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Till geochemical data for the southern Core Zone, Quebec and Newfoundland and Labrador (NTS 23-P and 23-I): samples collected in 2015 and 2016

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ABSTRACT

This open file reports geochemical data for till samples collected in 2015 and 2016 as part of a reconnaissance-scale till sampling and surficial mapping project across the southern Core Zone, Quebec and Newfoundland and Labrador (NTS map sheets 23-I and 23-P). Additional geochemical data (Au, Pt, Pd) of till samples collected in 2014 are also reported here as well as re-analysis of select archived till samples collected by the Geological Survey of Canada as part of the Canada - Newfoundland Mineral Development Agreement (1984-1989) in the southern Core Zone. Data reported in this open file include geochemical analyses of the <0.063 mm fraction using aqua regia (partial), borate fusion (total), and fire assay (total Au, Pt, Pd), as well munsell colour, grain-size data, loss on ignition, and total carbon analyses.

INTRODUCTION

The southern Core Zone has experienced a complex ice-flow history related to the buildup, migration, and demise of the Ancestral Labrador ice divide associated with the Laurentide Ice Sheet (LIS) (Dyke and Prest, 1987; Vincent, 1989; Klassen and Thompson, 1993; Rice et al., 2015, 2016). As a result, a discontinuous cover of surficial sediments has made bedrock mapping and mineral exploration in the region challenging. There remains a significant portion of northern Quebec and Newfoundland and Labrador that have neither surficial geology maps, nor till geochemical or mineralogical data to aid the evaluation of mineral potential or to support mineral exploration programs.

New surficial mapping and surficial geochemical studies are being carried out as part of an integrated regional mapping program (McClenaghan et al., 2015) centred on Archean Core Zone rocks between the Torngat Orogen to the east and New Quebec Orogen to the west (Fig.1). This mapping and sampling program is being carried out by the Geological Survey of Canada (GSC) as part of its Geo-mapping for Energy and Minerals 2 (GEM 2) program and in collaboration with the Ministère de l'Énergie et des Ressources naturelles du Quebec (MERNQ) and the Geological Survey of Newfoundland and Labrador (GSNL). These surficial activities coupled with bedrock mapping (Sanborn-Barrie et al., 2015; Sanborn-Barrie, 2016) will produce new regional geoscience data that will increase the geological understanding, support natural resource exploration, and allow for responsible resource development in the region.

This open file reports geochemical data for the matrix of till samples collected in the southern Core Zone in NTS sheets 23-I and 23-P in 2015 and 2016 as well as for selected archived GSC till samples collected in 1986 and 1987 (Klassen and Thompson, 1993) in the current southern Core Zone study area.

LOCATION AND ACCESS

Straddling the border between Quebec and Newfoundland and Labrador, the southern Core Zone study area is located east of the town of Schefferville, Quebec, in the Lac Résolution (National Topographic System NTS 23-P) and Woods Lake (NTS 23-I) map sheets, between latitudes 52°N and 57°N and longitudes 57°W and 70°W. The study area is within the Lake Plateau portion of the James Region and the George Plateau and Whale Lowland divisions of the Davis Region within the Canadian Shield (Bostock, 2014). It spans the drainage divide that is the provincial boundary between Quebec and Newfoundland and Labrador, separating northern flow to Ungava Bay, and southern to southeastern flow to the Labrador Sea. Due to the lack of transportation infrastructure, remoteness, and rugged terrain of the study area, field sites were only accessible via helicopter. Site selection was therefore limited to locations allowing for safe helicopter operation, usually treeless highlands, large bedrock outcrops, edges of wetlands, and open lake shorelines.

PHYSIOGRAPHY

Typical of Canadian Shield terrain, the topography of the study area is generally undulating with low to moderate relief, and irregular bedrock knobs dispersed between numerous lakes. Elevation ranges from <350 m in the George River valley to a maximum of 668 m (above mean sea level) on the highest bedrock knob.

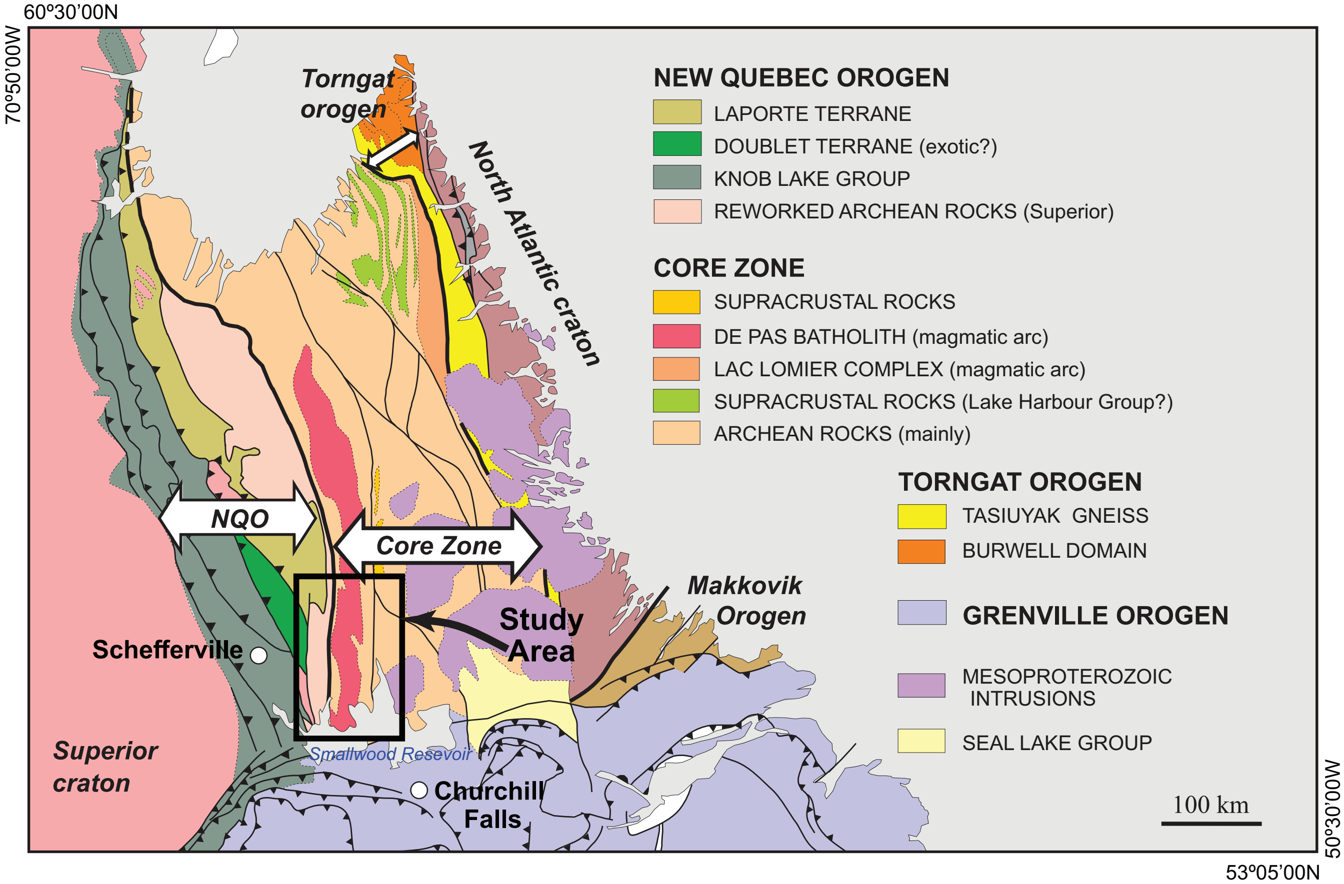

Figure 1. Simplified bedrock geological map of the Core Zone and bounding orogens in Quebec and Newfoundland and Labrador. The south Core Zone surficial mapping area (NTS 23-P and 23-I) is outlined in black. Bedrock geology is modified after James et al. (2003). Note: NQO = New Quebec Orogen.

Hills and upland regions typically have outcrops covered by thin veneers of glacial sediment and are flanked by thick glacial deposits of ribbed and streamlined terrain crosscut by numerous, small esker systems and meltwater corridors. Lowland regions are mantled by littoral sediments of varying thickness that formed when glacial lakes were impounded in the topographic lows at the end of glaciation (Ives, 1960a,b; Clark and Fitzhugh, 1990; Jansson, 2003).

The northern map sheet (Lac Résolution, NTS 23-P), which has the greatest variation in elevation, is characterized by abundant barren highlands scattered with perched glacial erratics. Lakes are common in the eastern and northwestern portion of the map sheet; notably the elongated lakes are structurally controlled by bedrock joints and faults.

The southern portion of the study area (Woods Lake, NTS 23-I) is dominated by the Smallwood Reservoir, a large hydroelectric reservoir created by the damming of the Churchill River in 1974, and now occupies the former basins of Ossokmanuan, Lobstick and Michikamau lakes. Glacial sediment thickness varies throughout the southern part of the map sheet, with thin till veneer covering highland areas, thicker till on the flanks of highland areas, and thick glacial sediments infilling many of the lowland areas. An extensive esker network crosscuts the southern and eastern portion of the Woods Lake region. North of the reservoir, extensive drift cover results in low-lying swamps, fens, and bogs that are confined between a plethora of small lakes.

The study area is dominated and bisected by the De Pas batholith, a north-south trending plutonic unit that is characterized by high flat-topped topographic relief with abundant bedrock outcrops (Sanborn-Barrie, 2016). East of the batholith, the terrain is radially punctuated with well-defined eskers, several of which continue for tens of kilometres.

Vegetation varies with topography and latitudinal location. The southern part of the study area is within the Boreal Forest woodlands, with abundant small and stunted black spruce (*Picea mariana*) and tamarak/larch (*Larix laricina*), interspersed between small bushes and moss floors. The northern part is forested tundra with barren highlands covered in caribou lichen (*Cladonia rangiferina*), grasses, and small plants. The entire region has isolated patches of discontinuous permafrost (Heginbottom et al., 1995), which occur only in the northern map sheet at higher elevations.

BEDROCK GEOLOGY

The southern Core Zone is located just east of the Schefferville iron-ore district. It is the southern extent of the 300 km long - 40 km wide Core Zone, which extends south-southeast from Ungava Bay in the north and is bounded by the Grenville Orogen to the south. The Core Zone, a Precambrian lithotectonic terrain at the eastern edge of Canadian Shield, is bounded to the west by lithologies associated with the New Quebec Orogen and to the east by the Torngat Orogen (Fig. 1) (Wardle et al., 2002). Two major shear zones transect the region, the dextral Lac Tudor shear zone and the dextral Rivière George Shear Zone (Sanborn-Barrie, 2016). The Core Zone is centred along the Archean cratonic Meta Incognita rocks, dominated by Churchill basement rocks overlain by Doublet Zone fine-grained mafic metavolcanic rocks in the north (Corrigan et al., 2015). The Smallwood Reservoir separates the Core Zone rocks from the Grenville Orogen rocks of southern Quebec and Newfoundland and Labrador.

The northern half of the study area is dominated by the De Pas batholith, a felsic granitic unit characterized as a K-feldspar porphyritic monzogranite-granodiorite-syenogranite. The mineralogy changes across the batholith from more orthopyroxene-rich assemblages in the western half to more hornblende-biotite-rich in the eastern half (Sanborn-Barrie, 2016). A broad band of Archean orthogneiss flanks both the western and eastern margins of the De Pas batholith (Fig. 2). In the western portion of the map sheet, Churchill Province basement rocks are overlain by fine-grained mafic metavolcanic rocks of the Doublet Zone in the south and metasedimentary rocks of the Laporte domain to the north. The Tudor Lake shear zone separates these domains along a general north-northwest/south-south-east vector (Corrigan et al., 2015; Sanborn-Barrie, 2016). East of the De Pas batholith and associated eastern orthogneiss, the study area is underlain by supercrustal rock assemblages, including the Ntshuku, Atshakash, and Zeni (Girard, 1990; van der Leeden et al., 1990). These assemblages include interbedded graphitic schists, cherty quartz arenite, schistose metatuff, and metabasalt. Southeast of these domains is the Mistinibi-Raude migmatite domain, which is distinguished by its high-grade magmatic character (van der Leeden et al., 1990).

The southern part of the study area (NTS 23-I) is bisected by the De Pas batholith and associated orthogneiss. The fine-grained mafic metavolcanic rocks of the Doublet Zone extend from NTS 23-P into the northwest portion of NTS 2-3I, where they are bounded by lithologies associated with the Labrador Trough (Knob Lake Group) and the Superior Craton (Wardle, 1982; Sanborn-Barrie, 2016). The wedges of fault-bounded metaplutonic rocks are also referred to as the Snelgrove Arch (Wardle and Bailey, 1981), as its most northern terminus is at Snelgrove Lake (Fig. 2). The south-central portion of the map sheet, just west of the De Pas batholith on the northwestern shores of the Smallwood Reservoir, is characterized by semipelite, iron-rich metasedimentary, and mafic volcanic rocks of the Lobstick group. East of the De Pas batholith on the northeastern shore of the Smallwood Reservoir, Mesoproterozoic intrusions cut into the aforementioned Archean lithologies of the Core Zone. For a detailed summary of lithological assemblages and their lithotectonic significance and relationships, see James et al. (1992) and Sanborn-Barrie (2016).

SURFICIAL GEOLOGY

The study area underwent extensive glacial modification as a result of continuous ice cover throughout the Wisconsin glaciation. Specifically, northern Quebec was covered by a major ice dispersal centre of the Quebec-Labrador sector of the LIS, often referred to as the New Québec dome, with the Ancestral Labrador Divide extending into the study area (Vincent, 1989). The proximity to a former dynamic ice centre has resulted in a complex glaciological history of glacial deposition and dispersal. Understanding this complex history, including past ice-flow trajectories, their associated landforms, bedrock erosion, glacial drift transport and its eventual deposition, is vital for successful drift prospecting in the region.

The oldest documented ice-flow phase in the region was to the northeast (Fig. 3) and likely originated somewhere in the Laurentian highlands of southern Quebec (Veillette et al., 1999). This ice-flow event was sporadically (yet consistently) the oldest phase observed within the study area and has been largely eroded by later ice flows. The second oldest flow phase resulted from radially flowing ice from the Labrador ice centre, with the Ancestral Labrador Ice Divide position on the east side of the De Pas batholith. This second phase was responsible for most of the erosional landforms in the study area. The third ice-flow phase was imparted onto the landscape after the westward migration of the ice divide, west of the De Pas batholith. Evidence of the shift in the ice centre was observed in several opposing bi-faceted outcrops in the north-central part of the northern map sheet (Rice et al., 2016) and resulted in a number of areas experiencing a complete reversal of ice flow. The fourth phase occurred in the early stages of deglaciation as ice flowed eastward to the Labrador Sea and reduced the ice-sheet profile in the eastern section of the LIS (Margold et al., 2015). This fourth phase remobilized the previously deposited tills and created crosscutting landforms and elongated mega-scale glacial lineations in corridors of fast-flowing ice. After the paleo ice-

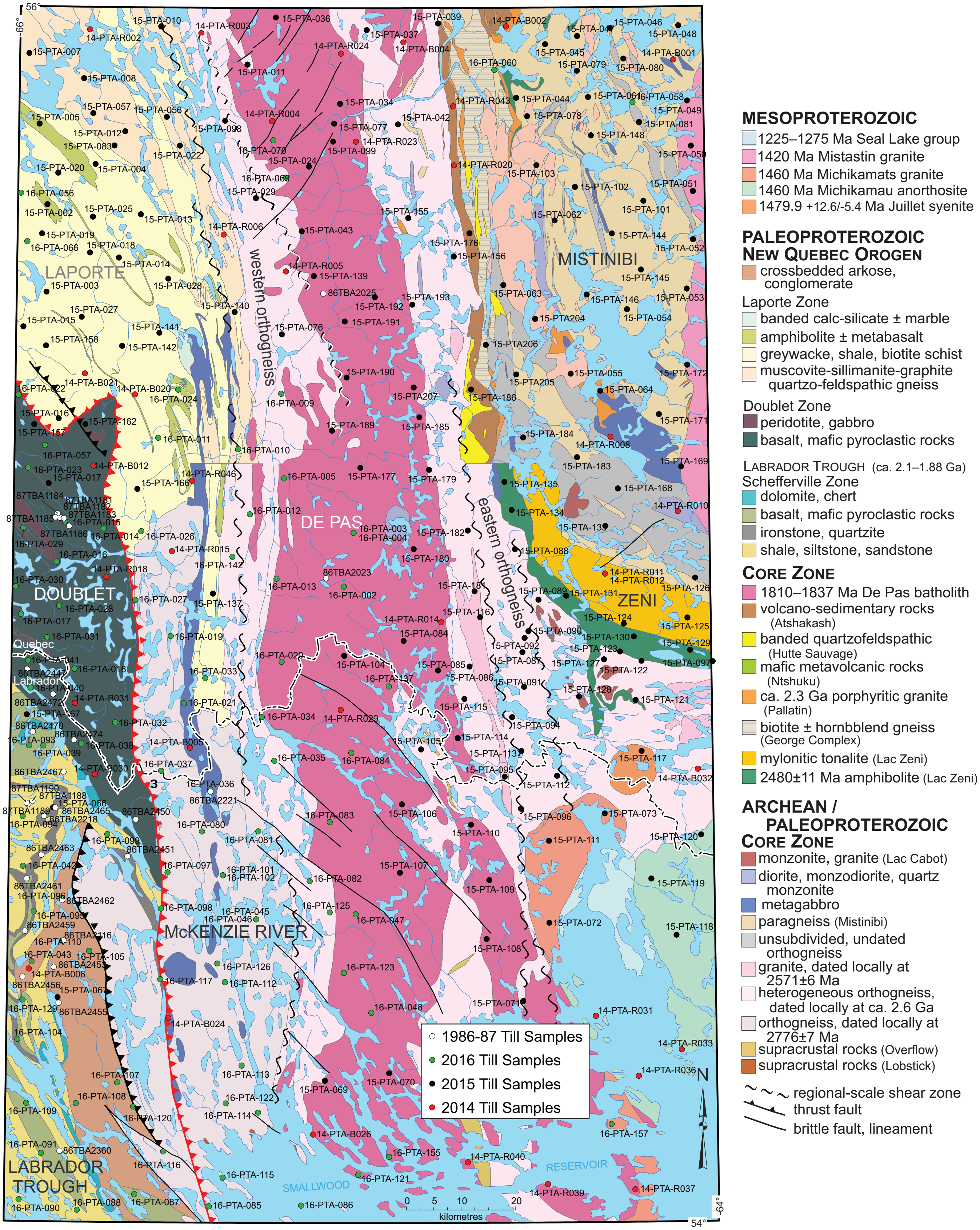

Figure 2. Locations of GSC till samples collected in 2014, 2015, and 2016 shown on the bedrock geology of the GEM-2 southern Core Zone project area (NTS 23-P and 23-I) highlighting crustal domains (uppercase letters) within the New Quebec Orogen and southern Core Zone. Bedrock geology is after Wardle et al. (1997), and Ministère de l'Énergie et des Ressources naturelles (2010).

