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MANITOBA TILL-MATRIX GEOCHEMISTRY COMPILATION 3:
CLAY ($<2\ \mu\text{m}$) SIZE-FRACTION BY ATOMIC ABSORPTION
SPECTROMETRY OR INDUCTIVELY COUPLED PLASMA-
EMISSION SPECTROMETRY AFTER AQUA-REGIA DIGESTION

Manitoba Geological Survey





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**Manitoba till-matrix geochemistry compilation 3:
clay (<2 µm) size-fraction by atomic absorption
spectrometry or inductively coupled plasma–emission
spectrometry after aqua-regia digestion**

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Winnipeg, 2020**

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Cover illustration:

Getting ready to take a till sample in the Gillam area, northeastern Manitoba.

Abstract

This Open File provides a digital dataset for till-geochemistry surveys carried out in Manitoba. Dataset 3 is a compilation of 25 projects that includes 8890 till samples where the clay (<2 µm) size-fraction of the till matrix was analyzed by atomic absorption spectrometry or inductively coupled plasma–emission spectrometry after an aqua-regia digestion. This data can be brought into GIS software, and integrated with other geo-science data, to generate new exploration targets and design follow-up exploration programs.

Résumé

Ce fichier ouvert offre un jeu de données numériques pour les relevés de géochimie du till effectués au Manitoba. Le jeu de données 3 est une compilation de 25 projets comprenant 8 890 échantillons de till dans lesquels la fraction granulométrique colloïdale d'argile (<2 µm) de la matrice de till a été analysée par spectrométrie d'absorption atomique ou par spectrométrie à couplage inductif plasma-émission après digestion à l'eau régale (*Aqua Regia*). 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 suivi.

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Appendix 3: Manitoba Geological Survey till-matrix compilation 3: ICP-AES after aqua-regia on the clay size-fraction (<2 µm) of till matrices - March 2020.....	OF2020-5.zip

Introduction

This report captures till-matrix geochemistry data collected from surveys on the clay (<2 µm) fraction of tills, carried out in Manitoba between 1985 and 2002 (Figure 1; Appendix 1, Table 1). 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. However, the current forms of data include paper, scanned PDF, diskettes and project-based Microsoft® Excel® spreadsheets, which limit its usefulness.

Moving forward in a digital age, all till-geochemistry data are compiled into databases that will allow users to quickly view, compile and interact with the data from different regions of Manitoba. Importantly, this release also includes graphs depicting the relative abundance (background) of important elements across Manitoba, in both calcareous and non-calcareous till. These data enable users to quickly identify when an element concentration is atypical for an area.

The clay (<2 µm) fraction of till matrices was historically analyzed for trace-element concentration related to base metal sulphide mineralization because

- 1) concentrations of many trace elements are greater in this fraction than in coarser size-fractions due to primary enrichment of metal in the structure of phyllosilicates, which dominate this size-fraction (Shilts, 1984),
- 2) it provides more uniform sampling medium than sample sub-splits comprising a wider range in grain size, thereby minimizing geochemical trends related to grain size variation in the till (Shilts, 1975), and
- 3) it is known to reflect sulphide mineralization because it will adsorb a representative portion of trace elements released during the weathering of labile minerals (Shilts, 1975, 1984).

This paper serves as a help file for compilation dataset 3. Due to cost, the Manitoba Geological Survey (MGS) no longer analyzes the clay (<2 µm) fraction of till matrices. Unlike datasets 1 (Gauthier, 2020a) and 2 (Gauthier, 2020b), no updates are anticipated.

Methods

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 publications.

Till-geochemical surveys in Manitoba were first compiled to produce a till geochemistry index map (Manitoba Agricul-

ture and Resource Development 2020f). Following that, the data itself were manually compiled and separated according to size-fraction and analytical method. This is the third published compilation, and includes all data where the clay (<2 µm) fraction of till matrices was analyzed.

