AER/AGS Open File Report 2014-06

Alberta Energy Regulator

Compilation of Boreholes Drilled or Logged by the Alberta Geological Survey

AGS
ALBERTA GEOLOGICAL SURVEY

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Abstract

Since its inception in 1920, the Alberta Geological Survey (AGS) has drilled several thousand boreholes across the province. Most were drilled only into the unconsolidated sediments overlying the top of bedrock. In 2010, AGS staff began a project to systematically compile all of the borehole log information into a database. This report and its companion digital data product, DIG 2014-0012, are the interim results of this initiative.

This report contains a brief description of our method to compile, scan, and create PDF archives of all borehole lithologs on file at the AGS. In addition, because most of the holes were drilled as part of a project, there are overviews of each of the project data subsets that provide context and other relevant information not presented in the individual borehole record. The scanned lithologs are grouped into project subfolders together with this report in a ZIP file.

1 Introduction

Since its inception in 1920, the Alberta Geological Survey (AGS) has been administratively housed in various agencies within the Government of Alberta, much of the time within the Alberta Research Council (ARC), then later within the Department of Energy (DOE), the Alberta Energy Utilities Board (EUB), the Energy Resources Conservation Board (ERCB), and now most recently the Alberta Energy Regulator (AER). Throughout its 94-year history, the AGS has conducted its own field mapping, including borehole investigations, to describe, document, and publish geological data and information on a variety of geoscience-related topics. During that time, the AGS has drilled or logged core/cuttings from more than 6500 boreholes (Figure 1). This information is a valuable resource for studies of the upper 200 m of the earth's surface because, although Alberta is rich in subsurface drillhole data compared to other jurisdictions, the bulk of those data are from below the top of bedrock. AGS borehole data therefore provides a rare, high-quality characterization of the near-surface sediments and are useful for a range of applications including land-use planning, shallow groundwater modelling, municipal planning, and understanding the glacial history of the province.

In 2010, the AGS initiated a project to compile the borehole data into a database, for three main reasons. First, given the age range of these records, we wanted to use the experience of staff who had first-hand knowledge of past drilling projects and who also were the custodians of many of the hard-copy records. Second, many of the field logs were never published, although the knowledge gained from them was used in other AGS maps and reports. Finally, new digital mapping projects at the AGS need borehole data in machine-readable format to help calibrate other more variable quality datasets.

The purpose of this data release (see Figure 2) is to document and disseminate tabular data of the project objectives, the borehole details, and the lithological descriptions for use in GIS and other digital mapping applications. This data release will be updated periodically as we finish digitizing the remaining 47 project data sets.

2 Methods

For this project we defined an AGS borehole as a drillhole that AGS staff either commissioned and logged, or which an AGS staff member logged from a hole drilled by others such as other government agencies, consultants, or industry.

Sets of borehole data were grouped by the project for which they were drilled. Each hole is tagged with a numeric source identifier which, together with the hole name given on the log, uniquely identifies it in the database. Project sources in this data release are listed and briefly described in Table 1.

All available hard-copy records were gathered and stored by project name in preparation for scanning and digitizing. Digital records such as spreadsheets, MS Access databases, or Log ASCII Standard (LAS) files were stored on the AGS file system, also organized by project name.

The nature and quality of the drillhole records differs between projects. Typical cases include detailed field lithologs handwritten at the time of drilling; typed and edited descriptive logs; and summary data sheets, graphical striplogs, and geological cross-sections where all but the most basic lithological information has been omitted. For a few borehole sets, more than one type of record is available (e.g., a striplog and a descriptive log).

An important source of near-surface geological information is the Alberta Water Well Information Database (WWID) maintained by Alberta Environment and Sustainable Resource Development (2013).

We identified nearly 3000 unique location records in that database where the well owner is described (in one form or another) as the Alberta Research Council (e.g., “A.R.C.”, “ARC”, “R.C.A.”, “RCA”, “RESEARCH COUNCIL”). While many of the boreholes drilled by the AGS and reported in this report may also be recorded in the WWID, their lithological descriptions can differ. The WWID contains the driller’s account of the sediments encountered during drilling, whereas the AGS log contains the AGS geologist’s descriptions and is usually more detailed. Nevertheless the WWID is an important cross-reference and source for locating some AGS borehole information.