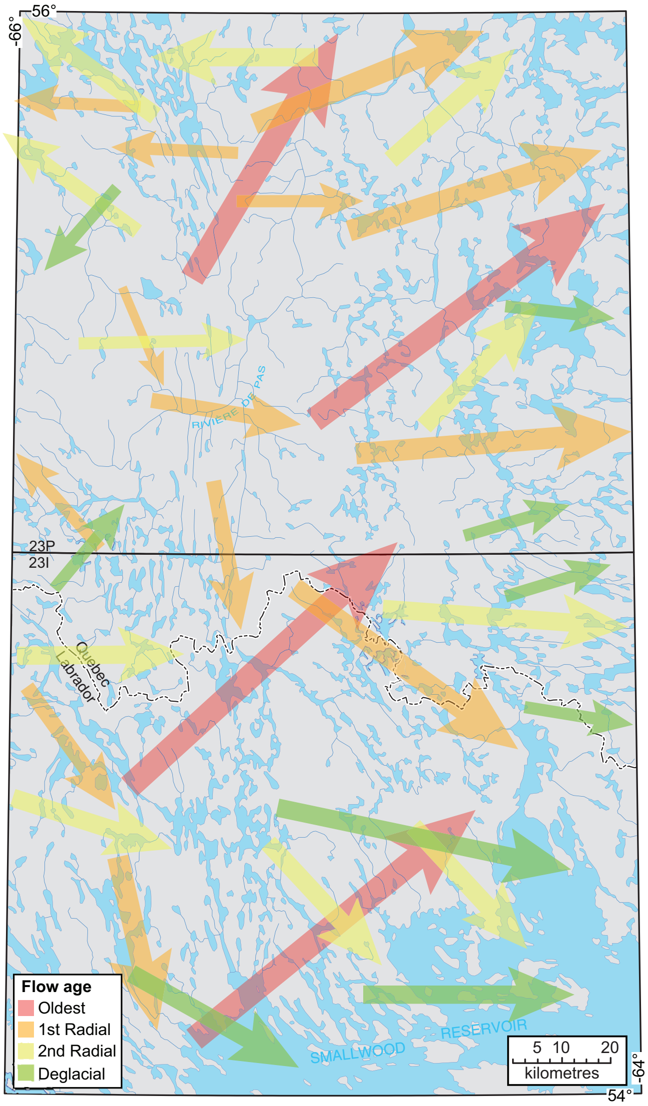

Figure 3. Generalized ice-flow chronology in the study area. Red arrows indicate the oldest known ice flow recorded in the region, likely originating from the Laurentian Highlands in southern Quebec (Veillette et al., 1999). Orange arrows indicate early phase radial flow from the Labrador ice sector of the Laurentide Ice Sheet. Yellow arrows indicate later phase radial flow as the ice divide shifted westward. Green arrows indicate the youngest known ice flow that occurred during deglaciation (from McClenaghan et al., 2016).

stream network shut down, a deglacial land system remained and records the last glacial events in the region and is dominated by radial esker networks in the eastern half of the map area, with local deviations that resulted from topographically controlled ice flow. In the western part of the map area, meltwater channels impacted the landscape during the stagnation and ablation of remnant ice masses.

During deglaciation, three glacial lakes formed in the study area: 1) glacial Lake Low (Paulen et al., 2017) in the southern part of NTS 23-I, in the present day Smallwood Reservoir basin; 2) glacial Lake Naskaupi, which occupied the George River basin in the northeast part of NTS 23-P (Ives, 1960a,b); and 3) glacial Lake McLean, which occupied the Rivière à la Baleine (Whale River) basin (Barnett, 1967) in the northwest part of NTS 23-P. Below an elevation of 450 m asl till within the George River basin in the northeast part of the study area was winnowed and the fines were washed away leaving large expanses of bedrock washed clean. As a result, finding till to sample at or near surface in this part of the study area is difficult.

PREVIOUS WORK

The southern Core Zone was first recognized as a region of significant ice accumulation, dispersal, and wasting during the incredible expedition by GSC scientist Albert Peter Low in the late 1890s (Low, 1896). Other than minor observations of glacial deposits during economic exploration (e.g. Gill et al., 1937), little work had been reported for the surrounding region until the release of aerial photographs of the region following World War II. Douglas and Drummond (1953) compiled a map of large-scale landforms using air-photo interpretation. Ives (1959) and Kirby (1960) were the first to conduct detailed field work around the town of Schefferville, Quebec. They suggested the area once contained an ice dome, citing large meltwater channels as evidence of significant meltwater runoff associated with the deglaciation of a large ice dome within the region. A reconnaissance till sampling program was carried out by the GSC in the 1980s across western Labrador and northeastern Quebec, including the south Core Zone study area. Data from this program were reported in Klassen and Thompson (1987, 1989, 1990, 1993), Klassen (1999), and Klassen and Knight (1995).

METHODS

Till sampling methods

Till samples were collected across the study area using established GSC protocols (Spirito et al., 2011; McClenaghan et al., 2013). Where possible, active mud boils were targeted for till sample collection at depths between 0.2 and 1.0 m. These sites were mainly in map sheet NTS 23-P (Fig. 4a,b), as discontinuous permafrost is found throughout this region. In the southern map sheet (NTS 23-I), south of the limit of discontinuous permafrost, till samples were collected by digging through the naturally developed soil profile (Fig. 4c) to sample unoxidized till (C horizon). Cobbles (clasts > 64 mm) were removed from till samples to maximize the amount of till matrix being collected. At each site, two samples were collected: a large till sample (averaging 12 kg) for recovery of indicator minerals, and a smaller sample (~3 kg) for archiving and geochemical analysis. For till samples collected in Labrador in 2016, an additional 3 kg till sample was collected by the

Geological Survey of Newfoundland and Labrador for matrix till geochemistry using different analytical protocols (Campbell et al., 2017). Locations for all till samples collected in 2014, 2015, and 2016 are shown in Figure 2. Metadata for till samples collected in 2015 and 2016 are reported in Appendix A1.

Till samples were collected across the region in 1986 and 1987 as part of the Canada-Newfoundland Mineral Development Agreement (1984-89). These 2-4 kg till samples were collected from hand-dug pits, or mudboils where available, at depths of between 30 and 80 cm, targeting unoxidized material (Klassen and Thompson, 1993). Thirty-one of these archived samples that were collected within the current study area were submitted for reanalysis together with the till samples collected in 2014 (Batch #2). These older samples help to provide a regional context in which to interpret the results. Metadata for these older till samples are reported in Appendix A1.

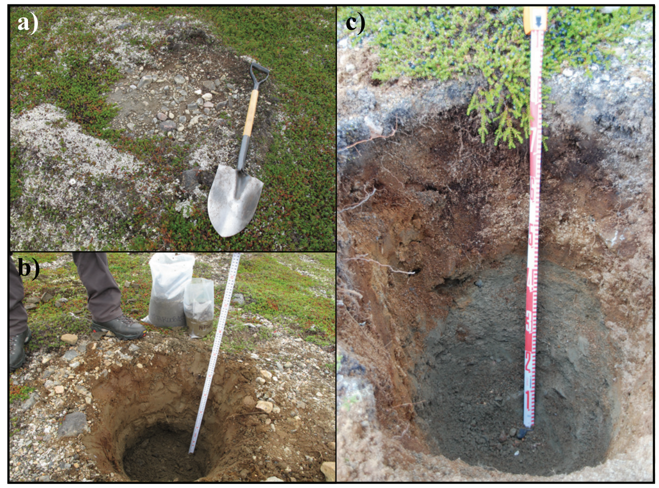

Figure 4. a) Mudboil typical of those sampled in the northern portion of the study area where permafrost is discontinuous; **b)** sample pit in a mud boil with routine geochemistry (small) and indicator mineral (large) samples; **c)** sample pit typical of the southern portion of the study area where there is no permafrost and natural soil horizons have developed on till.

Sample processing

The 3 kg till samples were submitted to the GSC Sedimentology Laboratory, Ottawa. Each sample was air dried by being laid out on dry Kraft paper and, if needed, disaggregated inside a plastic sample bag using a rubber mallet (Girard et al., 2004). For each dried sample, an ~800 g split was archived and the remainder was subjected to matrix grain-size analysis, Munsell colour determination, and sieving to recover the <0.063 mm fraction following GSC protocols as outlined by Spirito et al. (2011) and McClenaghan et al. (2013) and shown in Figure 5. The <0.063 mm fraction of each till sample was isolated by dry sieving in a stainless-steel US standard 230 mesh sieve in preparation for geochemical analysis.

Grain-size analysis of the sediment matrix was conducted on a separate aliquot using a combination of wet and dry methods (Girard et al., 2004). The size classes for the >0.063 mm material were determined by dry sieving in a stack of sieves; the size classes for the <0.063 mm material were determined using a Lecotrac LT-100 Particle Size Analyzer. Sediment classification was based on the Shepard (1954) system for determining sand-silt-clay ratios. Data from the reported grain-size determinations are listed in Appendix A2. Munsell colour (dry) was determined for each dry till-matrix sample using a Spectrophotometer linked to IQC colour software. Munsell colour determinations are also reported in Appendix A2.

Geochemical analysis

All analytical data are reported in Appendices B to D. Total carbon, organic and inorganic carbon contents, and loss on ignition (LOI) were determined for the <0.063 mm fractions using the LECO® RC-412 Carbon Analyzer at the GSC Sedimentology Laboratory, Ottawa. Till samples were separated into two aliquots: one portion was heated to 1350ºC to determine percentage of total inorganic carbon and total carbon through infrared detection of liberated CO_2; the second aliquot of each sample was heated for 1 hour at 500ºC to determine the LOI. Total carbon and LOI data for samples collected in 2015 and 2016 are reported in Appendix B1 and D1, respectively.

The <0.063 mm fraction of each till sample was submitted to Bureau Veritas Minerals Canada Ltd. (BV), Vancouver, for analysis of a suite of major, minor, and trace elements using (1) a modified aqua regia digestion (HCl:HNO_3 in a 1:1 ratio) followed by an ICP-MS determination (BV AQ250 package on 0.5 g); (2) lithium metaborate/tetraborate fusion followed by nitric acid digestion/ICP-ES (BV LF200 package on 0.2 g), which included the determination of total Cu, Pb, Zn, and Mo; (3) fire assay/ ICP-ES/MS analysis on 30 g aliquots of till samples for Au, Pt, and Pd; and (4) total S and total C were determined by the LECO® RC-412 Carbon Analyzer. At the same time, 30 g of GSC till samples collected in 2014 were re-submitted for fire assay ICP-ES/MS analysis. Samples were analyzed in three batches: Batch #1 consists of samples collected in 2015; Batch #2 consists of samples collected in 2014 plus samples collected in 1986-87 and submitted for additional analyses; and Batch #3 consists of samples collected in 2016.

Geochemical data for the <0.063 mm fraction of Batch #1 till samples that were analyzed in 2015 are reported in Appendix B2. Results for the Batch #2 2014 till samples that were re-submitted for fire assay analysis are reported in Appendix C1. Geochemical data for

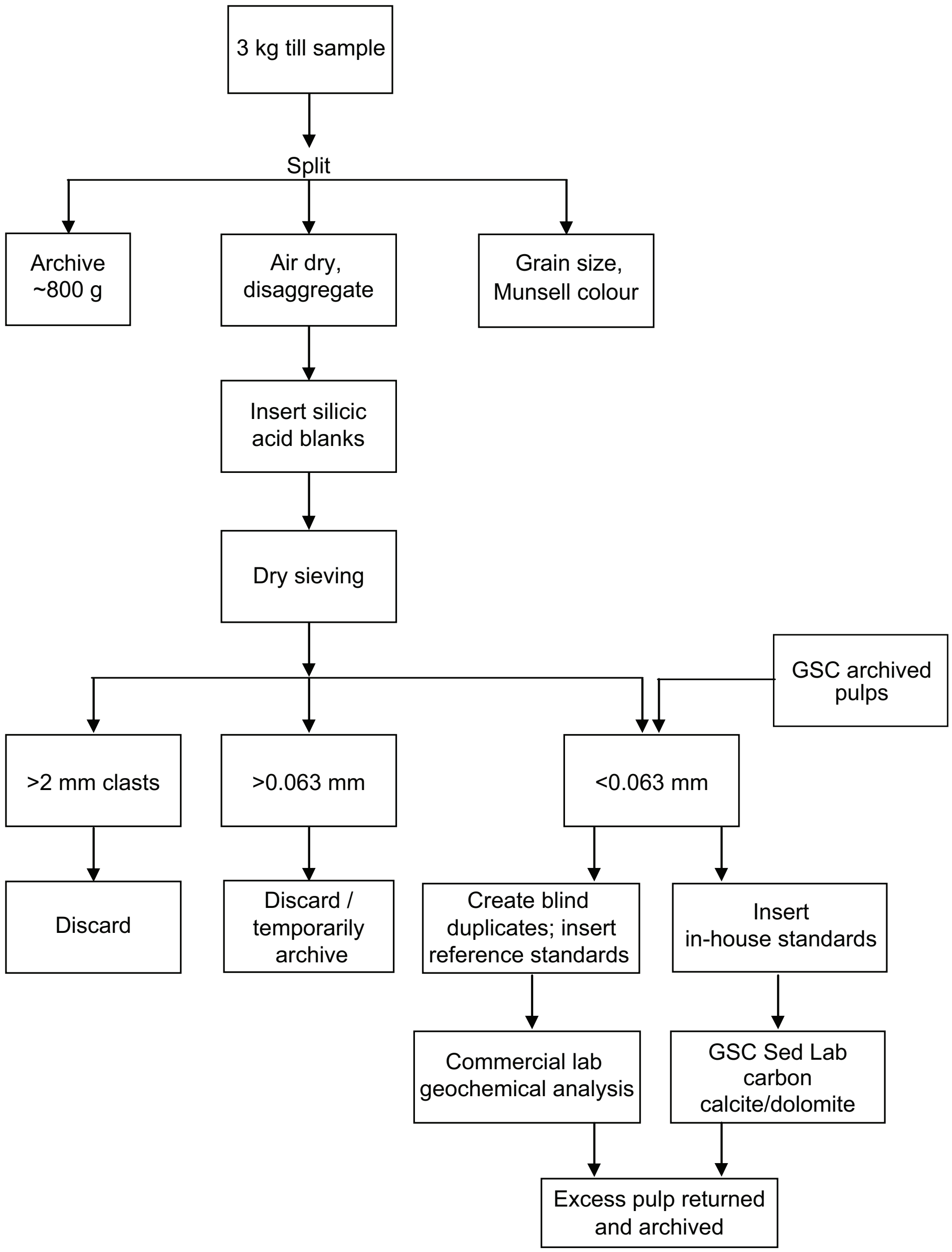

Figure 5. Flow chart outlining sample processing and preparation of the <0.063 mm fraction of till samples at the Geological Survey of Canada's Sedimentology Lab, Ottawa, (modified from McClenaghan et al., 2013).

archived till samples collected in 1986 and 1987 and re-analyzed as part of this study are also reported in Appendix C1. Data for the Batch #3 2016 samples are reported in Appendix D2.

The results listed in Appendix D2 for the 2016 samples include data for GSC till samples collected at the Strange Lake peralkaline granite, 250 km to the northeast of Schefferville. The geochemical data for these samples are reported here because the samples were analyzed as part of a larger batch. To fully evaluate the quality assurance/quality control (QA/QC) of the entire batch, all data must be considered. Location data for these Strange Lake till samples will be reported in a subsequent GSC Open File.

Laboratory duplicates

For the Batch #1, four blind (analytical) duplicates were inserted by the GSC Sedimentology Laboratory to monitor analytical precision. Sample 15-PTA-001B is a duplicate of sample 15-MPB-008; 15-PTA-009-B is a duplicate of 15-MPB-102; 15-PTA-110-B is a duplicate of 15-MPB-024; and 15-PTA-157-B is a duplicate of 15-PTA-097; these data are reported in Appendix B3.

