



Natural Resources
Canada

Ressources naturelles
Canada

**GEOLOGICAL SURVEY OF CANADA
OPEN FILE 7989**

**Reconnaissance sub-bottom profiling survey
at Lac Duparquet, Quebec**

G.R. Brooks

2016

Canada



**GEOLOGICAL SURVEY OF CANADA
OPEN FILE 7989**

**Reconnaissance sub-bottom profiling survey
at Lac Duparquet, Quebec**

G.R. Brooks

2016

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources Canada, 2016
doi:10.4095/297469

This publication is available for free download through GEOSCAN (<http://geoscan.nrcan.gc.ca/>).

Recommended citation

Brooks, G.R., 2016. Reconnaissance sub-bottom profiling survey at Lac Duparquet, Quebec; Geological Survey of Canada, Open File 7989, 1 .zip file. doi:10.4095/297469

Publications in this series have not been edited; they are released as submitted by the author.

Abstract

As part of a reconnaissance sub-bottom acoustic profiling (SAP) survey, 36 SAP were collected along the northern area of Lac Duparquet, Quebec, on July 17, 2014. There is good penetration into the sub-bottom along most of the profiles. Three depositional facies are present within the SAP returns that represent lacustrine, glaciolacustrine and mass movement deposits. The profiling reveals that Lac Duparquet is a suitable basin for follow-up detailed profiling and core collection to further investigate the mass movement deposit(s).

Introduction

Large areas of northwestern Quebec-northeastern Ontario were inundated by a succession of glacial lakes, known as Barlow, Barlow-Ojibway and Ojibway, that evolved within the Timiskaming and Hudson Bay basins between 10 570 and 8470 ± 200 cal BP (Vincent and Hardy 1979; Veillette 1994; Breckenridge et al. 2012). A legacy of these glacial lakes is the regional occurrence of glaciolacustrine deposits that form the Great and Lesser clay belts areas, as has been described in early geological reports (e.g., Coleman 1909, 1922; Wilson 1918; James 1923). Studies in the 1920s by Antevs (1925; 1928) interpreted that the rhythmically laminated couplets composing the deposits are varves which represent annual accretions. He recognized that the varves form a time series that can be correlated throughout the region, based on varve thickness patterns, as subsequent research has verified (Hughes, 1959; 1965; Breckenridge et al., 2012). Many reports mention the presence of beds of “contorted”, “deformed”, “disturbed” and “slidden” varves within the glaciolacustrine deposits (Wilson 1918; Antevs 1925, 1928; Hughes, 1959; Breckenridge, 2012). Some of these disturbed deposits have been interpreted or inferred to be stratigraphic evidence of paleoearthquakes that occurred during local deglaciation (Adams 1982, 1989; Doughty et al. 2011, 2013).

Recent literature indicates that lake basins are promising areas for investigating paleoseismicity, by identifying stratigraphic levels that contain the deposits of multiple, synchronous, submarine landslides and/or turbidity currents (e.g., Moernaut et al. 2007, 2009; Upton and Osterberg, 2007; Bertrand et al. 2008; Anselmetti et al. 2009; Beck 2009, 2011; Maloney et al. 2013; Morey et al. 2013; Strasser et al. 2013). Mass movement deposits have been recognized within the deposits of lake basins in eastern Canada, including northwestern Quebec-northeastern Ontario, that are attributed to both modern and prehistoric earthquakes (e.g., Shilts, 1984; Shilts and Clague, 1992; Shilts et al., 1992; Ouellet, 1997; Normadeau et al., 2013; Doughty et al., 2010; 2014). Brooks (2015) advocated applying an integrated seismo- and chrono-stratigraphic approach to investigating mass movement deposits as evidence of paleoseismicity preserved in lake basins.

To identify the occurrence of disturbed deposits (i.e., landslide, turbidity currents and/or soft sediment deformation) preserved in the sub-bottoms of lakes, reconnaissance sub-bottom acoustic profiling (SAP) surveys were collected by the Geological Survey of Canada in July 2014 at eight lakes in the Rouyn-Noranda-Kirkland Lake area, northwestern Quebec-northeastern Ontario (Fig. 1). The results allow an assessment of the extent and character of disturbed deposits in the region and can be used to identify lake basins (or portions thereof) for more detailed SAP surveys to investigate regional paleoseismicity.