2.1 Scanning and PDF File Preparation

AGS staff scanned the paper borehole log records directly to PDF format. We assembled all lithological records, including descriptions, strip logs, and cross-sections, into a single PDF document. We also inserted metadata tags into each PDF file. Files were named with a prefix “Litholog_” plus the hole number exactly as written or typed on the log, and then saved in the project folder.

We used a folder-naming convention consisting of the numeric source ID plus a brief descriptive identifier, such as project site name, the year the work was done, or the key staff member who undertook the work (e.g., *2_RedEarth97_Pawlowicz*). This naming convention is also used for the PDF files associated with this report.

2.2 Borehole and Interval Attributes

We compiled the information described in Table 2 for each borehole. The data are given in the file called ‘Boreholes.txt’ in AGS Digital Dataset 2014-0012, which accompanies this report. Data were compiled into an MS Access database (‘AGSBoreholes.mdb’) using a variety of software including Microsoft Excel, Access, and FME Desktop 2010. Some of the AGS’s borehole and interval description data had already been partly entered into an in-house working database used for other projects. In these cases, we uploaded data directly into the ‘AGSBoreholes.mdb’ database.

Data for the geological intervals described in each borehole log were also compiled. Table 3 summarizes the parameters collected. The data are given in the file ‘Intervals.txt’ in AGS Digital Dataset 2014-0012, which accompanies this report.

In most cases, we recorded the described interval depths exactly as described on the log. However, in cases where the length of the drilled interval differed from that of the described interval, we adjusted the described intervals to take into account loss (or gain) of recovery noted on the log. For example, the log for borehole W98-5, source ID 7 (Appendix 1), is a good illustration of the need for this adjustment. It shows instances where the amount of core recovered is greater than the drilled depth as well as the opposite case. These adjustments were made to intervals from data source IDs 2, 3, 4, 5, 6, 7, 33, and 36.

2.3 Borehole Locations

Boreholes locations not already georeferenced for other AGS projects were digitized using one of the following methods. If coordinates were written on the log (or listed in related documents) they were entered into Excel and imported into ArcGIS. If an Alberta Township System land description was given on the log, these coordinates were transformed to geographic coordinates. When no coordinates were given on the log but a location map was stored among the AGS’s files, the map was georeferenced in ArcMap using provincial basemap data (hydrography, township fabric, or roads) as the base. Locations were then digitized in ArcMap. In all cases an estimate of the spatial precision of the hole location was

made and captured in the ‘Spatial_precision’ field in the Boreholes table. Once the features had been captured in ArcGIS, their geographic coordinates were also uploaded to the Boreholes table.

2.4 Quality Control

Several measures were taken throughout the course of the project to ensure that the fidelity of the data was maintained during digitization. Counts of borehole locations digitized were reconciled against the number of PDF files of lithologs for the features on the file system. Where possible, constraints were put on the field properties in MS Access to minimize entry errors, such as entering a coordinate that lies outside of Alberta. Primary keys were established on each table to ensure no duplicate records were entered. Interval data were spell-checked in Excel before uploading to the database. The data were viewed in ArcMap to ensure that the PDF files were correctly identified and were not missing. Finally, data were posted as strip logs and cross-sections using ViewLog™ software and checked by the project geologist.

