SNORE 97

SNORCLE Refraction Experiment 1997
Refraction / Wide-Angle Reflection Data

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Slave-Northern Cordillera Refraction Experiment (SNORE'97): Field Acquisition and Preliminary Data Processing Report

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Executive Summary

In August-September 1997, SNoRE'97, the refraction/wide-angle reflection component of the Lithoprobe SNORCLE Transect, was carried out through the combined efforts of university and government scientific groups. This document reports on this field program and the excellent data set acquired and is intended to accompany the electronic data set filed in the Lithoprobe data archive and with the Iris Data Management Center.

To assist future users of the data, this document provides the scientific setting and the objectives of the experiment, the field procedures and parameters, the post-experiment preprocessing of the data and the formats in which it is stored. Further, to enable an initial evaluation of the data, all vertical component and selected horizontal sections are displayed.

To assist the planners of future experiments, the manpower requirements and a summary of the budget for SNORE'97 are also provided.

1. Introduction

SNORE'97 is the seismic refraction/wide-angle reflection (R/WAR) component of Lithoprobe's Slave-Northern Cordillera Lithospheric Evolution (SNORCLE) transect. The eastern-most component is within the Slave geological province of the Northwest Territories (Figure 1) within which the oldest known rocks (~4.0 Ga) are found. The transect extends westward through the Yukon and northern British Columbia where progressively younger rocks and structures resulting from accretionary and transpressional processes continue to the present day and record the westward growth of the North American continent.

Clowes (1997) has pointed out that the questions being addressed within the SNORCLE Transect, from Archean to Cenozoic crustal evolution, provide an exceptional opportunity for results of global significance. Some of these questions are:

- What kind of deep crust and mantle underlie the oldest rocks on Earth?
- Is the tectonic style of Early Archean protocontinental nuclei unique?
- How have 4 Ga cratons been modified since the Archean?
- Are deep structural and stratigraphic characteristics of Proterozoic orogens fundamentally different from those of Phanerozoic orogens and if so, why?
- How have deep Precambrian structures been significant in controlling the stratigraphic and structural evolution of Phanerozoic orogens?
- Why is the 2,500 km-long foreland basin of the Cordilleran Orogen much more extensive, both areal and vertically, in the south (Alberta) than in the north (northwestern Canada)?
- Why do inter-related tectonic characteristics of the Canadian Cordillera, such as lithospheric extension, intracontinental slip and amount of contraction toward the craton, change south to north?
- How were outboard Cordilleran terranes assembled to produce the present distribution of exotic elements enveloped by terranes of apparent North American affinity?

To address these and other questions, the transect has been divided into three corridors: Corridor 1 in the NWT addresses the region between exposed rocks of the Slave Province in the east and the thrust front of the northern Cordillera in the west; Corridor 2 in northern B.C. is concerned with the foreland basin and Proterozoic-Paleozoic miogeocline west of the Cordilleran deformation front and within the Cordillera; and Corridor 3 in the Yukon extends from deformed rocks of the Proterozoic-Paleozoic miogeocline in the Selwyn Basin of the Mackenzie Mountains into accreted terranes that were emplaced above, or adjacent to, ancestral North American crust.

1.1 Regional Tectonic Setting

Until the initiation of SNORCLE, few ground-based geophysical studies had been conducted in this region of Canada. Thus, prior to 1997, our understanding of the region was primarily based on geological studies, airborne magnetics and in the area west of the shield wells drilled to the Precambrian. A geotectonic overview of the transect, primarily extracted from Clowes (1997), is as follows.

The geological evolution began with the formation of continental nuclei, the Slave and Rae cratons (Figure 1), between about 4 Ga and 3 Ga (Bowring et al. 1989). Subsequent westward growth of the continent through a series of extension – ocean basin formation – accretion episodes resulted in north-striking orogenic belts between the oldest rocks and the Pacific Ocean. Within the transect area, these include the Wopmay Orogen (broadly the Great Bear to Fort Simpson terranes), the Racklan Orogen (beneath Phanerozoic cover), and the Cordilleran Orogen subdivided into eastern (or foreland) and western (accreted) components.

The geological elements of the Slave Province crossed in Corridor 1 are representative of Archean cratons worldwide. The Contwoyto terrane is a granite greenstone terrane to the west of which lies the Sleepy Dragon Complex, a gneissic basement of continental affinity. The boundary between them probably represents a major east-dipping Archean terrane boundary. On the western side of the Sleepy Dragon Complex lies the Yellowknife domain, a complete metamorphosed supracrustal basin with the transition either a primary "basement-basinal" transition or a structural boundary such as a thrust or thrust reactivated as an extensional fault. The Yellowknife greenstone belt, the origin of which is unclear, is separated from the Yellowknife domain by a boundary that may have been an Archean left-lateral transpression feature modified by a Proterozoic strike-slip fault. The Anton terrane is the oldest known sialic crust. Its boundary with the Yellowknife greenstone belt is either an original rifted margin or a major thrust contact modified by intrusion. Investigation of these geological elements and the processes that shaped their boundaries are a major component of Corridor 1 investigations.

Flanking the Slave Province on its west is a series of Paleoproterozoic accreted terranes and magmatic arcs, collectively referred to as the Wopmay Orogen. From east to west, these are the Great Bear calc-alkaline magmatic arc, Hottah accreted arc terrane, Fort Simpson magmatic arc and the enigmatic Nahanni terrane (buried beneath the Phanerozoic cover). With the exception of the latter unit, major features can be followed southward in the subsurface on the basis of potential field data (e.g. Hoffman 1987). To the west of the shield, the surface geological characteristics are well known and are supplemented by a number of wells which penetrate to the Precambrian and thus help constrain the Mesoproterozoic contractional orogen, possibly a component of the Racklan Orogen in the northern Cordillera, which is buried beneath the Phanerozoic cover. However seismic studies are required to constrain the geometric relationships of the Proterozoic units at depth.

In the Mesoproterozoic (1500 Ma) the western margin of ancestral North America developed into a rifted margin and was overlain by a passive margin miogeoclinal sequence that spanned geological time from the Mesoproterozoic until the Middle Devonian (380 Ma) (Monger and Price 1979; Gabrielse and Yorath 1992). The five geomorphological belts of the Canadian Cordillera resulted from two major accretionary episodes (Gabrielse et al. 1992). In the early Jurassic, the Intermontane superterrane (Stikinia, Cache Creek, Quesnellia, Slide Mountain and Cassiar terranes) was thrust eastward over North America, at the same time folding, upthrusting and moving the passive margin sequences eastward to form the Foreland Belt. The Omineca Belt represents the suture zone of this collision and straddles autochthonous terranes to the east in the Foreland Belt and allocthonous terranes to the west in the Intermontane Belt. During the mid-Cretaceous, the exotic Insular superterrane of the Insular Belt (Alexander and Wrangellia terranes) collided with North America, further deforming the Intermontane terranes. The Coast

Belt is the granitic and high-grade metamorphic zone linking the superterranes (Monger et al. 1982).

The Tintina Fault, a Late Cretaceous to Oligocene structure, defines the boundary between the Foreland Belt and the Omineca Belt in northern British Columbia-southern Yukon. The fault has been interpreted as a crustal-scale intracontinental transform fault based on its unusual continuity and the juxtaposition of crust with distinct physical properties (Roddick 1967; Lowe et al. 1994). The extent and timing of right-lateral displacement have been topics of great debate with estimates based on geological evidence ranging from 450 km to greater than 1000 km in the mid to Late Cretaceous (Tempelman-Kluit et al. 1976; Price and Carmichael 1986; Gabrielse 1985), and with estimates based on paleomagnetic evidence ranging from 650 km to more than 1000 km since the Late Cretaceous (Irving et al. 1996). More recent geological evidence supports 420 km of displacement during the Early Paleogene (Jackson and Mortensen 2000). The exact location of the fault at the Yukon/BC border remains controversial as drift cover sediments of the Liard Plain mask its surface expression.

