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## ABSTRACT

As part of the Canadian LITHOPROBE Program approximately 390 km of deep reflection data were recorded along 9 lines across the Kapuskasing Structure Zone (KSZ), the Wawa and Abitibi subprovinces of the Superior Province. The survey was designed to resolve the deep structure associated with the KSZ, which exposes middle to lower crustal rocks affected by wide-spread compression and extension in the Archean and a major intra-plate thrust event sometimes in the Proterozoic.

Data were generated using up to four vertical vibrators, recorded with a 240 channels, conventionally processed in CMP geometry, and migrated. The stacked, migrated and coherency enhanced data presented in this report are plotted at 1:100000. This format allows interested parties to interpret the data independently and to compare directly the results with a wide variety of seismic reflection data being released by other groups.

## RÉSUMÉ

Le programme canadien LITHOPROBE a fait l'acquisition de neuf profils de sismique réflexion à grande pénétration dans la Province du Supérieur aux environs de Kapuskasing; ces lignes totalisent environ 390 km dans la Zone Structurale de Kapuskasing (ZSK), la Sous-province de Wawa et celle de l'Abitibi. Le levé a été conçu de façon à identifier les structures profondes associées à la ZSK où affleurent des roches de la croûte moyenne et inférieure; ces roches ont subi l'influence de compressions et d'extensions importantes d'âge Archéen, ainsi que d'un épisode majeur de chevauchement intra-plaque d'âge Protérozoïque.

Jusqu'à quatre camions vibrateurs à mouvement vertical ont été utilisés avec un système d'enregistrement à 240 canaux pour faire

l'acquisition des données; celles-ci ont été traitées de façon conventionnelle par la méthode des points-milieu communs, et migrées. Les coupes sismiques sommées, migrées et filtrées pour la cohérence présentées dans ce rapport ont été mises en plan à une échelle de 1:100000. Ce format permet aux personnes intéressées d'interpréter indépendamment les données de sismique réflexion et de comparer directement celles-ci avec un large éventail de données sismiques mises à la disposition du public par d'autres groupes.

## INTRODUCTION

LITHOPROBE, Canada's national geoscience program, involves participation from Federal and Provincial agencies, universities and industry. As part of LITHOPROBE's Kapuskasing transect, several deep reflection profiles were acquired in the central Superior Province of the Canadian shield. Approximately 390 km of seismic reflection data were collected across the Kapuskasing structural zone (KSZ), a granulite facies terrane that cuts obliquely across the Archean Superior craton. The KSZ may represent the lowest structural level of an exposed cross section of Archean crust that was thrust southeastward over lower grade rocks of the Abitibi granite-greenstone belt during early Proterozoic tectonism [Percival and Card, 1983;1985]. The LITHOPROBE Kapuskasing transect aims to resolve the structure, geometry, relationship and evolution of the crust at depth of various tectonic units such as the Wawa and Abitibi belts of the Superior Province, the Chapleau and Groundhog River block of the KSZ. A generalized geological map of the KSZ region is shown in Figure 1 and line locations of the LITHOPROBE seismic profiles are shown in Figure 2.

In 1987/88, under a contract to the Federal Department of Supply and Services, multichannel seismic reflection data were collected for

LITHOPROBE by Veritas Geophysical Ltd. of Calgary. Initial processing of the data was completed through a contract to Veritas Seismic Ltd. of Calgary. Additional migrations of the stacked profiles, coherency enhancement and display at 1:100000 scale, was completed at the Continental Geoscience Division's seismic processing center in Ottawa.

Information presented in this report include coherency enhanced migrated and unmigrated reflection profiles; survey information; necessary information on data acquisition, processing and display parameters. No interpretations of the Kapuskasing transect data are given here. Preliminary results have been reported by West and others [1989], Green and others [1989], Geis and others [1989], Percival and others [1989].

## DATA ACQUISITION PARAMETERS

The Vibroseis reflection survey for LITHOPROBE was conducted by Veritas Geophysical Ltd. (Calgary). during the period of 25/09/1987 to 14/01/1988.

### Basic Field Parameters — Regional Survey

These parameters apply to seismic reflection profiles 1 to 6 that are crossing the Chapleau Block of the KSZ, undershoot experiments that close gaps between profiles 2 and 3 and profiles 3 and 4, and profiles 8 to 10 that are crossing the Groundhog River Block of the KSZ (see Figures 1 and 2)\*.