This report contains the results of the reconnaissance SAP survey undertaken at Lac Duparquet, Quebec, on July 17, 2015 (Figs. 1 and 2). It summarizes the SAP methodology, includes a map of the profile lines, provides a generalized overview of the deposits contained in the sub-bottom, and a brief notation of the content of the individual profiles. The report contains digital data of the SAP profiles in .keb and .sgy formats, and raster images of the profile returns (bmp). It also contains .kea files that list the date and time of collection, water depth, and geographical coordinates for the profile routes. This report is one of eight that summarize the results of the July 2014 reconnaissance SAP surveys, as listed in Table 1.

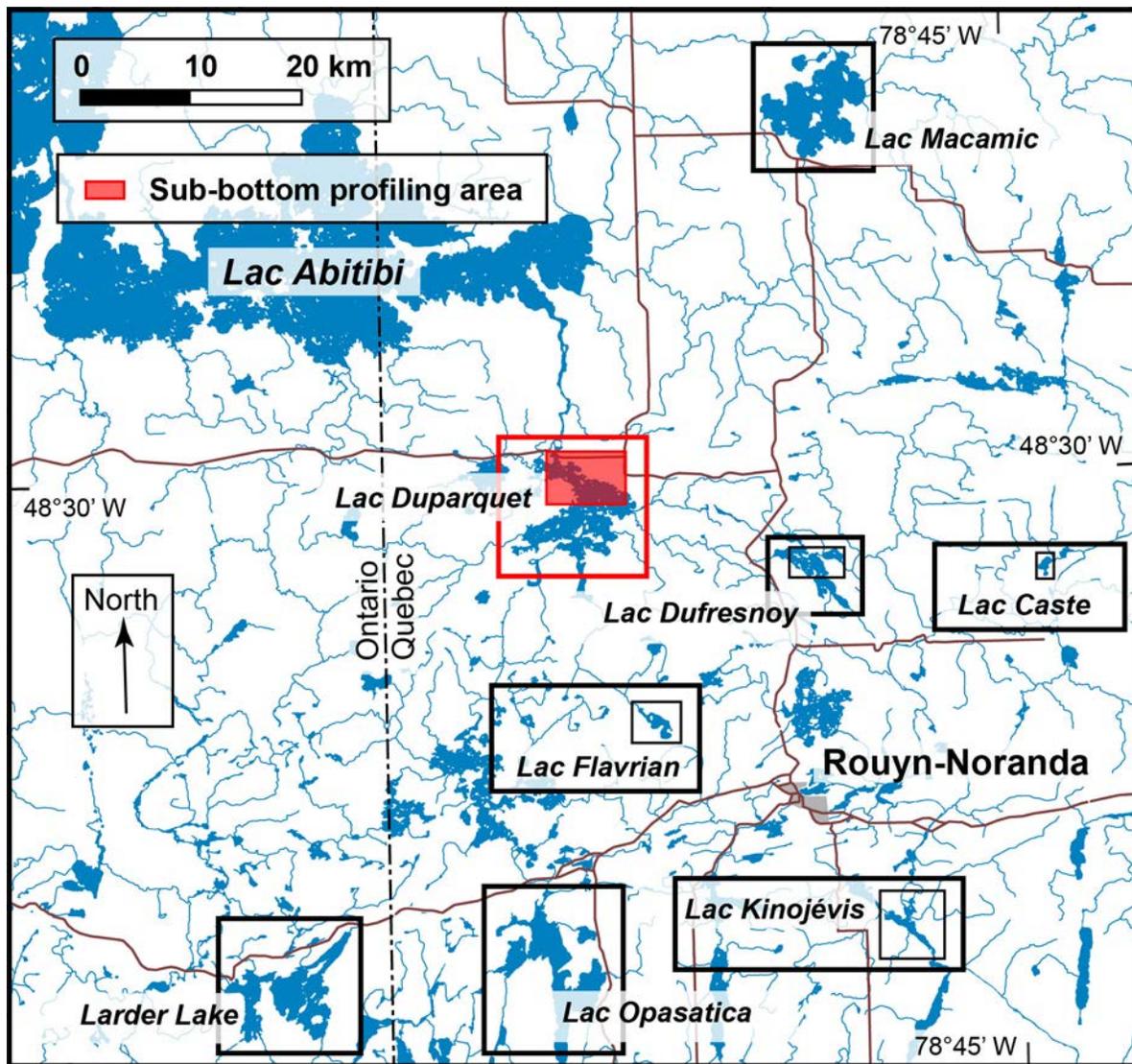


Fig. 1 Map showing the locations of Lac Duparquet and the other seven lake basins in the Rouyn-Noranda area, Quebec, where reconnaissance sub-bottom profiling surveys were conducted in July, 2014. The pink-shaded box over the northern area of Lac Duparquet shows the location of the map in Fig. 2.

