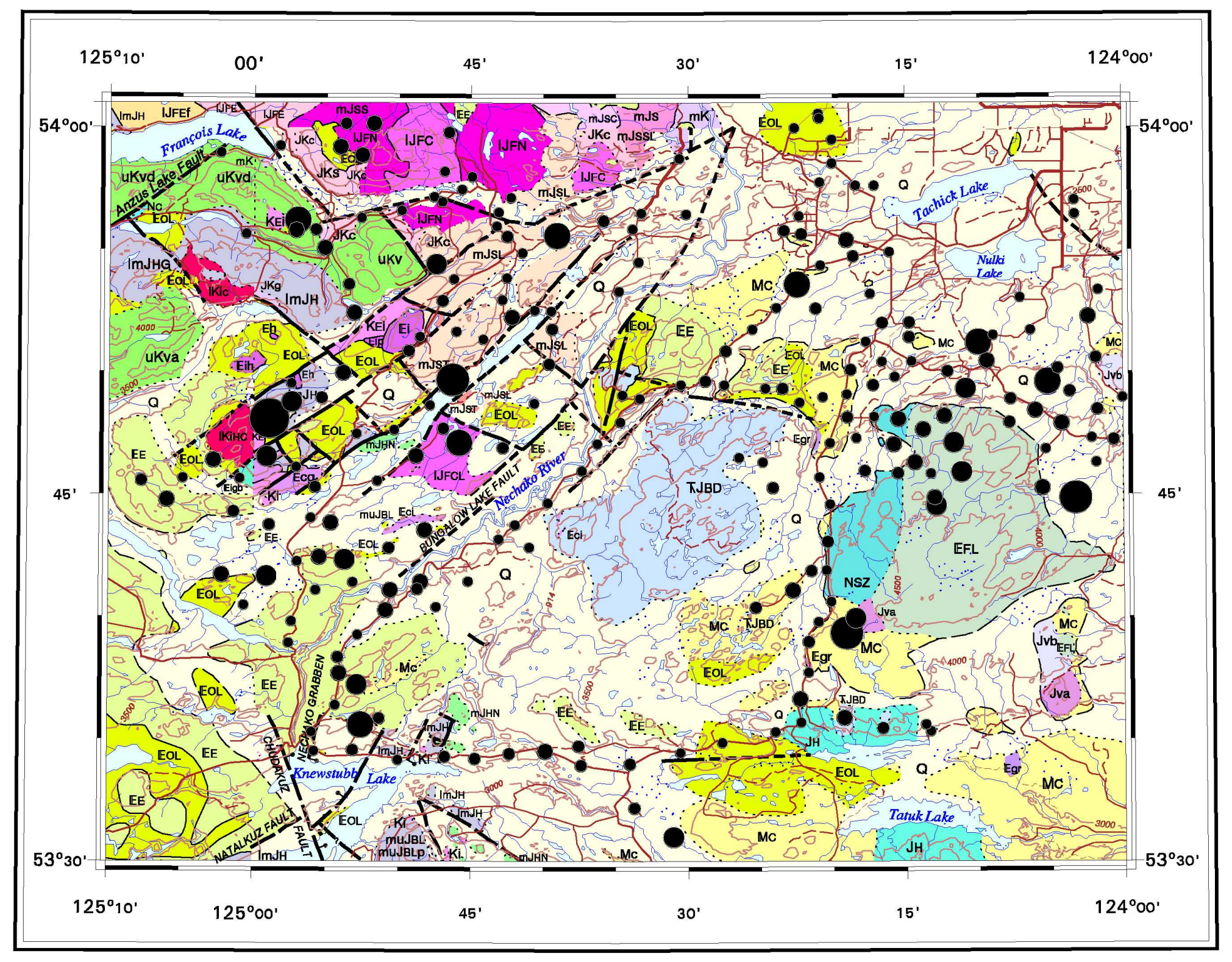
Natural Resources Canada   Ressources naturelles Canada

GEOLOGICAL SURVEY OF CANADA   COMMISSION GÉOLOGIQUE DU CANADA

NATMAP
CARTNAT
Canada's National Geoscience Mapping Program
Le Programme national de cartographie géoscientifique du Canada

