GEOLOGICAL SURVEY OF CANADA

OPEN FILE 2331

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**1991**

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## ENGINEERING REFLECTION SEISMIC TESTS
## GOLDEN POND AREA, CASA-BERARDI TOWNSHIP, QUEBEC

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## INTRODUCTION

A major problem faced by mineral exploration firms is exploring for potentially valuable mineralization within bedrock in areas with significant drift cover. In recent years, till sampling has been used to locate and map the glacial dispersal of the mineralization within the overburden. Till sampling programs can be expensive, as they require the drilling of a large number of boreholes over the area of interest. Any means of optimizing drilling locations so as to ensure that all holes encounter till, or of identifying the depth to till units to minimize the amount of core recovery required, could greatly improve the cost-effectiveness of such programs.

The recent development of shallow seismic reflection techniques may provide a means of obtaining such information. A test of the "optimum offset" shallow seismic reflection technique was proposed to Inco Gold, who offered the use of their facilities at their gold discovery in the Golden Pond area, Casa-Berardi Township, Quebec. The gold indicators in the overburden in the Golden Pond zone are found in the heavy mineral concentrates of the lower till that lines the bedrock depressions. The main objective of the survey was to map the lower till unit.

A crew from the the Terrain Geophysics Section of the Geological Survey of Canada spent 10 days at the test area and collected 3.5 kilometres of optimum offset data along accessible lines, where it was possible to walk and deploy the survey equipment on the muskeg terrain. Most of the test area was extremely boggy, making geophone and shot placement difficult.

## INSTRUMENTATION AND FIELD PROCEDURES

During this survey, a 12-gauge in-hole shotgun was used as the seismic source. Signals were picked up by single 100 Hz geophones spaced 3 m apart, attached to a 12 take-out geophone cable. The data were recorded on a Nimbus 1210F seismograph and G724S tape recorder. Before any common offset data were collected, expanding spreads were shot at many locations to test signal return and to set appropriate recording parameters. Raw data were recorded with

a 300 Hz low cut filter applied by the recording instrument. The optimum offset profiles presented in this Open File were recorded one trace at a time, using a common offset of 15 m between source and receiver.

The Golden Pond area could not be described as ideal terrain for shallow seismic reflection surveying. In the summer, most of the area is wet bog. Geophone placement and shot coupling were extremely variable, and in general, operations were slow and difficult. Line length varied from 1155 metres to only 33 metres, depending on terrain conditions and accessibility.

The location of the seismic lines are shown in Figure 1, along with the overburden thickness data later supplied by Inco Gold. Lines 1, 200 and 700 were run along access road and drill trail. All other profiles were run on cut lines into the muskeg. The optimum offset seismic reflection profiles collected during this test survey are shown without interpretation on Plate 1, and with interpretation on Plate 2.

## DATA PROCESSING

The data were transferred from the Nimbus G724S tape recorder to an Apple II+ microcomputer system for processing. Post-acquisition processing of the optimum offset data consisted of digitial bandpass filtering (300-800 Hz), the application of static corrections (small shifts in time) to each trace to align first arrivals, and the production of final plots with an automatic gain control and linear gain tapers to normalize trace amplitudes.

The multichannel data (expanding spreads) were analysed to determine a velocity-depth function, in order to calculate the depth scale corresponding to the two-way travel times of the sections. The lack of flat-lying reflectors in the area made the determination of a detailed velocity-depth function difficult. An average velocity of 1550 m/s was used to calculate the depth scales shown in Figures 2-16. The depth scale is non-linear in the near-surface because of the non-zero offset between source and receiver.

## RESULTS

Record quality in high resolution seismic reflection work is critically dependent on surface conditions, as this governs the signal coupling at each geophone and shot position. The boggy conditions in the Golden Pond area made consistent geophone and shot coupling difficult, and this resulted in large variations in data quality (particularly in frequency content) on some lines (e.g. Line 100, Figure 3). Overall, the seismic data recorded during this test survey ranged in quality from acceptable to poor.