Data captured include all data immediately relevant to the till sample (Appendix 1, Table 2). This includes publication number, laboratory used, project name, spatial coordinates, depth of sample and other important information. MGS project numbers are only assigned to some projects, as this is a 2019 internal initiative designed to better track projects from year to year. 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). 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 location is provided for each till sample. Technically, Manitoba crosses three UTM zones (14 to 16). For ease of display in GIS, all data have 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 the data table includes the column 'Year_sampled' instead of the publication year (Appendix 1, Table 2).

Analytical methods

The clay (<2 µm) fraction of most till samples underwent various geochemical procedures at various labs over time, including Acme Analytical Laboratories Ltd. (now Bureau Veritas Minerals; Vancouver, British Columbia; n=2), ALS Chemex (Vancouver, British Columbia; n=4) and Bondar-Clegg and Company Ltd. (Ottawa, Ontario; n=21). The full list of projects included, and elements analyzed, can be found in Appendix 1, Table 1. 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 Manitoba Geological Survey Midland Sample and Core Library (Winnipeg, Manitoba), and perhaps other undisclosed labs. The clay (<2 µm) fraction of most till samples collected between 1985 and 1996 was analyzed by atomic absorption spectrometry (AAS) after aqua-regia digestion (Appendix 1, Table 3). After 1996, the clay (<2 µm) fraction of most till samples was analyzed by inductively coupled plasma-atomic emission spectrometry (ICP-AES) after aqua-regia digestion (Appendix 1, Table 3). Analysis of As, Hg and U by ICP-AES was not precise at the time. To compensate for this, most projects also analyzed