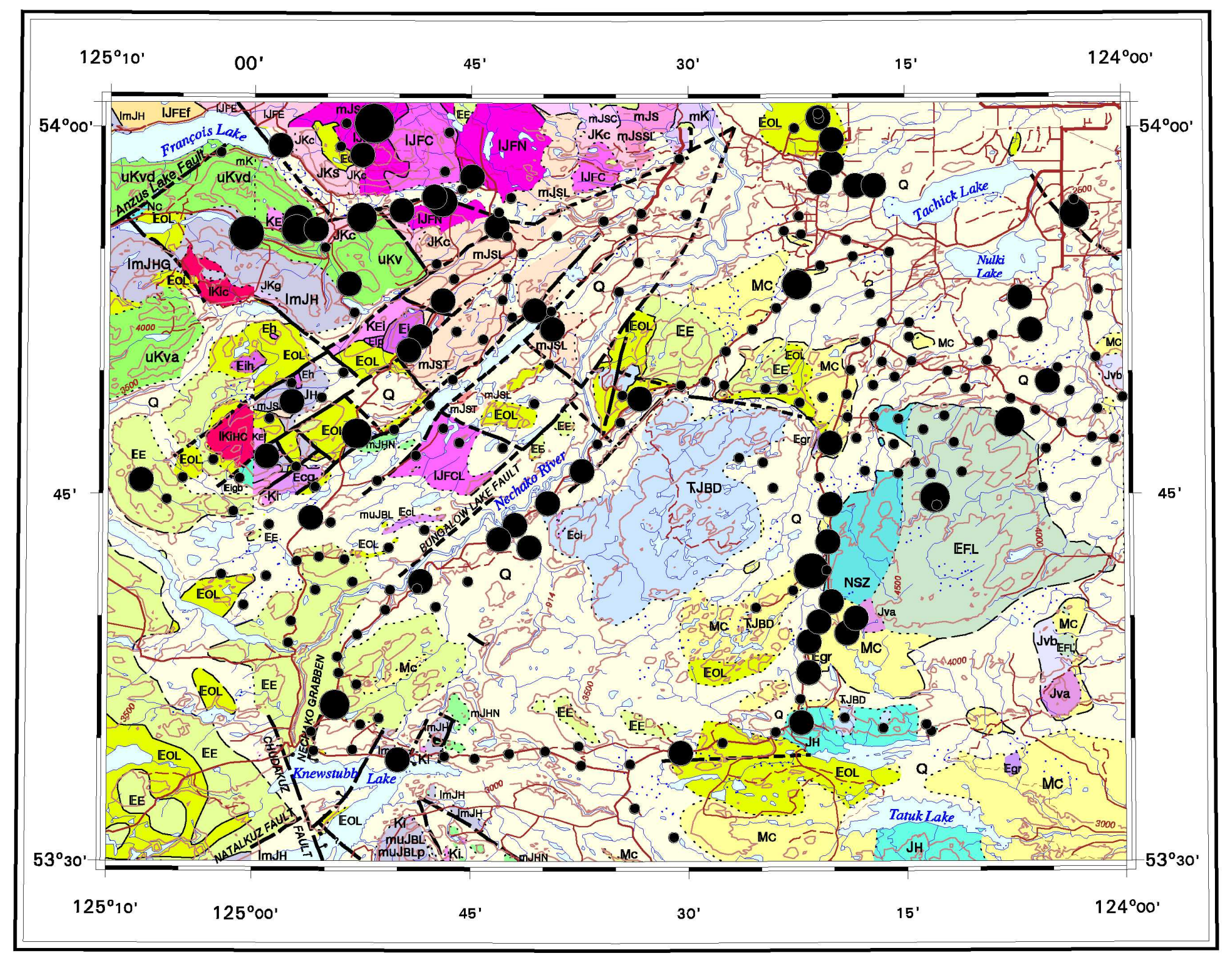


MANGANESE

ICP-ES

ppm	**Mn**	Percentile
17500	●	Maximum
13440	●	98
11200	●	95
9370	●	90
6930	●	75
4950	●	50
1180	●	Minimum

229 samples
Scalar Exponent = 1.5

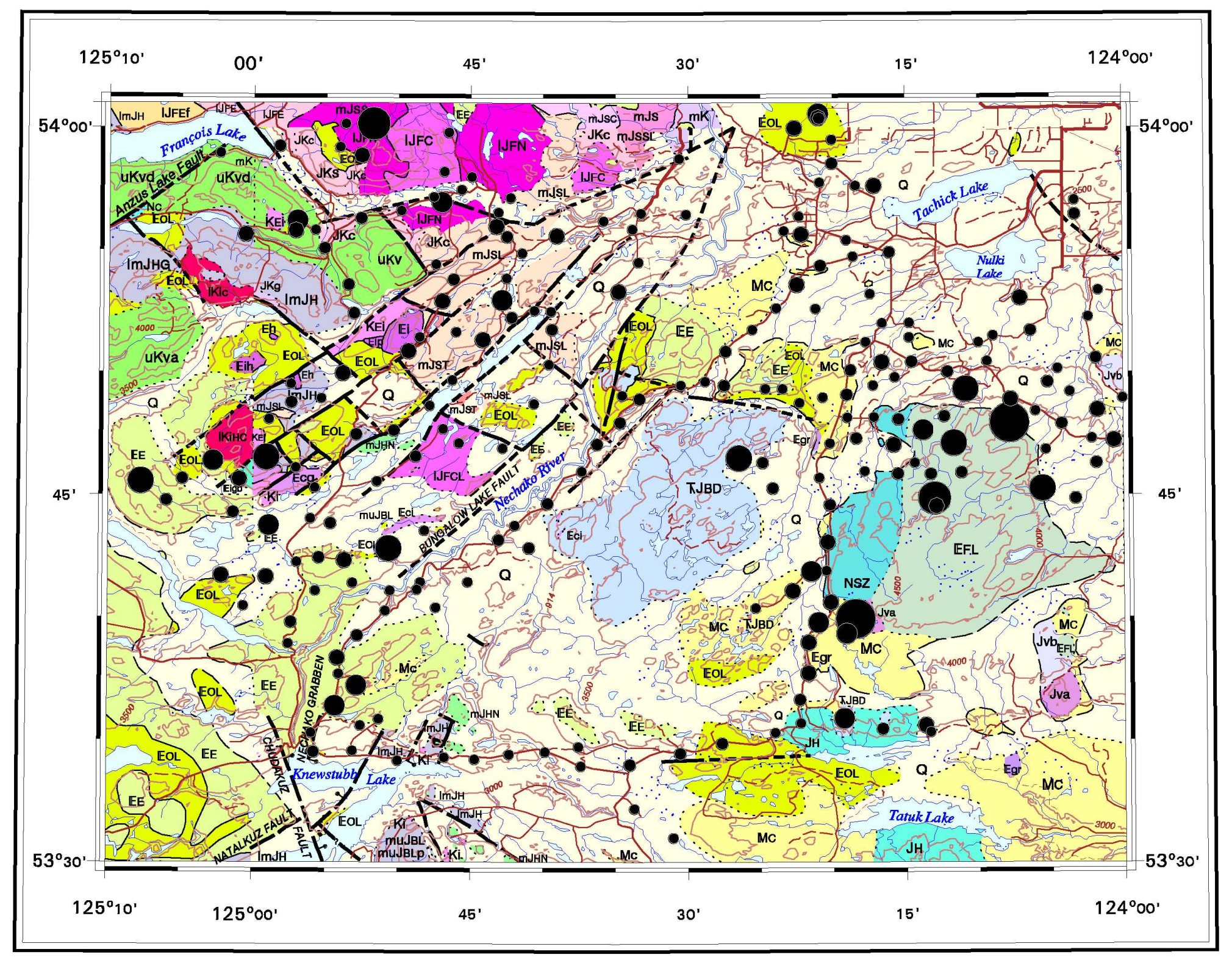


CESIUM

INAA

ppm	**Cs**	Percentile
4.8	●	Maximum
3.2	●	98
2.8	●	95
2.0	●	90
1.5	●	75
1.1	●	50
< 0.5	●	Minimum