For the Batch #2 till samples collected in 2014 (14-PTA series) and reanalyzed in 2016 with the 1986-87 samples, three analytical duplicates were analyzed: sample 87TBA1191-A is a duplicate of 14PTA-B021;

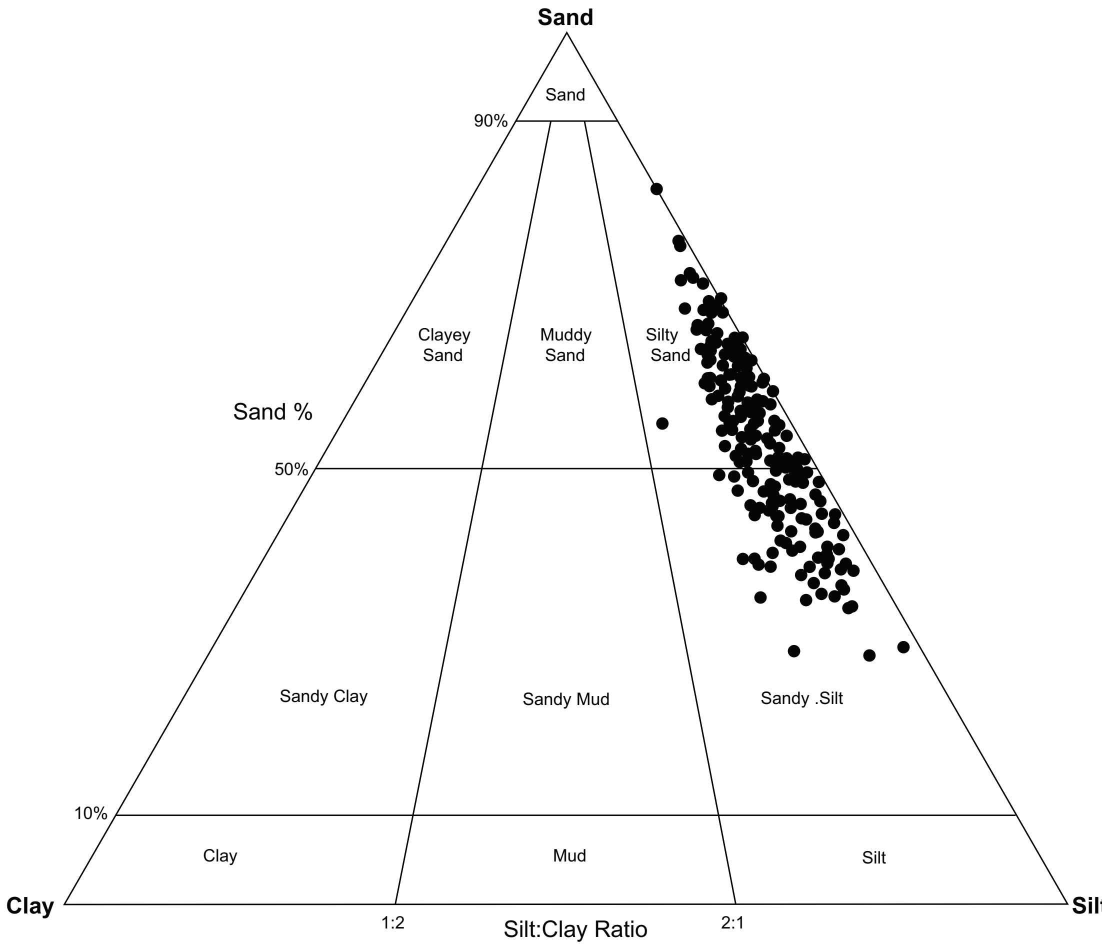

Figure 6. Ternary diagram showing the percentage of sand, silt, and clay in the till matrix of samples collected in 2014, 2015, and 2016 (N=278).

87TBA1192-A is a duplicate of 86TBA2025; and 87TBA1193-A is a duplicate of 87TBA1184. These data are reported in Appendix C2.

For Batch #3 till samples collected in 2016, three blind (analytical) duplicates were prepared and inserted into the batch of routine samples by the GSC Sedimentology Laboratory, to monitor analytical precision. Sample 16-PTA-004A is a duplicate of sample 16-MPB-004; 16-PTA-046A is a duplicate of 16-MPB-046; 16-PTA-102A is a duplicate of 16-MPB-102. These data are reported in Appendix D3.

Certified reference standards

CANMET certified reference standards TILL-1 and TILL-4 were inserted into Batch #1 prior to geochemical analysis to monitor analytical accuracy. Samples 15-MPB-010-A, 15-PTA-055-A, 15-PTA-182-A are TILL-1 and samples 15-MPB-022-A, 15-PTA-089-A, 15-PTA-128-A are TILL-4. These data are reported in Appendix B4. The certificate of analysis for TILL-1 and TILL-4 reference materials is available at: https://www.nrcan.gc.ca/mining-materials/certified-reference-materials/certificate-price-list/8137.

In Batch #2, TILL-4 was inserted as samples 14-PTA-B026-A, 14-PTA-R046-A, 86TBA2450-A, and 87TBA1190-A. The data for these standards are reported in Appendix C3.

In Batch #3, TILL-4 was inserted as the following samples 16-PTA-175, 16-PTA-176, and 16-PTA-177; the data for these samples are reported in Appendix D4.

Silica sand blanks

Silicic acid (silica sand) blanks were inserted into the analytical batches prior to sieving and analysis to monitor potential cross contamination between samples during sieving and/or during analytical procedures. In Batch #1, the silica blanks were 15-PTA-001-A, 15-PTA-025-A-C, 15-PTA-090-A-C, and 15-PTA-157-A-C. These data are reported in Appendix B4.

Four silica blanks were inserted into Batch #2. These blank samples were labelled 14-PTA-B032-A, 14-PTA-R001-A, 14-PTA-R011-A, and 86TBA2472-A. Analytical data for the four blanks are reported in Appendix C3.

In 2016, six silica blanks were inserted into Batch #3 and are labelled as: 16-PTA-001-A, 16-PTA-100-A,

16-PTA111-A, 16-PTA-172-A, 16-PTA-173-A, and 11-PTA-174-A. The data for these blank samples are reported in Appendix D4.

RESULTS

Till characteristics

Despite the large geographical area and a variety of bedrock lithologies, the grain-size distribution of the till samples collected in 2014, 2015, and 2016 is remarkably uniform (Fig. 6). All the till samples have a sandy-silt to silty-sand matrix with an average composition of 55% sand, 41% silt, and 4% clay. Matrix grain-size data for the 2015 and 2016 till samples are reported in Appendix A2.

Munsell colour determination also shows little variability across the study area. Over 75% of the till samples collected had a light yellowish brown (2.5Y 6/3), light brownish grey (2.5Y 6/2), or light olive grey (5Y 6/2) matrix colour. Munsell colour determinations for the 2015 and 2016 till samples are reported in Appendix A2.

Total carbon, inorganic and organic carbon, and LOI results for the 2015 and 2016 till samples are reported in Appendix B1 and Appendix D1, respectively. Results indicate consistently low levels of inorganic and organic carbon with an average of 0.2% inorganic carbon. The levels of organic carbon are similarly low with an average of 0.7%. Three samples have higher levels of organic carbon: samples 15-PTA-083C (6.0%), 15-PTA-073 (3.0%), and 15-PTA-072 (2.8%). Sample 15-PTA-083C is an oxidized till collected from a thin till unit overlying bedrock, which would account for the elevated organic carbon content. The elevated levels of organic carbon in samples 15-PTA-073 and 15-PTA-072 are unknown. Loss on Ignition (LOI) results showed similar trends to those observed for organic carbon content, with an average LOI value of 2.9% and elevated LOI values for samples 15-PTA-083C (17.1%), 15-PTA-073 (10.5%), and 15-PTA-072 (9.1%).

Geochemical results

Geochemical data for the <0.063 mm fraction of till samples collected in 2015 and 2016 are listed in Appendix B2 and Appendix D2, respectively. Geochemical data for the 2014 samples analyzed using fire assay/ICP-MS are listed in Appendix C1. Till geochemical data for <0.063 mm fraction of archived till samples from 1986 and 1987 are reported in Appendix C1.

Geochemical for till samples collected in 2014 (McClenaghan et al., 2016) were combined with the new data reported here and are presented for selected elements as proportional dot maps in Appendix E (maps 1 to 25). Data classes for each dot size were determined using Jenks natural break optimization calculation within the ArcMap software (v. 10.3.1). Data for field duplicates were not included on these distribution maps.

Gold and silver in the <0.063 mm fraction of till

Gold abundance shown on Appendix E Map 1 was determined by fire assay/ICP-MS. Gold values throughout the study area range from below detection limit (<2 ppb) to 23 ppb. Three till samples had elevated values of gold: 15-PTA-157 (19 ppb), 15-PTA-028 (21 ppb), and 87TBA1186 (23 ppb). All three of these till samples were collected over the Doublet Zone volcanic rocks (Fig. 2) near the Ashuanipi River Shear Zone boundary, which separates the mafic volcanic rocks from the Laporte metasediment domain to the north. Silver content was determined by aqua regia/ICP-MS. Silver values in till range from <2 ppb to 693 ppb (Appendix E, Map 2). Of the three till samples that contained elevated gold contents, till sample 15-PTA-157 also contained an elevated value of silver (693 ppb).

Platinum and palladium in the <0.063 mm fraction of till

Platinum and palladium values plotted on maps 3 and 4 (Appendix E) were determined using fire assay/ICP-MS. Platinum values in till range from <3 to 8 ppb and palladium values vary between <2 and 6 ppb. Overall the values in till are low. The highest values overlie the Doublet Zone and the Labrador Trough rocks on the west side of the study area. A single archived till sample (86TBA2447) contains the highest levels of platinum (8 ppb) and palladium (6 ppb).

Copper, lead, and zinc in the <0.063 mm fraction of till

Copper, lead, and zinc were determined by aqua regia/ICP-MS. Copper values range from 10 to 205 ppm, with the highest values detected overlying the Doublet Zone and the Laporte domain (Appendix E, Map 5). Overall, lead values in till across the region were extremely low (<30 ppm) (Appendix E, Map 6). Zinc values display patterns similar to copper with elevated values in the western portion of the map sheet overlying the Doublet Zone, the southern Laporte domain, and the Labrador Trough (Appendix E, Map 7).

Cobalt, nickel, and chromium in the <0.063 mm fraction of till

Cobalt, nickel, and chromium values, plotted on maps 8 to 10 (Appendix E), were determined using aqua regia/ICP-MS. Cobalt values vary between 5 and 58 ppm. Nickel values range from 8 to 191 ppm. Chromium values range from 16 to 294 ppm. All three elements display patterns similar to copper, with higher concentrations within the Doublet Zone, Laporte domain, and, to a lesser extent, the Knob Lake Group rocks of the Labrador Trough.

Antimony in the <0.063 mm fraction of till

Antimony values (Appendix E, Map 11) were determined using aqua regia/ICP-MS. Antimony values in till are highest overlying the Labrador Trough and to a lesser extent the Doublet Zone on the west side of the study area. This Sb pattern in the till is likely related to the large geochemical province defined by elevated antimony abundance in lake sediments that overlies the entire 600 km length of the Labrador Trough and was recently reported by Amor et al. (2016).

Major oxides in the <0.063 mm fraction of till

Major oxide concentrations were determined by lithium metaborate/tetraborate fusion/nitric acid digestion/ICP-ES. In general, the patterns for the till samples, as shown in maps 12 to 15 (Appendix E), reflect the composition of the underlying bedrock. For example, the highest Fe_2O_3 and MgO values in till overlie the Doublet Zone mafic volcanic rocks.

Vanadium in the <0.063 mm fraction of till

Vanadium values (Appendix E, Map 18) were determined using lithium metaborate/tetraborate fusion /nitric acid digestion/ICP-ES. Values range from 53 to 372 ppm and are highest overlying the Doublet Zone volcanic rocks and Laporte metasedimentary rocks on the west side of the study area.

Rubidium and yttrium in the <0.063 mm fraction of till

Rubidium and yttrium values were determined using lithium metaborate/tetraborate fusion/nitric acid digestion/ICP-ES. Both elements display similar patterns within the till (Appendix E, maps 19 and 21).

DISCUSSION AND CONCLUSION

In general, the underlying bedrock geology has had a large influence on the elemental composition of the till matrix. Till samples collected over the Laporte terrane metasedimentary rocks, Labrador Trough (Knob Lake Group), and Doublet terrane mafic volcanic rocks have distinct geochemical signatures characterized by elevated Cu, Zn, Au, Pt, Pd, and Sb contents. The elevated Au and Ag values in till over the Doublet Zone rocks coincides with the elevated gold grain content in till samples (>6 grains / 10 kg) overlying the Doublet Zone mafic volcanic rocks (McClenaghan et al., 2017).

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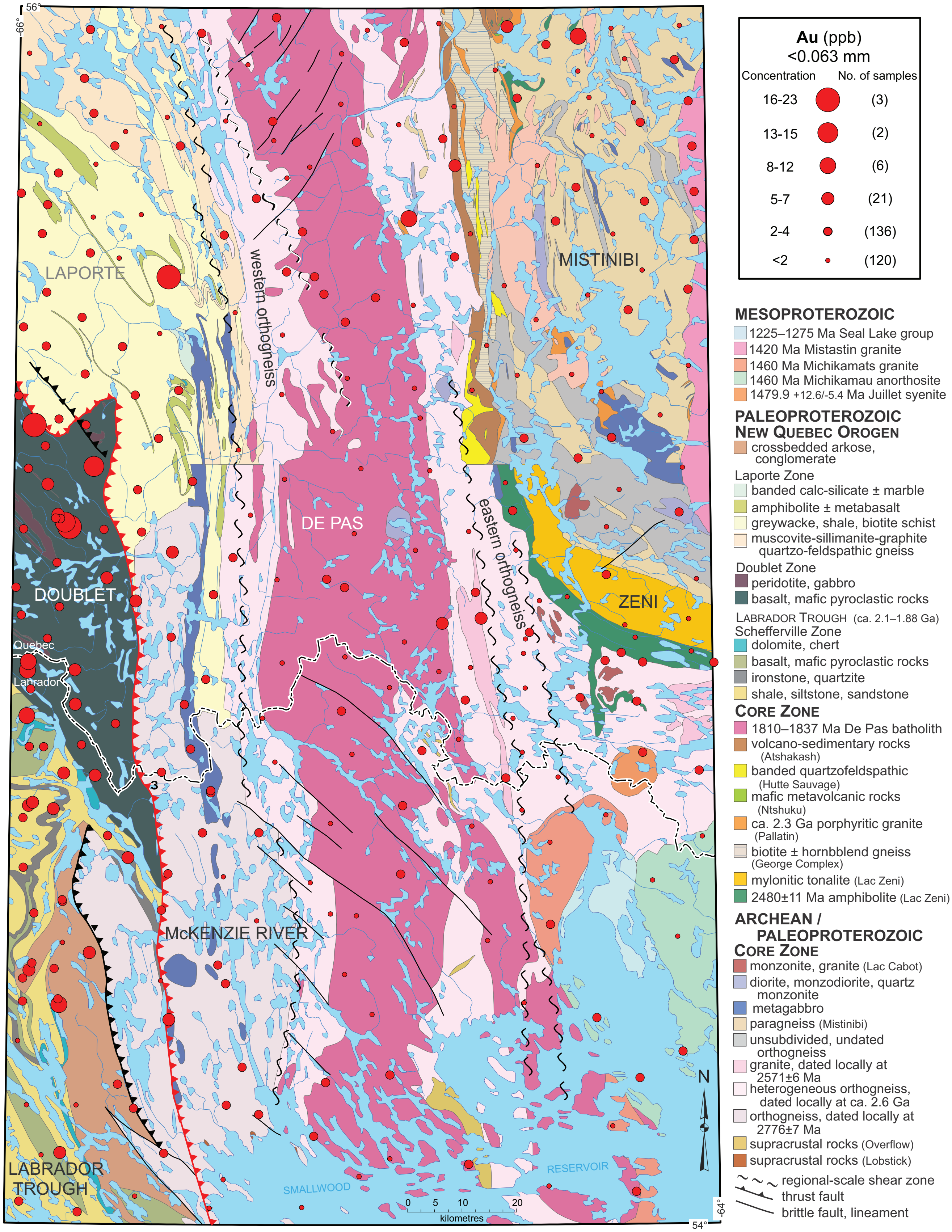
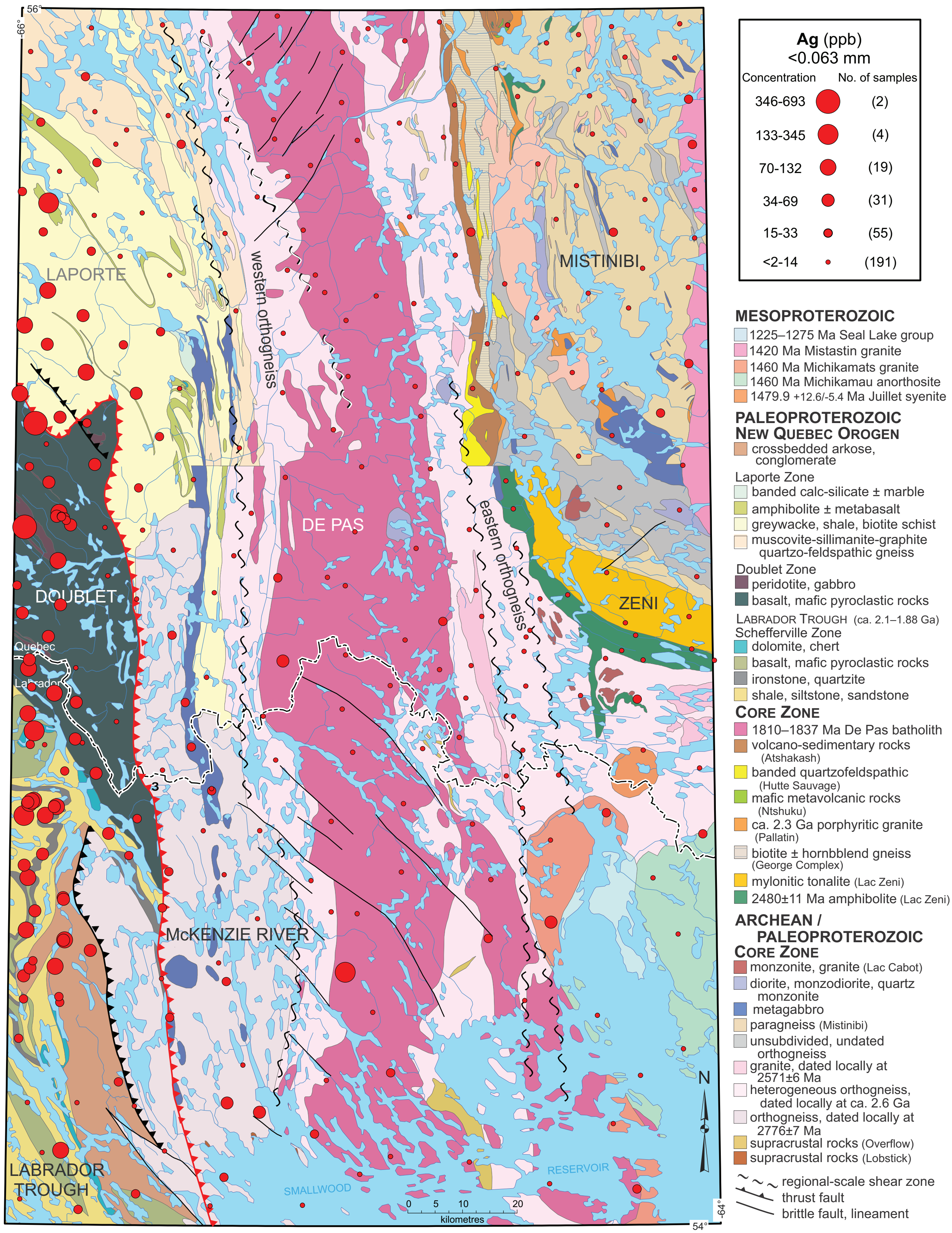
Appendix E. Proportional dot maps geochemical data for the <0.063 mm fraction of till samples collected in 1986-87, 2014, 2015, and 2016. Bedrock geology is the same as shown in Figure 2.