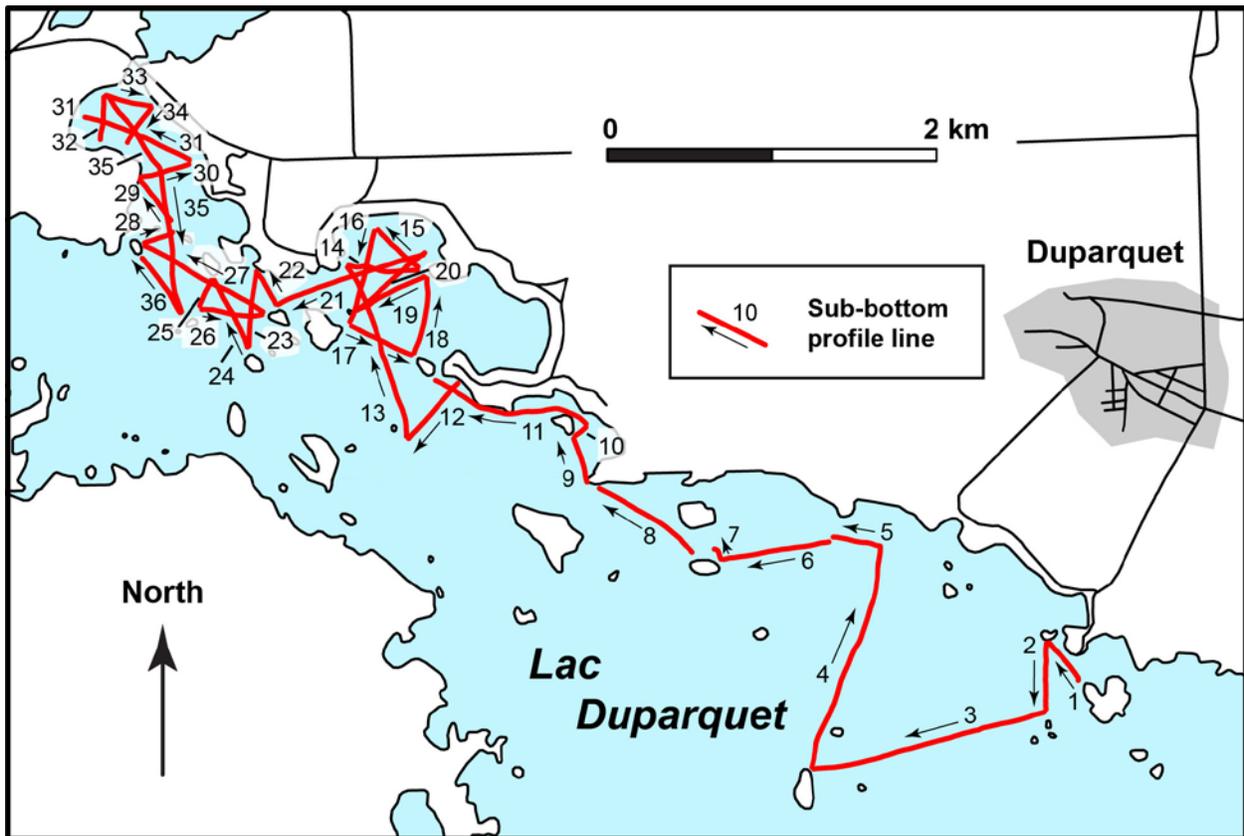


Fig. 2 Map showing the locations and numbering of the 36 sub-bottom profile lines along the northern side of Lac Duparquet.

Table 1 List of Open Files containing reconnaissance sub-bottom profiling of eight lakes in the Rouyn-Noranda-Kirkland Lake area, northwestern Quebec-northeastern Ontario.