1.2 SNORE'97

Clowes (1997) has clearly stated the objectives of this experiment. Its primary purposes are a determination of the velocity structure of the crustal and sub-crustal lithospheric mantle of the tectonic elements crossed by the profiles in the three SNORCLE corridors and relationship of the results to the coincident seismic reflection, magnetotelluric and other geophysical and geological data to better define the current tectonic structure of these domains. The experimental results will provide (i) a near-continuous velocity structural cross-section of the lithosphere from the westernmost Archean Slave craton to the young accreted crust of the Cenozoic western Cordillera; (ii) an indication of the lateral variability of crustal structure along strike in the northern Cordillera; (iii) a direct tie with ACCRETE, an NSF-funded seismic reflection and R/WAR experiment, in combination with geological studies, located in the southern Alaska Panhandle (Hollister and Andronicos 1997); (iv) a comparison with the velocity structure of the southern Canadian Cordillera (Clowes at al. 1995), which, in contrast to the northern Cordillera, has experienced extensive Eocene extension; and (v) comparison with a seismic cross-section across a similar region of Alaska (Beaudoin et al. 1994). The combination of studies will enable variations in the continental-scale, three-dimensional structure of the Cordilleran orogen to be investigated.

2. SNORE'97 Field Experiment

2.1 Experimental Design

The experimental design was largely controlled by the limited road access. To achieve the experimental objectives with the 552 available receivers (326 vertical, 226 3-component) required 4 deployments (Figure 2) with a nominal shot spacing of 60 km.

Line 11 along transect Corridor 1 from ~65 km east of Yellowknife to Nahanni Butte on the west using the Ingraham Trail -Yellowknife/Mackenzie/Liard Highways route, a length of 560 km (a crooked line road distance of ~645 km). This deployment consisted of 477 receivers. As well as the 12 shots within the line, a 10,000 kg charge (Shot 1100) was detonated by BHP Diamonds at the Ekati Mine, 280 km to the northeast and a 5000 kg charge (Shot 1113), 225 km to the southwest. The southeasterly branch of Corridor 1 which crosses the Great Slave Lake shear zone was not targeted due to financial limitations.

The length and geometry of Corridor 2 required two deployments, Lines 21 and 22. To investigate the structure between these profiles, in particular the Tintina Trench, the design included broadside as well as inline recording. For the 8 shots of Line 21, 485 recorders were deployed for inline recording along the Alaska Highway from southeast of Fort Nelson to west of Watson Lake, a line length of ~465 km. In addition 62 recorders were deployed along the Line 22 corridor over ~200 km southward from Shot 2108. For the 9 shots of Line 22, 418 recorders were deployed along 552 km of the Cassiar Highway and 124 recorders along Line 21 for ~250 km eastward from Shot 2209.

For Corridor 3, Line 31 extends 343 km along Canol Road from Johnson Crossing to near MacMillan Pass. For the 6 shot points (Shots 3106 and 3107 were detonated at the same location), 449 recorders were inline with the 100 units deployed broadside along the Robert Campbell Highway covering ~85 km each side of Canol Road to provide 3-D coverage.

The distances between corridors required that separate field headquarters be used: Fort Providence, Watson Lake and Ross River (see Figure 2).

2.2 GPS Surveying of Receiver Locations

During July 1997, receiver sites were positioned using the Global Positioning System (GPS). Stakes were set up at each receiver location and annotated with the station number. Road logs were constructed so that instrument deployment teams could locate the stations easily from their deployment vehicles. Four to five minutes of GPS readings were recorded at each location (about the time it took to hammer in the stake and update the road log on the field laptop computer.) A separate GPS base station provided survey information at known geographic locations so that differential processing could be applied to the data to improve the accuracy of the measurements. Once differential processing was complete, the accuracy of the recorded position is within 5 m horizontally and 10 m vertically.

2.3 Drilling and Loading of Source Locations

Following initial shot site selection, environmental permits were obtained from the Yukon, Northwest Territories and British Columbia governments. The drilling and loading started well in advance of the deployment crew's arrival in the field. In most cases, holes were drilled to a depth of 50 m by conventional drill trucks, similar to those that would be used for drilling water wells. Depth depended in part on the amount of explosive that would be loaded into the hole.

Steel piping was used at many locations to case the upper part of the hole to prevent collapse. In several cases the drillers moved the site due to difficult drilling conditions or other reasons. Positioning was by a combination of GPS and 1:50,000 topographic maps. In several cases adjustments based on first arrivals at nearby receivers were required later. Maximum uncertainty in shot location is estimated as 100 m.

Each hole was loaded with Hydromex T-3 and 3 PENTEX 16 boosters, each with a detonator attached. At several shot points (3101, 2104) it is suspected that there was incomplete detonation of all the explosives, most probably due to gaps in the charge. Shot point details are provided in Appendix 1.

3. Data Acquisition

SNoRE'97 was conducted in the period 8 August to 6 September 1997. A daily schedule of the operations is provided in Appendix 2.

3.1 Seismometer Deployment

Four different field recording systems were used in the experiment, each with its own operational characteristics. These are discussed in section 3.2. On the evening prior to or in the early morning of the deployment day, the seismographs were programmed at the field headquarters. The two person field team drove the recording systems in vans to their pre-assigned locations. Each team deployed 20 – 35 units. Those deploying horizontal seismometers had the smaller number of units. To minimize possible gaps in data due to misprogrammed units, each team deployed at alternate sites, i.e. instruments were interleaved.

The procedure for setting up a temporary seismograph station in the field differs depending on the instrument type, but the main steps were:

- locate the survey stake corresponding to the desired station number.
- select a position within a few meters of the stake where the seismograph instrument box can be positioned free from natural and man-made hazards.
- record identification numbers of all instruments left at each station in a field log.
- dig a hole or holes to bury the geophone(s). A depth of at least 50 cm or a location on bedrock is optimal.
- position and level the geophones in the holes and attach them to the instrument box. Horizontal geophones were aligned with respect to geomagnetic directions. The magnetic declinations along the seismic lines based on the data provided on topographic maps is provided in Appendix 3.
- carefully bury the geophones to ensure good coupling with the ground.
- tidy up the site to ensure that it will not be disturbed by animals or people during the period of data collection.

Most of the stations were located close to the public roads, either in the ditches or on adjacent banks.

All shots were fired at night in order to minimize cultural noise (cars, trucks, other human activity). The following morning, the deploying teams returned to the field to pick up the instruments. These were brought back to the headquarters where the recordings were downloaded into the headquarter computers.

3.2 Timing Corrections

Relative shot-receiver timing is essential in refraction seismology. A limited number of the seismographs contained GPS units. The remaining seismographs and the shooter boxes relied on crystal clocks that are calibrated before deployment and after pickup using satellite information. Corrections are then applied assuming linear instrument drift. For this experiment, all seismograph clock drifts have been incorporated into the trace start time shown in the headers. The drift time used for each instrument is stored in trace header word *cor* (bytes 217-218). This is for informational purposes only and no further processing is required by the user.

3.3 Field Instrumentation

Four types of instruments were used during these experiments. These are briefly described below.

3.3.1 PRS-1 Number Used: 177 Owner: GSC

The Geologic Survey of Canada developed these Portable Recording System instruments specifically for use in large scale refraction surveys. The field unit is programmed by one of several PC's running LithoSEIS software in the field headquarters and then connected to a geophone at the deployment site. For these experiments, L-4 2 Hz geophones from Mark Products were used. The PRS-1 instruments record one channel (the vertical component) of data in solid state memory. The recorded information is uploaded to the same field PC that programmed the seismograph when it is returned to the field instrument centre. The data for all the PRS instruments is then compiled in SEG-Y format and archived on CDs.

3.3.2 PRS-4 Number Used: 20 Owner: GSC

These instruments extend the abilities of the PRS-1 instruments by including the ability to record three components. They also have a triggering ability that enables them to be used in earthquake seismology experiments.

3.3.3 RefTek Number Used: 206 Owner: IRIS-PASSCAL

These instruments are manufactured by Refraction Technology Inc. and were provided by the Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL) of the Incorporated Research Institutions for Seismology (IRIS). The field units are programmed by a palmtop computer at the HQ and then attached to a three-component geophone at the deployment site. Some of the RefTek units contain GPS receivers and are therefore capable of avoiding clock drift problems. (At the time of the experiment, the software was not yet available which would let the unit calculate an accurate geographic position.) L-28, L-22 and S6000 geophones (all 2 Hz) were used. The RefTeks record their data on disk, which enables long recording times. When the instruments were returned to the field headquarters, the information was uploaded to a Sun Sparcstation for compilation processing. Data were archived to exabyte tapes.