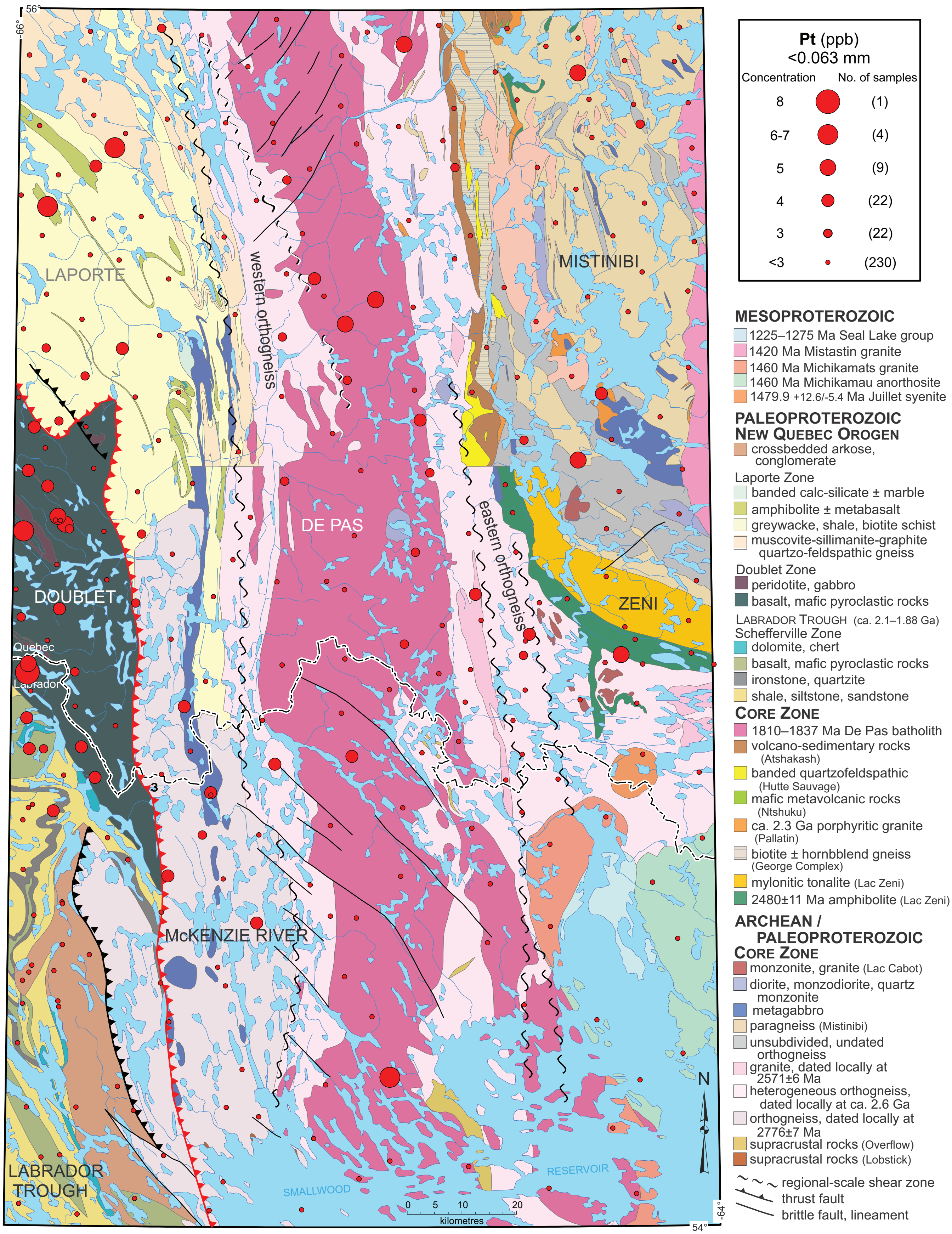
Appendix E, Map 1. Au by fire assay/ICP-MS.

Appendix E continued.



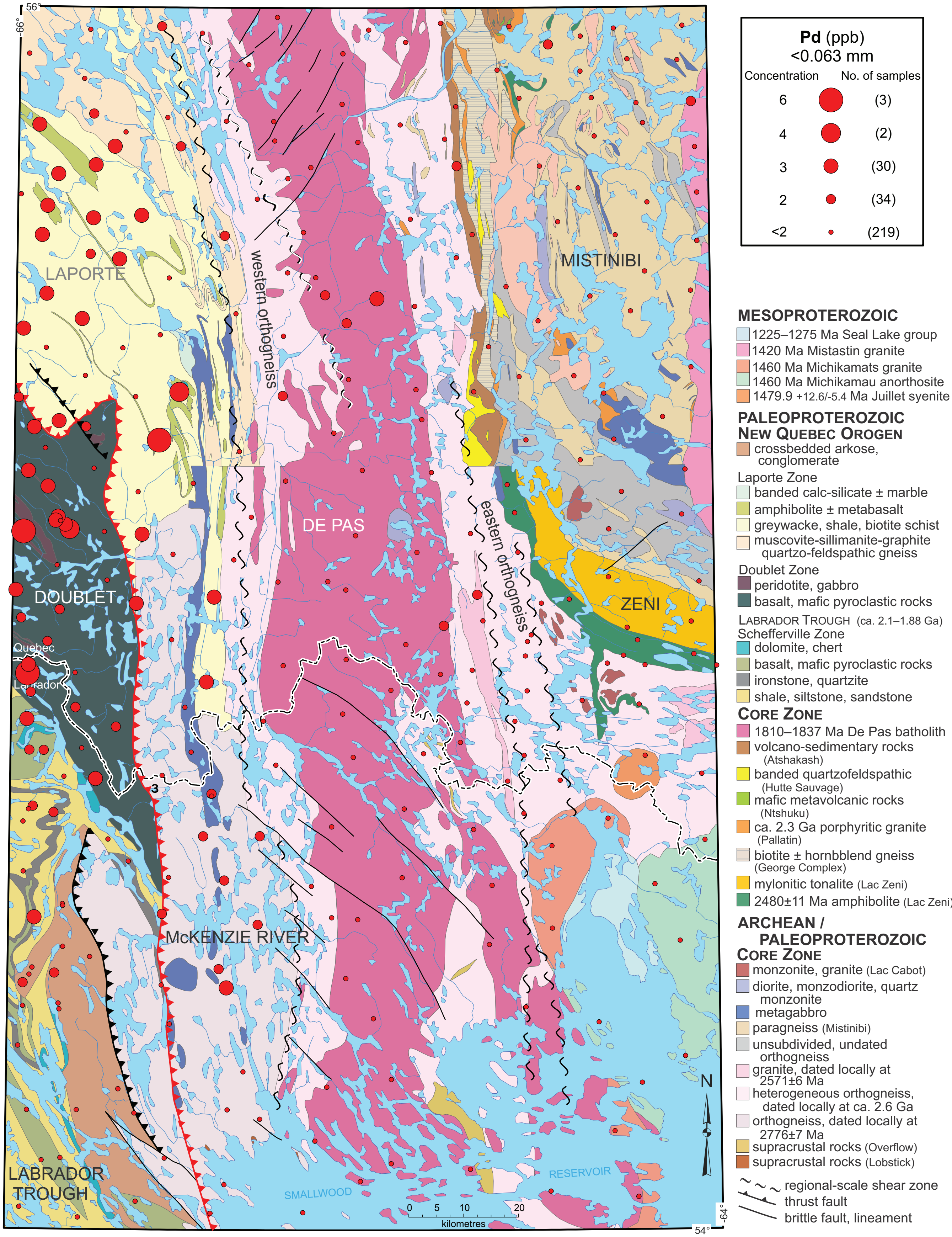
Appendix E, Map 2. Ag by aqua regia/ICP-MS.

Appendix E continued.



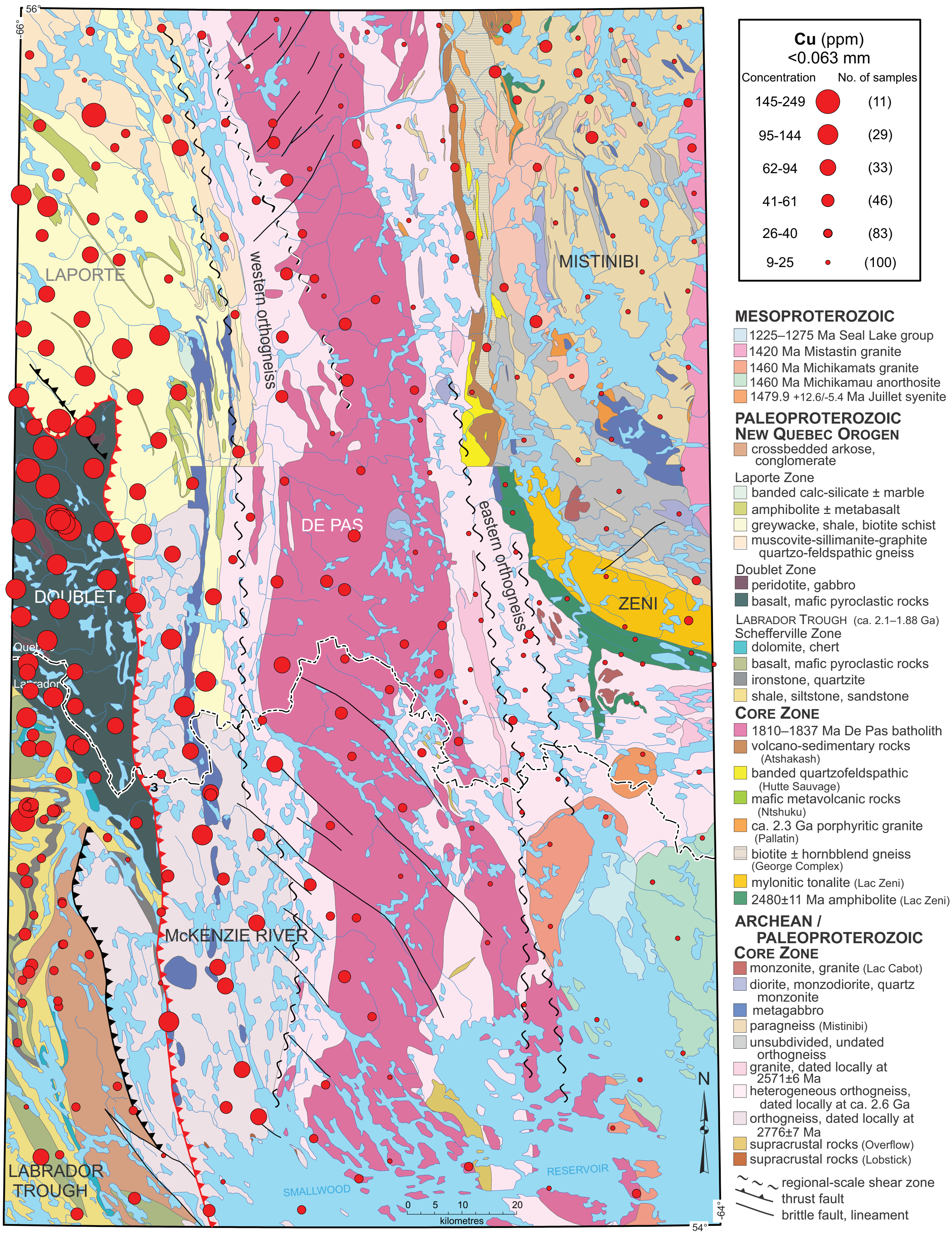
Appendix E, Map 3. Pt by fire assay/ICP-MS.

Appendix E continued.



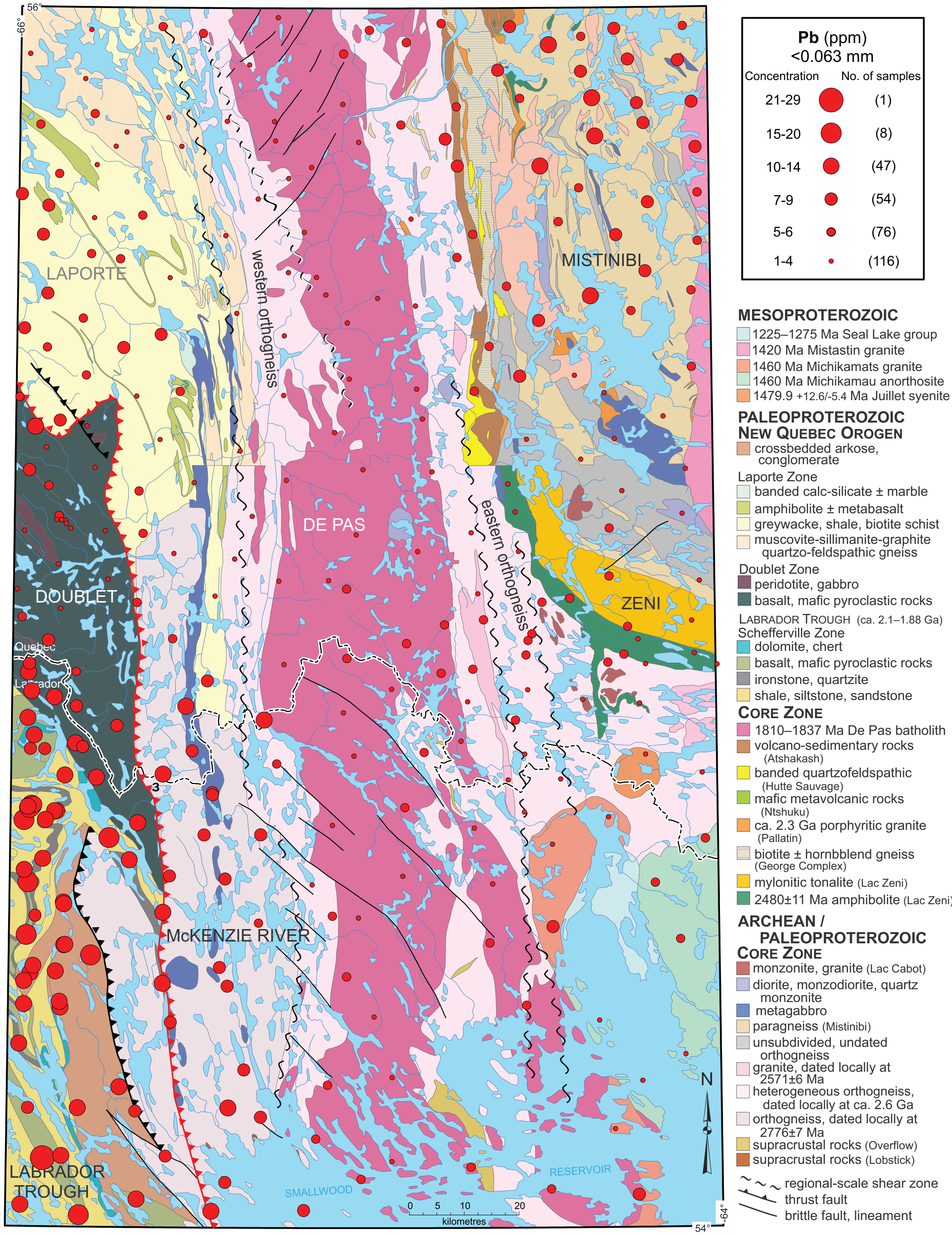
Appendix E, Map 4. Pd by fire assay/ICP-MS.

Appendix E continued.



