Report on
Refraction Seismograph Survey
for
Rothsay Mines Limited
Fairbanks Township, Sudbury Mining District
Ontario

Abstract

Rothsay Mines Limited in attempting
to probe the favourable contact between the Onwatin
slate and the Onaping tuff in the delta area of
the Vermillion River found considerable difficulty
with drilling the deep overburden. On the advice
of Sulmac Exploration Services Limited an attempt
was made to find the contours on the top of the
bedrock surface in order to locate the drill where
overburden conditions would be most favourable.
To this end, a portable 12 channel refraction seismograph system was brought down from Calgary and work started on a network of grid lines. Great difficulty was found in getting useable data from this equipment. The basic reason for this was the inability to get seismic energy into the ground because of a layer of soft wet deltaic deposit about ten feet down. An attempt has been made to analyse the information that was obtained and a map showing this has been included herewith.
Purpose:

The problem in this instance was to determine the place for a drill location which would satisfy the conditions of the geology and shallowest overburden. There are two techniques for determining overburden depths geophysically, that is by seismic methods or by resistivity.

Resistivity is a rather inaccurate method which often times will not give any useable information at all, whereas seismic methods, both reflection and refraction will ordinarily give quite precise data.

In the present situation the writer had been involved with similar work in much the same area and found that refraction seismic methods were accurate to plus or minus 10% in determining overburden depths. He therefore recommended that a similar survey be carried out on the Rothsay property. This survey was designed for Rothsay by Sulmac Exploration Services and with the field work and interpretation done by Velocity Surveys of Calgary. A plan of the results and the Velocity Surveys report is included herewith.
The Rothsay mining property consists of 40 mining claims in the Sudbury Mining Division, twenty miles west of the city of Sudbury. They are located on the north shore of Vermillion Lake where the Vermillion River enters the lake. The claims may be more particularly described as follows.

**Fairbanks Township**

- Claim No. 106897 - 926 30 claims
- 106928 - 36 9 claims

**Trill Township**

- Claim No. 106927 1 claim

**Total** 40 claims

The property is quite accessible in that a good all weather road goes into the north shore of Vermillion Lake from the Levack highway. There are boats available for rent on the lake which can take personnel to the property in less than one-half hour. It would also be accessible by float plane to Vermillion Lake and taxiing up the Vermillion River.
Geology:

The property lies within the Sudbury basin which is one of the world's better known geological phenomena. The Sudbury basin is thought by some to be a downfolded sill branching off from a vertical dike or stock on the south side with the intrusive complex segregating into the basic Norite at the bottom up through a transition zone to a Micropegmatite at the top. Within this folded sill have been deposited the Whitewater sediments consisting of the Onaping tuff as a lower member, the younger, Onwatin slates and the youngest, Chelmsford sandstone. The Whitewater sediments are relatively undisturbed for Precambrian sediments. There are major faults cutting through them as well as the familiar diabase dikes.

Economically, the nickel-copper-precious metal ore bodies have invariably been associated with the Norite and Quartz Diorite dikes on the outer rim of the basin. Within the basin, however, Consolidated Sudbury Basin Mines has outlined a copper-zinc-lead ore body on the south shore of Vermillion Lake. This mineral zone is present at the contact of the Onwatin
slates with the Onaping tuffs. The property of Rothsay Mines is located astride this same contact on the north limb of the basin fold. Heading through the property is the Cameron Creek fault. Geological conditions would seem to be favourable for a similar type of deposition as the Consolidated Sudbury Basin Mines, some two or three miles distant.

Holes were planned to probe this contact down dip. The first hole went down 430 feet in overburden before hitting a boulder bed which was found impossible to penetrate. The second hole, some 800 feet up dip penetrated 350 feet of overburden and was continued down to 1,050 feet. The contact zone between the slates and the tuffs was reached at 550 feet.