3.3.4 SGR   Number Used: 149   Owner: Stanford University

The Seismic Group Recorders were developed by Amoco, built by Globe Universal Sciences, Inc. for regional refraction studies in the Middle East in the 1980's and were provided for this experiment by Stanford University. They have an overall frequency response of 2 to 200 Hz and a theoretical dynamic range of 156 dB. The deployment process is similar to that of the PRS instruments. L-4 and L-28 geophones (both 2 Hz) from Mark Products were used with these instruments. Data are recorded in digital format on specially designed tape cassettes that are removed from the instrument and read into an Everex System 1800 microcomputer upon return to the field headquarters. The compiled data are archived on 9-track tapes.

3.4 Clean-up

Post survey clean-up was undertaken wherever our activities affected the surrounding countryside. At all shot point locations, it was a condition of the permit that clean-up be done. This involved filling any resulting holes or craters and removing any debris such as rock and casing ejected from the shot hole. Contractors were hired to perform this reclamation work upon completion of the experiment. At seismograph station locations, geophone holes were refilled and any visible signs of the experiment (e.g., stakes and flagging) were removed.

4. Post-Experiment Procedures

4.1 Merging of Seismic Data Sets

Merging of field data sets was done using the PLOTSEC suite of programs (Amor 1996). The major steps in the process were to:

- read the various field tapes into PLOTSEC environment.
- update and correct the file header information for each instrument.
- update and correct the trace header information for each data trace.
- select an appropriate time window for archiving data.
- merge the data from each instrument type into a single SEG-Y file.

4.1.1 PLOTSEC

Four different types of instruments were used in the field, each with a slightly different data format based on the Society of Exploration Geophysics standard known as SEG-Y.

In order to merge the various data sets, the PLOTSEC suite of programs were used to read, modify and merge the various input data sets into a single, standardized SEG-Y format file for each shot point.

The data were read into the system using a routine called plotsec_raw, one of the features of which is the ability to resample the input data. This was necessary for the PRS instruments to align them with the other (REFTEK, SGR) instrument types to produce a common sampling interval (8.0 msec).

4.1.2 Gain

Trace amplitude gain was dealt with either during the initial input into plotsec using plotsec_raw or later using plotsec_filt. Instrument - geophone combinations result in various amplitude scaling factors. In an attempt to appropriate 'true relative amplitude' between the data of various instruments types, the trace amplitudes were scaled as follows;

Instrument Type	***Geophone Type***	***Gain Applied***
PRS-1	L-4	1.0
PRS-4	L-4	0.5
REFTEK	L-28	-3.289E7
SGR	L-22	-1.136E7
SGR	L-4	0.584E7

The PRS-4 scaling is an empirical factor which was consistent for all shots. Some gain concerns remain and may be evident in certain data sections. In particular, the mix of L4 and L22 geophones for SGR stations caused some uncertainties most of which were resolved.

4.1.2 Updating of SEG-Y Headers

The final data are all saved in SEG-Y format according to IASPEI (version 3.0, 1993) extensions for refraction data with minor modifications. The various header updates were done using plotsec_update. Appendix 4 lists the IASPEI definition of the headers. The major updates that were required globally were:

- shot and receiver survey information. These data were compiled in SEG-P1 format files that can be read directly by plotsec_update
- shot information , i.e. time of shot, and charge size.
- receiver information such as geophone orientation, geophone type, and instrument type.

For a limited number of cases, corrections to station id, geophone type and for the SGR's some stations/shots required time corrections.

4.1.3 Merging Data and Creating Final Data Sets

Once all the headers from the various instrument types were updated, the data were merged into a single file (shot point gather) using plotsec_merge. At this point the data are still in plotsec format and contain all the recorded data. SEG-Y files were created from these final data sets using plotsec_wsegy routine. In this routine the time window and reducing velocity were selected to make the data more manageable in size. Appendix 5 provides the SEG-Y file and trace header descriptions.

This data is available through the Lithoprobe Seismic Processing Facility at the University of Calgary and the IRIS Data Management Center in Seattle.

5. Data

Vertical component sections for all shots are provided in Appendix 7. A number of horizontal sections are shown in Appendix 8 with the selection largely based on the signal-to-noise ratio of the seismic section. (For display purposes, a minimum trace separation of 2 km is used for these sections.) As indicated earlier, horizontal components are oriented in geomagnetic north and east. Magnetic declinations along the lines are provided in Appendix 3 and are derived from the values on topographic maps.

6. Administrative Issues

6.1 Personnel Requirements

An experiment of this type is intrinsically manpower intensive. Due to the remote area, road conditions and presence of dangerous wildlife, two person teams were required for the most part. For the benefit of future planners a generalized personnel requirement for this experiment is provided.

(i) Scouting of shot points and permitting: two-person months; as a number of government agencies are likely to be involved in the permitting process, this activity should be initiated a year in advance of the experiment.
(ii) Monitoring of drilling: three person-months; one individual is required to oversee every two or three drilling crews.
(iii) Scouting of receiver sites: 4 person-months
(iv) Field experiment personnel: headquarters administrative – 3; data center – 8; shooters –8; deployers – 50. It is assumed deployers or other personnel serve as shooter’s assistants. (Note: In this experiment, a number of the personnel were present for only part of the experiment. The total number of participants was 86.) Experience has shown that several additional personnel to serve as backup in case of injuries or other unusual situations is desirable.
(v) Editing and merging of data sets – two person-months

6.2 Budget

The total budget for this experiment was ~$1.127M. Details are provided in Appendix 9.

6.3 Public Relations

Public relations for the experiment were handled primarily by Lithoprobe's Communications Adviser, Horst Heise of Calgary, Alberta. In advance of and during the project, he distributed general information to the print and electronic media within the region of the experiment. As headquarters were being set up, the lead field scientists contacted the local RCMP detachment or representative to inform them of our plans, mainly because the large explosive charges at the shot points might be felt by some residents and a large number of personnel in vans would be working along the highways. When the lead scientists were reasonably certain that a shot or shots would likely be felt by nearby residents, a brief notice and explanation was provided to them prior to the shot to allay their concerns.

7. Publications

Completed research programs based in whole or in part on this data set are Creaser (2000), Fernando Viejo et al. (1999), Hammer et al. (2000), Welford (1999), Welford et al. (2001) and Fernando Viejo and Clowes (2002).

8. Acknowledgements

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Appendices

Appendix 1

Shot Point Information

Shot	Latitude			Longitude			Elevation	Year	Day	Hr	Min	Sec	Charge
1100	64	43	39.49	-110	35	25.63	370	1997	245	9	30	0.069	10000
1101	62	31	7.86	-113	22	54.59	205	1997	246	5	30	0.004	2925
1102	62	30	20.00	-114	48	0.00	154	1997	246	8	40	0.040	1200
1103	62	41	19.21	-115	25	58.92	146	1997	247	8	40	0.058	2125
1104	62	46	23.16	-116	3	49.69	152	1997	245	8	40	0.024	400
1105	62	28	55.82	-116	29	38.05	252	1997	245	6	40	0.023	1000
1107	61	23	25.70	-117	29	5.35	137	1997	246	5	19	59.973	1200
1108	61	3	16.00	-118	22	50.00	227	1997	246	5	10	0.027	862
1109	61	8	25.60	-119	49	41.69	253	1997	245	5	19	59.985	1000
1110	61	28	8.18	-121	16	41.51	198	1997	245	8	19	59.984	2400
1111	61	17	56.93	-122	18	34.82	168	1997	245	8	10	0.016	3000
1112	61	3	49.44	-122	53	8.56	185	1997	245	5	10	0.015	3000
1113	59	35	43.78	-126	31	59.09	548	1997	245	7	0	0.000	5000
2101	58	6	30.96	-122	44	28.80	563	1997	228	6	10	0.000	3000
2102	58	48	10.21	-123	31	46.80	423	1997	228	9	0	0.000	2000
2104	58	51	8.10	-125	4	7.89	670	1997	228	6	0	0.000	2000*
2105	59	35	43.78	-126	31	59.09	548	1997	229	6	20	0.000	1000
2106	59	43	31.68	-127	20	41.04	730	1997	229	6	30	0.000	2000
2107	59	58	27.55	-128	9	9.11	623	1997	228	6	30	0.000	1000
2108	60	4	36.58	-128	55	35.99	630	1997	228	9	20	0.000	2400
2109	60	11	17.70	-129	33	4.06	788	1997	228	6	40	0.000	3074
2201	56	6	38.00	-129	20	14.40	354	1997	232	6	10	0.000	3000
2202	56	43	27.30	-129	43	55.00	944	1997	232	9	10	0.000	2000
2203	57	26	36.16	-130	14	57.12	773	1997	232	6	20	0.000	1925
2204	57	56	58.32	-130	0	34.05	1311	1997	232	9	20	0.000	1000
2206	58	55	17.83	-130	0	44.55	732	1997	232	6	30	0.000	2000
2207	59	19	36.18	-129	50	16.13	1433	1997	232	6	40	0.000	2175
2208	59	33	50.43	-129	15	14.72	659	1997	232	9	30	0.000	2000
2209	60	4	36.58	-128	55	35.99	630	1997	232	6	0	0.000	2400
2210	60	26	23.64	-129	6	41.22	780	1997	232	8	0	0.000	3000
3101	62	54	32.83	-130	34	24.65	963	1997	238	4	0	0.020	1938*
3102	62	28	50.34	-131	23	28.20	896	1997	238	7	10	0.002	960
3103	62	3	0.40	-132	2	44.77	790	1997	238	13	0	0.036	1000
3104	61	49	41.00	-132	59	34.00	1100	1997	238	9	9	59.994	1000
3105	61	3	45.13	-133	0	30.47	895	1997	238	6	0	0.000	1200
3106	60	29	38.80	-133	18	1.50	950	1997	239	6	59	59.882	1000
3107	60	29	38.80	-133	18	1.50	950	1997	239	7	29	59.982	1000

*Partial detonation inferred.