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\* Data collected along profiles 12, 12A and 14 in the Kirkland Lake - Rouyn/Noranda area are presented by Mayrand and others [1989].

## Source Parameters

4 Mertz 18 vibrators  
with force control  
minimum 3 vibrators operating  
Sweep linear, 12-52 Hz  
source interval: 100 m  
number of sweeps per source point: 8

## Recording Parameters

Station spacing 50 m  
Recording channels 240  
Geophones OYO 14 Hz  
Group Design 12 geophone linear array  
array length: 50 m  
Spread design asymmetric split spread  
60 stations - 13 station gap - 180 stations  
Recording system 2 units with  
Texas Instruments DFS V  
I/O correlator-stacker FPCS  
with noise reject algorithm  
120 seismic channels  
4 ms sample period  
Filter 64 Hz high cut on  
low cut out  
Records 14 s sweep  
18 s listen  
18 s record field correlated

## Basic Field Parameters – High – Resolution Survey

These parameters apply to seismic reflection profile 2 that is crossing the Chapleau Block of the KSZ (see Figure 1). During data acquisition unit 1 recorded 120 channel vertical component data while unit 2 recorded 120 channel horizontal component data \*.

### **Source Parameters**

	2 Mertz 18 vibrators
	with force control
	minimum 2 vibrators operating
Sweep	linear, 20-130 Hz
	source interval: 20 m
	number of sweeps per source point: 8

### **Recording Parameters**

Station spacing	20 m
Recording channels	120
Geophones	
vertical component	OYO 14 Hz
horizontal component	Mark 28 L shear, 4.5 Hz
Group Design	
vertical component	12 geophone linear array
	array length: 25 m
horizontal component	2 geophones over 12 m
Spread design	end on
	120 stations - 8 station gap
Recording system	2 units with
	Texas Instruments DFS V
	I/O correlator-stacker FPCS
	with noise reject algorithm

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\* horizontal component data are available in digital form, for details see page 11 of this report



	120 seismic channels
	2 ms sample period
Filter	high cut, low cut out
Records	8 s sweep
	8 s listen
	8 s record field correlated

Additional information concerning data acquisition parameters has been given by West and others [1988].

## DATA PROCESSING SEQUENCE

Phase 1 processing of Kapuskasing transect reflection data was done under contract by Veritas Seismic Ltd. in Calgary; phase 2 processing, additional migrations of the stacked profiles, coherency enhancement\* and display at 1:100000 scale, was completed at the Lithosphere and Canadian Shield Division's seismic processing center in Ottawa.

A brief example of the basic processing sequence leading to stacked and migrated seismic sections is listed below.

### Processing Sequence – Regional Survey

#### Basic Processing Parameters

1. Demultiplex	processed record length: 16 s
2. Recording gain removal	2 s automatic gain control
3. Geometry definition	crooked line
4. Elevation correction	datum 400 m
	replacement velocity 5000 m/s

---

\* For more details on coherency enhancement of seismic data see Milkereit and others [1988] and Milkereit and Spencer [1989].

- |                                 |                                      |
|---------------------------------|--------------------------------------|
| 5. CDP sort                     | max. fold (nominal coverage 60 fold) |
| 6. Stacking velocity analysis   | constant velocity stacks             |
| 7. Trace editing                | first break mute                     |
|                                 | surgical mute                        |
| 8. Automatic static corrections | correlation window 1-11 s            |
| 9. CDP stack                    | max. fold                            |
| 10. Output to tape              | SEG-Y data format                    |

### Migration Processing Parameters

- |  |                                    |
|--|------------------------------------|
| 11. Input stacked section from SEG-Y format tape |                                    |
| 12. Vertical sum (2 to 1)                        |                                    |
|  | CDP spacing: 50 m                  |
| 13. Bandpass filter                              | 2/5 - 32/38 Hz                     |
| 14. Constant velocity F-K migration tests        |                                    |
|  | velocity interval: 5000 - 7000 m/s |
|  | velocity increment: $\leq 250$ m/s |
| 15. F-K migration                                | best velocity distribution         |
| 16. Display/Output to tape                       | SEG-Y data format                  |