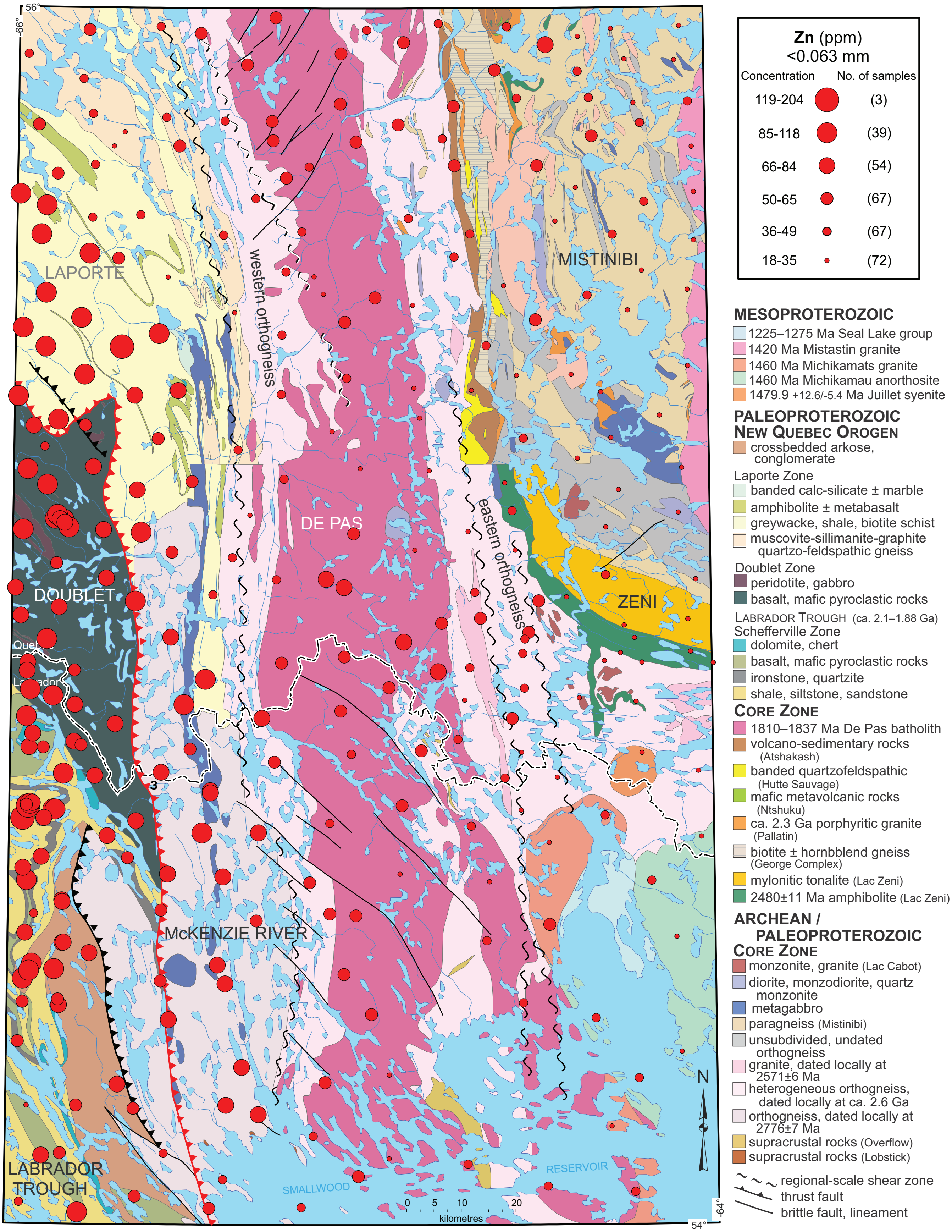
Appendix E, Map 5. Cu by aqua regia/ICP-MS.

Appendix E continued.



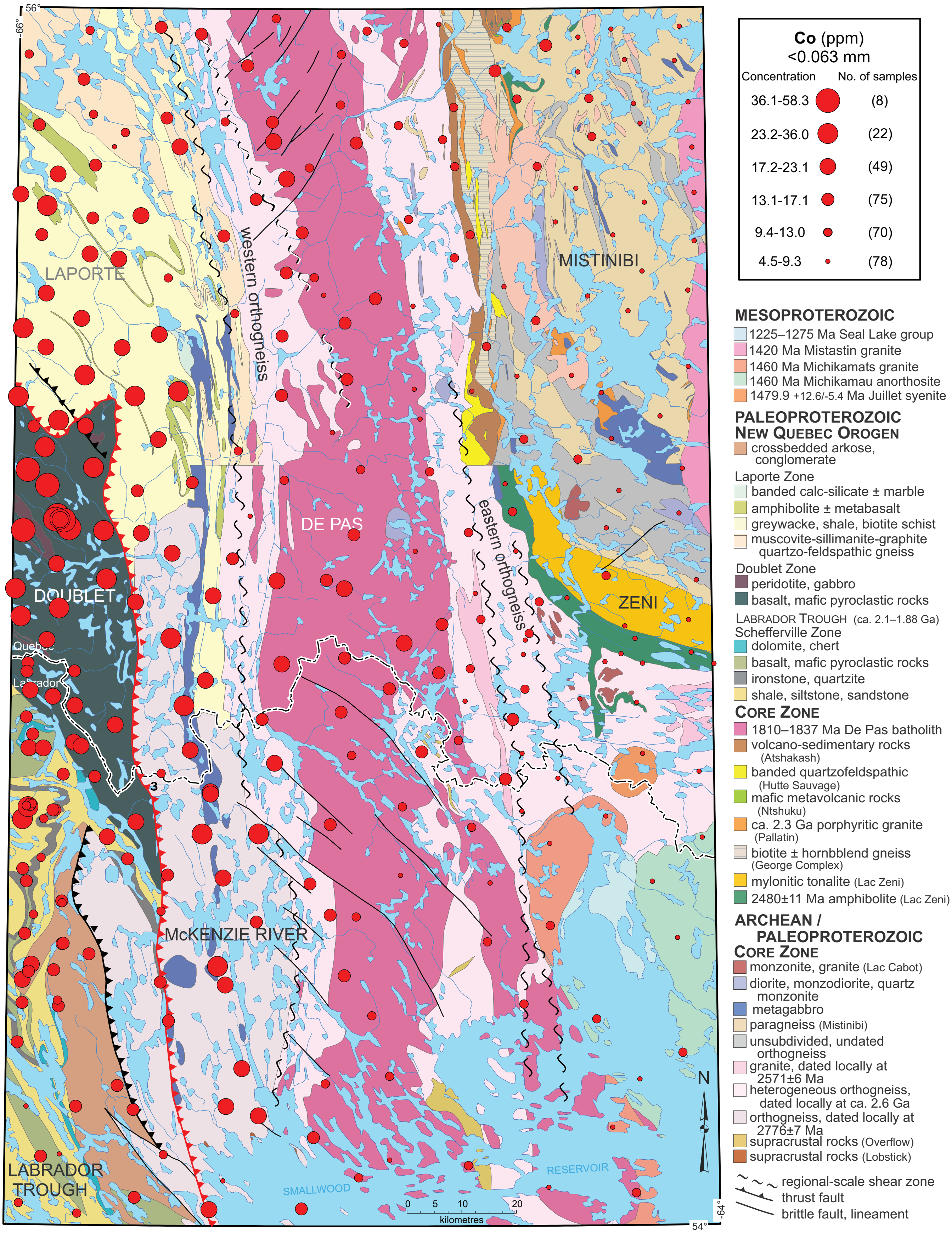
Appendix E, Map 6. Pb by aqua regia/ICP-MS.

Appendix E continued.



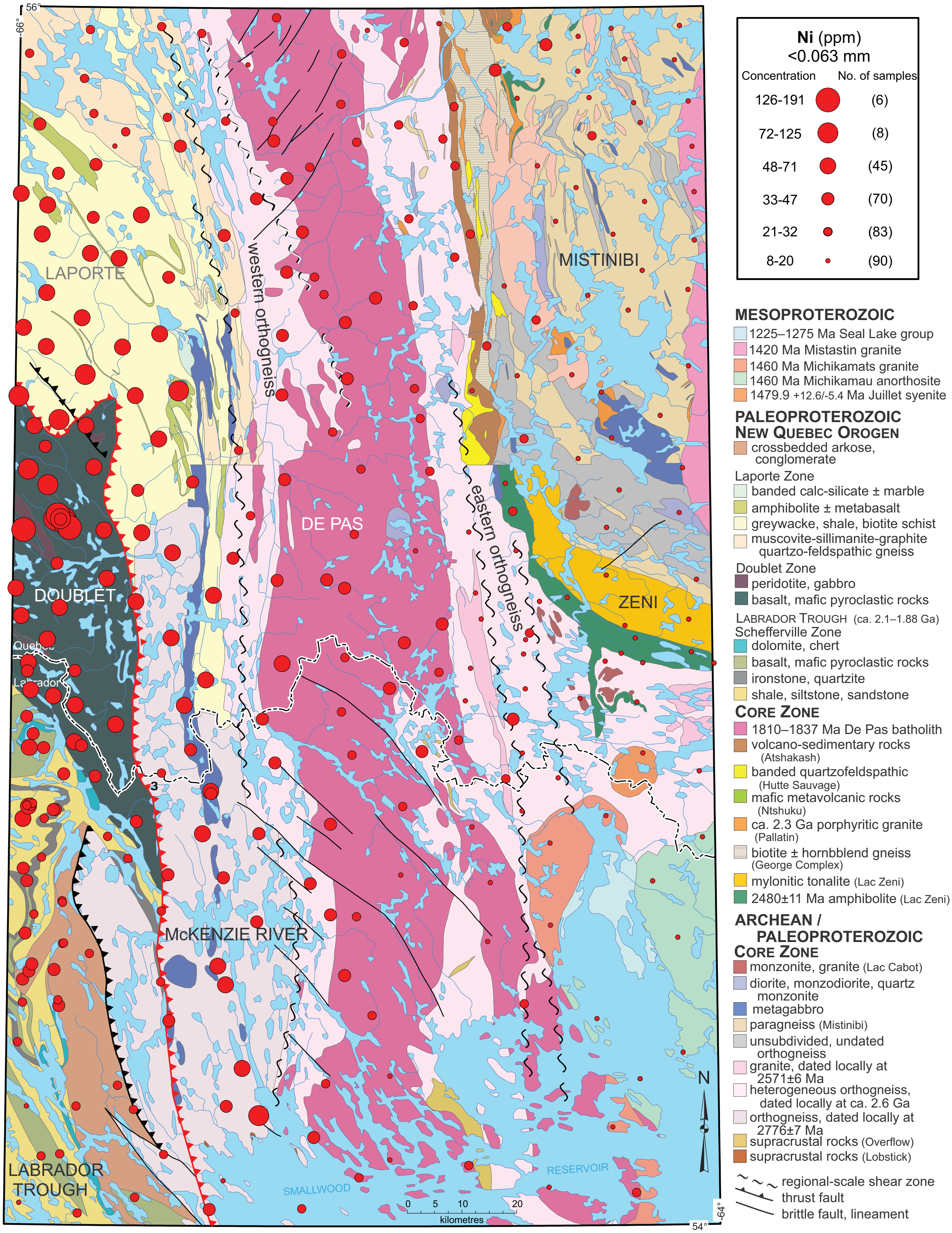
Appendix E, Map 7. Zn by aqua regia/ICP-MS.

Appendix E continued.



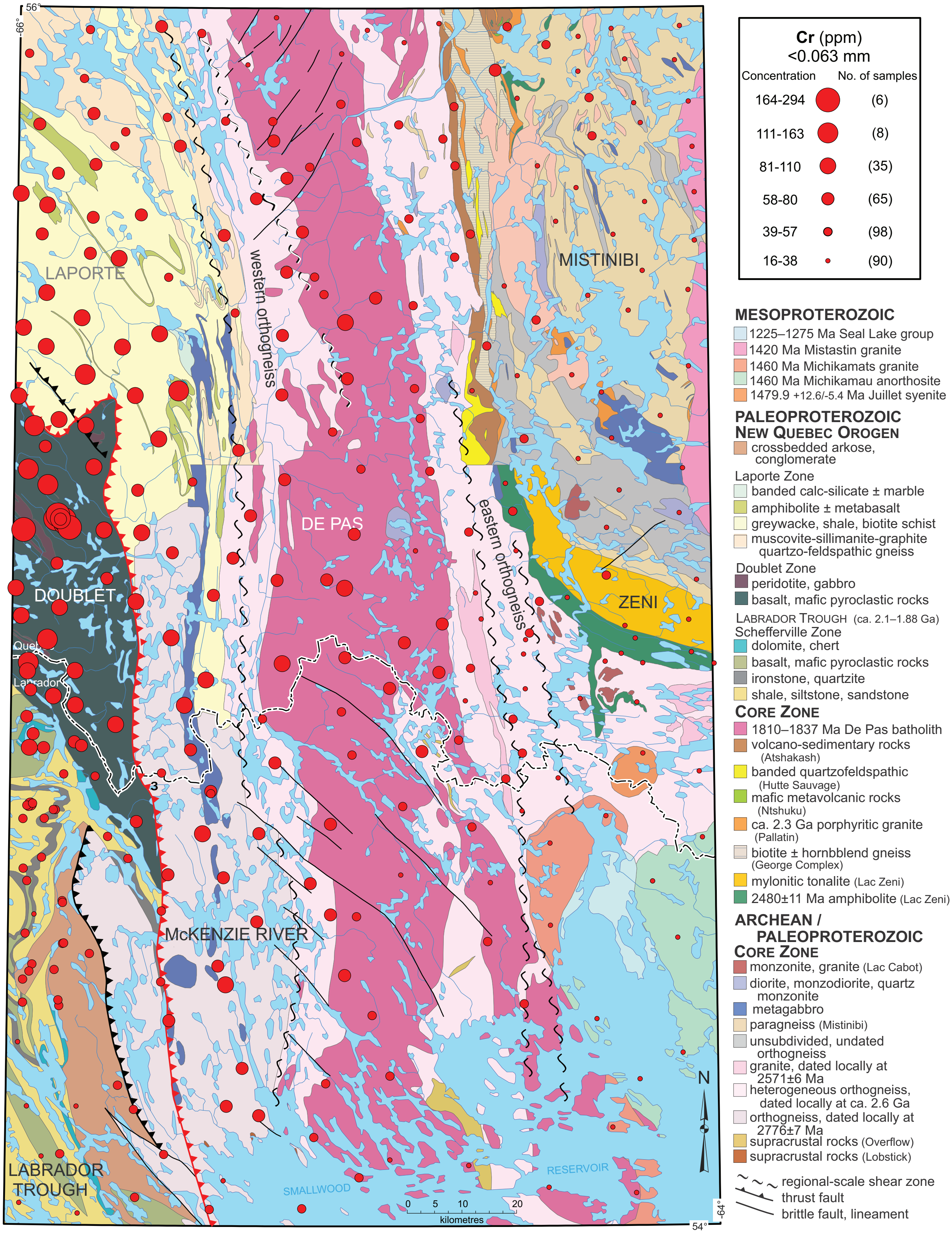
Appendix E, Map 8. Co by aqua regia/ICP-MS.

Appendix E continued.



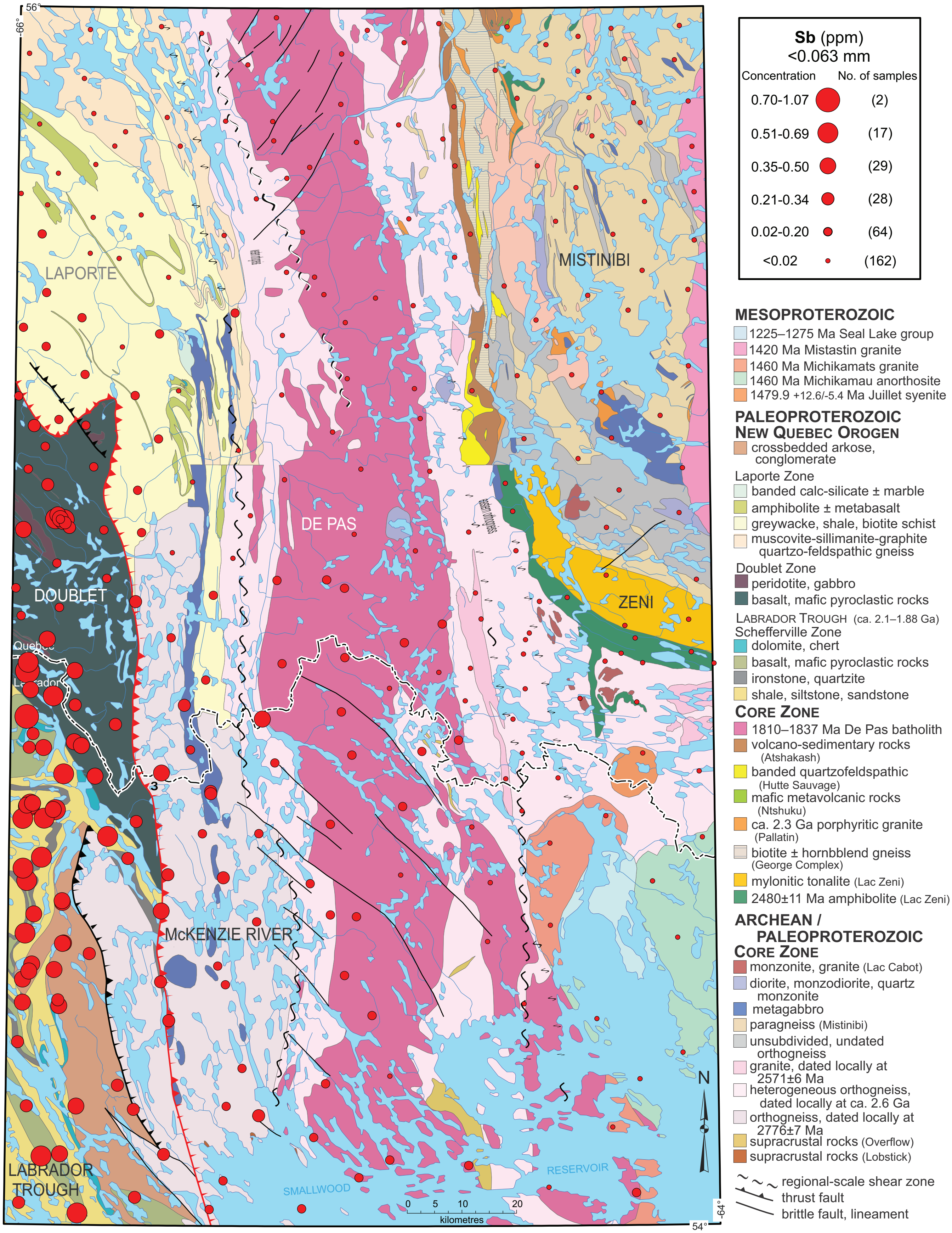
Appendix E, Map 9. Ni by aqua regia/ICP-MS.