Appendix 2

SNORE'97 Field Schedule

June/July:	Scouting of shot points and receiver locations**.**
August 8:	Vans picked up and equipment loaded. Personnel arrive from eastern locations. BC shooter exams held in Prince George.
August 9:	Personnel depart from Vancouver, Saskatoon and Calgary for Watson Lake.
August 11:	Arrival in Watson Lake.
August 12-14:	Unpack, set up lab, train deployment personnel, instruments for eastern section of line programmed and deployers depart for overnight accommodation.
August 15:	Deploy Line 21 and shoot first 6 shots.
August 16:	Shoot remaining 2 shots on Line 21.
August 17-18:	Pick up Line 21 and download.
August 19:	Deploy and shoot Line 31.
August 20:	Pick up Line 22 and download.
August 21:	Complete downloading of Line 22 data and initiate packing.
August 22-24:	Move headquarters to Ross River.
August 25:	Deploy and shoot at 5 locations on Line 31.
August 26:	Shoot final 2 sites on Line 31. Shooting delayed due to misplacement of shot points close to bridge.
August 27:	Pick up Line 31 and download data.
August 28:	Complete downloading and initiate packing in order to move headquarters.
August 29-31:	Move to Fort Providence and set up headquarters.
September 1:	Deploy and shoot first 8 shots on Line11.
September 2:	Shoot next 4 shots on Line 11.
September 3:	Final shot on Line 31.
September 4-5:	Pick up Line 11, download data and initiate packing.
September 6:	Complete packing and depart for home bases.

Appendix 3

Declinations

Location				Base Year	Est. Declination 1997 (deg, min - east)	
<u>Line 11</u>						
62	22.5	-114	45.0	1986	26	27
62	52.5	-115	45.0	1977	27	30
61	22.5	-117	15.0	1977	29	17
61	7.5	-120	15.0	1973	30	10
61	22.5	-122	15.0	1973	29	31
<u>Line 21</u>						
58	52.5	-123	45.0	1984	26	27
59	22.5	-126	15.0	1984	27	30
60	7.5	-128	45.0	1985	28	5
60	7.5	-129	45.0	1985	28	12
<u>Line 22</u>						
56	7.5	-129	45.0	1989	24	35
57	30.0	-130	0.0	1990	25	26
58	30.0	-130	0.0	1994	26	43
60	7.5	-128	45.0	1985	28	10
<u>Line 31</u>						
63	7.5	-130	15.0	1981	33	21
62	7.5	-133	45.0	1972	30	28
61	22.5	-132	45.0	1984	29	17
60	22.5	-133	45.0	1984	28	21