Geophysics:

Method

A simple schematic diagram has been included with this report to show as simply as possible the principle of the seismic refraction method. In short terms the method consists of applying a source of
sound energy to the ground and timing the travel from this source to a detector or detectors. Usually the source will be an explosives but in recent years methods have been developed using hammered plates and dropped weights. The detectors are known as geophones which consist of miniature seismographs able to detect minute quantities of seismic energy. In refraction work it is often necessary to off-set the shot point several hundred feet from the spread or line of geophones in order to give the energy enough time to travel through the low speed layer and the high speed layer. In our present instance this had to be done because of the relatively thick overburden. The reader is referred to a report by W.T. Robsin Seismologist with Velocity Surveys, which gives a comprehensive description of the method and results.

Also included with this report is a copy of the map prepared by Velocity Surveys.
Discussion of Results

The results may generally be described as being disappointing. It was thought by the writer from his past experience doing similar work within four or five miles of this location that an extremely useful survey would be made. This goal was frustrated by the fact that a very low speed absorbent layer of material existed just below the surface of the ground. This layer is probably due to the deltaic nature of the material deposited in this portion of the claims.

The difficulty could have been surmounted undoubtedly by drilling deeper holes for the shots. However, this would have entailed considerable additional expense which was not felt to be warranted in the present survey. It is unfortunate that more positive data was not available but every technique short of drilling deeper holes was tried to improve the quality. For example, off-setting the shot point, multiple holes, larger charges, smaller charges and finally resorting to working down from the location of the No. 2 drill hole where results were useable
towards the No. 1 drill hole to where no energy could be put into the ground. The north east side of the river could not be worked because of inaccessibility to the equipment. In addition there were many parts of the main portion of the grid area which could not be worked because of extreme wetness. This wetness prevented the shooting of reverse spreads as suggested in the Velocity Survey Report, since all holes were hand augered, in wet ground they would fill up with water as fast as material could be removed.

**Summary and Conclusions**

In summary the purpose of the survey was not accomplished. Although an area of lower ground has been suggested by the Velocity Survey Report this area is based on seven depth determinations which would indicate a high degree of speculation. The survey failed in its purpose because of an unpredicted zone of wet and highly absorbent material just below the surface of the ground which would not pass the seismic energy. The difficulty could have been surmounted
by drilling deeper holes for the shots but it was considered that the additional expense was not warranted.

Respectfully submitted,

July 27, 1959
Toronto, Ontario

Diagram showing typical travel paths of first arrivals.

Formulae for calculation:

\[ d_1 = \frac{X_c'}{2} \left( \frac{V_2 - V_1}{V_2 + V_1} \right) \]

\[ d_2 = d_1 + \frac{X_c''}{2} \left( \frac{V_3 - V_2}{V_3 + V_2} \right) + \frac{d_1}{V_1} \left[ \frac{V_3}{V_3 - V_1} - \frac{V_2}{V_2 - V_1} \right] \]

Sample calculation:

\[ V_1 = 1500 \text{ ft per sec.} \]
\[ V_2 = 3500 \text{ ft per sec.} \]
\[ V_3 = 15000 \text{ ft per sec.} \]
\[ X_c' = 80 \text{ ft.} \]
\[ X_c'' = 200 \text{ ft.} \]

\[ d_1 = \frac{80}{2} \sqrt{\frac{3500 - 1500}{3500 + 1500}} = \frac{40}{2} \sqrt{2000} = 25.3 \text{ ft} \]

\[ d_2 = 25.3 + \frac{200}{2} \sqrt{\frac{15000 - 15000}{15000 + 15000} + \left( \text{very small} \right)} \]

\[ = 25.3 + 77.4 = 102.7 \text{ ft} \]
FINAL REPORT

REFRACTION SEISMOGRAPH SURVEY

on

SUDBURY BASIN AREA

for

SULMAC EXPLORATION SERVICES LIMITED

by

VELOCITY SURVEYS LIMITED

July 20, 1959.

Headquarters: 530A - 6th Avenue S. W., Calgary, Alberta.