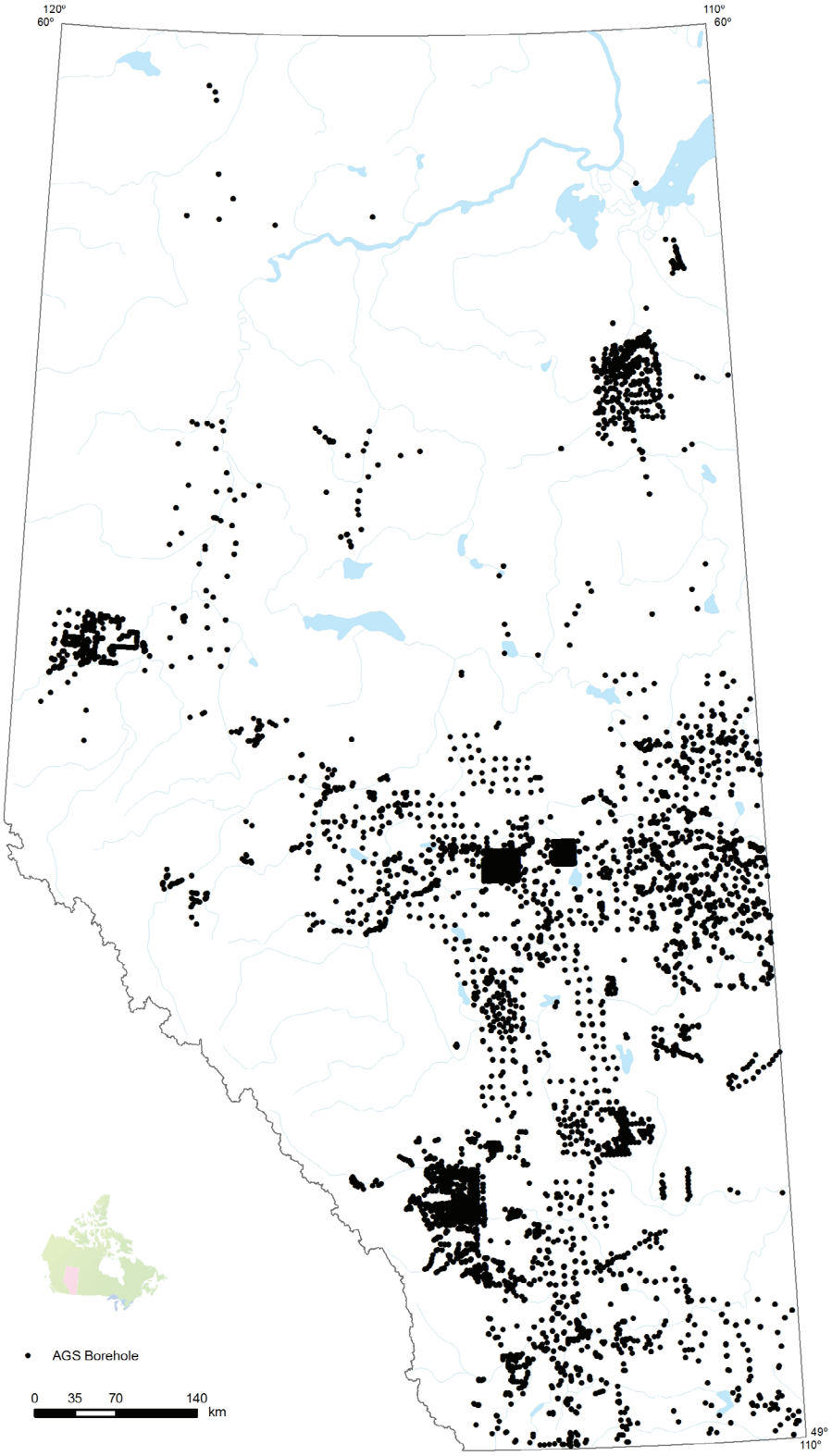

Figure 1. Locations of all AGS boreholes compiled to 2013.