229 samples
Scalar Exponent = 1.0

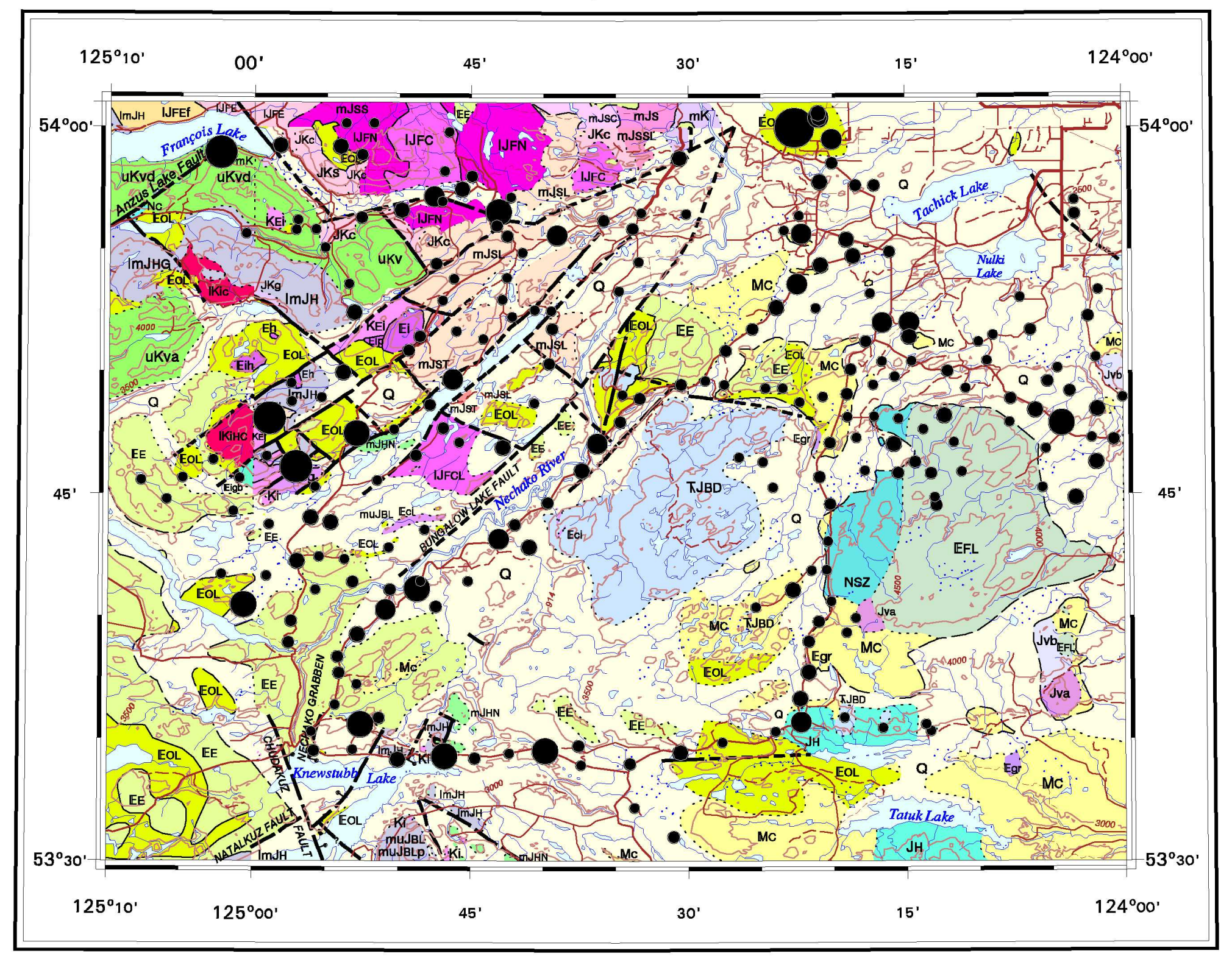


RUBIDIUM

INAA

ppm	**Rb**	Percentile
130	●	Maximum
114	●	98
95	●	95
83	●	90
62	●	75
45	●	50
< 5	●	Minimum