Seismologist: W. T. Robson

Supervisors: F. C. McConnell
             P. R. Grier
ABSTRACT

A refraction seismograph survey was carried out in the Chemsford area of the Sudbury Basin with the purpose of determining the thickness of the overburden above the Precambrian country rock. Very swampy terrain limited the size of the drilling equipment, consequently, only shallow shot holes were available, while the geophone plants were generally poor, owing mainly to the soft ground. Much of the program was not completed due to the poor results in the wettest parts of the prospect. Six spreads were shot with sufficient length to obtain a depth calculation for the underlying Precambrian formations. The isopach of the overburden shows the west half of the area to have about 325 to 350 feet of drift, while the east part has from 350 to over 450 feet of overburden. Our results indicate that the extreme northwest corner has the shallowest overburden.

A. RECORDING EQUIPMENT

Twelve S.I.E., P-11 modified amplifiers were used, along with an S.I.E., 24 trace oscillograph, a 1320 foot, 24 conductor cable, and twelve Electro-Tech, EVS4B - 7½ cycles per second geophones.
B. FIELD TECHNIQUES

The one test hole in the area was used for several shots, and fair to good first arrivals were obtained from shots about 20 feet. A hand auger was used for other shot points and most shots were taken at about six feet. The results from the shallow holes were poor to fair. The geophones were offset several hundred feet from the shot holes after early results revealed a considerable depth of overburden.

C. COMPUTATION PROCEDURE

The first arrivals were plotted on a time-distance graph and the velocities and intercepts were determined. The depth of the Precambrian rock was calculated as follows:

\[ D = \frac{T_1 - \text{uht} \times \cos F}{2} + H \]

where:

- \( D \) equals distance to Precambrian from surface.
- \( T_1 \) equals intercept from high velocity.
- \( \text{uht} \) equals time from shot to surface (estimated).
- \( \cos F \) equals low velocity/cos \( i \) (\( V_0/V_1 \) equals sin \( i \)).
- \( H \) equals hole depth.

Two spreads showed apparent three layer cases which were computed in the conventional manner.

As the spreads were shot in one direction only, the exact high velocities could not be obtained, however, from previous knowledge.
and from inspection of the plots, a figure of 19,000 feet per second was calculated to be the velocity in the Precambrian rocks. The overburden had a velocity of about 4,700 feet per second. Variations from the above figure were taken to result mainly from a change in the dip of the bed rock. Patches of swamp and muskeg also appeared to affect the arrival times. In any future operations of this kind, we would recommend shooting the spreads in both directions.

D. FINDINGS

An isopach of the overburden thickness is presented. The thickness values vary in reliability and the control is sparse. The west part of the area has a thinner overburden layer than the east part, and the extra high one-way velocities in the northwest suggest that the thinnest layer of overburden is in that region. The depth of the overburden may be about 300 feet in the northwest corner of the area.

Respectfully submitted,

VELOCITY SURVEYS LIMITED

W. T. Robson - Seismologist

Approved:

F. C. McConnell - Supervisor
Assessment Data:

Owner of Property: Rothsay Mines Limited, Suite 810, 100 Adelaide Street West, TORONTO 1, Ontario.

Location: Fairbanks and Trill Townships Sudbury Mining Division.

Personnel:

Geophysical
All - Suite 904, 80 Richmond St. W., Toronto 1 Ontario.
D. Olson - June 5 - July 10, 1959
W. Fallow - June 5 - July 10, 1959
D. MacKay - June 5 - July 10, 1959
J. B. Frennergast - July 10 - July 15, 1959
E. H. George - July 10 - July 15, 1959


Mandays Seismic Survey and Field drafting (8 hr.) 150 x 4 - 420
Mandays Final Drafting (8 hr.) 6 x 4 - 24
Final Report and Supervision 6 x 4 - 24

Total - 468

Work to be applied 468 - 93 days per claim
SEE ACCOMPANYING MAP(S) IDENTIFIED AS

FAIRBANK-0016-#1

FAIRBANK-0016-#2

LOCATED IN THE MAP CHANNEL IN THE FOLLOWING SEQUENCE (X)
PLAN OF SEISMIC BEDROCK DETERMINATIONS

ROTHSAY MINES LIMITED
SUDBURY MINING DISTRICT
FAIRBANKS TWP., ONTARIO
SULMAC EXPLORATION SERVICES LIMITED

SCALE 1" = 200'

DEC. 1959