GeoFile 2-2023 ReadMe

Manitoba till-matrix geochemistry compilation: silt plus clay (<63 µm) size-fraction by inductively coupled plasma–mass spectrometry after an aqua-regia or modified aqua-regia digestion

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Abstract

This GeoFile provides a digital dataset for till-geochemistry surveys carried out in Manitoba, where the silt plus clay (<63 µm) size-fraction of the till matrix was analyzed by inductively coupled plasma–mass spectrometry after an aqua-regia or modified aqua-regia digestion. This compilation of 35 projects includes 3554 till samples, and will be updated annually or bi-annually. This data can be brought into GIS software, and integrated with other geoscience data, to generate new exploration targets and design follow-up exploration programs.

Résumé

Ce géodossier offre un jeu de données numériques pour les relevés de géochimie du till effectués au Manitoba, pour lesquels la classe granulométrique du limon et de l'argile (<63 µm) de la matrice de till a été analysée au moyen d'une spectrométrie de masse à plasma à couplage inductif (ICP-MS) après digestion à l'eau régale ou à l'eau régale modifiée. Cette compilation de 35 projets comprend 3 554 échantillons de till et sera mise à jour une fois par an ou une fois tous les deux ans. Ces données peuvent être téléchargées dans un logiciel SIG et intégrées à d'autres données géoscientifiques, afin de générer de nouvelles cibles d'exploration et de concevoir des programmes d'exploration de suivgi.

DIGITAL DATA

Zip file geofile2.zip contains the following content:

- GeoFile_2-2023_ReadMe.pdf (this file)
- GeoFile_2-2023.xlsx:
  - Table 1: Detection limits.
  - Table 2: Till-matrix ICP data on the silt plus clay (<63 µm) size-fraction.
  - Table 3: Summary statistics for the till-matrix ICP data on the silt plus clay (<63 µm) size-fraction.
  - Table 4: References.

Introduction

This GeoFile captures till-matrix geochemistry data collected from surveys carried out in Manitoba since the 1990s. These surveys generally combine surficial mapping, paleo ice-flow mapping and sampling of till to be analyzed for geochemistry. Publication of the till-geochemistry data from these surveys have been successful in generating exploration activity, as well as providing 'background' baseline values.

Moving forward in a digital age, all till-geochemistry data is compiled into databases that will allow users to quickly view, compile and interact with the data from different regions of Manitoba. This data will enable users to more quickly identify when an element concentration is atypical for an area.

This GeoFile includes data from 3554 till samples collected between 1991 and 2023, where the silt plus clay (<63 µm) size-fraction of the till matrix was analyzed by inductively coupled plasma–mass spectrometry (ICP-MS) after an aqua-regia or modified aqua-regia digestion (Figure 1). This database will be updated as new data is released.

Methods

Updates

Data from Manitoba Geological Survey (MGS) fieldwork was added for northern Manitoba (Gauthier and Hodder 2022; Hodder and Gauthier 2022a, b; Gauthier and Hodder 2023b–d) and southeastern Manitoba (parts of 62H2, 7; Gauthier and Hodder, 2023a); as well as company data given to the MGS from the Snow Lake area (Assessment File 63K231070, Manitoba Economic Development, Investment, Trade and Natural Resources, Winnipeg). Two hundred far-northern Manitoba samples were re-analyzed, and the new data is recorded herein (Gauthier and Godbout, 2023). Coordinates were updated from the incorrect NAD27 to the correct NAD83 for Dredge and McMartin (2007), Thorleifson and Matile (1993) and Thorleifson et al. (2009). In addition, notes were added on the stratigraphy for southeastern Manitoba rotosonic drillcores (NTS 62H7; from Thorleifson and Matile, 1993), based on information in Matile et al. (2023).

Collection methods

Till samples were collected from road cuts, borrow pits, ditches, natural exposures, hand-dug holes, Dutch-auger holes and boreholes across Manitoba. Wherever possible, till samples were collected from the C horizon in order to minimize potential weathering effects. To learn more about the characteristics of individual till samples, the reader is encouraged to view the original publication.