229 samples
Scalar Exponent = 1.5

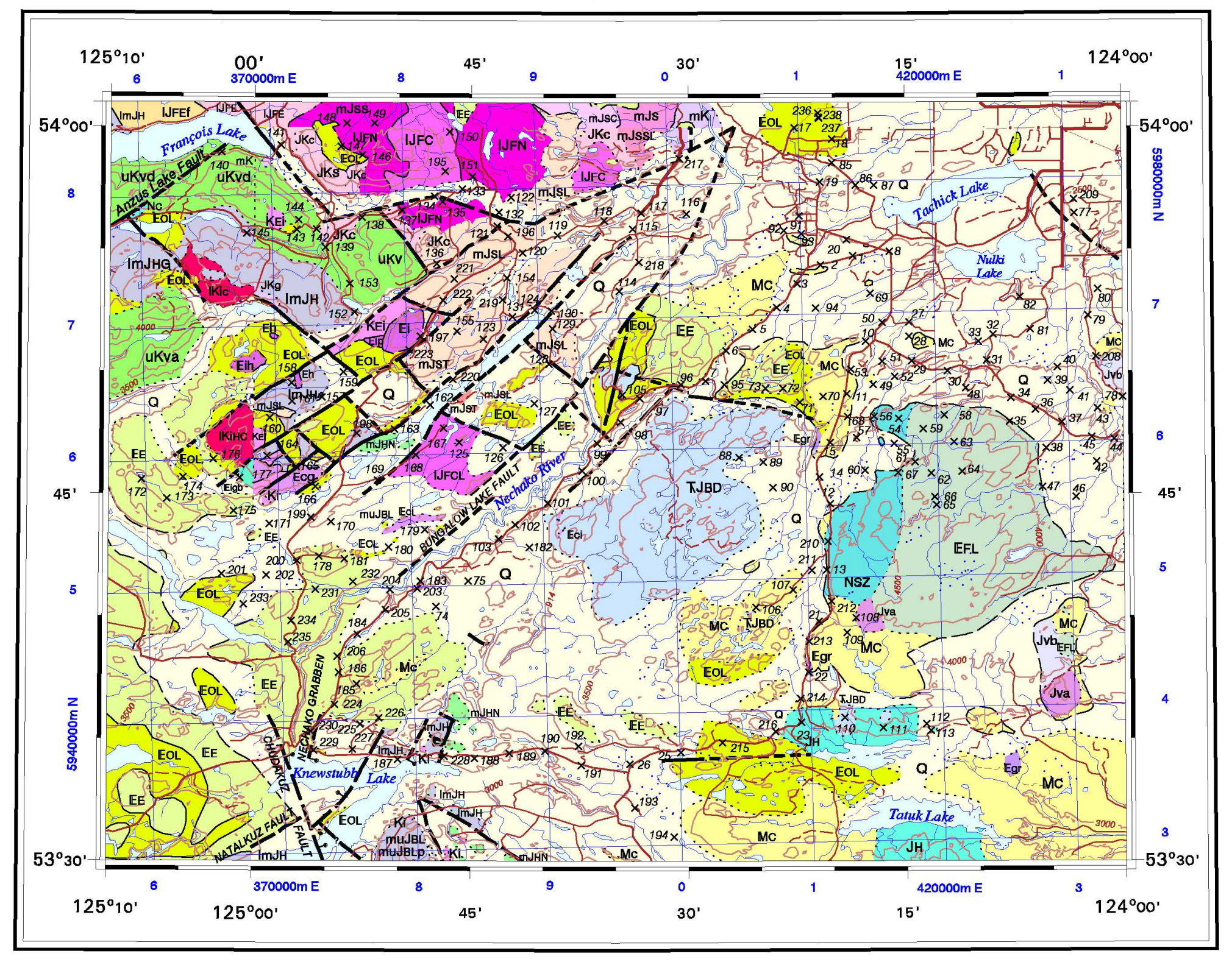


BARIUM

INAA

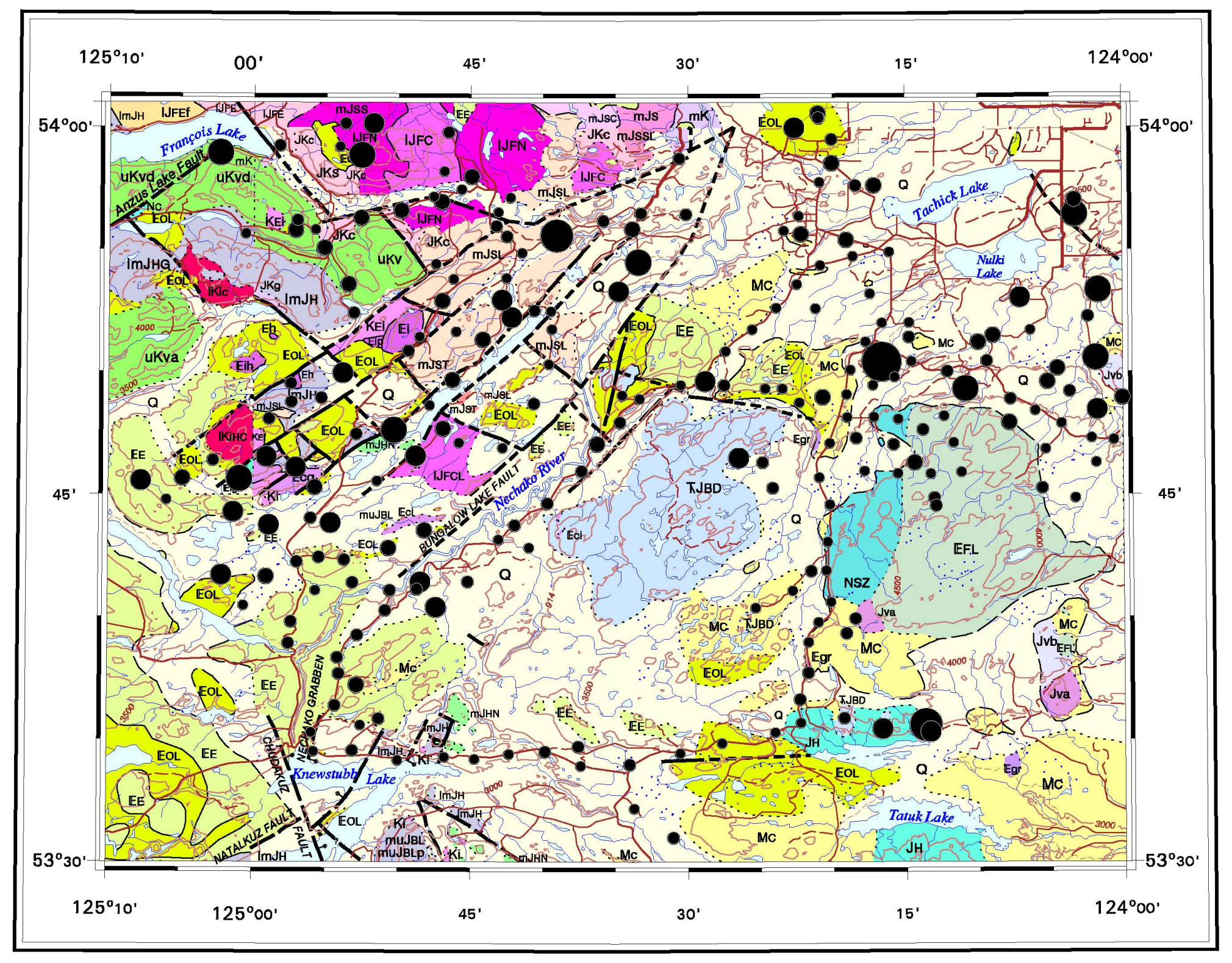
ppm	**Ba**	Percentile
3700	●	Maximum
1040	●	98
840	●	95
690	●	90
590	●	75
470	●	50
94	●	Minimum

229 samples
Scalar Exponent = 1.5



SAMPLE LOCATION MAP

× 35 Sample Numbers (All data for each sample are listed on diskette available separately as Open File D3594d)