Profiled lake basin	GSC OF number
Lac Caste	7991
Lac Dufresnoy	7990
Lac Duparquet	This report
Lac Flavrian	7988
Lac Kinojévis	7987
Lac Macamic	7985
Lac Opasatica	7984
Larder Lake	7986

Lac Duparquet

Lac Duparquet is located ~33.5 km north-northwest of Rouyn-Noranda, Quebec. The lake is irregular in shape, up to ~11 km long, 10 km wide and 50.4 km² in area (Fig. 2). The shoreline is commonly composed of bedrock outcrops and there are numerous bedrock islands within the lake. The major inflow into the lake occurs via the Kanasuta River, which enters the southern side of the basin. The outlet to the Duparquet River, which flows north to Lac Abitibi, is located on the north end of the lake.

Access to the lake was obtained using a public boat launch on the northeastern side of the lake, located just south of the Village of Duparquet.

Methodology

The SAP survey on Lac Duparquet was undertaken on July 17, 2014, using a Knudsen 320M™ profiler coupled to low (28 kHz) and high (200 kHz) frequency transducers. The pole-mounted transducers were attached on the side of a 4.9 m (16 ft) aluminum boat powered by a 30 hp motor. Traversing speed during profiling ranged between 5 to 7 km.hr⁻¹. Profiling routes were mapped using streamed differentially-corrected GPS coordinates collected with a Novotel Smart-V1 antenna-receiver and recorded in combination with the digital SAP data. The active window of the profiler was set to 0-20 m. The profiling routes are depicted in Fig. 2.

Profiler and GPS data for each profile were recorded digitally on a notebook computer as .keb and .kea files. A .keb file is a Knudsen proprietary format that can be opened with Knudsen PostSurvey™ v1.61¹ software, which is included with the download of this Open File. In the .keb format, the profile returns include a depth scale and vertical line stamps which display time and geographical coordinates (degree-decimal minutes). The vertical line stamps are made at the start/end of the profiles as well as at 20 sec intervals during profiling (Fig. 3).

¹ PostSurvey v1.61 is proprietary property of Knudsen Engineering Ltd.™ and is intended for authorized use only. Any use, other than the specific purpose of playback/displaying Knudsen data is prohibited. PostSurvey v1.61 has been included in the download of OF-7989 with the permission of Knudsen Engineering Ltd.™. The software has been provided for the convenience of the OF-7989 user. A user of this software does so entirely at their own risk.

To further facilitate profile viewing, the .keb file of the 28 kHz channel returns for each profile has been converted to a .sgy format file as well as a .bmp raster image. The .kea file contains the date and time of data collection, water depth, and geographical coordinates of the profile routes. The .kea files are an ASCII format and can be opened through a spreadsheet software, such as Microsoft Excel®. Depths on the profiles in the .keb and .kea files are based on a sound velocity in water of 1500 m.s⁻¹.

The .keb, .sgy, .bmp and .kea files for each profile are contained in designated profile folders. The folders form a digital Appendix that accompanies the download of this report. The .keb, .sgy, .bmp and .kea files for each profile are contained in designated profile folders. The folders form a digital Appendix that accompanies the download of this report.