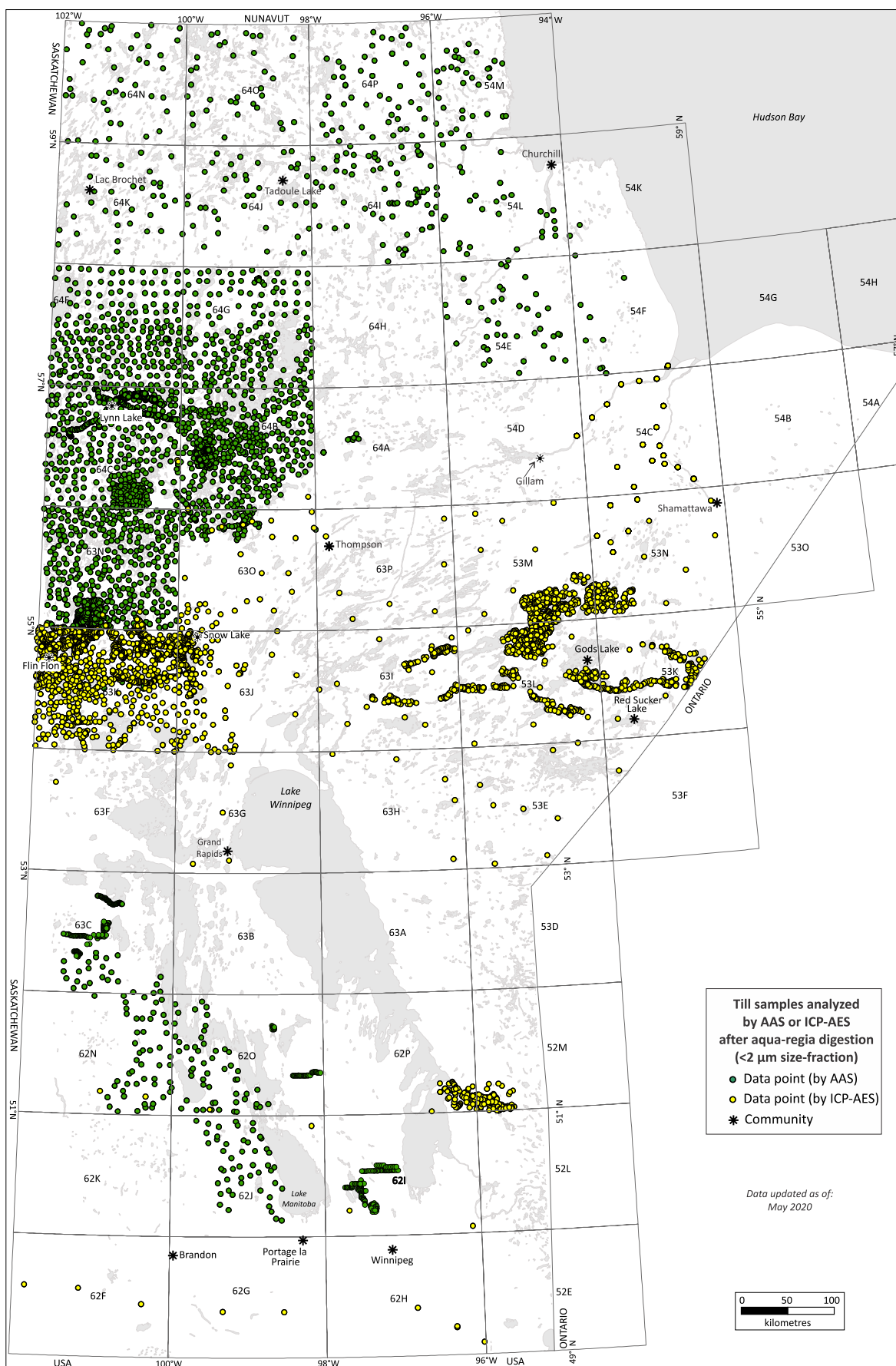


Figure 1: Till-sample locations where the clay (<2 μm) size-fraction of the matrix was analyzed by atomic absorption spectrometry (green dots) or inductively coupled plasma–emission spectrometry (yellow dots) after aqua-regia digestion in Manitoba. Abbreviation: ICP-AES, inductively coupled plasma–atomic emission spectrometry.

As concentration by either colourimetry (5 projects) or hydride generation AAS (8 projects), Hg by cold-vapour AAS (8 projects) and U by U-fluorimetry (Kaszycki, 1989; Dredge and Pehrsson, 2006). All data are included herein, and no efforts have been made to compare methods.

Compilation methods

This digital database includes data from 8890 till samples collected from 25 different projects. No effort was made to re-analyze, level or otherwise standardize these values. Some studies reported Hg using different measurements—all have been reported as ppb in Appendix 1, 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 (Appendix 1, Table 3). The reader should assess the data accordingly.

Preliminary results

Summary statistics

The summary statistics for all reported elements are depicted in Tables 4_1 (AAS) and 4_2 (ICP-AES) of Appendix 1. The data are separated by AAS and ICP-AES because each method-type covers a different spatial area (Figure 1). Different geology underlies the different spatial areas, hence it is difficult to assess the accuracy between methods. Elements where the 90th percentile of values are at or below detection limit using AAS after aqua-regia include Ag. Elements where the 90th percentile of values are at or below detection limit using ICP-AES after aqua-regia include Au, B, Be, Bi, Cd, Ga, Sn, Ta, Te, Ti, U and W. Diagrams showing probability plots for all other elements are within Appendix 2 (AAS) and Appendix 3 (ICP-AES). The reader can use these plots to quickly understand the statistical distribution of each element, including elevated values and background concentrations. However, given that geology has spatial patterns, all data of interest should be analyzed spatially as well (Grunsky, 2010). For example, background values of Fe 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 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. Furthermore, 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 be more prospective than the same concentration within noncalcareous till. The total carbonate (wt. %) concentration is reported for most samples within Appendix 1, Table 2. Total carbonate (wt. %) concentration is plotted against the compilation 3 dataset for Co and Pb (ICP-AES) in Figure 3. For Co and Pb, higher concentrations tend to occur where the total carbonate concentration of Manitoba tills is low. ‘Elevated values’ of metals occurring at high carbonate concentration, such as the 64 ppm Co measurement at 43 wt. % CO₃, could require follow-up sampling when conducting drift exploration. 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 Agriculture and Resource Development, 2020b). To help with analysis, the following data is also available:

- Manitoba carbonate dispersal analyses in till (Manitoba Agriculture and Resource Development, 2020c);
- index of surficial geology maps in Manitoba (Manitoba Agriculture and Resource Development, 2020e);
- compiled surficial materials maps (Manitoba Agriculture and Resource Development, 2020d);
- digital compilation of surficial point and line features, including ice-flow data (striations, streamlined landforms) and bedrock outcrop locations (Gauthier and Keller, 2020; Manitoba Agriculture and Resource Development, 2020a); and
- the current understanding of ice-flow history in northeastern Manitoba (Gauthier et al., 2019).

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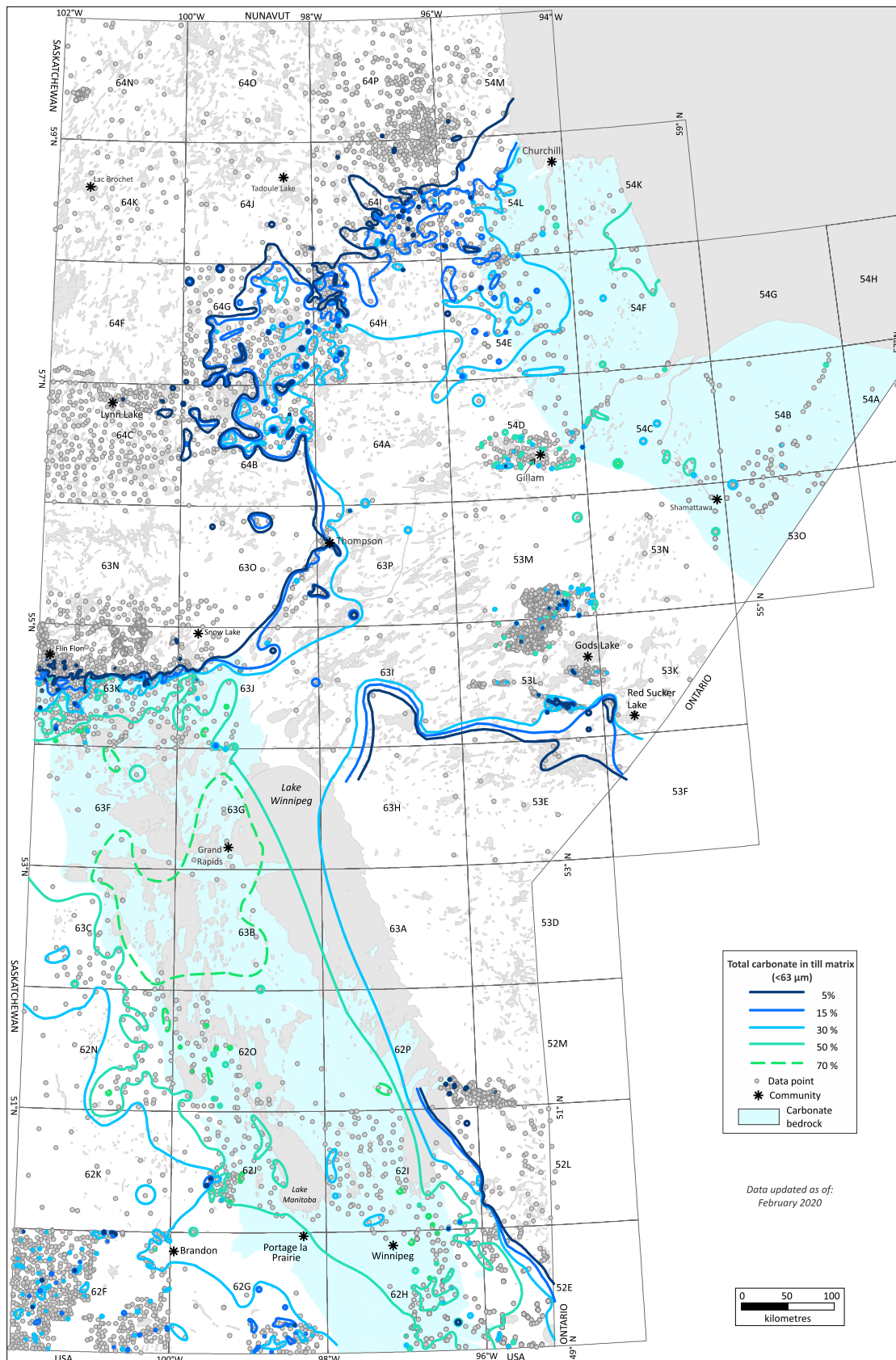