Till-geochemical surveys in Manitoba were first compiled to produce a till geochemistry index map. Following that, the data itself was manually compiled and separated according to size-fraction and analytical method. This compilation includes all data where the matrix (<63 µm size-fraction) was analyzed by ICP-MS after an aqua-regia or modified aqua-regia digestion. There are also till compilations for analyses by instrumental neutron activation (Gauthier, 2020a), the clay size-fraction (Gauthier, 2020b), visible gold in the heavy mineral fraction (Gauthier, 2023b) and kimberlite-indicator minerals (Keller, 2019).

Data captured includes all data immediately relevant to the till sample. This includes publication number, laboratory used, project name, spatial coordinates, depth of sample and other important information. Depth of sample was transcribed from the original publications, and includes both depth ranges (e.g., 0.7–1.2 m) and single digits (e.g., 1.2 m). MGS project numbers are only assigned to some projects as this is a newer internal initiative designed to better track projects from year to year. The user should note that the compilation includes samples taken at depth, in some cases by drilling and in others accessed by natural river sections.

Sample location

Sample locations are provided for each till sample. Technically, Manitoba crosses three UTM zones (14 to 16). For ease of display in GIS, all data has been re-projected into zone 14. Hence, all coordinates herein are reported as UTM zone 14, NAD83. Some older samples may be misplaced by as much as 200 m, as it is unknown when recording methods switched from NAD27 to NAD83. While coordinates were compiled from the original reports, some projects were pre-GPS and the locations were digitized from hand-drawn field maps. Again, the coordinates of these older till samples are to be used as a guide instead of a precise location. This is why Table 2 includes the column 'Year_sampled' instead of the publication year.

Analytical methods

Till samples were prepared for geochemistry analysis at the Saskatchewan Research Council Geoanalytical Laboratories (Saskatoon, Saskatchewan), the Geological Survey of Canada's Sedimentary Laboratory (Ottawa, Ontario), the MGS Midland Sample and Core Library (Winnipeg, Manitoba), and perhaps other undisclosed labs. This compilation includes data from 35 Manitoba till-sampling projects where the matrix (<63 µm size-fraction) was analyzed by ICP-MS after an aqua-regia or modified aqua-regia digestion between 1991 and 2023. Data from five projects (Henderson, 1994; McClenaghan et al., 2009; Hodder, 2018; Gauthier, 2019; Gauthier and Hodder, 2020) where Au, Pd and/or Pt was analyzed by ICP-MS after fire assay is also included (FA_ICP; Table 2). The processing and analytical methods used vary according to the date of the survey. Earlier surveys may have been analyzed for a restricted suite of elements, or at different detection limits (Table 1). Samples from the 35 projects were analysed at various labs over time, including the Saskatchewan Research Council Geoanalytical Laboratories, Acme Analytical Laboratories Ltd. (now Bureau Veritas Commodities Canada Ltd.; Vancouver, British Columbia), Activation Laboratories Ltd. (Ancaster, Ontario) and ALS Chemex (now ALS-Geochemistry; Vancouver, British