As well as the problem of inconsistent data quality, the interpretation of the seismic profiles is sometimes ambiguous because the bedrock reflection is not always a clearly identifiable event. In this area, the top of till units can produce equally large (or larger) reflections. This means that additional information (e.g. some borehole control) is needed to confidently interpret the bedrock topography.

Line 1 (Figure 2)

This line was run in the water filled ditch of the access road to the Inco-Golden Knight Resources Inc. mill site. The line is 1115 metres in length, and consists of 35 records of 12 traces. The data quality was fairly good, except in two zones where data quality deteriorated (records 19-21 and 27-29). The irregular bedrock surface is identifiable as a large-amplitude reflection along parts of the line, and has been interpreted to vary from 20 metres depth at the west end of the section to approximately 50 metres depth at the east end. Within the overburden there is evidence of several laterally continuous reflection events. These are interpreted to represent lithological horizons, though drill hole control would be required to identify the lithologic units involved.

Line 100 (Figure 3)

Line 100 is a short (99 m) line that runs north from a point midway along Line 1. This profile clearly illustrates the importance of good ground coupling of geophones and shots. Geophones 10-12 of profile C-101 were planted in thick muskeg. The 2 m geophone leads were too short to allow the geophones to make solid contact. The severe deterioration in data quality that resulted is obvious. Bedrock has been interpreted to be relatively flat across the short profile at a depth of approximately 40 m. The overburden reflections identified on Line 1 are also observed on this section.

Line 200 (Figure 4)

This line was run in the water filled ditch alongside the north-south portion of the access road, and is 528 m in length. Data quality on much of the line is poor. The slightly better data at the south end of the section suggests that bedrock is approximately 60 m below surface here. The bedrock surface is tentatively interpreted to shallow abruptly midway along the line to a depth of approximately 20 m. Reflections from within the overburden are at best poorly defined.

Lines 300-600 (Figures 5-8)

These short north-south lines were run over drill sites that were located just off Line 700. Lines 300 and 400 are 66 m lines

centred over drillholes 71253 (located on the surface at geophone 10 of C-300) and 70297 (located on the surface at geophone 1 of C-401). Lines 500 and 600 are very short (33 m) lines run south from drillhole 79628 (located on the surface at geophone 1 of C-500) and north from drillhole 79618 (located on the surface at geophone 5 of C-600) respectively.

The data quality on these short lines is, in general, quite acceptable, except on Line 300 and the north end of Line 400. The interpretation of the bedrock reflections is shown on Figures 5-8 on Plate 2 (where bedrock is assumed to be the deepest observable event). The correlation between this interpretation and the depth to bedrock as determined from the drillholes (see Figure 1) is good. The exception to this is along Line 500, where bedrock is interpreted to be approximately 45 m below surface from the seismic data, but 58 m below surface according to the drill data. Line 500 is very short, and it is possible that the bedrock reflection has been wrongly interpreted; however, Line 500 intersects Line 700 (see below) and the interpreted depth to bedrock is supported by the Line 700 data as well.

Line 700 (Figure 9)

Line 700 is an east-west line, shot approximately 15 m off the edge of the drill trail, which joins the off-road profiles shot over drillhole locations (Lines 300-600, 800, 900, 1100 and 1300). The line consists of 28 12-trace records, and is approximately 1 km in length. Schematic logs from three drillholes that were located close to the seismic line have been drawn on the section using the appropriate non-linear depth scale.

Line 700 is characterized by a bedrock reflection that is "patchy", but is identifiable across most of the section. Bedrock is interpreted to be gently rolling across the profile at depths between 40 and 55 m below surface. In general, there is good agreement between the deepest large-amplitude reflection on the seismic section and the depth to bedrock as determined by the drillholes. However, in the vicinity of drillhole 70283, the largest amplitude reflection appears to correlate with the top of the lower till, and the signal from bedrock is relatively weak.