Appendix 4 - SEG-Y 3.00 (IASPEI) - Definition of Headers

```
c- Start of FINAL segy.inc version 3.00 (IASPEI), January 25, 1993 ----
c
c Isa Asudeh, Geological Survey of Canada
c           1 Observatory Crescent
c           Ottawa, Ontario
c           Canada K1A 0Y3
c           Tel. 613-996-5757
c           Fax. 613-992-8836
c           e.mail asudeh@cg.emr.ca
c
c This file is an implicit definition of the SEGY format with additions
c for refraction work. It is based on the SEGY standard of Barry et al,
c Geophysics (1975) with extensions labelled SEGY_IASPEI
c for refraction work. This version has been checked and verified by
c the U.S. Geological Survey and the IRIS/PASSCAL Consortium and will
c be used for data exchange in North America.
c
c This format is primarily for the EXCHANGE of data between processing
c centers. All information that we consider to be  essential for the
c successful exchange of data are marked with a "R" in column 70:     R
c Items considered desirable are marked with a "D" in column 70:      D
c
c Some items have been added to facilitate disk
c storage in a SEGY type file.
c Items purely for tape use are labelled TAPE                TAPE
c in column 62 items purely for disk user are
c labelled DISK, otherwise this field                    DISK
c is left blank.
c
c-Units:
c  Refraction ground velocities are
c  in nanometers/sec. We adopt the convention:
c     (tape data word)*(10**gc) = nanometers/sec;
c  where tape data word is the value in the trace
c  data block and gc is a two byte gain constant word
c  beginning in byte 121 of the trace header.
c
c-Dimensions:
c These may vary from system to system.
c SEGY allows no more than 32767
c samples per trace. Maximum number of bytes needed to
c hold a single trace and its header is:
c 131308 = (32767 samples)*(4 bytes per sample) + 240 bytes header.
c For TAPE we recommend that
c no more than 32767 bytes per trace be used (including

c 240 bytes for a header). This leaves space for
c 16728 two byte samples or 8139 4 byte samples per trace.
```

```
c Start of Declarations:
c
c Parameter Statements:
c

c      maximum number of bytes per trace
      integer MAXLEN
      parameter (MAXLEN = 131308)

c      maximum number of samples per trace
      integer MAXSAM
      parameter (MAXSAM = 32767)

c      EBCDIC/ASCII header length (bytes)
      integer EBCDIC
      parameter (EBCDIC = 3200)

c      Reel Header Length (bytes)
      integer RHLEN
      parameter (RHLEN = 400)

c      Trace Header Length (bytes)
      integer THLEN
      parameter (THLEN = 240)
c
c Dimension Statements:
c

c      SEGY reel identification header part 1
       character*1  segy1a(EBCDIC)

c      SEGY reel identification header part 2
       character*1  segy1b(RHLEN)

c      SEGY trace data block
       character*1  segydb(MAXLEN)

c      SEGY trace header
       character*1 thead(THLEN)
       equivalence (segydb(1),thead(1))

c      real and integer data arrays
      integer*2    idata(MAXSAM)
      real*4       rdata(MAXSAM)
       equivalence (segydb(241),idata(1),rdata(1))
c
c end of Declarations.
c

c
c-------------------------------------------------------------------+
c Reel Identification Header (total 400 bytes)    Starts here        |
c-------------------------------------------------------------------+
c
```

```
c Job identification number                    SEGY_STANDARD
      integer*4    jobid
       equivalence  (segy1b(1),jobid)

c Line number                          SEGY_STANDARD        R
      integer*4    lineno
       equivalence  (segy1b(5),lineno)

c Reel number                          SEGY_STANDARD  TAPE   R
      integer*4    reelno
       equivalence  (segy1b(9),reelno)

c Number of data traces per record              SEGY_STANDARD         R
c By "record" we mean gather
      integer*2    ntrace
       equivalence  (segy1b(13),ntrace)

c Number of auxilliary traces per record        SEGY_STANDARD         R
      integer*2    nauxt
       equivalence  (segy1b(15),nauxt)

c Sample interval in microseconds (this data),  SEGY_STANDARD         R
c See override for this value (sinto, bytes 117-120) for
c more precise presentation.
      integer*2    sint
       equivalence  (segy1b(17),sint)

c Sample interval in microseconds (in field)    SEGY_STANDARD
c See override for this value (sint2o, bytes 121-124) for
c more precise presentation.
     integer*2    sint2
      equivalence  (segy1b(19),sint2)

c No of samples per trace this data             SEGY_STANDARD         R
c The total number of samples per trace is also
c stored with each trace, so this word is not
c essential. It can be used to calculate
c record length for disk files.
c If number of sample per trace varies
c from trace to trace leave this as 0.
     integer*2    nsam
      equivalence  (segy1b(21),nsam)

c No of samples per trace in the field          SEGY_STANDARD
     integer*2 nsamf
      equivalence  (segy1b(23),nsamf)

c Data sample format code                       SEGY_STANDARD        R
c  1   IBM 370 floating point (4 bytes)         SEGY_STANDARD        R
c  2   Fixed point            (4 bytes)         SEGY_STANDARD        R
c  3   Fixed point            (2 bytes)         SEGY_STANDARD        R
c  4   Fixed point with gain  (4 bytes)         SEGY_STANDARD        R
c
      integer*2    icode
       equivalence  (segy1b(25),icode)

c No of traces per  CDP ensemble                SEGY_STANDARD
      integer*2    ncdp
       equivalence  (segy1b(27),ncdp)

c Trace sorting code                            SEGY_STANDARD         R
c      itsort=1     Shot Gathers                SEGY_STANDARD
c      itsort=2     CDP ensemble                SEGY_STANDARD
c      itsort=3     Single fold continuous      SEGY_STANDARD
c      itsort=4     Horizontal stack            SEGY_STANDARD
c      itsort=5     Receiver Gather             SEGY_IASPEI
c      itsort=6     Gathers Sorted By Distance  SEGY_IASPEI
c      itsort=7     Gathers Sorted By Azimuth   SEGY_IASPEI
c      itsort=0     No sort.                    SEGY_IASPEI
      integer*2    itsort
       equivalence  (segy1b(29),itsort)

c  Vertical sum code                            SEGY_STANDARD
c  vcode = n sum on n traces                    SEGY_STANDARD
      integer*2    vcode
       equivalence  (segy1b(31),vcode)

c Start sweep frequency (HZ)                    SEGY_STANDARD
      integer*2    ssweep
       equivalence  (segy1b(33),ssweep)

c End sweep frequency (HZ)                      SEGY_STANDARD
      integer*2    esweep
       equivalence  (segy1b(35),esweep)

c Sweep length in milliseconds                  SEGY_STANDARD
      integer*2    sleng
       equivalence  (segy1b(37),sleng)

c Sweep type                                    SEGY_STANDARD
c     stype=1  linear                           SEGY_STANDARD
c     stype=2  parabolic                        SEGY_STANDARD
c     stype=3  exponential                      SEGY_STANDARD
c     stype=4  other                            SEGY_STANDARD
c     stype=5  borehole explosive source        SEGY_IASPEI
c     stype=6  water explosive source           SEGY_IASPEI
c     stype=7  airgun source                    SEGY_IASPEI
c     stype=8  earthquake                       SEGY_IASPEI
c     stype=9  quarry_blast                     SEGY_IASPEI
      integer*2    stype
       equivalence  (segy1b(39),stype)

c Trace no of sweep channel                     SEGY_STANDARD
      integer*2    nts
       equivalence  (segy1b(41),nts)

c Sweep trace taper in milliseconds at start    SEGY_STANDARD
      integer*2    stts
       equivalence  (segy1b(43),stts)

c Sweep trace taper  in milliseconds at end     SEGY_STANDARD
      integer*2    stte
       equivalence  (segy1b(45),stte)

c Taper type                                    SEGY_STANDARD
c     ttype=1 linrst                            SEGY_STANDARD
```

```
c     ttype=2 cos**2                              SEGY_STANDARD
c     ttype=3 other                               SEGY_STANDARD
      integer*2    ttype
       equivalence  (segy1b(47),ttype)

c Correlated data traces                          SEGY_STANDARD
c     cort=1 no, 2=yes
      integer*2    cort
       equivalence  (segy1b(49),cort)

c Binary Gain recovered                           SEGY_STANDARD
c     bgr=1 yes, 2=no
      integer*2    bgr
       equivalence  (segy1b(51),bgr)

c Amplitude recovery methods                      SEGY_STANDARD
c      arm=1 none, 2=spherical, 3=AGC, 4=other
      integer*2    arm
       equivalence  (segy1b(53),arm)

c Measurement system                              SEGY_STANDARD        R
c     1=meters, 2=feet                            SEGY_STANDARD
      integer*2    isys
       equivalence  (segy1b(55),isys)

c Polarity                                        SEGY_STANDARD
c   ipol=1 upward case movement gives negative  SEGY_STANDARD
c   ipol=2 upward case movement gives positive  SEGY_STANDARD
      integer*2    ipol
       equivalence  (segy1b(57),ipol)

c Vibrator polarity code                          SEGY_STANDARD
      integer*2    vpc
       equivalence  (segy1b(59),vpc)

c     number of traces in the tape/file           SEGY_IASPEI
      integer*2 notif
       equivalence (segy1b(61),notif)

c attribute information
c attri=0    velocity data nanometers/s           SEGY_IASPEI
c attri=1    instantaneous velocity nanometers/sSEGY_IASPEI
c attri=2    instantaneous frequency milliHz    SEGY_IASPEI
c attri=3    instantaneous phase  degrees       SEGY_IASPEI
c attri=4    slowness (m/ms)                    SEGY_IASPEI
c attri=5    semblance (0-1000)                 SEGY_IASPEI
c attri=6    displacement nanometers            SEGY_IASPEI
      integer*2 attri
       equivalence (segy1b(63),attri)

c Mean amplitude of all samples in all            SEGY_IASPEI
c      traces in the file.
      real*4 meanas
       equivalence (segy1b(65),meanas)

c Domain of data                                  SEGY_IASPEI
c       domain=0 time/distance
c            =1 fk
c            =2 tau-p
      integer*2 domain
       equivalence (segy1b(69),domain)

c Not in use from version 3.00.
c Set to 1 for compatibility.
      integer*2 msexp
       equivalence (segy1b(71),msexp)


c Reduction velocity in meter(feet)/sec           SEGY_IASPEI          R
      integer*4   vred
       equivalence (segy1b(73),vred)

c Seconds of window start time                    SEGY_IASPEI          R
      real*4 wstart
       equivalence (segy1b(77),wstart)

c Seconds of window end time                      SEGY_IASPEI          R
      real*4 wend
       equivalence (segy1b(81),wend)

c Minimum of all samples in the file.             SEGY_IASPEI