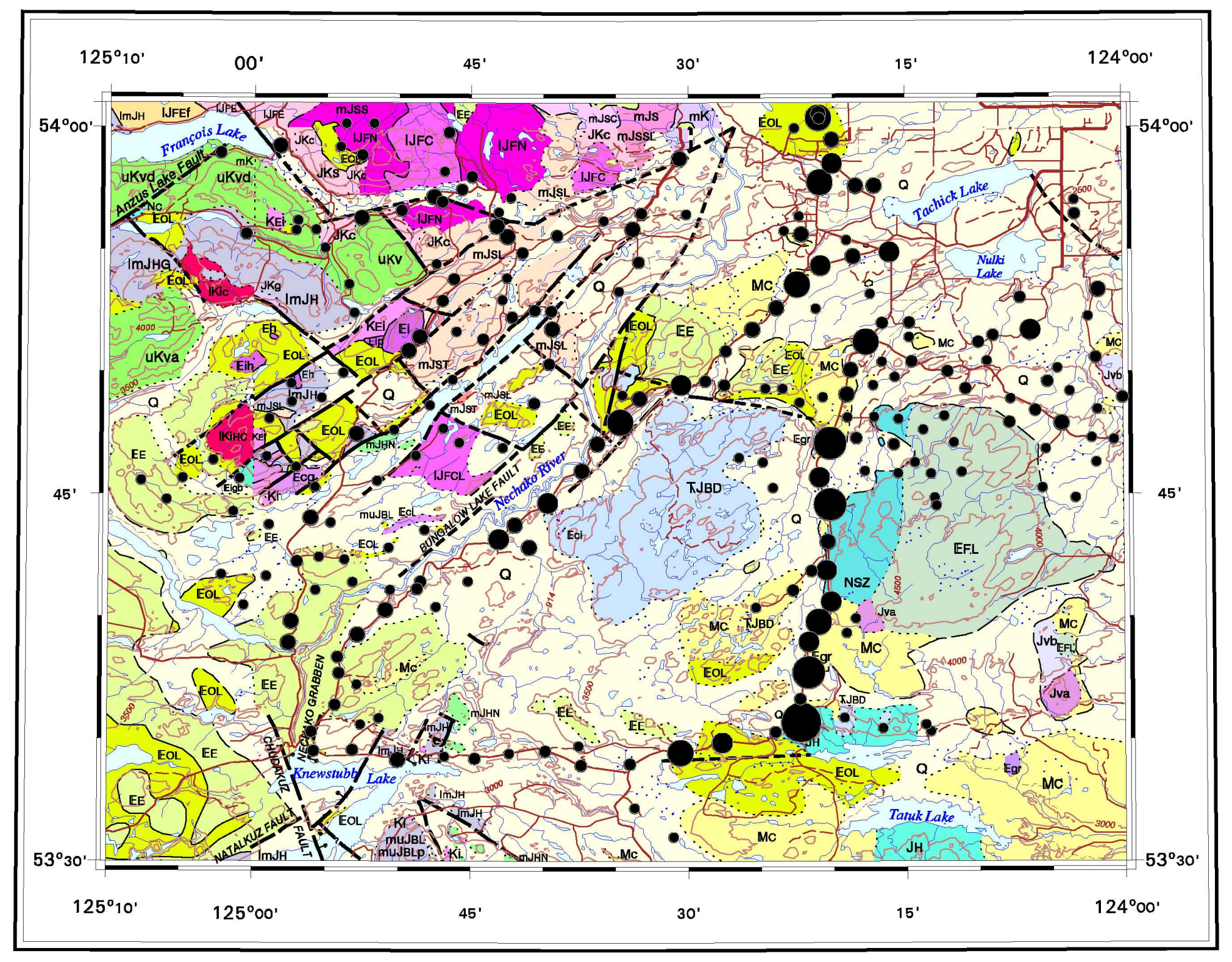


POTASSIUM

INAA

percent	**K**	Percentile
11.5	●	Maximum
8.29	●	98
6.86	●	95
6.00	●	90
4.66	●	75
3.77	●	50
1.31	●	Minimum

229 samples
Scalar Exponent = 1.5

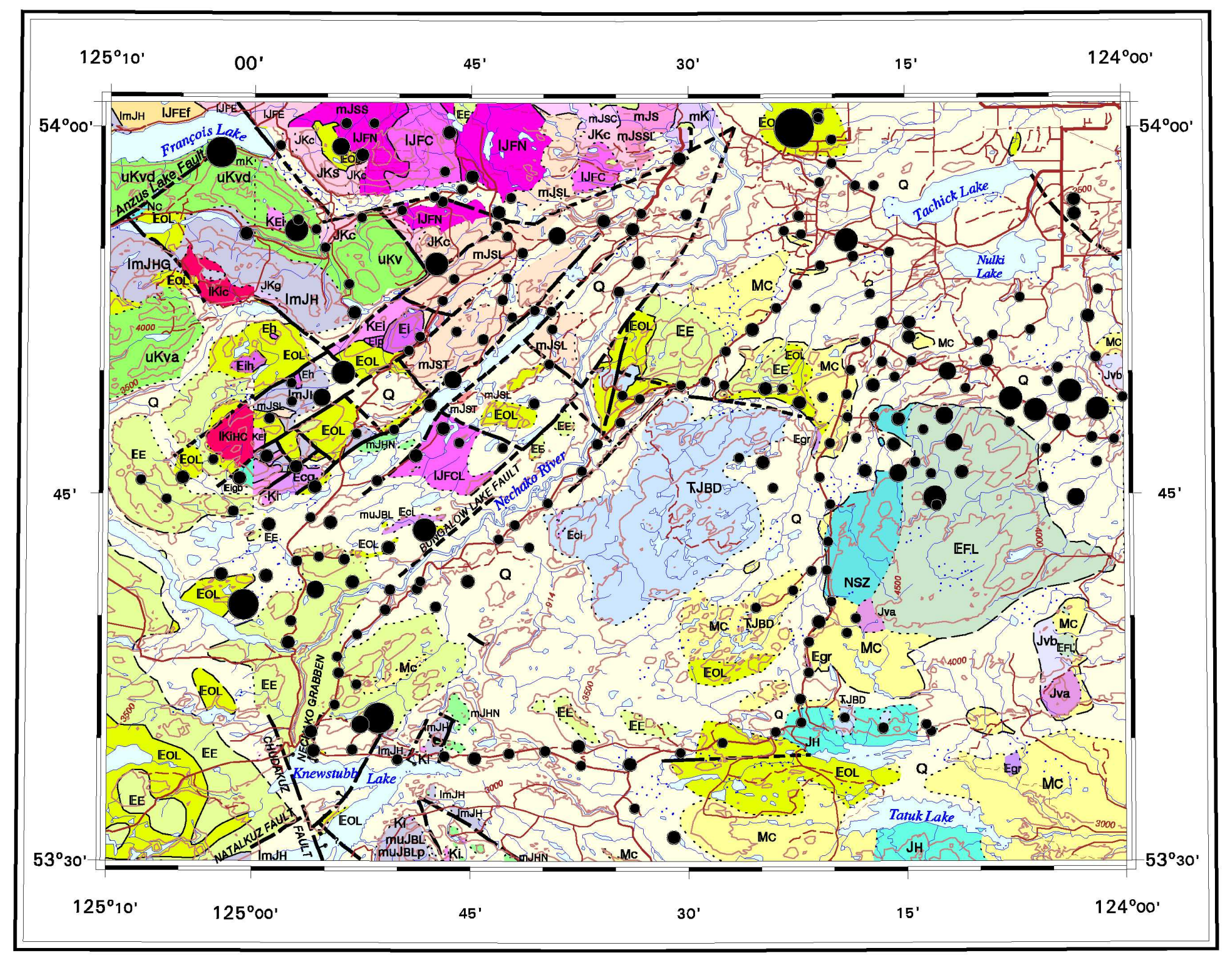


SODIUM

INAA

ppm	**Na**	Percentile
30000	●	Maximum
24500	●	98
19100	●	95
17300	●	90
11400	●	75
4860	●	50
851	●	Minimum