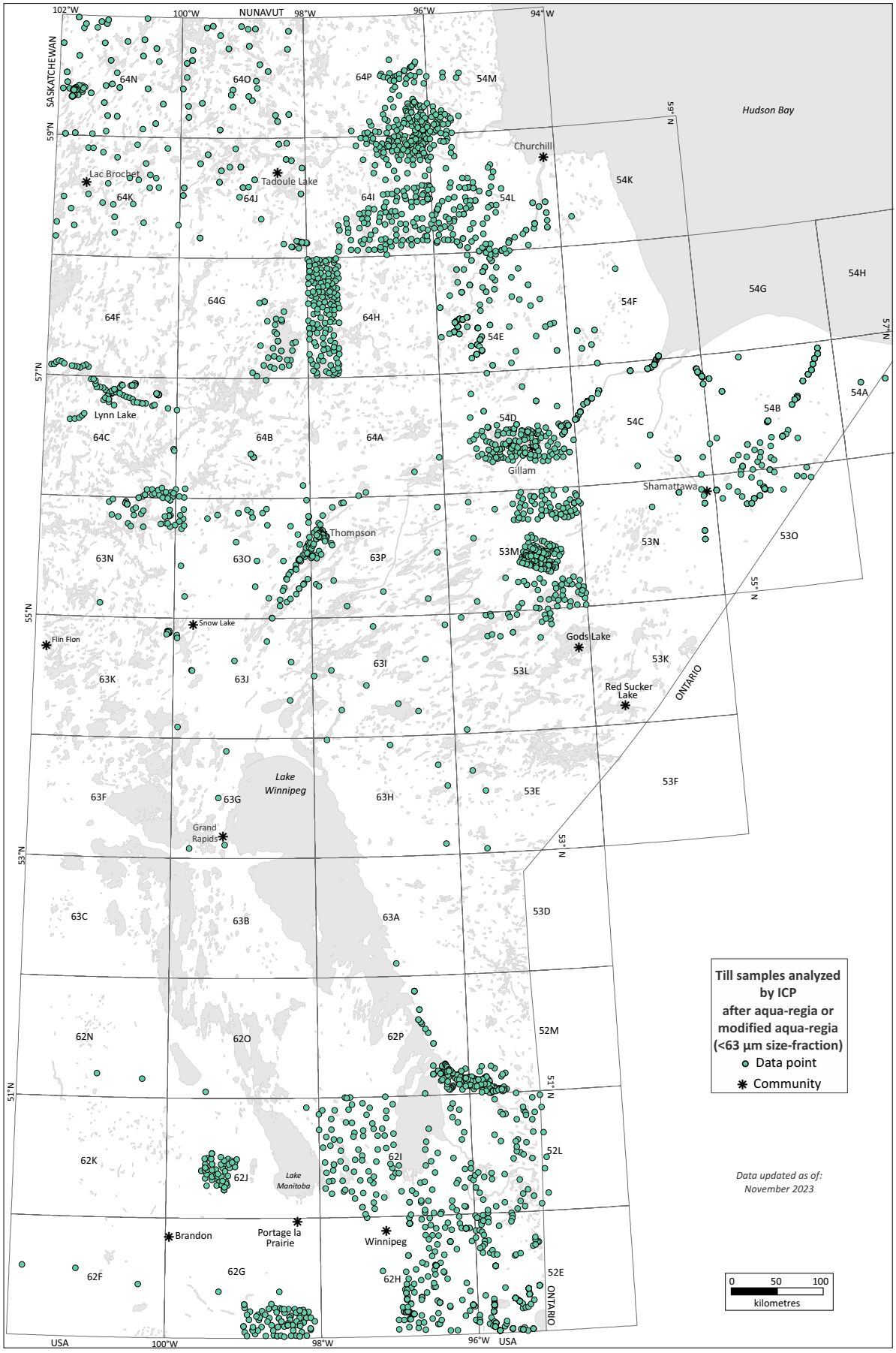

Figure 1: *Till-sample locations where the silt plus clay (<63 µm) size-fraction of the matrix was analyzed by inductively coupled plasma–mass spectrometry after an aqua-regia or modified aqua-regia digestion in Manitoba.*

Columbia). The full list of projects included, and elements analyzed, can be found in Table 4.

Compilation methods

Included in this digital database is data from 3554 till samples collected from 35 different projects. No effort is made to re-analyze, level or otherwise standardize these values. Some studies reported Ag, Au, Hg and Re using different measurements—all have been reported as ppb in Table 2. Concentrations of P, reported as ppm in three studies (Table 3), have been converted to percent in Table 2.

Values below the detection limit are reported as the negative of the detection limit. This is because the detection limits for most elements vary in orders of magnitude over time (Table 1). The reader should assess the data accordingly.