      real*4    minass
       equivalence (segy1b(85),minass)

c Maximum of all traces in the file               SEGY_IASPEI
      real*4     maxass
       equivalence (segy1b(89),maxass)

c Recording instrument type                       SEGY_IASPEI          R
c If instrument types in reel header and trace
c header are different, then the trace header value
c must be used.
c
c       =0 Not specified.
c       =1 EDA (Scintrex) PRS1
c       =2 USGS cassette
c       =3 GEOS
c       =4 Springnether
c       =5 Teledyne
c       =6 Kinemetrics
c       =7 SGR
c       =8 TERATEK
c       =9 EDA (Scintrex) PRS4
c       =10 MARS 88
c       =11 MARS 66
c       =12 PCM 5800
c       =13 REFTEK
c       =14 GEOSTORE
c       =100 Mixed data
      integer*2 iinstr
       equivalence(segy1b(93),iinstr)

c File creation date - Year                       SEGY_IASPEI          R
      integer*2 cryear
       equivalence(segy1b(95),cryear)
```

```
c File creation date - Month                    SEGY_IASPEI           R
        integer*2 crmnth
         equivalence(segy1b(97),crmnth)

c File creation date - Day                      SEGY_IASPEI           R
        integer*2 crday
         equivalence(segy1b(99),crday)

c Disk File format                                       DISK
c   pad first header record past 3600 to data length
c   =0 Reel Header is 3600 bytes, data has
c      variable length records.
c   =1 Reel Header is 3600 bytes,
c      data is padded to nnb bytes.
c   =2 Reel Header and data are padded to nnb bytes.
c      All data have the same length.
        integer*2 padtyp
         equivalence (segy1b(101),padtyp)

c Character code. Must use EBCDIC for tape exchange.
c       =1 EBCDIC                        SEGY_IASPEI    TAPE   R
c       =2 ASCII                                        DISK
        integer*2 ccode
         equivalence(segy1b(103),ccode)

c File record length in bytes,                            DISK
c    data are padded to nnb bytes.
c  if padtyp=1,
c       then nnb should be >= trhlen+data length in bytes)
c  if padtyp=2, t
c       then nnb should be >= max(3600,trhlen+data length in bytes)
        integer*4 nnb
         equivalence (segy1b(105),nnb)

c Byte order within words                                 DISK
c    1   ='00 01'x Most  Signicant Byte first.
c    2   ='02 00'x Least Significant Byte first.
c Default for tape is MSB. Default for disk depends on machine.
        integer*2 bord
         equivalence(segy1b(109),bord)

c Trace header length                                     DISK
c   traces on disk are stored with header length
        integer*2 trhlen
         equivalence(segy1b(111),trhlen)

c Max number of channels per seismograph        SEGY_IASPEI           D
        integer*2 nchps
         equivalence(segy1b(113),nchps)
c
c n.b. bytes 115-116 of Binary Reel ID are empty.
c

c Override for sample interval(this data; sint) SEGY_IASPEI           D
c This variable is related to variable sint bytes (17-18).
c If this variable is set to non-zero, it holds a more
c precise value than sint.
c
c This is the status table for the value of this variable:
c      Variable Name  Overrides  Value       Result
c     sinto         sint      0          No action
c     sinto         sint      < 0        Sample rate in samples per second
c     sinto         sint      > 0        Sample interval in Nanoseconds
c
        integer*4 sinto
         equivalence(segy1b(117),sinto)

c Override for sample interval(in field; sint2) SEGY_IASPEI           D
c This variable is related to variable sint2 bytes (19-20).
c If this variable is set to non-zero, it holds a more
c precise value than sint2
c
c This is the status table for the value of this variable:
c      Variable Name  Overrides  Value       Result
c     sint2o        sint2     0          No action
c     sint2o        sint2     < 0        Sample rate in samples per second
c     sint2o        sint2     > 0        Sample interval in Nanoseconds
c
        integer*4 sint2o
         equivalence(segy1b(121),sint2o)

c      Distance-Azimuth Calculation Algorithm   SEGY_IASPEI
c      0 = Not specified
c      1 = Sodano algorithm. The program utilizes the
c         Sodano and Robinson (1963) direct solution
c          of geodesics (Army Map Service, Tech Rep #7,
c          section IV).
        integer*2 daca
         equivalence(segy1b(125),daca)

c      Earth Dimension Code                    SEGY_IASPEI
c      0 = Not specified
c      1 = Fisher 1960
c      2 = Clark 1866
c      3 = Ref ellipsoid 1967
c      4 = Hayford Internationl 1910
c      5 = World Geodetic Survey 1972
c      6 = Bessel 1841
c      7 = Everest 1841
c      8 = Airy 1936
c      9 = Hough 1960
c      10= Fischer 1968
c      11= Clarke 1880
        integer*2 edc
         equivalence(segy1b(127),edc)

c
c n.b. bytes 129-398 of Binary Reel ID are empty.
c

c Format version number times 100              SEGY_IASPEI           R
c        =99 Version .99
c        =100 Version 1.0
c        =200 version 2.0
c        =300 version 3.0
        integer*2 fvn
```

```
      equivalence (segy1b(399),fvn)

c
c-------------------------------------------------------------------+
c Reel Identification Header (total 400 bytes)    Ends here          |
c-------------------------------------------------------------------+
c

c
c-------------------------------------------------------------------+
c Trace Identification Header (total of 240 bytes) Starts here       |
c-------------------------------------------------------------------+
c

c Trace sequence number within line            SEGY_STANDARD        R
      integer*4 tsnl
       equivalence (thead(1),tsnl)

c Trace sequence number within tape            SEGY_STANDARD        R
      integer*4 tsnt
       equivalence (thead(5),tsnt)

c Original field record number                 SEGY_STANDARD        D
c Sequential Shot Number                       SEGY_IASPEI
      integer*4 ofrn
       equivalence (thead(9),ofrn)

c Trace number withint original field record    SEGY_STANDARD        R
c Receiver Site Number                         SEGY_IASPEI
      integer*4 tnofr
       equivalence (thead(13),tnofr)

c Energy source point number                   SEGY_STANDARD        R
c Shot Site Number                             SEGY_IASPEI
      integer*4 espn
       equivalence (thead(17),espn)

c CDP number                                   SEGY_STANDARD
      integer*4 cdp
       equivalence (thead(21),cdp)

c Trace number within CDP                      SEGY_STANDARD        R
      integer*4 tncdp
       equivalence (thead(25),tncdp)

c Trace identifications code                   SEGY_STANDARD        R
c     tic=1 seismic data                       SEGY_STANDARD
c     tic=2 dead                               SEGY_STANDARD
c     tic=3 dummy                              SEGY_STANDARD
c     tic=4 time break                         SEGY_STANDARD
c     tic=5 uphole                             SEGY_STANDARD
c     tic=6 sweep                              SEGY_STANDARD
c     tic=7 timing                             SEGY_STANDARD
c     tic=8 water break                        SEGY_STANDARD
c      tic=11 --> tic=20 component number + 10
c                    for multi-compnent data SEGY_IASPEI
c     e.g. tic=11 (vertical component, horizontals following);
c          tic=12 (North-South component of 3 component);
c          tic=13 (East-West component of 3 component).
c     tic=100 calibration pulse                SEGY_IASPEI
c     tic=101 calibration Frequency            SEGY_IASPEI
c           /Amplitude/Phase triplets
c
      integer*2 tic
       equivalence (thead(29),tic)

c Number of vertically summed traces           SEGY_STANDARD
c yeilding this trace
      integer*2 nvs
       equivalence (thead(31),nvs)

c Number of horizontally stacked traces         SEGY_STANDARD
c  yeilding this trace
      integer*2 nhs
       equivalence (thead(33),nhs)

c Data use   (1=productions, 2=test)            SEGY_STANDARD
      integer*2 duse
       equivalence (thead(35),duse)

c Distance from source to receiver (meters)     SEGY_STANDARD
      integer*4 idist
       equivalence (thead(37),idist)

c Receiver group elevation                      SEGY_STANDARD
      integer*4 irel
       equivalence (thead(41),irel)

c Surface elevation of source                   SEGY_STANDARD
      integer*4 ishe
       equivalence (thead(45),ishe)

c Source depth                                  SEGY_STANDARD
      integer*4 ishd
       equivalence (thead(49),ishd)

c Datum elevation at receiver                   SEGY_STANDARD
      integer*4 delr
       equivalence (thead(53),delr)

c Datum elevation at source                     SEGY_STANDARD
      integer*4 dels
       equivalence (thead(57),dels)

c Water depth at source                         SEGY_STANDARD
      integer*4 wds
       equivalence (thead(61),wds)

c Water depth at receiver                       SEGY_STANDARD
      integer*4 wdr
       equivalence (thead(65),wdr)

c Scalar multiplier/divisor(+/-)for bytes 41-68 SEGY_STANDARD
      integer*2 smul1
       equivalence (thead(69),smul1)
```

```
c Scalar multiplier/divisor(+/-)for bytes 73-88  SEGY_STANDARD
      integer*2 smul2
       equivalence (thead(71),smul2)

c Source coordinate X or Longitude
c (East positive)                          SEGY_STANDARD
      integer*4 ishlo
       equivalence (thead(73),ishlo)

c Source coordinate Y or Latitude
c (North positive)                         SEGY_STANDARD
      integer*4 ishla
       equivalence (thead(77),ishla)

c Group coordinate X or Longitude
c (East positive)                          SEGY_STANDARD
      integer*4 irlo
       equivalence (thead(81),irlo)

c Group coordinate Y or Latitude
c (North positive)                         SEGY_STANDARD
      integer*4 irla
       equivalence (thead(85),irla)

c Coordinate units (1 : meters/feet,        SEGY_STANDARD
c                  2 : seconds of arc
c                    (smul2 holds multiplier)
c                 -N : mod 100 = TX UTM zone
c                      div 100 = RX UTM zone
      integer*2 cunits
       equivalence (thead(89),cunits)

c Weathering velocity (meters(feet)/sec)      SEGY_STANDARD
      integer*2 wvel
       equivalence (thead(91),wvel)

c Subweathering velocity (meters(feet)/sec)    SEGY_STANDARD
      integer*2 swvel
       equivalence (thead(93),swvel)

c Uphole time at source                    SEGY_STANDARD
      integer*2 utimes
       equivalence (thead(95),utimes)

c Uphole time at group                     SEGY_STANDARD
      integer*2 utimeg
       equivalence (thead(97),utimeg)

c Source static correction                 SEGY_STANDARD