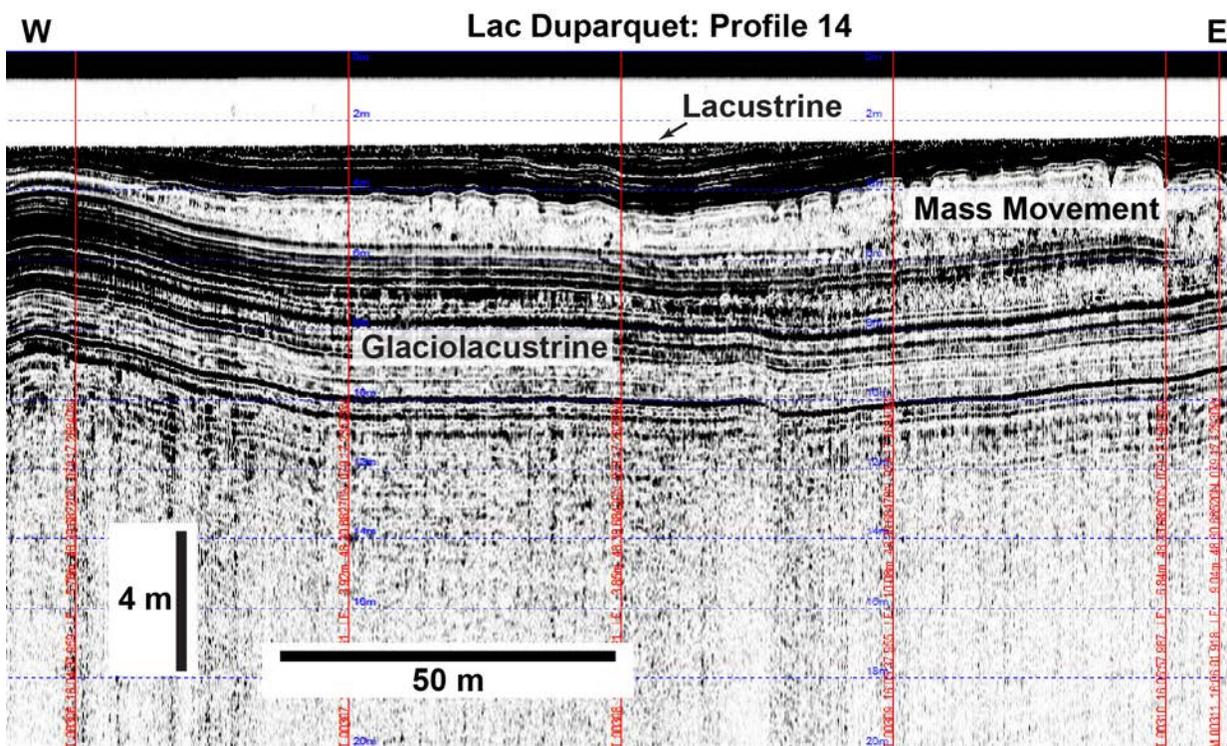


Fig. 3 Example of a sub-bottom acoustic profile (portion of profile 14) from Lac Duparquet, showing lacustrine, glaciolacustrine and mass movement facies. See Fig. 2 for the location of the profile. At least two beds of mass movement facies separated by glaciolacustrine facies are visible on the right third of the profile. The lacustrine facies forms a thin veneer overlying glaciolacustrine facies at the immediate top of the sub-bottom. The horizontal dashed lines show depth at 2 m intervals and the vertical lines are time-geographical coordinates stamps.

Results

Thirty-six SAP profiles were collected from Lac Duparquet along the northern area of the lake basin (Fig. 2). Profiles 1 to 12 are located along the northern shore of the lake following a net northwesterly direction. Profiles 13 to 21 form a series of overlapping zig-zags in and out of a large bay on the northern end of the lake just east of the lake outlet. Profiles 22 to 36 also form a

series of overlapping zig-zags that are located within and just offshore of the bay at the entrance to the Duparquet River.

Penetration into the sub-bottom along the profiles is generally good, although there some exceptions (see Table 2). The returns in profiles 2, 3, 4, 8 and 12, however, exhibit a shimmering that was caused by wave-induced boat heave.

Up to three depositional facies are present in the SAP profiles, as exemplified in Fig. 3 and summarized as follows:

Lacustrine facies – consists of transparent to weakly bedded deposits (Fig. 3); bed spacing is variable. The basal boundary is conformable and can be either defined by a strong impedance layer or indistinct. Deposits of this facies are interpreted to have aggraded in the post-glacial basin of Lac Duparquet.

Glaciolacustrine facies – consists of multiple, decimetre-scale, parallel reflectors that are draped on the underling topography (Fig. 3). Deposits exhibiting this facies are common to many lakes on the Canadian Shield and reflect sedimentation within a glaciolacustrine depositional environment. The deposits of this facies in Lac Duparquet deposits are interpreted to have aggraded within glacial Lake Ojibway (see Breckenridge et al., 2012).

Mass movement facies – consist of transparent or diffuse returns (Fig. 3), possibly including blocks (clasts) of intact glaciolacustrine deposits the bedding of which may be rotated with respect to the glaciolacustrine facies. The upper surface of the facies may be smooth or irregular. Bed thickness is variable from decimetres to several metres in scale and may pinchout laterally. Basal contact can be conformable or erosive along a given profile.

A bedrock facies is present in many profiles, as noted in Table 2. This facies generally forms a strong, opaque reflector with a smooth, curved, or irregular surface topography. Where occurring near the start or end of a profile, the bedrock likely outcrops along the shoreline, island or shoal.

The glaciolacustrine facies deposits along parts of many profiles in the two bays (profiles 13 to 22 and 23 to 36; Fig. 2) are truncated erosively at the modern lake bed. In many cases, deeper glaciolacustrine deposits occur relatively close to the lake bed because of the truncation.

Summary and conclusions

Thirty-six SAP were collected from Lac Duparquet, Quebec, on July 17, 2014, along the northern area of the lake.