Figure 2: Hand-contoured distribution of total carbonate concentration in the till matrix (silt plus clay, <63 µm size-fraction) of surface till samples in Manitoba. This till-matrix total carbonate compilation represents ongoing work and is sourced from a number of different studies with slightly different methods (Manitoba Agriculture and Resource Development, 2020c). 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).

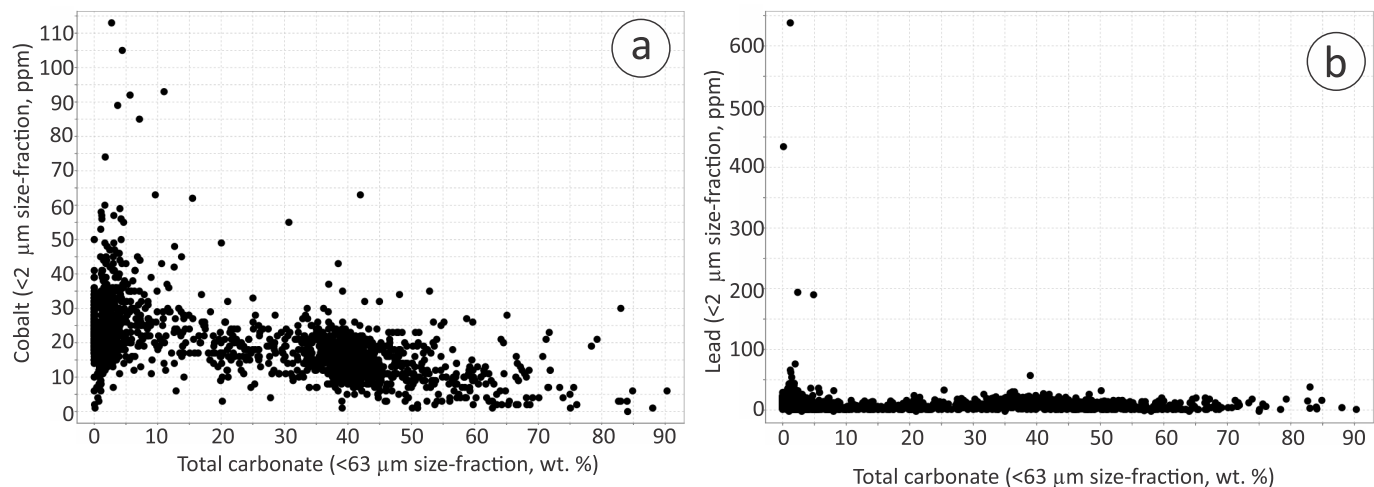


Figure 3: Plots of cobalt (a) and lead (b) concentration versus total carbonate concentration—for the entire dataset—show that the concentration of metals varies with the concentration of carbonate in the tills in Manitoba.

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