      integer*2 sstati
       equivalence (thead(99),sstati)

c Group static                             SEGY_STANDARD
      integer*2 gstati
       equivalence (thead(101),gstati)

c Total static                             SEGY_STANDARD
      integer*2 tstati
       equivalence (thead(103),tstati)

c Lag time A                               SEGY_STANDARD
      integer*2 istime
       equivalence (thead(105),istime)

c Lag time B                               SEGY_STANDARD
      integer*2 ibtime
       equivalence (thead(107),ibtime)

c Delay recording time                     SEGY_STANDARD
      integer*2 ictime
       equivalence (thead(109),ictime)

c The above times as defined for SEGY are not
c adequate for refraction data because they
c are limited to 32s. Use cor and tstart later on.

c Mute time start                          SEGY_STANDARD
      integer*2 mtimes
       equivalence (thead(111),mtimes)

c Mute time end                            SEGY_STANDARD
      integer*2 mtimee
       equivalence (thead(113),mtimee)

c No of samples in this trace              SEGY_STANDARD       R
      integer*2 length
       equivalence (thead(115),length)

c Sample interval in microseconds          SEGY_STANDARD       R
c See override for this value (isin, bytes 201-204) for
c more precise presentation.
      integer*2 isi
       equivalence (thead(117),isi)

c Gain type  (1=fixed, 2=binary, 3=floating)    SEGY_STANDARD
      integer*2 gaint
       equivalence (thead(119),gaint)

c Gain constant                            SEGY_STANDARD       D
c data in nanometers/sec = (tape data)*(10**gc) SEGY_IASPEI
      integer*2  gc
       equivalence (thead(121),gc)

c Instrument or initial gain in dB         SEGY_STANDARD
      integer*2 gidb
       equivalence (thead(123),gidb)

c Correlated 1=no, 2=yes                   SEGY_STANDARD
      integer*2  tcorr
       equivalence (thead(125),tcorr)

c Start sweep frequency (HZ)               SEGY_STANDARD
      integer*2    tsswee
       equivalence  (thead(127),tsswee)

c End sweep frequency (HZ)                 SEGY_STANDARD
```

```
      integer*2    teswee
       equivalence  (thead(129),teswee)

c Sweep Length in milliseconds                 SEGY_STANDARD
      integer*2    tsleng
       equivalence  (thead(131),tsleng)

c Sweep type                               SEGY_STANDARD        D
c     tstype=1  linear                     SEGY_STANDARD
c     tstype=2  parabolic                  SEGY_STANDARD
c     tstype=3  exponential                SEGY_STANDARD
c     tstype=4  other                      SEGY_STANDARD
c     tstype=5  borehole source            SEGY_IASPEI
c     tstype=6  water explosive source     SEGY_IASPEI
c     tstype=7  airgun source              SEGY_IASPEI
c     tstype=8  earthquake                 SEGY_IASPEI
c     tstype=9  quarry-blast               SEGY_IASPEI
c
      integer*2    tstype
       equivalence  (thead(133),tstype)

c Sweep trace taper in milliseconds at start    SEGY_STANDARD
      integer*2    tstts
       equivalence  (thead(135),tstts)
c
c Sweep trace taper in milliseconds at end      SEGY_STANDARD
      integer*2    tstte
       equivalence  (thead(137),tstte)

c Taper type                               SEGY_STANDARD
c     ttype=1 linear
c     ttype=2 cos**2
c     ttype=3 other
      integer*2    tttype
       equivalence  (thead(139),tttype)

c Anti alias filter frequency              SEGY_STANDARD
      integer*2    aif
       equivalence  (thead(141),aif)

c Alias filter slope                       SEGY_STANDARD
      integer*2    ais
       equivalence  (thead(143),ais)

c Notch filter frequency                   SEGY_STANDARD
      integer*2  nif
       equivalence (thead(145),nif)

c Notch filter slope                       SEGY_STANDARD
      integer*2    nis
       equivalence  (thead(147),nis)

c Low cut frequncy                         SEGY_STANDARD
      integer*2    flc
       equivalence  (thead(149),flc)

c High cut frequncy                        SEGY_STANDARD
      integer*2    fhc
       equivalence  (thead(151),fhc)

c Low cut slope                            SEGY_STANDARD
      integer*2    slc
       equivalence  (thead(153),slc)

c High cut slope                           SEGY_STANDARD
      integer*2    shc
       equivalence  (thead(155),shc)

c Year of start of trace                   SEGY_STANDARD        R
      integer*2    tyear
       equivalence  (thead(157),tyear)

c Julian day of start of trace             SEGY_STANDARD        R
      integer*2    tday
       equivalence  (thead(159),tday)

c Hour of start of trace                   SEGY_STANDARD        R
      integer*2    thour
       equivalence  (thead(161),thour)

c Minute of start of trace                 SEGY_STANDARD        R
      integer*2    tmin
       equivalence  (thead(163),tmin)

c Second of start of trace                 SEGY_STANDARD        R
      integer*2    tsec
       equivalence  (thead(165),tsec)

c Time basis code  1=local, 2=gmt          SEGY_STANDARD        R
      integer*2    tbcode
       equivalence  (thead(167),tbcode)

c Trace weighting factor                   SEGY_STANDARD
      integer*2    twf
       equivalence  (thead(169),twf)

c Geophone group no on roll switch         SEGY_STANDARD
c first position
      integer*2    ggrp1
       equivalence  (thead(171),ggrp1)

c Geophone group no trace position 1 on rec     SEGY_STANDARD
      integer*2    ggtp
       equivalence  (thead(173),ggtp)

c Geophone group no on last trace of filed rec  SEGY_STANDARD
c     Or institution use
      integer*2    gglp
       equivalence  (thead(175),gglp)

c Gap size                                 SEGY_STANDARD
c     Or institution use
      integer*2    gapsz
       equivalence  (thead(177),gapsz)

c Field LINE number                        SEGY_IASPEI          D
```

```
      integer*2    overt
       equivalence  (thead(179),overt)

c Microseconds of trace start time              SEGY_IASPEI           R
      integer*4   mst
       equivalence (thead(181),mst)

c Charge size in kg or airgun size in litres    SEGY_IASPEI           R
      integer*2   charge
       equivalence (thead (185),charge)

c Shot or triger time - year                    SEGY_IASPEI           R
      integer*2 syear
       equivalence (thead(187),syear)

c Shot or triger time - Julian day              SEGY_IASPEI           R
      integer*2 sday
       equivalence (thead(189),sday)

c Shot or triger time - hour                    SEGY_IASPEI           R
      integer*2 shour
       equivalence (thead(191),shour)

c Shot or triger time - minute                  SEGY_IASPEI           R
      integer*2 smin
       equivalence (thead(193),smin)

c Shot or triger time - second                  SEGY_IASPEI           R
      integer*2 sseco
       equivalence (thead(195),sseco)

c Shot or triger time - microsecond             SEGY_IASPEI           R
      integer*4 ssmic
       equivalence (thead(197),ssmic)

c Override for sample interval.                 SEGY_IASPEI           D
c This variable is related to variable isi bytes (117-118).
c If this variable is set to non-zero, it holds a more
c precise value than isi.
c
c This is the status table for the value of this variable:
c      Variable Name  Overrides  Value       Result
c     isin          isi       0          No action
c     isin          isi       < 0        Sample rate in samples per second
c     isin          isi       > 0        Sample interval in Nanoseconds
c
      integer*4 isin
       equivalence (thead(201),isin)

c Azimuth of geophone orientation axis with     SEGY_IASPEI           D
c respect to true north in minutes of arc
      integer*2 geoazi
       equivalence (thead(205),geoazi)

c Angle between geophone orientation axis and   SEGY_IASPEI           D
c vertical in minutes of arc
      integer*2 geover
       equivalence (thead(207),geover)

c Static correction                             SEGY_IASPEI           D
c time to be added to recorded trace time to
c get actual trace start
c time. To be used when data has been reduced
      integer*4   ttrace
       equivalence (thead (209),ttrace)

c Flag to signal that ttrace has been used to   SEGY_IASPEI           D
c modify trace start time
c  tapply=0   static ttrace has been used to
c            reduce the data
c            and trace start time updated
c  tapply=1   static ttrace has beed has been
c            used to reduce the data but trace
c            start time has not been corrected
c
      integer*2   tapply
       equivalence (thead(213),tapply)

c Recording instrument type                     SEGY_IASPEI           R
c If instrument types in reel header and trace
c header are different, then the trace header value
c must be used.
c
c      =0 Not specified.
c      =1 EDA (Scintrex) PRS1
c      =2 USGS cassette
c      =3 GEOS
c      =4 Springnether
c      =5 Teledyne
c      =6 Kinemetrics
c      =7 SGR
c      =8 TERATEK
c      =9 EDA (Scintrex) PRS4
c      =10 MARS 88
c      =11 MARS 66
c      =12 PCM 5800
c      =13 REFTEK
c      =14 GEOSTORE
      integer*2 instru
       equivalence(thead(215),instru)

c Millisecond of timing correction              SEGY_IASPEI           R
c to be added to reported times to get true
c local or gmt times.
c This should be the sum of all timing
c corrections such as master clock and
c seismograph drifts.
      integer*2   cor
       equivalence (thead(217),cor)

c Azimuth of receiver                           SEGY_IASPEI           D
c from shot in minutes of arc
      integer*2 azimut
       equivalence (thead(219),azimut)

c
```

```
c-------------------------------------------------------------------+
c Binary part of Trace Identification Header Ends here              |
c-------------------------------------------------------------------+

c Character information.

c Recording instrument name
      character*4   scrs
      equivalence (thead (221),scrs)

c Shotpoint name
      character*4 spname
      equivalence (thead(225),spname)

c Receiver site name
      character*4 rstnam
      equivalence (thead(229),rstnam)

c Shot site name
      character*4 shotid
      equivalence (thead(233),shotid)

c Geophone mnemonic
c for example L4-Z, L4-N
c use reel header to explain the mnemonics
c used on a tape.
      character*4 geopin
      equivalence (thead (237),geopin)
c
c-------------------------------------------------------------------+
c Trace Identification Header (total of 240 bytes) Ends   here       |
c-------------------------------------------------------------------+
c
c- End   of FINAL segy.inc version 3.00 (IASPEI), January 25, 1993 ----
```