There is good penetration of the sub-bottom along most of the profiles.

Three depositional facies can be identified within the SAP returns that represent lacustrine, glaciolacustrine and mass movement deposits. In many profiles, multiple occurrences of mass movement deposits can be identified.

The reconnaissance profiling reveals that Lac Duparquet is a suitable basin for follow-up detailed profiling and core collection to further investigate the mass movement deposit(s). The

areas of the two bays, where profiles 13 to 22 and 23 to 36 were collected, are good areas to target.

Acknowledgements

I thank Jim Hunter for reviewing this report. Matt DeGeer assisted with the collection of the SAP profiles. Figures 2 and 3 were made by Katie MacDonald, who also compiled Table 2. This research was supported through the Public Safety Geoscience Program, Earth Sciences Sector, Natural Resources Canada.

Table 2 Summary listing of the Lac Duparquet sub-bottom profile lines

Profile Number	Direction of boat travel	Length (m)	Comments
1	NW	295	- Good penetration along entire profile - Returns show lacustrine and glaciolacustrine deposits
2	S	404	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and mass movement deposits
3	WSW	1452	- Good penetration along most of profile, sporadic zones of no returns - Returns show lacustrine, glaciolacustrine and mass movement deposits, and bedrock
4	NNE	1429	- Good penetration along first quarter and at very end of profile mostly no penetration in between - Returns show lacustrine, glaciolacustrine and mass movement deposits, and bedrock
5	WNW	282	- Faint returns at beginning of profile and no penetration elsewhere - Returns show lacustrine and glaciolacustrine deposits
6	WSW	652	- Shallow to no penetration for most of profile, good to faint returns at the end - Returns show lacustrine, glaciolacustrine and mass movement deposits
7	NNW	78	- Short profile (terminated due to shallow water) - Good penetration along first half only - Returns show lacustrine, glaciolacustrine and mass movement deposits
8	NW	694	- Good penetration along first three quarters of the profile and little to no penetration along the last quarter - Returns show lacustrine, glaciolacustrine and mass movement deposits
9	NNW	279	- Good penetration along most of the profile - Returns show lacustrine, glaciolacustrine and mass movement deposits
10	NE	84	- Very short profile - Good penetration along first half of profile, no penetration elsewhere - Returns show lacustrine and glaciolacustrine deposits
11	NW then W then NW again	1003	- Penetration ranges from good to none locally along profile - Returns show lacustrine, glaciolacustrine and mass movement deposits
12	SW	453	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and mass movement deposits, and bedrock
13	NNW	1101	- Mostly no penetration along first half of profile, but good penetration along latter half - Returns show lacustrine, glaciolacustrine and mass movement deposits
14	E	426	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits
15	NW	333	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits, and bedrock

16	SSW	572	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits, and bedrock
17	ESE	405	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits
18	NNE	467	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits, and bedrock
19	WSW	464	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits
20	NE	538	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits
21	WSW	936	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits
22	NW	206	- Good penetration along most of profile, sporadic sections of faint returns - Returns show lacustrine, glaciolacustrine and several mass movement deposits
23	S	457	- Good penetration along most of profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits
24	NW	455	- Good penetration along most of profile - Returns show lacustrine, glaciolacustrine and mass movement deposits
25	SSW	168	- Short profile - Good penetration along entire profile, except part of middle - Returns show lacustrine, glaciolacustrine and several mass movement deposits
26	E	372	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and mass movement deposits
27	NW	825	- Good penetration along most of profile, short areas of shallow penetration locally in the middle - Returns show lacustrine, glaciolacustrine and several mass movement deposits
28	ENE	183	- Short profile - Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits, and bedrock
29	NW	309	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits
30	ENE	300	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits
31	WNW	691	- Good penetration along most of profile, no penetration at the beginning - Returns show lacustrine, glaciolacustrine and several mass movement deposits
32	N	260	- Good penetration along entire profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits
33	ESE	280	- Good penetration along entire profile with no penetration at very end of profile - Returns show lacustrine, glaciolacustrine and several mass movement deposits

34	SW	257	<ul style="list-style-type: none">- Good penetration along entire profile- Returns show lacustrine, glaciolacustrine and several mass movement deposits
35	SE then S	1426	<ul style="list-style-type: none">- Good penetration along most of profile- Returns show lacustrine, glaciolacustrine and several mass movement deposits, and bedrock
36	NW	403	<ul style="list-style-type: none">- Good penetration along most of the profile- Returns show lacustrine, glaciolacustrine and several mass movement deposits, and bedrock