Preliminary results

Summary statistics

The summary statistics for all reported elements are depicted in Table 3. Nine elements where the 90th percentile of values are at or below detection limit are shown in grey. Most of these elements are not useful for exploration purposes using ICP after aqua-regia or modified aqua-regia. Given that geology has spatial patterns, all data of interest should be analyzed spatially as well (Grunsky, 2010). For example, background values of iron will be lower for tills derived from carbonate bedrock than from granitoid bedrock.

Carbonate till distribution

A significant portion of the till in Manitoba is calcareous (Figure 2). This carbonate has two sources: Paleozoic bedrock within the Hudson Bay Basin in the far northeast, and with the Western Canada Sedimentary Basin (WCSB) in the south (Wheeler et al., 1996). The net carbonate-dispersal pattern within the till is complex (Figure 2), and generally decreases in concentration to the west, southwest, and south of Hudson Bay. Then, the concentrations increase drastically within tills south of Flin Flon and Snow Lake, reflecting quick entrainment of calcareous detritus from the WCSB. Within this larger pattern, however, the calcareous surface tills locally contain a range of carbonate concentrations that relate to overprinting (dilution and/or reworking) and inheritance (preservation) during till transportation and deposition (e.g., Trommelen et al., 2013; Trommelen and Ross, 2014; Gauthier et al., 2019).

Prospective and background concentrations

Because carbonate rocks are less resistant than most Precambrian shield rocks, they can mask, or dilute, the 'signature' of elements important to exploration. Within areas of Manitoba covered by calcareous till, 'low' concentrations of desired elements may still be more prospective than the same concentration within noncalcareous till. The total carbonate (wt. %) concentration is reported for most samples within Table 2. The entire dataset of Manitoba tills is plotted in Figure 3 for As, Cr, Cu, Ni and Zn analyzed by ICP-MS after an aqua-regia or modified aqua-regia digestion. For As and Ni, higher concentrations tend to occur when the total carbonate concentration of Manitoba tills is low. For the entire dataset, 'low' could be defined as 5% for arsenic (Figure 3a), and 35% for nickel (Figure 3d). 'Elevated values' of metals occurring at high carbonate concentration, such as the 30 ppm As measurement at 67 wt. % CO_3, could require follow-up sampling when conducting drift exploration. For Cr, Cu and especially Zn, there is a negative correlation to the total carbonate concentration of Manitoba tills (Figure 3b, c, e). These are necessarily broad general statements, and there are anomalies within each graph. The reason 'why' a particular relationship occurs would depend on what bedrock the till is overlying, what bedrock types the till is sourced from, and what other materials may have been incorporated into the till (glaciolacustrine, glaciomarine, nonglacial sediment types, etc). In general, calcareous values should be noted and different populations should not necessarily be treated as one dataset.

Supporting data

The original files for each project can be found through the Bibliography of Manitoba Geology and Resource Centre Catalogue (Manitoba Geological Survey, 2021a). To help with analysis, the following data is also available:

- Manitoba carbonate dispersal analyses in till (Gauthier, 2023a)
- index of surficial geology maps in Manitoba (Manitoba Geological Survey, 2021c)
- compiled surficial materials maps (Manitoba Geological Survey, 2021b)
- digital compilation of surficial point and line features, including ice-flow data (striations, streamlined landforms) and bedrock outcrop locations (Gauthier et al., 2022)
- the current understanding of ice-flow history in northeastern Manitoba (Gauthier et al., 2019)