Appendix E continued.



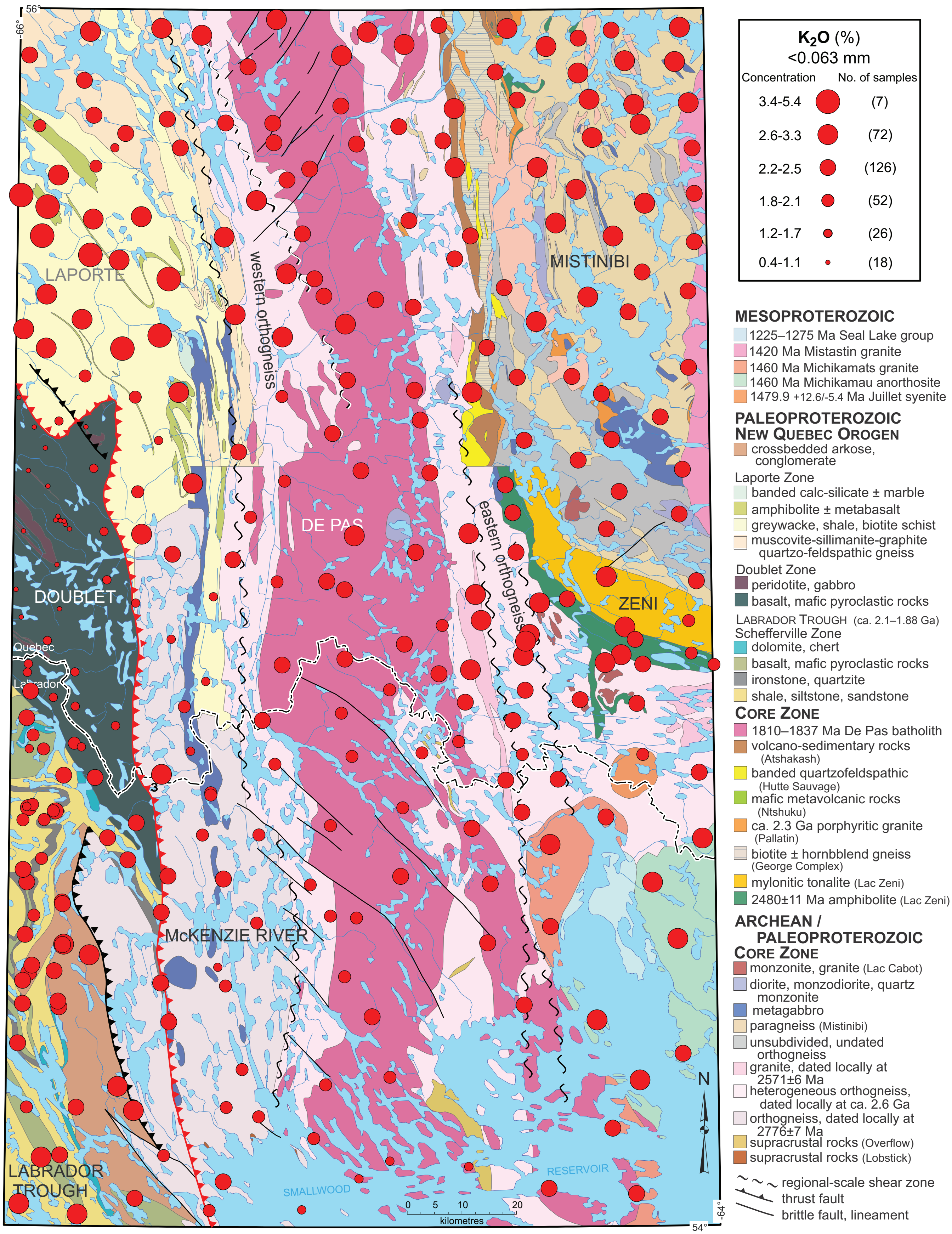
Appendix E, Map 10. Cr by aqua regia/ICP-MS.

Appendix E continued.



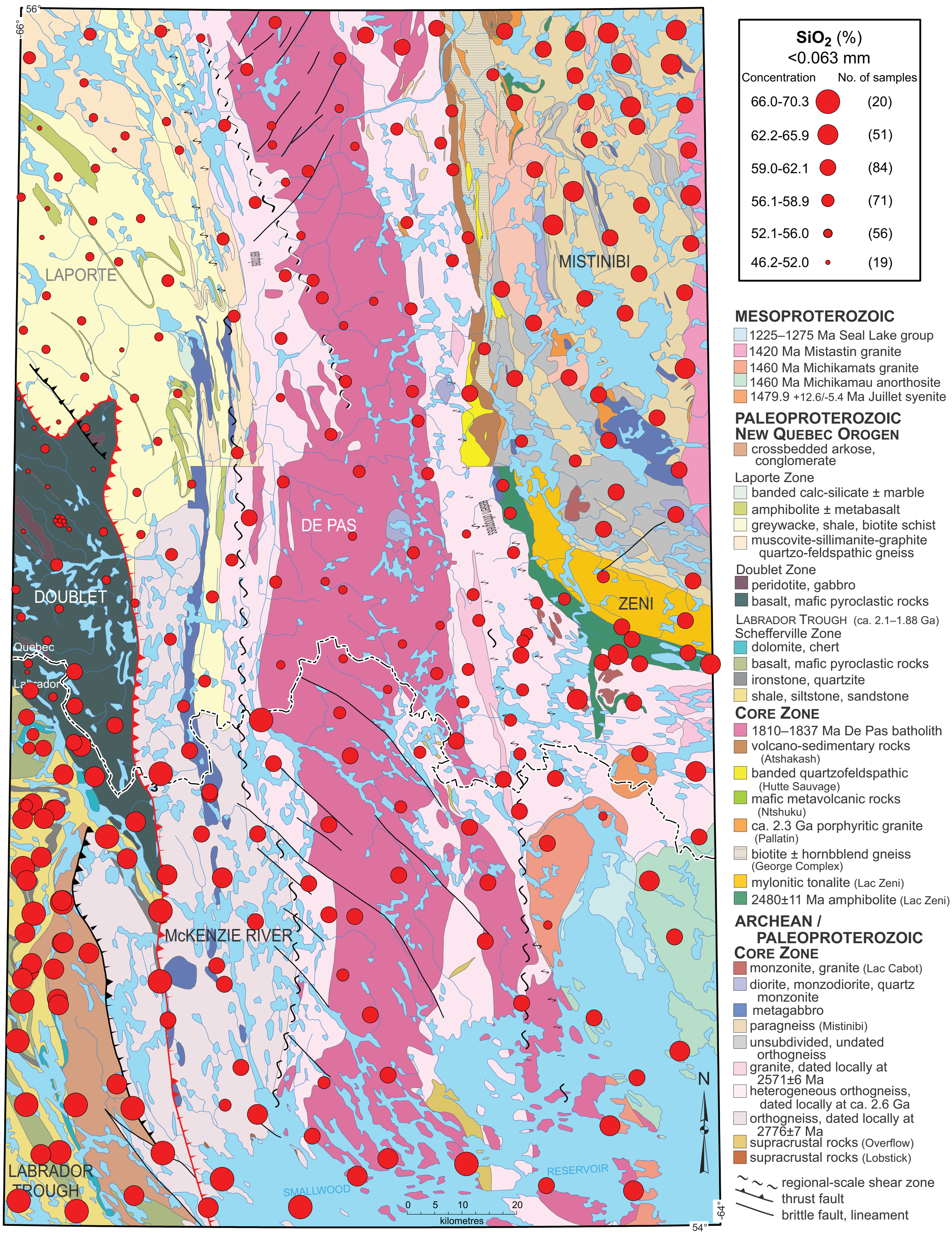
Appendix E, Map 11. Sb by aqua regia/ICP-MS.

Appendix E continued.



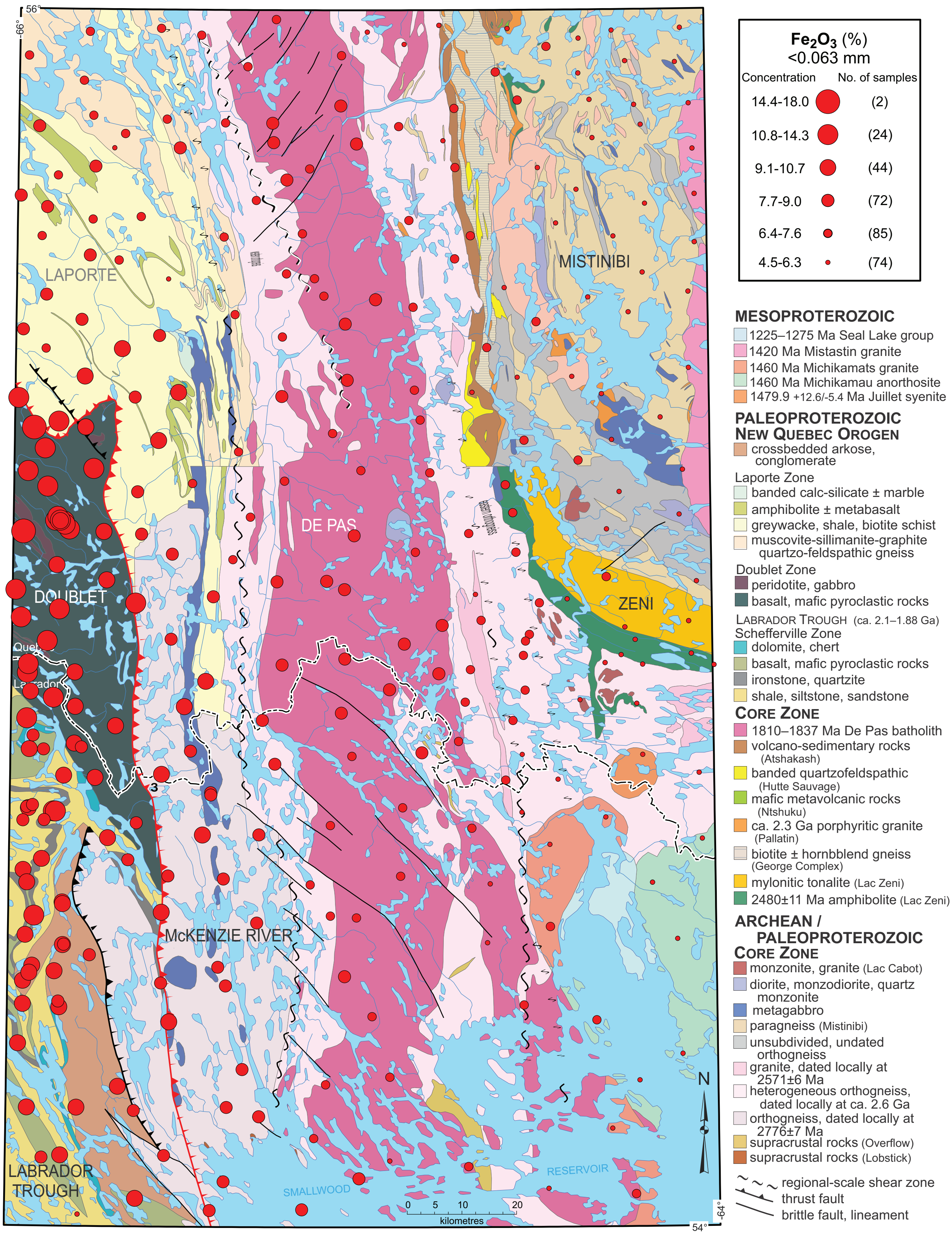
Appendix E, Map 12. K_2O by borate fusion/ICP-ES.

Appendix E continued.



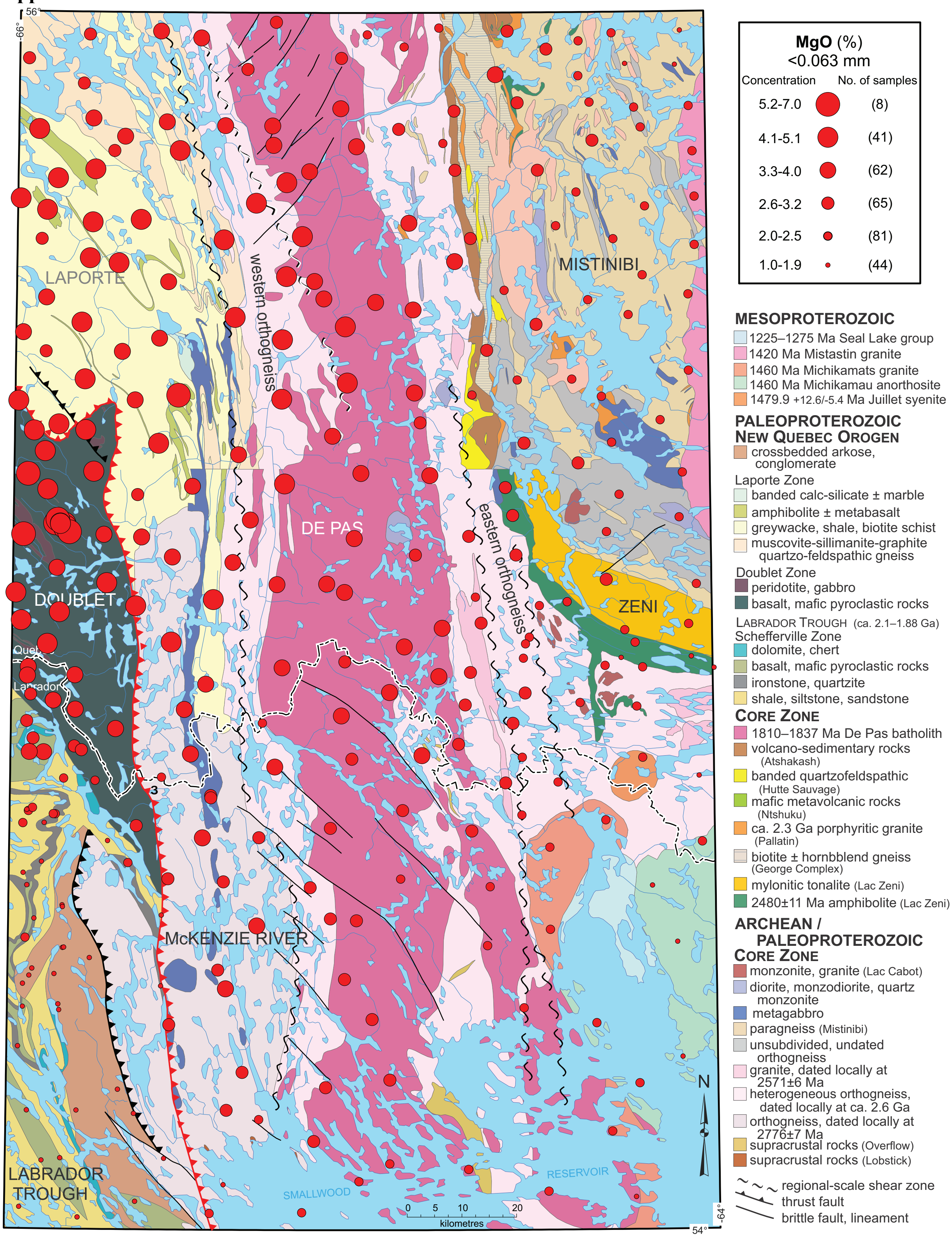
Appendix E, Map 13. SiO_2 by borate fusion/ICP-MS.

Appendix E continued.



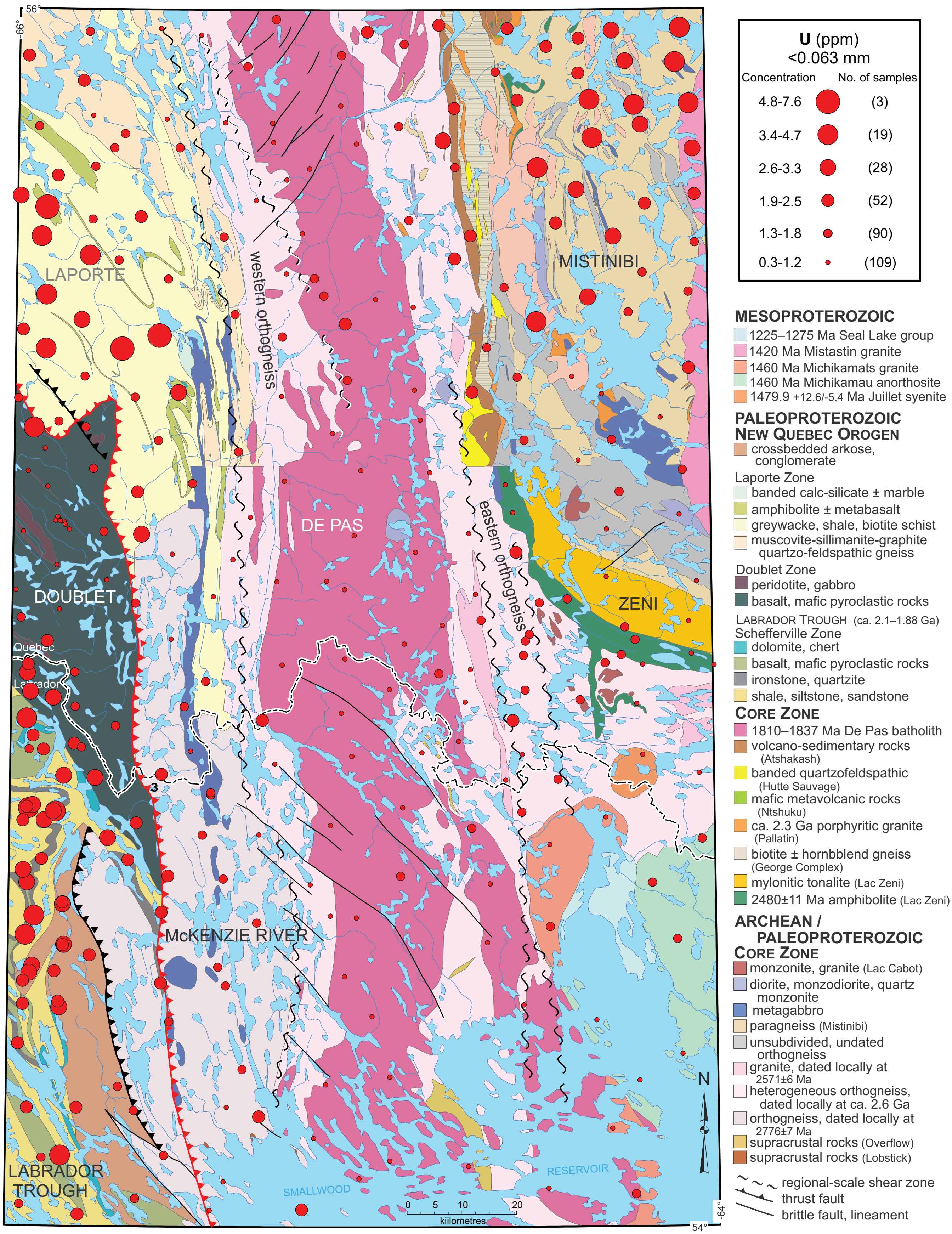
Appendix E, Map 14. Fe_2O_3 by borate fusion/ICP-MS.