References

- Adams, J., 1982, Deformed lake sediments record prehistoric earthquakes during the deglaciation of the Canadian Shield (abstract): EOS, Transactions, American Geophysical Union, v. 63, p. 436.
- Adams, J., 1989, Postglacial faulting in eastern Canada: Nature, origin and seismic hazard implications: Tectonophysics, v. 163, p. 323-331.
- Anselmetti, F.S., Ariztegui, D., De Batist, M., Gebhardt, A.C., Haberzettl, T., Niessen, F., Ohlendorf, C., and Zolitschka, B., 2009, Environmental history of southern Patagonia unravelled by the seismic stratigraphy of Laguna Potrok Aike: Sedimentology, v. 56, p. 873-892.
- Antevs, E., 1925, Retreat of the last ice-sheet in eastern Canada, Geological Survey of Canada Memoir 146, 138 p.
- Antevs, E., 1928, The last glaciation with reference to the retreat in northeastern North America, American Geographical Society Research Series No. 17: New York, 262 p.
- Beck, C., 2009, Late Quaternary lacustrine paleo-seismic archives in north-western Alps: Examples of earthquake-origin assessment of sedimentary disturbances: Earth-Science Reviews, v. 96, p. 327-344.
- Beck, C., 2011, Lake sediments as late Quaternary paleoseismic archives: Examples in the northwestern Alps and clues for earthquake-origin assessment of sedimentary disturbances, *in*: Audemard M, F.A., Michetti, A.M., and McCalpin, J.P., eds., Geological criteria for evaluating seismicity revealed: Forty years of paleoseismic investigations and the natural records of past earthquakes: Geological Society of America, Special Paper, 479, p. 159-179.
- Bertrand, S., Charlet, F., Chapron, E., Fagel, N., and de Batist, M., 2008, Reconstruction of the Holocene seismotectonic activity of the Southern Andes from seismites recorded in Lago Icalma, Chile, 39° S: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 259, p. 301-322.
- Breckenridge, A., Lowell, T.V., Stroup, J.S. and Evans, G., 2012, A review and analysis of varve thickness records from glacial Lake Ojibway (Ontario and Quebec, Canada): Quaternary International, v. 260, p. 43-54.
- Brooks, G.R., 2015, An integrated stratigraphic approach to investigating evidence of paleoearthquakes in lake deposits of eastern Canada: Geoscience Canada, v. 42, p. 247-261.
- Coleman, A.P., 1909, Lake Ojibway: last of the great glacial lakes. Ontario Bureau of Mines. v. 18, pt. 1, p. 284-293.
- Coleman, A.P., 1922, Glacial and post- glacial lakes in Ontario. University of Toronto Studies, Publications of the Ontario Fisheries Research Laboratory. v. 10, 76 p.