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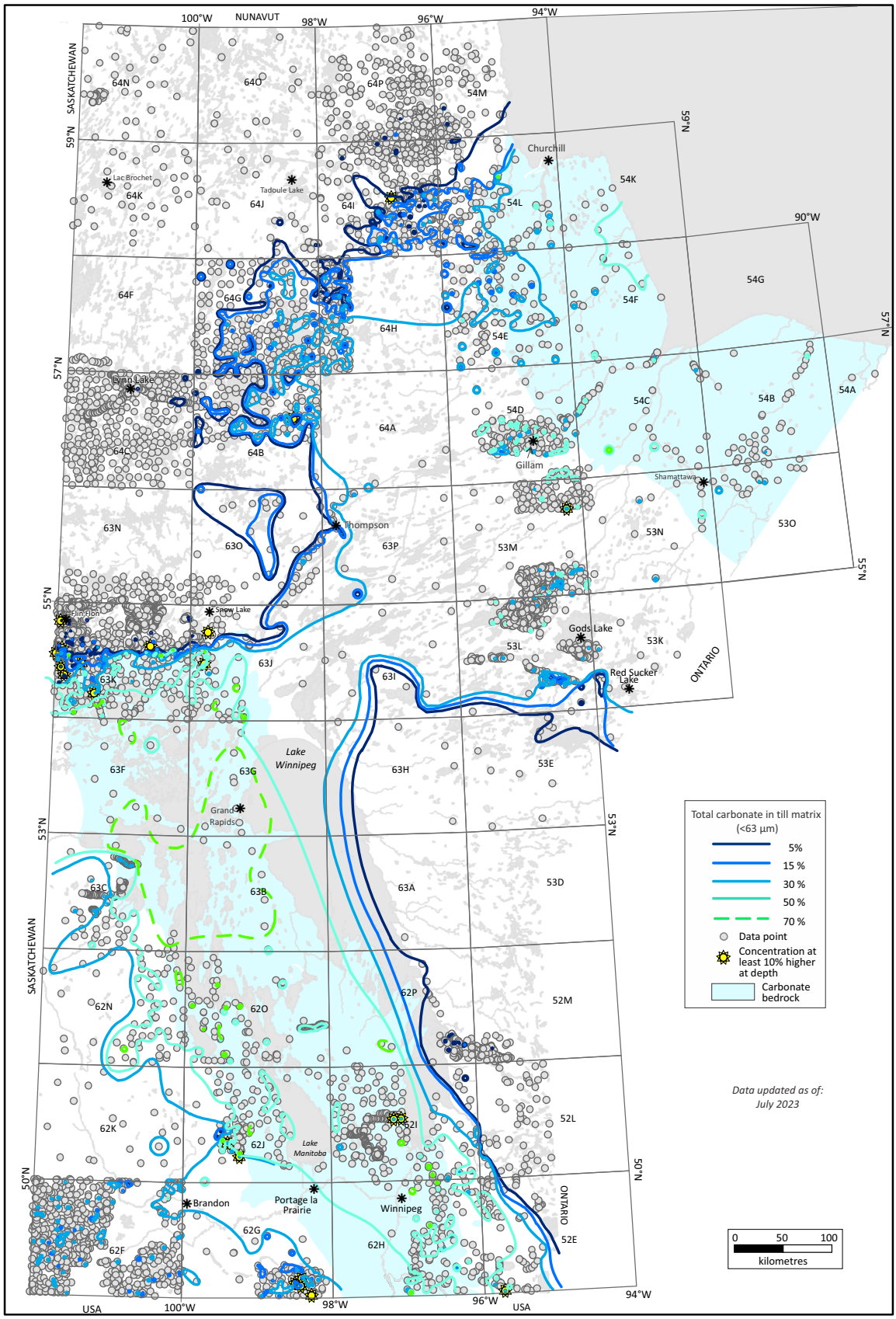

Figure 2: *Hand-contoured distribution of total carbonate concentration in the till matrix (silt plus clay, <63 µm size-fraction) of surface till samples in Manitoba. This till-matrix total carbonate compilation represents ongoing work and is sourced from a number of different studies with slightly different methods (Gauthier, 2023a). Owing to the limited number of data points in most areas, the hand-contoured data are not accurate at a detailed scale but provide a general overview of the carbonate-dispersal pattern. Similarly, the contours are more detailed where local-scale fieldwork has been conducted. The area in white is underlain by Precambrian shield rocks (Manitoba Department of Mines, Natural Resources and Environment, 1979).*