229 samples
Scalar Exponent = 1.5

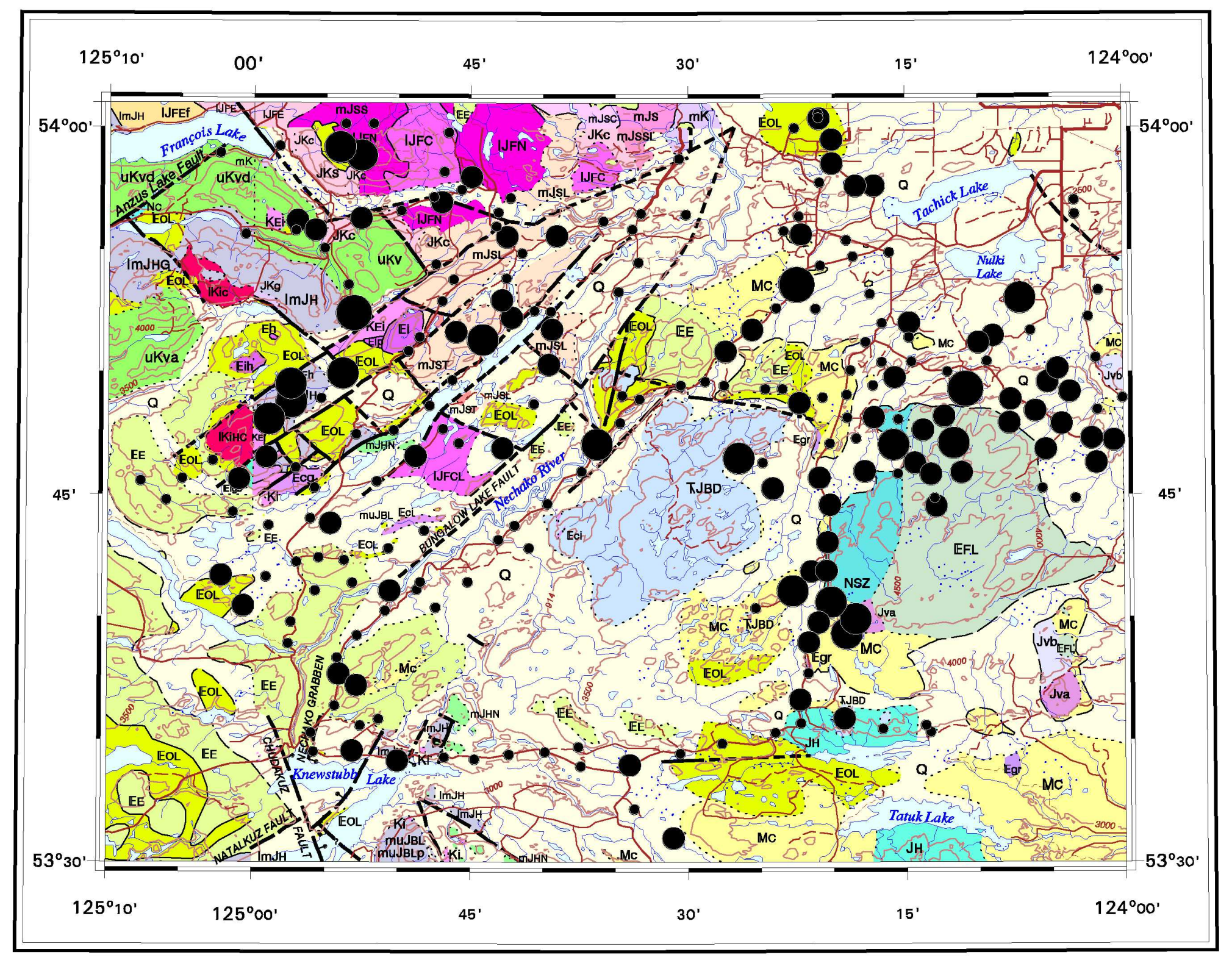


STRONTIUM

INAA

ppm	**Sr**	Percentile
2600	●	Maximum
1640	●	98
1500	●	95
1400	●	90
1100	●	75
930	●	50
< 300	●	Minimum

229 samples
Scalar Exponent = 2.0

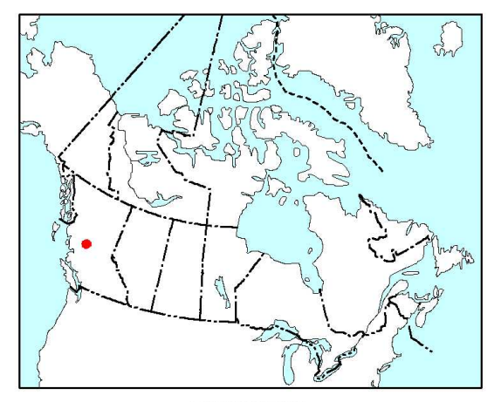


ALUMINUM

ICP-ES

percent	**Al**	Percentile
5.2	●	Maximum
3.4	●	98
2.8	●	95
2.4	●	90
1.8	●	75
1.3	●	50
0.1	●	Minimum

229 samples
Scalar Exponent = 0.8



LOCATION MAP

Canada

OPEN FILE 3594c

Biogeochemical survey of the Nechako River Area using outer bark of Lodgepole pine (NTS 93F/9, 93 F/10, 93 F/15, 93 F/16 and parts of 93 F/11, 93 F/14, 93 K/1 and 93 K/2)

ALKALI METALS, ALKALINE EARTHS, MANGANESE AND ALUMINUM

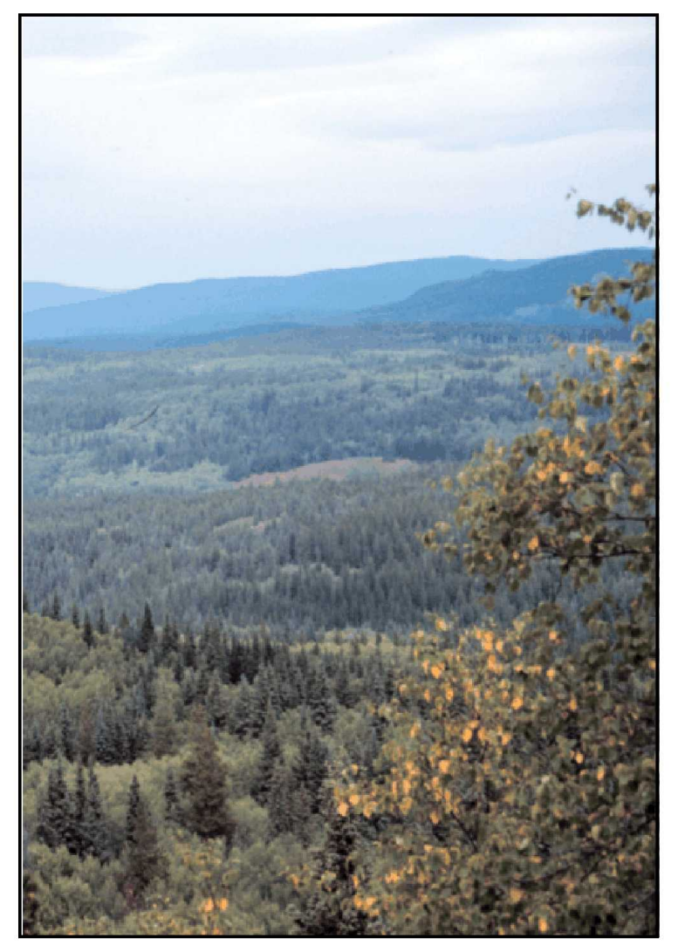
CENTRAL BRITISH COLUMBIA

Scale 1:400 000/Échelle 1/400 000

kilometres 10 0 10 20 30 40 kilomètres

Transverse Mercator Projection
North American Datum 1927

Projection transverse de Mercator
Système géodesique nord-américain de 1927



Scenic view of the Fort Fraser Area   Photo credit C.E. Dunn

Removal of bark sample   Photo credit C.E. Dunn

Collection of outer bark   Photo credit C.E. Dunn

Bark samples after reduction to ash   Photo credit C.E. Dunn

DESCRIPTIVE NOTES

INTRODUCTION

This sheet of nine maps is one of three of similar format provided in this Open File. Grouped together are elements of certain affinities and/or similar distribution patterns. The three sheets are titled:

1) Base Metals, Silver and Pathfinder Elements (Open File 3594a)
2) Mafic Suite of Elements with Thorium and Lanthanum (Open File 3594b)
3) Alkali Metals, Alkaline Earths, Manganese and Aluminum (Open File 3594c).