Several reflections can be observed within the overburden. Again, independent data is required to identify the lithologic horizons that give rise to these reflections. It is interesting to note that the lateral extent and the shape of the shallow sand body (esker) encountered in drillholes 70297 and 70278 is clearly shown on the seismic section. The interface between the sand and the underlying till or gravel gives rise to a clearly identifiable reflection. The sand unit pinches out abruptly approximately 100 m west of drillhole 70297.

It is also noted that the interface between till and an underlying

sand, encountered at a depth of approximately 25 m in drillhole 71442, produces a relatively strong reflection at this location (the discrepancy of a few metres between the reflection and the interface in the drill log is assumed to be due to a slight difference in location). According to the seismic section, this event is laterally continuous westwards to the location of drillhole 70283. Even though no sand unit was logged at approximately 20 m depth in this hole, it is suggested that this unit is also present there.

Lines 800, 900, 1100 and 1300 (Figures 10, 11, 13 and 15).

These lines are short north-south lines run over drillhole locations close to Line 700 (similar to Lines 300-600). Line 800 is a 99 m line run north from drillhole 76292 (located on the surface at geophone 6 of C-800). Line 900 is a 99 m line run south from drillhole 72921 (located on the surface at geophone 2 of C-900), and approximately centred over drillhole 72926 (located on the surface at geophone 11 of C-901). Line 1100 is a 99 m line run south from drillhole 79626 (located on the surface at geophone 5 of C-1100). Line 1300 is a 165 m line run south from drillhole 71722 (located on the surface at geophone 7 of C-1300).

Data quality on these lines is poor, except on the north end of Line 1100. At this site, the seismic section can be interpreted with the aid of the drillhole control shown on Line 700 (Figure 9). Strong reflections clearly delineate the top and bottom of the sand unit (esker) at depths of approximately 8 and 18 m. There are indications of possible reflections (lithologic boundaries) within the till unit below the sand, and bedrock is indicated by a strong reflection at a depth of approximately 50 m.

Lines 1000, 1200 and 1400 (Figures 12,14 and 16)

These lines are short (99 m) east-west lines that were run over borehole locations east of Line 700. Line 1000 was run over drillholes 70211 (located on the surface at geophone 11 of C-1001) and 70221 (located on the surface at geophone 6 of C-1003). Line 1200 was run over drillholes 71718 (located on the surface at geophone 1 of C-1201) and 70214 (located on the surface at geophone 6 of C-1200). Line 1400 was run over drillholes 71719 (located on the surface at geophone 9 of C-1403), 71720 (located on the surface at geophone 2 of C-1402), and 76290 (located on the surface at geophone 7 of C-1400).

Data quality on these lines is variable, and this, in conjunction with the shortness of the profiles, makes interpretation of the results difficult. The reflection from the bedrock surface is not a very clearly defined event, and reflections from within the overburden show little coherence along the length of the profiles.

## SUMMARY

The data obtained in this shallow seismic reflection survey in the Golden Pond area are useable, but not generally of high enough quality to accomplish the original objective of mapping the lower till unit. Two conditions contributed to this problem. The boggy surface conditions led to inconsistent, and sometimes very poor, ground coupling of the source and receivers. Consequently, data quality was variable and, in some cases, severely deteriorated as a direct result of surface conditions. As well, it appears that the variations between the acoustic properties of the various tills and coarser-grained overburden units, and sometimes between the tills and the underlying bedrock, are not sufficient to produce strong, coherent reflections. The well defined reflections from within the overburden that can be correlated to lithologic horizons in nearby drillholes are usually associated with interfaces between sand or clay and till.

The most useful optimum offset profiles that were collected during this survey are the longer sections - Lines 1 and 700. Even with the variations in data quality and the weak reflection events, there is a significant amount of useable information on these profiles. They can provide an estimate of the bedrock topography, as well as some general information on the overburden structure, especially when augmented by some sporadic drill control.

## ACKNOWLEDGMENTS

The author would like to express his gratitude to Mr. Barry Krause, Mr. Eberhart Berrer and Mr. Jorma Hannila of Inco Limited for their support and assistance. Dr.J.A.M. Hunter did extensive review and re-interpretation of the data and Dr. S.E. Pullan edited the final manuscript.