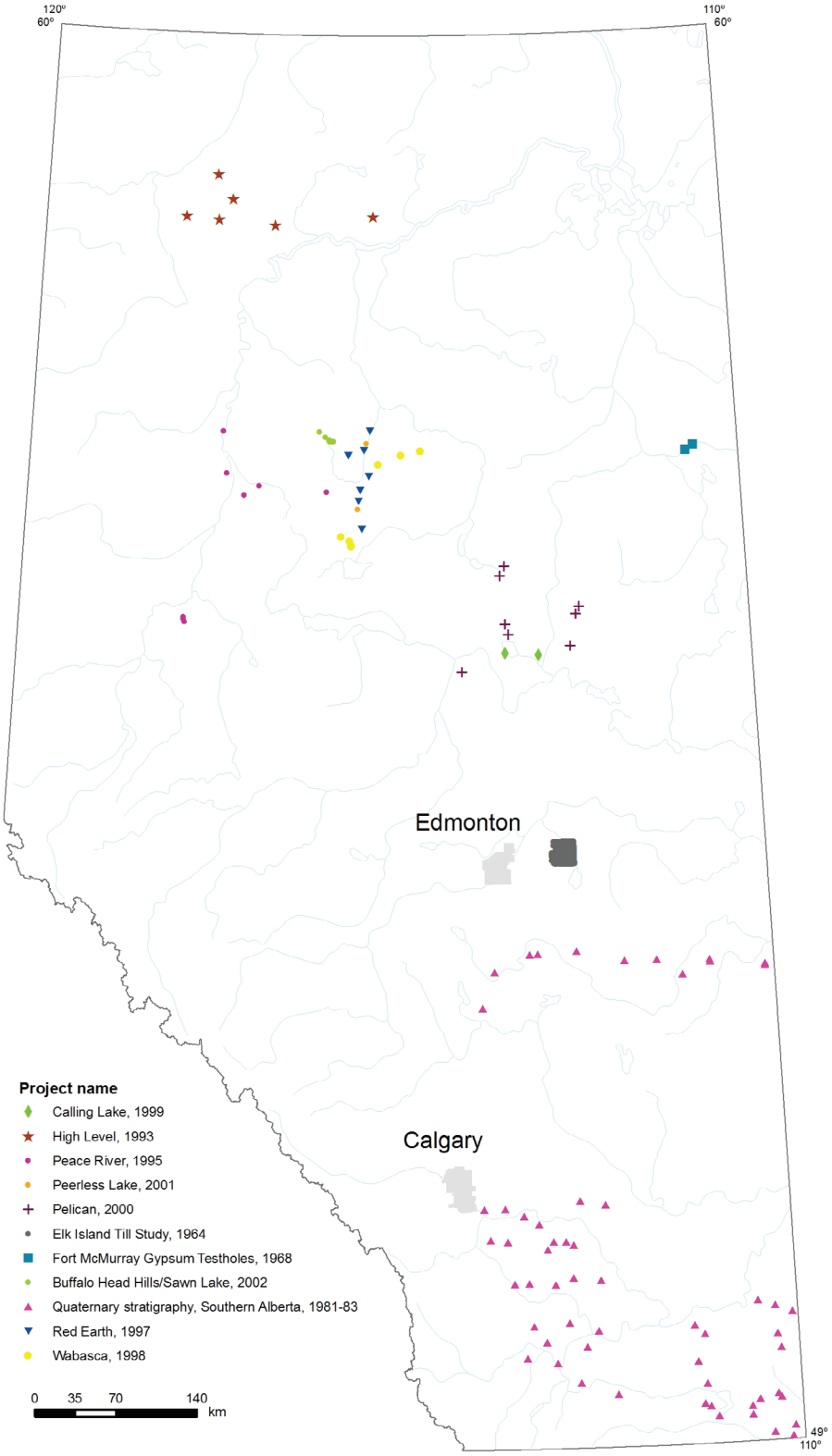

Figure 2. Locations of the boreholes in this release, grouped and symbolized by project.

Table 1. Descriptions of the drilling projects for which the sets of borehole data in this report were gathered. Each borehole record in the data table is tagged with the numeric source ID given in this table, which helps to uniquely identify the hole.