The elements depicted on these sheets are either those that show moderate geochemical data relief in the survey area, or they are representative of a closely associated suite of elements (e.g. of the rare-earth elements, only La is shown because the distribution patterns of the other 7 determined [Ce, Eu, Lu, Nd, Sm, Tb, Yb] are almost identical). Full data listings of concentrations of these and other elements in each sample are supplied in the diskette issued as Open File D3594d. The diskette includes, also, a more detailed description of the methodology, analytical methods and analytical quality control.

RATIONALE FOR BIOGEOCHEMICAL SURVEYS

The roots of a single large tree extract elements from many cubic metres of soil, overburden, groundwater and sometimes bedrock. These elements are then transferred to aerial parts of the tree where they may become locally concentrated. In a multi-disciplinary survey program, data derived from the analysis of an appropriate vegetation sample medium permits geochemical mapping, with enhanced background to anomaly contrast of certain elements, which may assist both in mapping bedrock and in the search for concealed zones of mineralization.

Because each species of plant has a different requirement for, and tolerance to, a range of chemical elements, some partitioning of elements takes place and there is selective absorption and transference into the plants. For biogeochemical exploration, conifers provide suitable and effective sample media because they are primitive plants that have a wide tolerance to many trace elements. The outer bark is a repository for many elements that are not required for the metabolic function of the tree.

The geochemical information supplied by the vegetation is different from that of the till. Just as two methods of geophysical survey may provide totally different information, so may two methods of geochemical survey. A high correlation between distribution patterns of two geochemical sample media is the exception rather than the rule. In geological environments where there is sufficient concentration of metals to form a mineral deposit, such a 'critical mass' of elements may be sufficient to generate biogeochemical anomalies above the mineral source (e.g. by upward diffusion) or close to it (e.g. by groundwater movement or movement in electrochemical cells). Tills, however, usually have geochemical anomalies displaced down-ice from a mineralised zone. Such factors need to be taken into consideration when interpreting geochemical results.

RECONNAISSANCE SURVEY

Lodgepole pine is the most common tree species in the Nechako area, and many metals concentrate in its outer bark. Hence, pine bark was selected as the sample medium for a reconnaissance-level biogeochemical survey in the Nechako project area. Samples were obtained by scraping approximately 100 g of outer bark from around the circumference of mature trees. The preferred sample interval was 2 km along roads, trails, and tracks. To minimise the effects of airborne contamination from roads, samples were collected at a distance of at least 100 m into the forest. Along lesser used trails and tracks this distance was reduced to approximately 50 m. During the summer of 1996, C. Dunn collected samples over part of the survey area during two periods of fieldwork. In addition, throughout the summer samples were collected by Alain Plouffe (GSC) and his assistants at sites close to where they obtained till samples. Because of the lack of roads and trails in some areas, the sampling grid is not even. However, on average the sample coverage is approximately 1 site per 8 km^2, and data from the analysis of 229 samples are used for the compilation of this Open File.

Bark samples were returned to the GSC laboratories in Ottawa where they were air-dried then reduced to ash by controlled ignition at 470°C for 24 hours. Ash samples were submitted for the analysis of 36 elements by instrumental neutron activation (INAA), and 30 elements by inductively coupled plasma emission spectrometry (ICP-ES) at Activation Laboratories Ltd. (Ancaster, ON). The INAA analysis reports the total concentration of elements in the sample. The ICP-ES is performed on an aqua regia digest of the ashes, and provides data on the total or near total concentrations of most elements. Data for some elements are obtained by both methods, but after review of the data from a quality control standpoint only the more accurate and precise set of values is recorded in the data listings.

MAP PRODUCTION AND DATA PRESENTATION

The proportional dot maps are plotted using the Universal Transverse Mercator projection (NAD27 datum), with a central meridian of 124°35' (Zone 10). They were generated using AML (ARC/INFO Macro Language). The macro, with its corresponding input menu, prompts the user to input percentile break points and an appropriate scaling exponent for each element to be mapped. Proportional dots are then generated, using the ARC/INFO SPOTSIZE, POINTSPOT and SPOT commands, with the user specifying an appropriate minimum and maximum dot size. Exponents for individual elements were chosen to provide the best view of the analytical data. Accordingly, care should be exercised when attempting to compare different elements plotted with different exponents. Comments on distribution patterns are given in the digital file on the diskette sold separately as Open File D3594d.

LEGEND

STRATIFIED ROCKS

QUATERNARY	
Q	*Pleistocene glaciofluvial and glaciolacustrine sediments; Holocene alluvium*
MIOCENE	
	CHILCOTIN GROUP
MC	*Olivine basalt, columnar*
EOCENE	
	ENDAKO GROUP
EE	*Brownish-grey amygdaloidal, (olivine-) pyroxene- and plagioclase-phyric basalt and basaltic andesite flow, hyaloclastite and volcaniclastic rocks; minor sandstone*
	OOTSA LAKE GROUP
EOL	*White to pinkish-brown rhyolitic, dacitic, and basal brown andesitic flows; pyroclastic, and volcaniclastic rocks*
Egr	*biotite ± hornblende granite, granodiorite, quartz-feldspar porphyry and microgranite*
UPPER CRETACEOUS	
uKv	*Porphyritic, intermediate and felsic volcanic flow and tuffaceous rocks;* uKvd: dacitic, *crystal-rich tuff;* uKva *andesitic to dacitic hornblende-plagioclase-phyric flows and breccia*
JURASSIC OR CRETACEOUS	
	BOWSER LAKE OR SKEENA GROUP
muJBL/lKS	*Tan to green pebble conglomerate and hornblende-and plagioclase-bearing sandstone*
muJBLp	*Rusty to black siltstone and chert-rich sandstone and conglomerate*
MIDDLE TO UPPER JURASSIC	
	NAGLICO FORMATION
mJHN	*Greenish grey clinopyroxene-phyric basalt, breccia, argillite, and volcaniclastic rocks*
LOWER TO MIDDLE JURASSIC	
	HAZELTON GROUP
lmJH	*Undivided maroon-grey heterolithic and monolithic breccia, and tuffaceous grit, sandstone, and mudstone*
lmJHG	*Maroon and green, heterolithic fine- to coarse-grained volcaniclastic and epiclastic volcanic rocks; minor associated porphyry*
JH	*Andesite, rhyolite, basalt, dacite, crystal tuff, flow and breccia; related intrusive rocks, monzonite, monzodiorite, andesite-feldspar porphyry*
	VANDERHOOF METAMORPHIC COMPLEX (Jva - Jvb)
Jvb	*Biotite quartzo-feldspathic schist, amphibolite, biotite-amphibole schist, marble, calc-silicate, quartzite; minor granitoid dykes and sills*
Jva	*Amphibolite, calc-silicate veins?, local diorite dykes and sills*