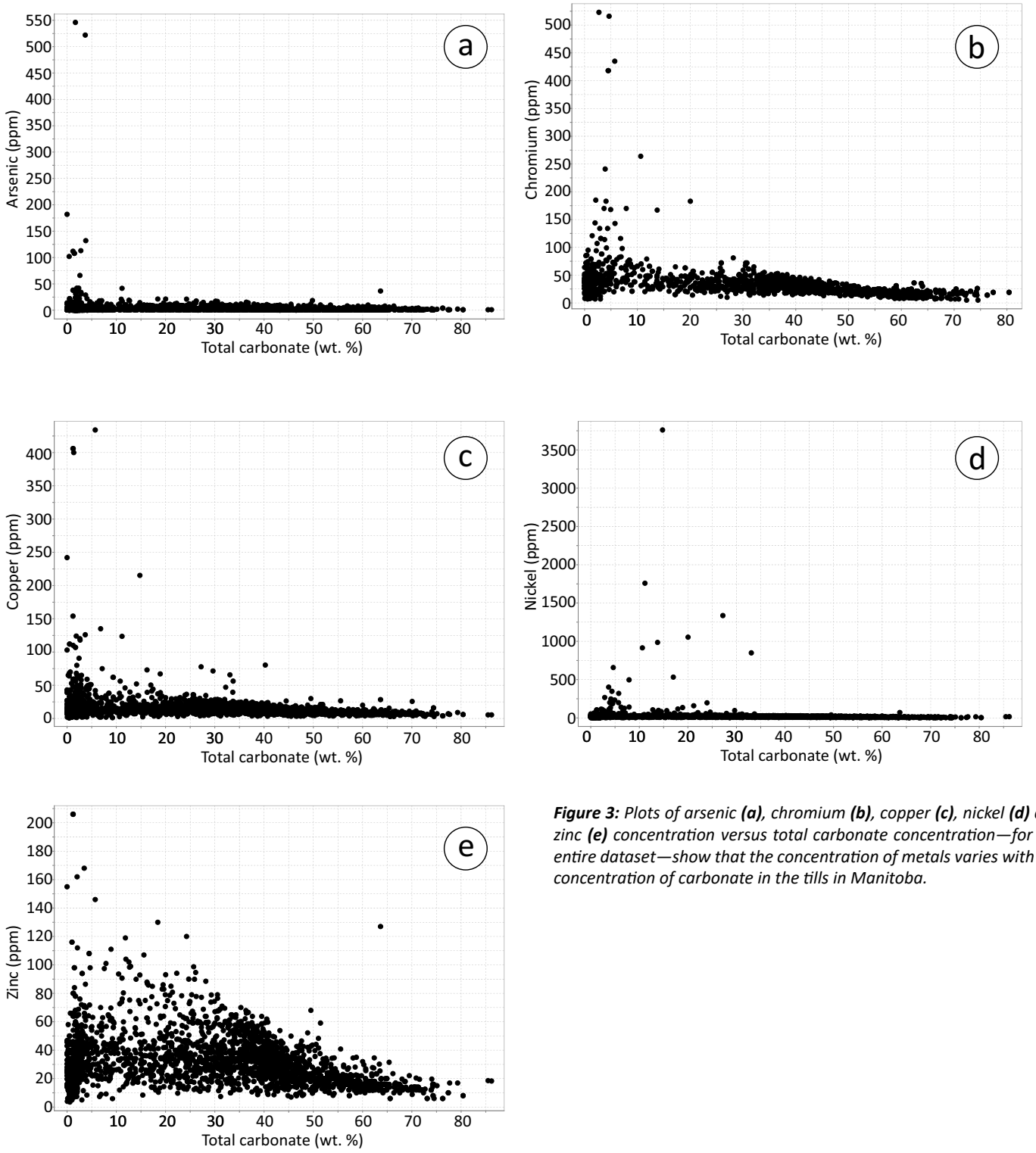

Figure 3: *Plots of arsenic **(a)**, chromium **(b)**, copper **(c)**, nickel **(d)** and zinc **(e)** concentration versus total carbonate concentration—for the entire dataset—show that the concentration of metals varies with the concentration of carbonate in the tills in Manitoba.*

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