Appendix E continued.



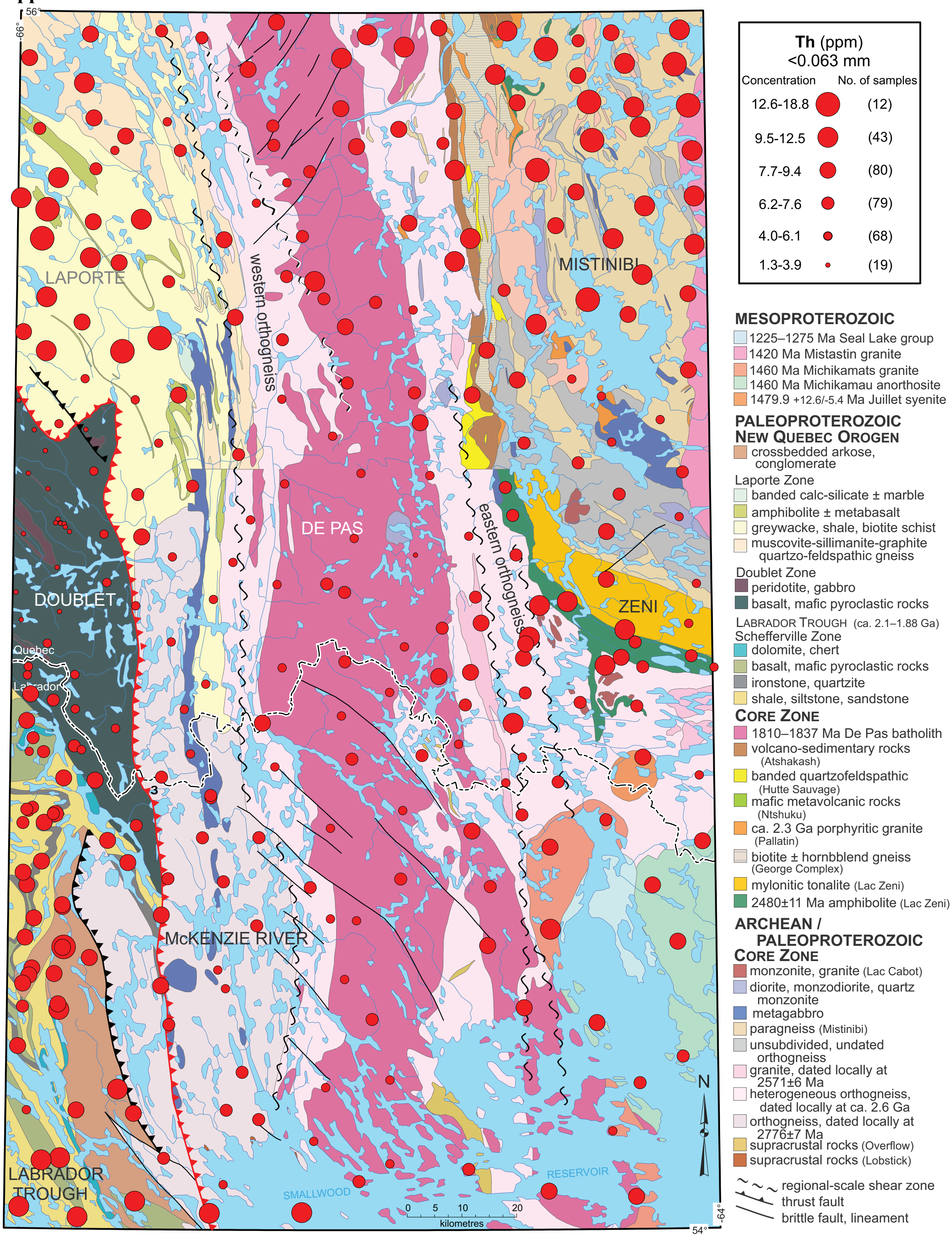
Appendix E, Map 15. MgO by borate fusion/ICP-MS.

Appendix E continued.



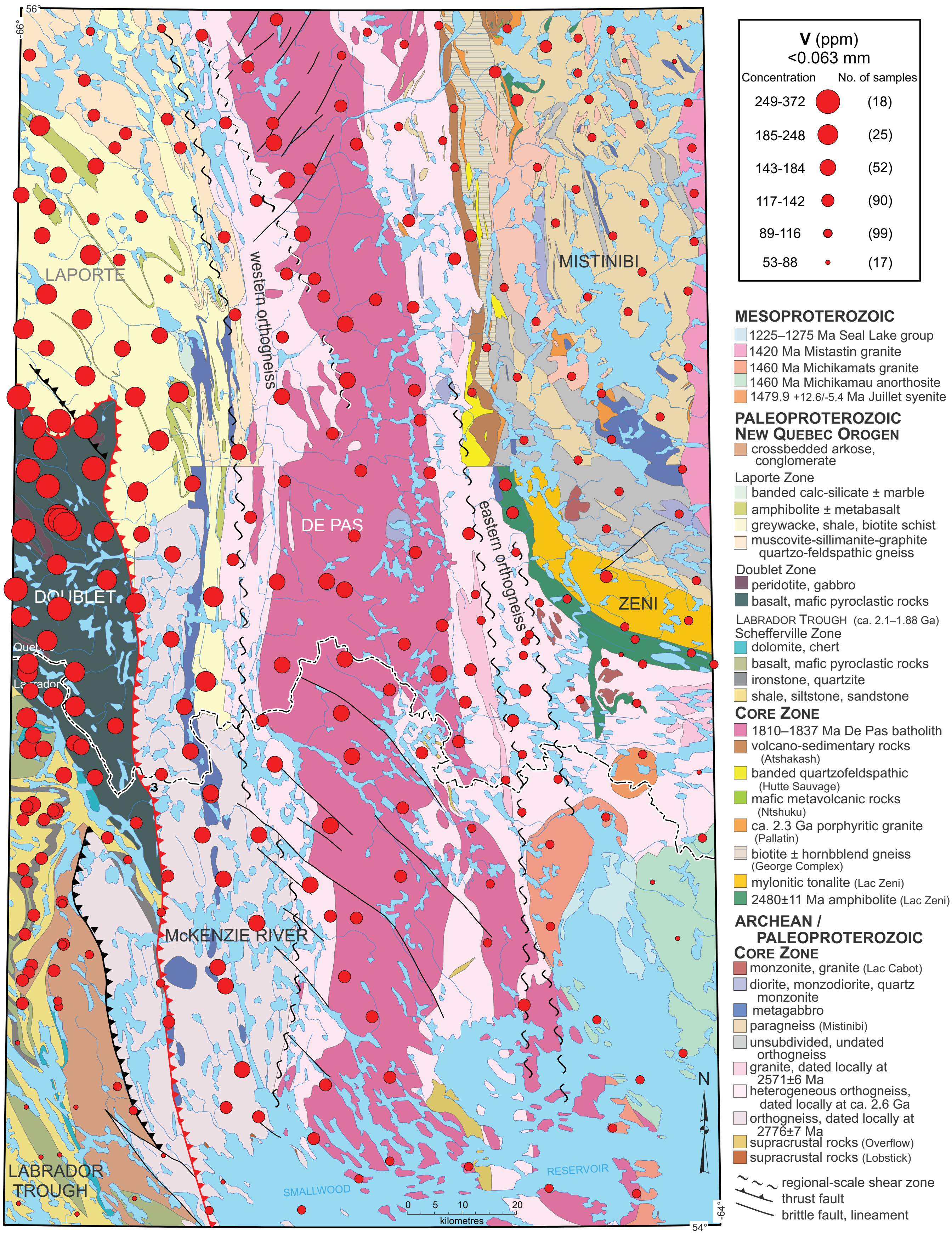
Appendix E, Map 16. U by borate fusion/ICP-MS.

Appendix E continued.



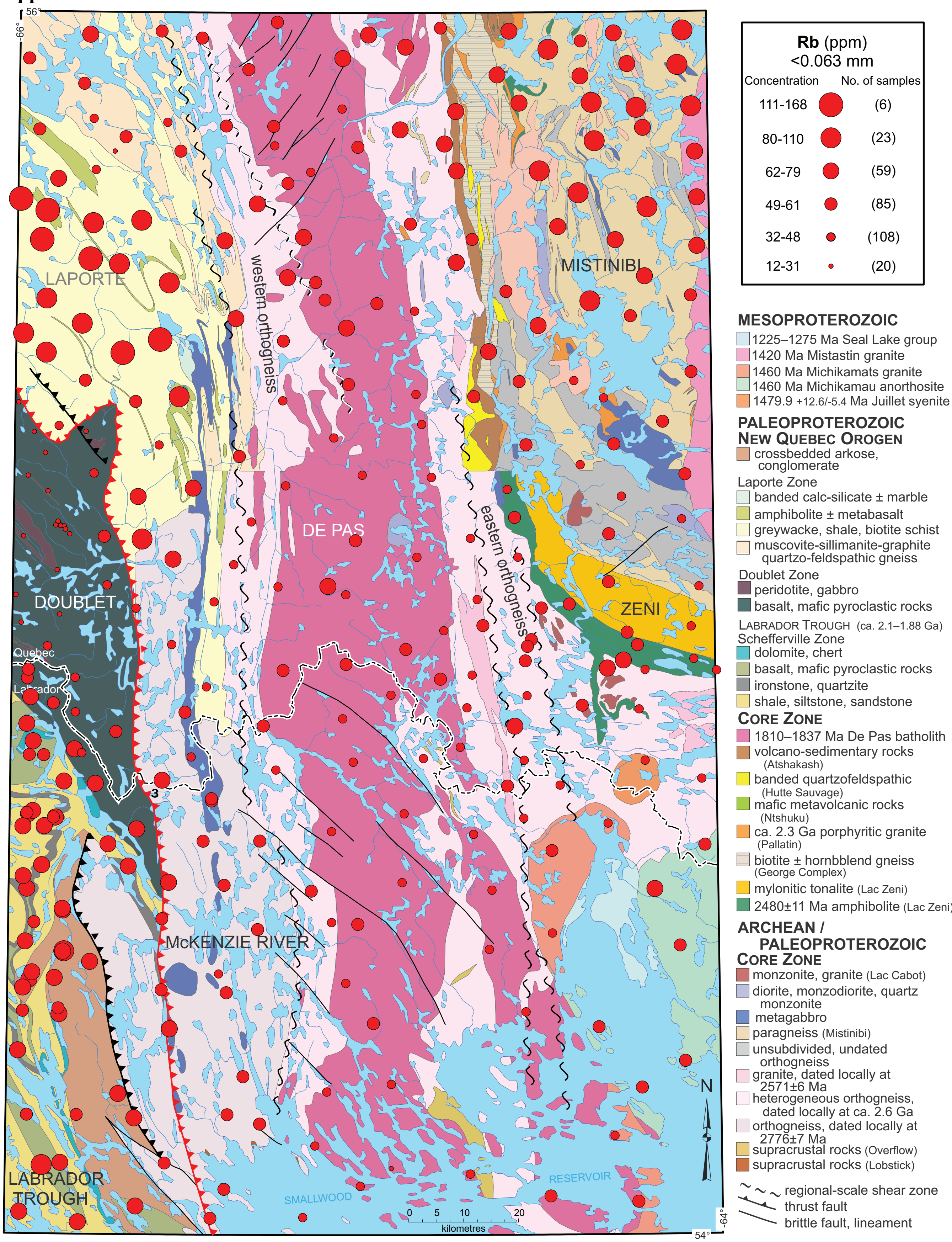
Appendix E, Map 17. Th by borate fusion/ICP-MS.

Appendix E continued.



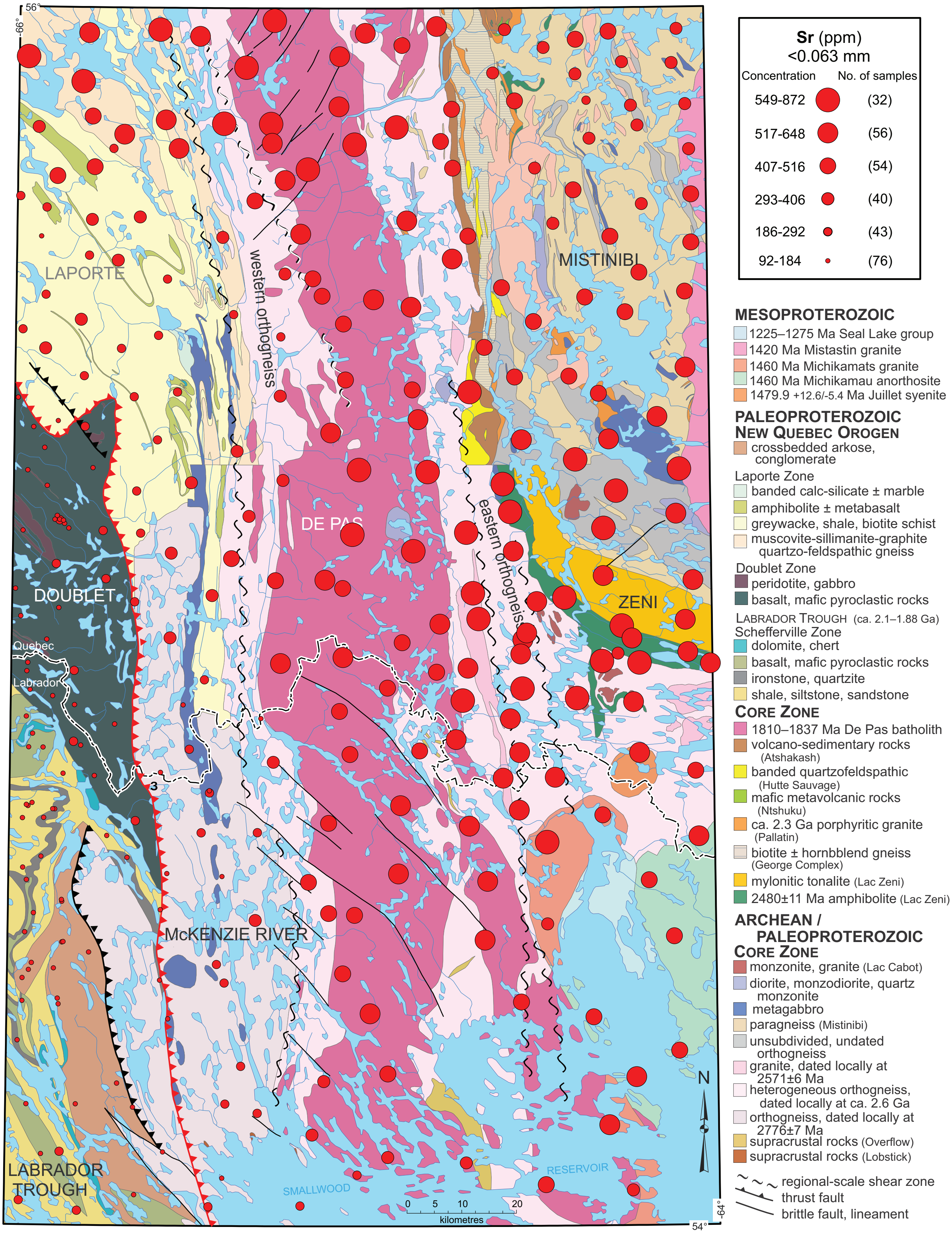
Appendix E, Map 18. V by borate fusion/ICP-MS.

Appendix E continued.