- Doughty, M., Eyles, N., and Daurio, L., 2010, Earthquake-triggered slumps (1935 Timiskaming M6.2) in Lake Kipawa, Western Quebec Seismic Zone, Canada: *Sedimentary Geology*, v. 228, p. 113–118, <http://dx.doi.org/10.1016/j.sedgeo.2010.04.003>.
- Doughty, M., Eyles, N. and Daurio, L., 2011, Ongoing neotectonic activity in the Timiskaming-Kipawa area of Ontario and Québec: *Geoscience Canada*, v. 37, p. 109-116.
- Doughty, M., Eyles, N., and Eyles, C.H., 2013, High-resolution seismic reflection profiling of neotectonic faults in Lake Timiskaming, Timiskaming Graben, Ontario-Quebec, Canada: *Sedimentology*, v. 60, p. 983-1006.
- Doughty, M., Eyles, N., Eyles, C.H., Wallace, K. and Boyce, J.I., 2014, Lake sediments as natural seismographs: Earthquake-related deformations (seismites) in central Canadian lakes: *Sedimentary Geology*, v. 313, p. 45-67.
- Hughes, O.L., 1959, Surficial geology of Smooth Rock and Iroquois Falls map areas, Cochrane District, Ontario: Department of Geology, University of Kansas, unpublished Ph.D. thesis, 190 p.
- Hughes, O.L., 1965, Surficial geology of part of the Cochrane District, Ontario, Canada. *in* International Studies on the Quaternary INQUA U.S.A. Wright Jr., H.E. and Frey, D.G. (ed.), Geological Society of America, Special Paper 84, 535-565.
- James, W.F., 1923, Duparquet Map-Area, Quebec. Geological Survey, Canada Department of Mines. Summary Report, 1922, Part D, p. 75-96.
- Maloney, J.M., Noble, P.J., Driscoll, N.W., Kent, G.M., Smith, S.B., Schmauder, G.C., Babcock, J.M., Baskin, R.L., Karlin, R., Kell, A.M., Seitz, G.G., Zimmerman, S., and Kleppe, J.A., 2013, Paleoseismic history of the Fallen Leaf segment of the West Tahoe-Dollar Point Fault reconstructed from slide deposits in the Lake Tahoe Basin, California-Nevada: *Geosphere*, v. 9, p. 1065-1090.
- Morey, A.E., Goldfinger, C., Briles, C.E., Gavin, D.G., Colombaroli, D., and Kusler, J.E., 2013, Are great Cascadia earthquakes recorded in the sedimentary records from small forearc lakes?: *Natural Hazards and Earth Systems Science*, v. 13, p. 2441-2463.
- Moernaut, J., De Batist, M., Charlet, F., Heirman, K., Chapron, E., Pino, M., Brummer, R., and Urrutia, R., 2007, Giant earthquakes in South-Central Chile revealed by Holocene mass-wasting events in Lake Puyehue: *Sedimentary Geology*, v. 195, p. 239-256.
- Moernaut, J., De Batist, M., Heirman, K., Van Daele, M., Pino, M., Brummer, R., and Urrutia, R., 2009, Fluidization of buried mass-wasting deposits in lake sediments and its relevance for paleoseismology: Results from a reflection seismic study of lakes Villarrica and Calafquén (South-Central Chile): *Sedimentary Geology*, v. 213, p. 121-135.
- Normandeau, A., Lajeunesse, P., and Philibert, G., 2013, Late-Quaternary morphostratigraphy of Lake St-Joseph (southeastern Canadian Shield): Evolution from a semi-enclosed glacimarine

- basin to a postglacial lake: *Sedimentary Geology*, v. 295, p. 38–52, <http://dx.doi.org/10.1016/j.sedgeo.2013.07.005>.
- Ouellet, M., 1997, Lake sediments and Holocene seismic hazard assessment within the St. Lawrence Valley, Quebec: *Geological Society of America Bulletin*, v. 109, p. 631-642.
- Shilts, W.W., 1984, Sonar evidence of postglacial tectonic instability of the Canadian Shield and Appalachians: *Current Research, Part A*, Geological Survey of Canada, Paper 84-1A, p. 567–579.
- Shilts, W.W., and Clague, J.J., 1992, Documentation of earthquake-induced disturbance of lake sediments using subbottom acoustic profiling: *Canadian Journal of Earth Sciences*, v. 29, p. 1018–1042, <http://dx.doi.org/10.1139/e92-084>.
- Shilts, W.W., Rappol, M., and Blais, A., 1992, Evidence of late and postglacial seismic activity in the Témiscouata -Madawaska Valley, Quebec–New Brunswick, Canada: *Canadian Journal of Earth Sciences*, v. 29, p. 1043–1069, <http://dx.doi.org/10.1139/e92-085>.
- Strasser, M., Monecke, K., Schnellmann, M., and Anselmetti, F.S., 2013, Lake sediments as natural seismographs: A compiled record of Late Quaternary earthquakes in Central Switzerland and its implication for Alpine deformation: *Sedimentology*, v. 60, p. 319-341.
- Upton, P., and Osterberg, E.C., 2007, Paleoseismicity and mass movements interpreted from seismic-reflection data, Lake Tekapo, South Canterbury, New Zealand: *New Zealand Journal of Geology and Geophysics*, v. 50, p. 343-356.
- Veillette, J.J., 1994, Evolution and paleohydrology of glacial Lakes Barlow and Ojibway. *Quaternary Science Reviews*, v. 13, p. 945-971.
- Vincent, J.-S. and Hardy, L., 1979, The evolution of glacial lakes Barlow and Ojibway, Quebec and Ontario. *Geological Survey of Canada Bulletin* 316, 18 p
- Wilson, M.E., 1918, Timiskaming County, Quebec. Geological Survey, Canada Department of Mines, Memoir 103, 197 p.