Source ID	Project Name	Description
1	Elk Island Till Study, 1964	In 1964, the ARC drilled 155 boreholes just east of Elk Island National Park. The project was intended to characterize the geochemistry of the area (Bayrock and Pawluk, 1969). The logs were never published.
2	Red Earth, 1997	Five boreholes were drilled for drift characterization to support diamond exploration in the 1990s (Pawlowicz and Fenton, 1998).
3	Buffalo Head Hills/Sawn Lake, 2002	Eleven auger coreholes were drilled to obtain information on the Quaternary stratigraphy and glacial dispersion of kimberlite indicator minerals (KIMs) within the Buffalo Head Hills kimberlite field. The core was sampled for geochemical, texture, and KIM analyses. In addition, palynology samples were collected from the bedrock (Pawlowicz et al., 2005).
4	High Level, 1993	Six holes were drilled to determine the regional variations in the texture, indicator minerals, and geochemistry of till in northern Alberta, to assist exploration by industry for diamondiferous kimberlite and lamproite, gold placers, and other minerals (Fenton and Pawlowicz, 1998).
5	Peace River, 1995	Nine boreholes were drilled to characterize the Quaternary stratigraphy in the Peace River region. Samples were taken for geochemical and diamond indicator mineral analysis (Pawlowicz et al., 1996).
6	Pelican, 2000	Eight locations were drilled in summer 2000, but the logs were never published. No geophysical logging was done on the holes.
7	Wabasca, 1998	Eight boreholes were drilled to characterize the Quaternary stratigraphy in the Wabasca area (at 7 locations). Samples were taken for geochemical and diamond indicator mineral analysis, grain size analysis, and matrix carbonate (Pawlowicz et al., 1998).
14	Quaternary stratigraphy, Southern Alberta, 1981–83	Fifty eight boreholes were drilled to characterize the Quaternary stratigraphy of the southern half of the province. Two 1:500 000 scale maps were ultimately produced (Shetsen, 1987 and Shetsen 1990) as well as a research paper (Shetsen, 1984). The logs were never published.
33	Peerless Lake, 2001	Two holes were drilled to characterize the Quaternary stratigraphy in the Peerless Lake map area (NTS 84B). Samples were taken for geochemical analysis, and geophysical logging was done on the holes. The logs were never published.
36	Calling Lake, 1999	Two holes were drilled as part of a regional Quaternary stratigraphy program. Samples were taken and geochemistry analyzed. Geophysical logging was done on both holes. The logs were never published.
58	Fort McMurray Gypsum Testholes, 1968	In 1968, two holes were drilled by the ARC near Fort McMurray to characterize the quality and extent of gypsum deposits underlying the Clearwater Formation. The holes are also recorded in the WWID (Hamilton, 1968).

Table 2. Attribute data compiled for each borehole.

Fields	Description
Name	Name of the borehole on the log. Part of primary key, with 'Source_ID'.
Source_ID	Foreign key to Source table. Part of primary key, with 'Name'.
Alias1	Alternate identifier for hole. See 'Comment' field for source.
Date_Drilled	Start date of drilling, in YYYYMMDD format.
Depth_Reference	Reference point for the depths cited on the log.
El_DR_masl	Elevation of 'Depth_reference', in metres above sea level (Canadian Geodetic Vertical Datum 1928). [m]
Elev_Method	Means by which 'El_DR_masl' was determined.
Total_Depth_m	Total depth drilled in metres. [m]
E_10TM83	Easting, 10 TM, NAD 83 datum. [m]
N_10TM83	Northing, 10 TM, NAD 83 datum. [m]
Lat_NAD83	Latitude of borehole at ground surface, NAD 83 datum. [decimal degrees]
Long_NAD83	Longitude of borehole at ground surface, NAD 83 datum. [decimal degrees]
Source_CRS	Coordinate reference system cited on or inferred from the log.
Drilling_Company	Name of drilling company or rig owner, if known.
Drilling_Method	Drilling method.
Driller	Name of the person who operated the drill.
Logger	Name of the person who logged the hole, if known.
Owner	Name of the organization that commissioned the hole.
Well_Presence	Whether or not a well of any kind was installed in the hole.
Spatial_Precision	Compiler's estimate of georeferencing error of hole location (+/- metres). [m]
Georef	Means by which original borehole coordinates (in x-y space) were determined.
Folder	Directory location of the PDF files.
LogPDF	Name of the scanned borehole log file, in PDF (Portable Document Format) format.
Purpose	Keywords indicating the purpose of the borehole.
Comment	Data compiler's comment.

Table 3. Attribute data compiled for each borehole interval.