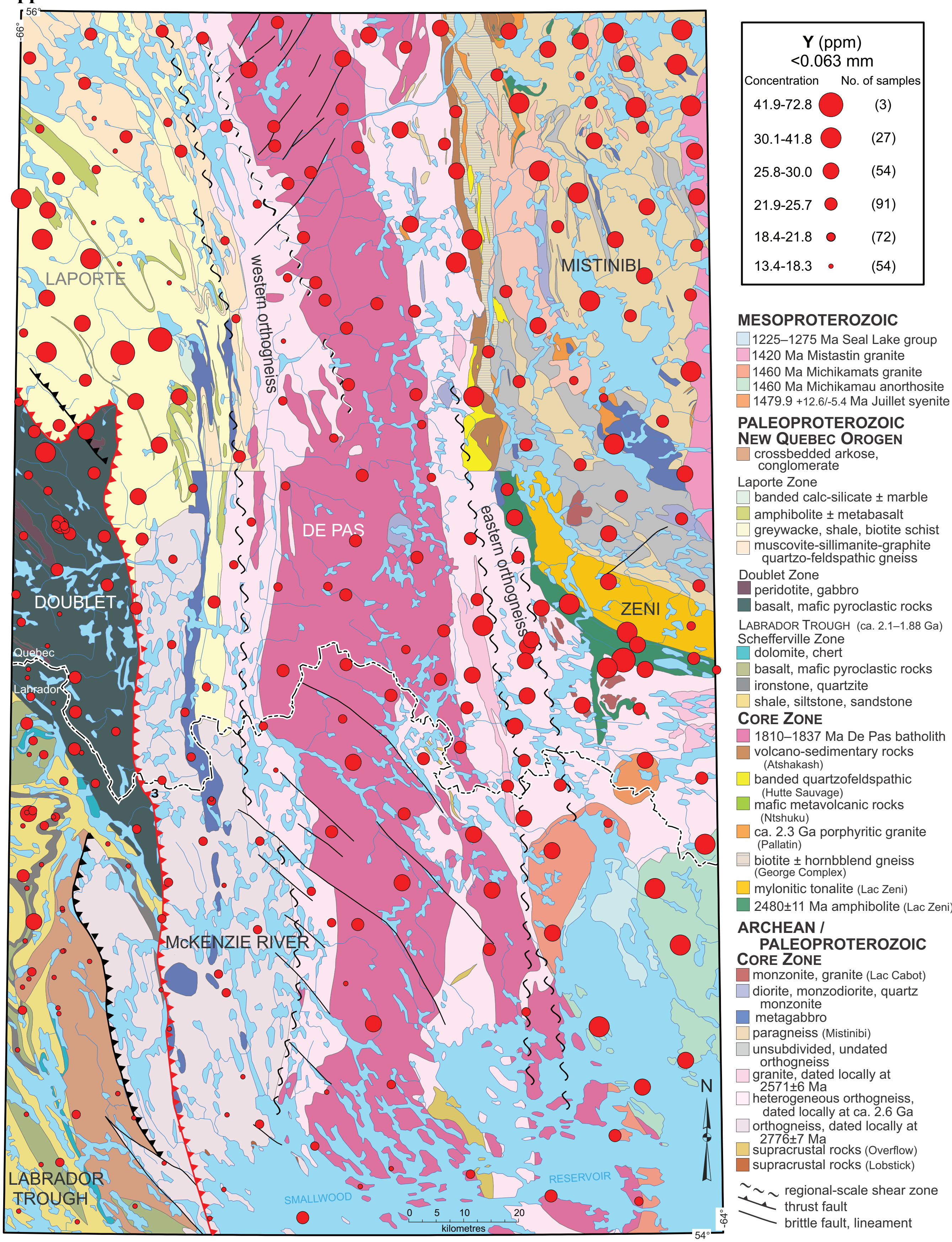
Appendix E, Map 19. Rb by borate fusion/ICP-MS.

Appendix E continued.



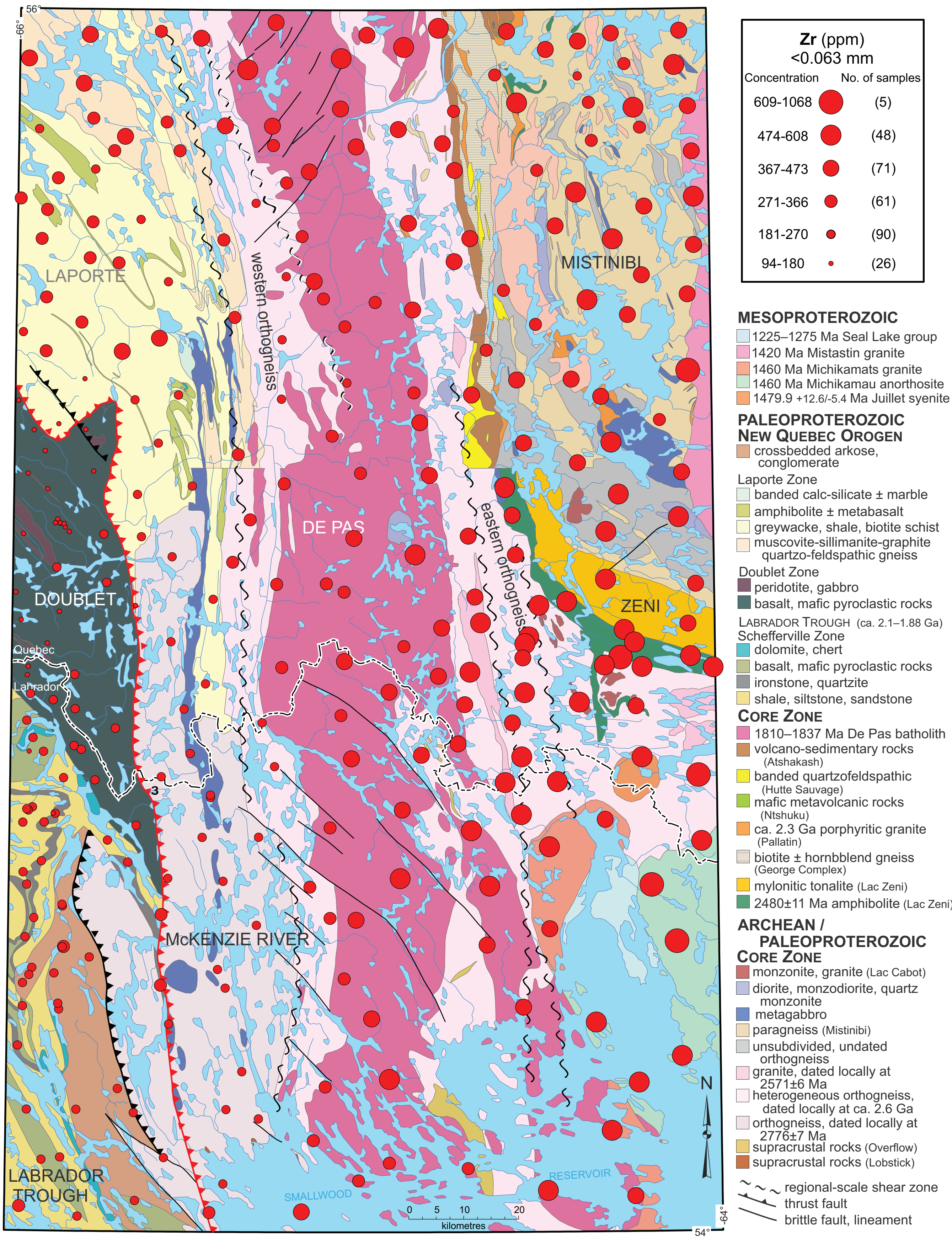
Appendix E, Map 20. Sr by borate fusion/ICP-MS.

Appendix E continued.



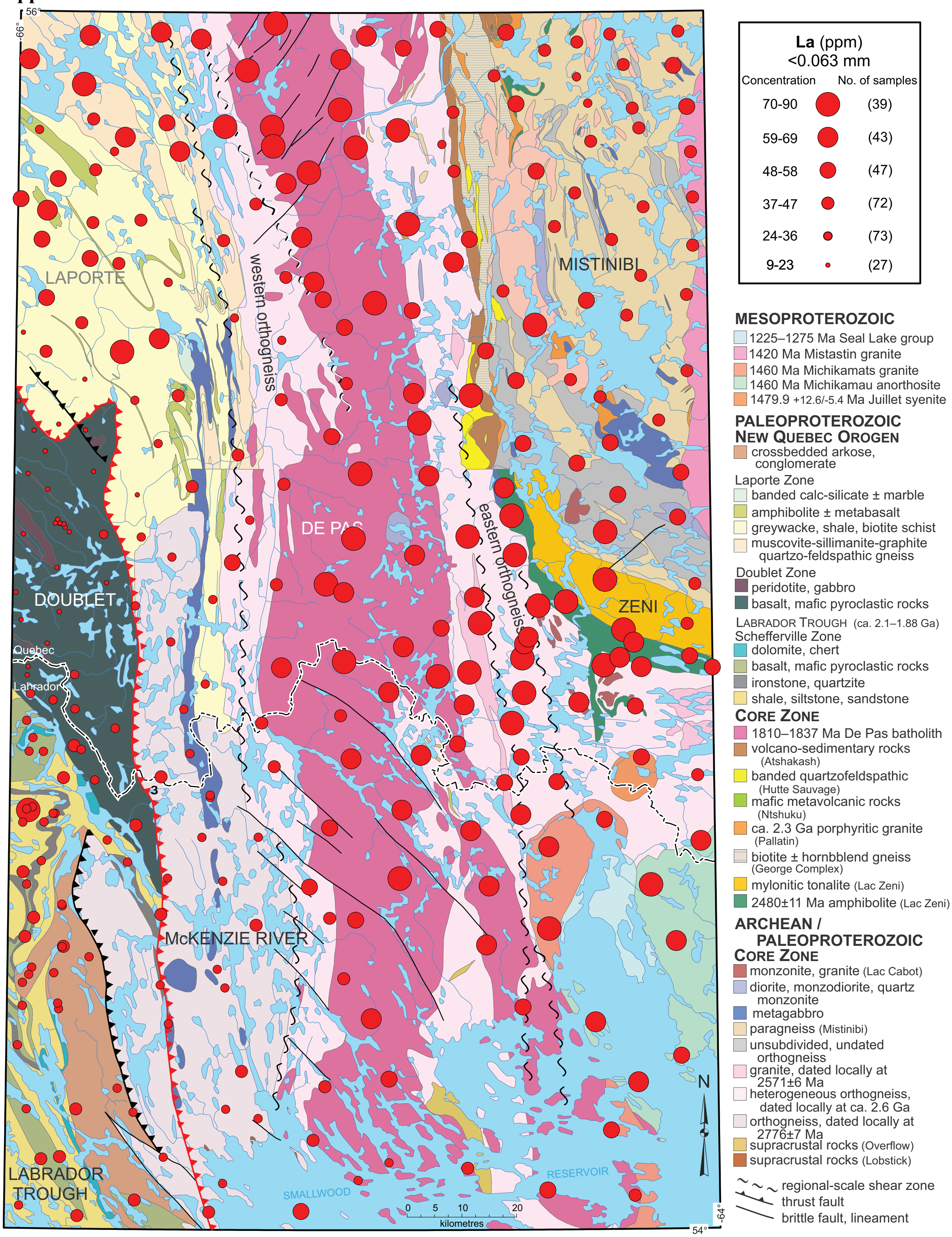
Appendix E, Map 21. Y by borate fusion/ICP-MS.

Appendix E continued.



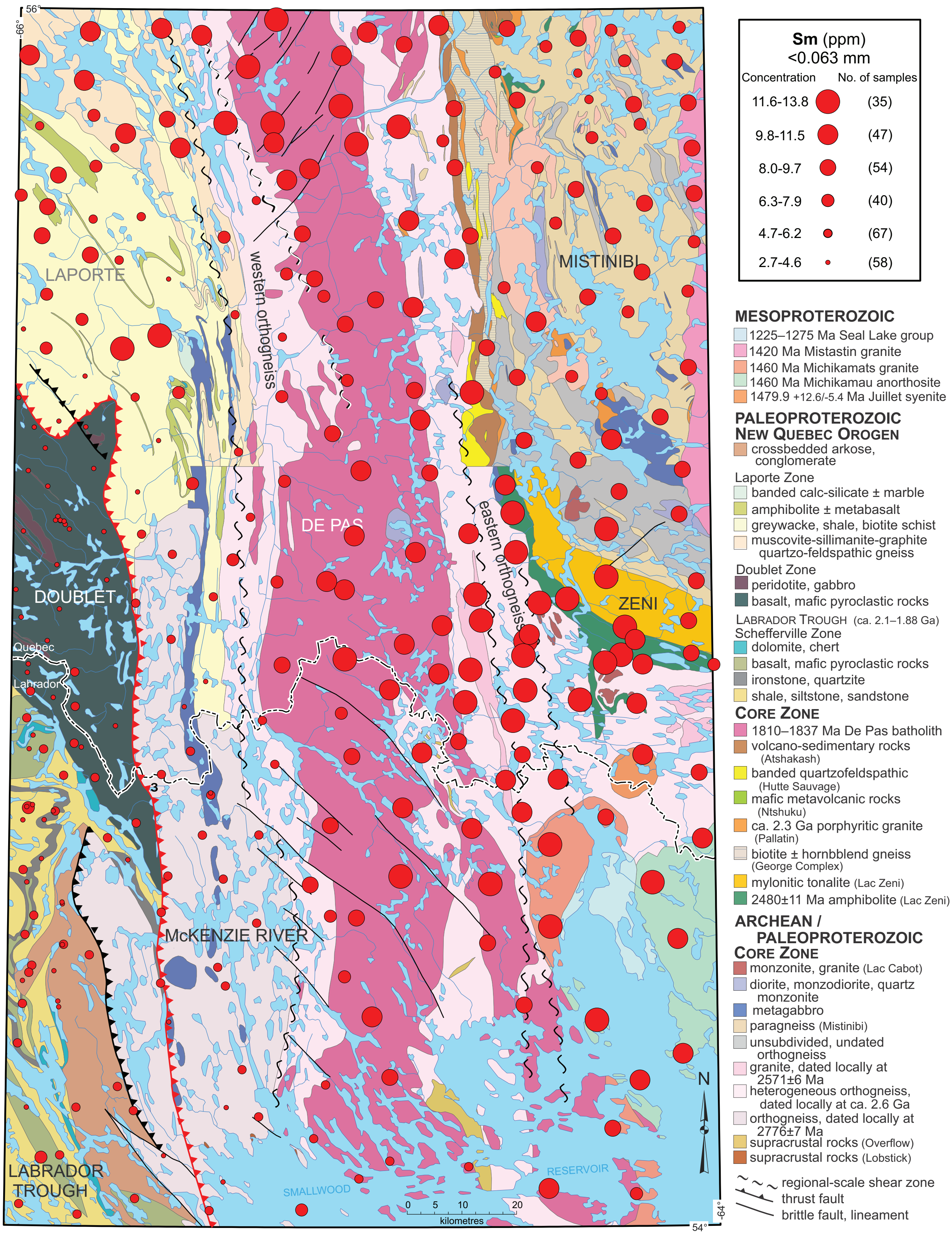
Appendix E, Map 22. Zr by borate fusion/ICP-MS.

Appendix E continued.



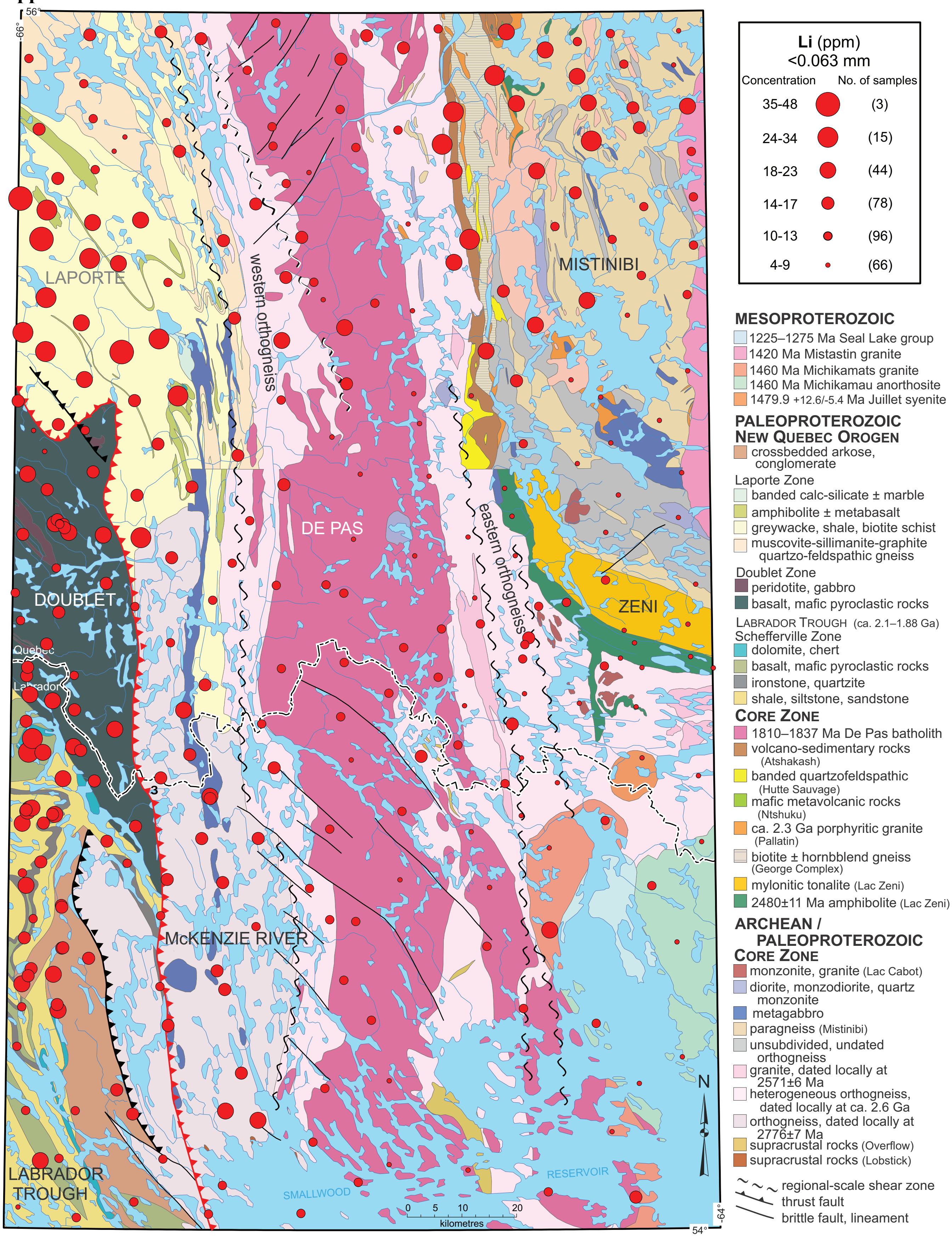
Appendix E, Map 23. La by borate fusion/ICP-MS.

Appendix E continued.



MAppendix E, Map 24. Sm by borate fusion/ICP-MS.

Appendix E continued.



Appendix E, Map 25. Li by aqua regia/ICP-MS.