INTRUSIVE ROCKS

EOCENE(?)	
	COPLEY LAKE PHASE
Ec	*Mottled pink and white, unfoliated, fine- to medium-grained biotite monzogranite; minor hornblende-plagioclase porphyry (*Ech*); intrusive crystal tuff and breccia (*Ect*) and fine grained gabbro (*Ecg*)*
Ei/Eh	*White miarolitic leucogranite (*Ei*) and hornblende-plagioclase porphyry (*Eh*); alkali feldspar porphyry (*Eip*)*
	NULKI SHEAR ZONE
NSZ	*Ductiley deformed Frank Lake Pluton and Brooks Diorite Complex*
	FRANK LAKE PLUTON
EFL	*Biotite, granodiorite, granite*
Eigb	*Gabbro, diabase*
Eih	*Hornblende-plagioclase porphyry*
LATE CRETACEOUS AND EOCENE(?)	
KEi	*Greenish grey, andesitic hornblende-plagioclase porphyry dark grey clinopyroxene gabbro (*KEig*)*
Ki	*Greenish grey, andesitic (clinopyroxene-) hornblende-plagioclase porphyry and diorite*
lKiHC	*Holy Cross hornblende-plagioclase porphyry; (*lKic*): Cabin Lake pluton: homogeneous, fine to medium-grained, (hornblende-) biotite quartz monzonite*
MID-CRETACEOUS OR EOCENE(?)	
mK	*Mottled pink and white, fine- to medium-grained, felsic granitic rocks, undivided; Cabin Lake pluton: leucocratic biotite quartz monzonite (*mKC*)*
LATE JURASSIC	
	CASEY PHASE
lJFC	*Granite, granodiorite*
	ENDAKO PHASE
lJFE	*Biotite ± hornblende granite to granodiorite*
	FRANÇOIS SUBPHASE
lJFEf	*Biotite granite to granodiorite*
	COPLEY LAKE PHASE
lJFCL	*Mottled pink and white, unfoliated, fine- to medium-grained biotite monzogranite*
	NITHI PHASE
lJFN	*Grey to pinkish-brown, unfoliated, medium-grained, equigranular to K-feldspar megacrystic biotite monzogranite (ca. 158-155 Ma)*
	GLENANNAN PHASE
lJFG	*Biotite granite and granodiorite, porphyritic*
JURASSIC OR EARLY CRETACEOUS	
	CALEDONIA PHASE
JKC	*Medium-grained, foliated biotite monzogranite with alkali-feldspar megacrysts*
	STELLAKO PHASE
JKS	*Quartz monzodiorite, minor diorite and gabbro*
MIDDLE(?) TO LATE JURASSIC	
	STAG LAKE PLUTONIC SUITE
	LIMIT LAKE INTERMEDIATE PHASE
mJSL	*Unfoliated to foliated, mesocratic hornblende-biotite quartz monzodiorite; minor granodiorite, megacrystic quartz monzonite*
	SUGARLOAF INTERMEDIATE PHASE
mJSSL	*Unfoliated to foliated, mesocratic subporphyritic hornblende-biotite granodiorite and quartz monzodiorite (ca. 171 Ma)*
	STELLAKO PHASE
mJSS	*biotite-hornblende quartz diorite to granodiorite*
	TWENTY-SIX MILE LAKE MAFIC PHASE
mJST	*Dark grey, heterogeneous, unfoliated, mafic (biotite-) equigranular to megacrystic hornblende diorite*
MID JURASSIC	
	CALEDONIA PHASE
mJSC	*Quartz monzonite, K-feldspar megacrystic*
	SUGARLOAF PHASE
mJS	*Granodiorite, subporphyritic*
TRIASSIC OR JURASSIC	
	BROOKS DIORITE COMPLEX
ŦJBD	*Diorite, monzodiorite, monzonite, amphibolite (Wetherup, 1997)*

Geological contact (defined, approximate, assumed) . . . .

Fault (defined, approximate, assumed) . . . .

Roads (primary , secondary, tertiary, cart-track) . . . .

Biogeochemical data by C.E. Dunn (1998), Mineral Resources Division

Geological compilation based on: 93 F9/16 S. Wetherup (1998), 93 F/10, 15, 11, 14 R.G. Anderson, L.D. Snyder, J. Resnick, N. Grainger, E.M Barnes (1998-1999), H.W. Tipper (1963) and S.P. Williams (1997), 93 K/2, 3 L.C. Struik (1998)

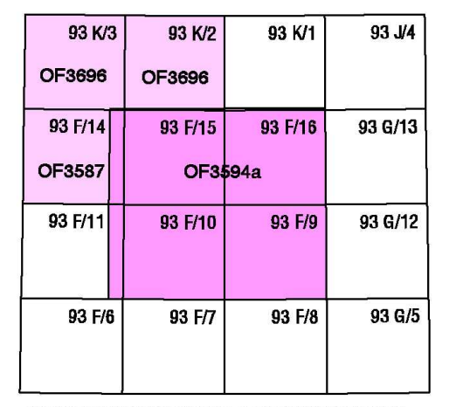
Digital cartography by N.L. Hastings, Pacific Division

Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

Digital contour data compiled by Geomatics Canada, published 1:250 000, modified by the Geological Survey of Canada

Magnetic declination 2000, 22°19'E decreasing 8.5' annually. Readings vary from 22°22'E in the NE corner to 22°16'E in the SW corner of the map

Elevations in feet above mean sea level



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

OPEN FILE
DOSSIER PUBLIC
3594c
GEOLOGICAL SURVEY OF CANADA
COMMISSION GÉOLOGIQUE DU CANADA
OTTAWA
06/2000

Recommended citation:
Dunn, C.E, and N.L. Hastings
2000: Biogeochemical survey of the Nechako River Area using outer bark of Lodgepole pine (NTS 93 F/9, 93 F/10, 93 F/15, 93 F/16 and parts of 93 F/11, 93 F/14, 93 K/1 and 93 K/2), central British Columbia; Alkali Metals, Alkaline Earths, Manganese and Aluminum; Geological Survey of Canada, Open File 3594c, scale 1:400 000.