Fields	Description
Borehole_Name	Unique identifier for hole. Foreign key to Borehole table (PK).
Source_ID	Foreign key to Source table (PK).
From_Depth	Upper bound of drilled interval, original units as given in 'Depth_Units'.
To_Depth	Lower bound of drilled interval, original units as given in 'Depth_Units'.
Depth_Units	Depth units, original. Either feet or metres.
From_Depth_mbgs	Upper bound of drilled interval in metres below ground surface. [m]
To_Depth_mbgs	Lower bound of drilled interval in metres below ground surface. [m]
Int_Top_Depth	Depth to the top of the described interval in metres below ground surface (PK). [m]
Int_Bot_Depth	Depth to the bottom of the described interval in metres below ground surface. [m]
Pri_Material	Primary lithological material classification, i.e. the dominant constituent.
Sec_Material	Secondary lithological material.
Colour	Colour of the lithological material, if noted.
Full_Text	Verbatim description of the interval as written on the original log.
Comment	Compiler's comments.

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Appendix 1 – Sample log illustrating the need to reconcile geological interval depths with sample recovery information

PROJECT: Wabasca	DATA NO: W98-5	LOGGED BY: J. Pawlowicz	DATE: 20 Oct 98
DRILLER: Kelly Faris, Canadian Geological Ltd.	TYPE DRILL: MS 61	Auger drilling rig	Continuous core using; CME 5' core barrel
LOCATION: NTS 84B	SURFACE ELEVATION: 671 m (approx.) from 1:50,000 map		Total depth: 32.9m
LOCATION: GPS	LONGITUDE: 115.51547° E	LATITUDE: 56.07193° N	
COMMENTS ON LOCATION: Utikuma Lake area, UNOCAL road, 6.9 km north of Hwy 750, old burrow pit clearing, 150m south of lake, high relief, hummocky terrain. Piezometer nest installed for water table installed.			

DRILLED DEPTH (meters)		CORE RECOVERY (cm)	DESCRIBED INTERVAL (cm)	LITHOLOGY	COMMENTS
FROM	TO				
0	0.9	115	70	fill	Dark grey-brown clay, no pebbles
			10	silt	Light grey-brown, clayey, massive, orange oxidation, noncalcareous
Drilled 0.9m but recovered 1.15m					
			35	clay	Silty, dark grey-brown, oxidized, massive, stiff and plastic, noncalcareous, no pebbles, strong Fe oxidation on high angle fractures
0.9	2.4	155	15	clay	SAB
			140	clay	Silty, mottled brown and dark brown, oxidized, massive, faint silt clay subhorizontal interbeds (deformed), noncalcareous, lacustrine, no pebbles or granules (quite silty)
2.4	4.0	135	135	clay	SAB, silty, deformed horizontal clay and silt interbeds, strongly oxidized fractures, noncalcareous, minor white calcareous deposits towards base of interval, vertical roots
Drilled 1.6m but recovered 1.35m					
4.0	5.5	125	32	silt	Clayey, massive, brown, strongly oxidized vertical fractures, white calcareous deposits and nodules, minor pebbles, noncalcareous
~~Drilled 1.5m but recovered 1.25m~~					
			27	clay	Mottled brown and dark brown, deformed bedding, no pebbles, noncalcareous, massive
			34	clay	Silty, brown, oxidized, 10° bedding, strongly oxidized, small gypsum crystals along bedding planes, noncalcareous
			32	clay	Silty, dark grey-brown, becoming sandier twards base, 10° brown clay/silt interbeds, gypsum crystals throughout (<1cm diameter), minor carbonate along bedding planes, strongly Fe oxidized deposits
5.5	7.0	100	68	silt	Clayey, dark grey-brown, slightly oxidized, 10° bedding, abundant gypsum crystals on bedding planes, occasional pebble, minor rusty grains, moist, matrix is slightly calcareous
Drilled 1.5m but recovered 1.0m					
			32	till	Dark brownish-grey, moist but not saturated, clayey silt till, few pebbles- quartzite, limestone, black shale, Fe oxidized, lenses throughout, minor gypsum, slightly calcareous, slightly oxidized

* SAB - Same As Before