### Coherency Enhancement and Display Parameters

- |                                       |                              |
|---------------------------------------|------------------------------|
| 17. Input data from SEG-Y format tape |                              |
|                                       | CDP stacked section: step 10 |
|                                       | FK migrated section: step 16 |
| 18. Data compression                  |                              |
|                                       | 8 ms sample interval         |
|                                       | 50 m trace spacing           |
| 19. Compute coherency filter          |                              |
|                                       | dip passband: $\pm 3.0$ km/s |
| 20. Apply coherency filter            |                              |

21. Display 16 s coherency enhanced data

vertical scale: 1.2 in/s

horizontal scale: 50 traces/in

Coherency enhanced CDP stacked and migrated sections of the Lithoprobe Kapuskasing Transect are shown in the Appendix, plates 1 to 10. Assuming an average crustal velocity of 6 km/s, these seismic profiles show no vertical exaggeration and the horizontal scale is approximately 1:100000. General survey information, profile direction, crustal thickness based on refraction studies [Boland and others, 1988], line intersections and shot point locations are annotated.

Processing Sequence — High Resolution Survey

**Basic Processing Parameters**

1. Demultiplex	processed record length: 8 s
2. Recording gain removal	2 s automatic gain control
3. Geometry definition	crooked line
4. Elevation correction	datum 400 m
	replacement velocity 5000 m/s
5. CDP sort	max. fold (nominal coverage 60 fold)
6. Stacking velocity analysis	constant velocity stacks
7. Trace editing	first break mute
	surgical mute
8. Automatic static corrections	correlation window 0.4 - 6 s
9. CDP stack	max. fold
10. Output to tape	SEG-Y data format

### Migration Processing Parameters

- 11. Input stacked section from SEG-Y format tape
- 12. Vertical sum (2 to 1)  
CDP spacing: 20 m
- 13. Constant velocity F-K migration tests  
velocity interval: 5000 - 7000 m/s  
velocity increment:  $\leq 250$  m/s
- 14. F-K migration  
best velocity distribution
- 15. Display/Output to tape  
SEG-Y data format

### Coherency Enhancement and Display Parameters

- 16. Input data from SEG-Y format tape  
CDP stacked section: step 10  
FK migrated section: step 15
- 17. Data compression  
4 ms sample interval  
40 m trace spacing
- 18. Compute coherency filter  
dip passband:  $\pm 3.0$  km/s
- 19. Apply coherency filter
- 20. Display coherency enhanced data  
vertical scale: 2.5 in/s  
horizontal scale: 30 traces/in

Coherency enhanced CDP stacked and migrated sections of the Lithoprobe high resolution data are shown in the Appendix, plates 11 and 12. Assuming an average crustal velocity of 6 km/s, these seismic profiles show no vertical exaggeration and the horizontal scale is approximately 1:50000. General survey information, profile direction and CDP locations are annotated.

## DIGITAL DATA

The following can be obtained for a nominal handling charge and the cost of materials and reproduction:

- (a) Digital tapes (SEG-Y data format)      unmigrated stacked sections
  - (b) Digital tapes (SEG-Y data format)      common shot gather  
raw data (demultiplexed and correlated)
  - (c) Digital tapes      location and elevation for each station
- by writing to

Director  
Lithoprobe Seismic Processing Facility  
Department of Geology and Geophysics  
University of Calgary  
Calgary, Alberta  
T2N 1N4

## SUMMARY

Results of Lithoprobe's 1987/88 Kapuskasing transect have been presented in this report. The migrated and non-migrated data have been displayed in a format that allows interested parties:

- (a) to interpret the data independently,
- (b) to compare results with reflection data being released elsewhere,
- (c) to utilize compiled information for reprocessing the data, and
- (d) to merge results obtained from the Kapuskasing reflection data with other geophysical and geological data bases.

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## APPENDIX

### Seismic Sections and Survey Information

#### Seismic Sections

Regional Data	Plates 1-10
High Resolution Data	Plates 11-12

#### Survey Information\*

##### Survey line geometry (1:50000)

Profile 1, part 1	Plate 13a
Profile 1, part 2	Plate 13b
Profile 1, part 3	Plate 13c
Profile 2	Plate 13d
Profile 3	Plate 13e
Profile 4	Plate 13f
Profile 5	Plate 13g
Profile 6	Plate 13h
Profiles 8-9-10	Plate 13i

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\* The contractor has used durable metal plates (approx. 2"x4") to mark each shot point location along the profiles. A complete listing of all survey data and additional plots of profile locations, topography and CDP binning are available from the Lithoprobe Seismic Processing Facility (see page 11 of this report).