Appendix 5
SEGY File and Trace Header Descriptions

Based on original descriptions by Isa Asudeh, GSC, Ottawa and John Amor, UBC, Vancouver and updated with comments by Andrew Gorman, UBC, Vancouver.

Comments

1. * - refers to variables which are not applicable to the seismic refraction method (e.g., variables associated with vibroseis data.)
2. / - refers to a variable which has not been used or calculated.

1. FILE HEADER INFORMATION

Variable	# bytes	Type	Byte address	Description	Value	Comments
jobid	4	I	1	Job identification number	1	(constant)
lineno	4	I	5	Line number	1	(constant)
reelno	4	I	9	Reel number	1	(constant)
ntrace	2	I	13	Number of data traces per record (gather)		-Varies for each instrument type. In the final merged dataset, 'ntrace' has been updated using plotsec_merge.
nauxt	2	I	15	Number of auxiliary traces per record	0	
sint	2	I	17	Sample interval in microseconds (these data)	8000	
sint2	2	I	19	Sample interval in microseconds (in field)		-All field data were collected at a sample interval of 8 ms with the exception of the PRS instruments which recorded 120 samples per second (sample interval = ~8.3333 ms) and the PDAS instruments which recorded at a cample interval of 10 ms.
nsam	2	I	21	No of samples per trace these data		-Varies for each instrument type; 'nsam has been updated using plotsec_raw.
nsamf	2	I	23	No of samples per trace in the field		-Varies for each instrument type; 'nsamf' should be the same as nsam except in the case of the PRS and PDAS data which have been resampled.
icode	2	I	25	Data sample format code: 1 = IBM370 floating point (4 bytes), 2 = fixed point (4 bytes), 3 = fixed point (2 bytes) 4 = fixed point with gain (4 bytes)	1	
ncdp	2	I	27	No of traces per CDP ensemble	/	
itsort	2	I	29	Trace sorting code. 0 = no sort	0	
vcode	2	I	31	Vertical sum code	/	
ssweep	2	I	33	Start sweep frequency (HZ)	*	
esweep	2	I	35	End sweep frequency (HZ)	*	
sleng	2	I	37	Sweep length in ms	*	
stype	2	I	39	Sweep type	*	
nts	2	I	41	Trace no of sweep channel	*	
stts	2	I	43	Sweep trace taper in ms at start	*	
stte	2	I	45	Sweep trace taper in ms at end	*	
ttype	2	I	47	Taper type	*	
cort	2	I	49	Correlated data traces	*	
bgr	2	I	51	Binary Gain recovered	/	
arm	2	I	53	Amplitude recovery methods	/	
isys	2	I	55	Measurement system: 1 = SI, 2 = Imperial	1	
ipol	2	I	57	Polarity	/	
vpc	2	I	59	Vibrator polarity code	*	
notif	2	I	61	number of traces in the tape/file	/	
attri	2	I	63	attribute information	/	
meanas	4	R	65	Mean amplitude of all samples in all	/	
domain	2	I	69	Domain of data	/	
msexp	2	I	71	Not in use - Set to 1 for compatibility		
vred	4	I	73	Reduction velocity in metres(feet)/sec	(8000)	8000 m/s is the approximate Pn velocity
wstart	4	R	77	Seconds of window start time		
wend	4	R	81	Seconds of window end time		
minass	4	R	85	Minimum of all samples in the file		
maxass	4	R	89	Maximum of all traces in the file		
iinstr	2	I	93	Recording instrument type: 0 = PDAS, 1 = PRS1, 2 = SCR, 7 = SGR, 9 = PRS4, 13 = RefTek, 100 = Mixed Data	100	Has not been updated in most cases.
cryear	2	I	95	File creation date - Year	1996 or 97	
crmnth	2	I	97	File creation date - Month	1 to 12	
crday	2	I	99	File creation date - Day		The file creation date is the date upon which the field data were combined into a merged SEGY format file.
padtyp	2	I	101	Disk File format: 0 = Reel Header is 3600 bytes, data have variable length records.	0	
ccode	2	I	103	Character code: 1 = EBCDIC, 2 = ASCII. Must use EBCDIC for tape exchange.	1	
nnb	4	I	105	File record length in bytes	/	
bord	2	I	109	Byte order within words	/	
trhlen	2	I	111	Trace header length	/	
nchps	2	I	113	Max number of channels per seismograph	/	
sinto	4	I	117	Override for sample interval(these data; sint)	0	
sint2o	4	I	121	Override for sample interval(in field; sint2)	0	-The merged header shows this value to be 0, which is true except for the PRS instruments for which the field sample rate was 120 samples per second.
daca	2	I	125	Distance-Azimuth Calculation Algorithm		
ebc	2	I	127	Earth Dimension Code		
fvn	2	I	399	Format version number times 100	300	Version 3.0 set by plotsec software

2. TRACE HEADER INFORMATION

Variable	# bytes	Type	Byte address	Description	Value	Comments
tsnl	4	I	1	Trace sequence number within line		- Each shot point is considered to be a separate line, therefore this trace is the sequential trace number for that particular shotpoint.
tsnt	4	I	5	Trace sequence number within tape		- as found on the raw tapes.
ofrn	4	I	9	Sequential Shot Number		- Shotpoint location (three digit number 0__ = SAREX, 1__ = Deep Probe Deployment 1, 2__ = Deep Probe Deployment 2)
tnofr	4	I	13	Receiver Site Number		- as found on the raw tapes.

espn	4	I	17	Shot Site Number	- same as ofrn
cdp	4	I	21	CDP number	- calculated using plotsec_update to be the distance in km (rounded up to the nearest km) from the common mid-point of the trace to the southernmost shotpoint in the survey (SP 133 or 233). Uses same calculation routine as 'idist.'
tncdp	4	I	25	Trace number within CDP	
tic	2	I	29	Trace ID code: 1 = seismic, 11 = vert. comp., 12 = N-S comp., 13 = E-W comp.	-->
nvs	2	I	31	Number of vertically summed traces yielding this trace	1
nhs	2	I	33	Number of horizontally stacked traces yielding this trace	1
duse	2	I	35	Data use (1=productions, 2=test)	1
idist	4	I	37	Distance from source to receiver (metres)	Calculated using routine from SAC as modified by John Amor
irel	4	I	41	Receiver group elevation	Entered from survey information
ishe	4	I	45	Surface elevation of source	Entered from survey information
ishd	4	I	49	Source depth	
delr	4	I	53	Datum elevation at receiver	
dels	4	I	57	Datum elevation at source	
wds	4	I	61	Water depth at source	
wdr	4	I	65	Water depth at receiver	
smul1	2	I	69	Scalar multiplier/divisor(+/-)for bytes 41-68	1
smul2	2	I	71	Scalar multiplier/divisor(+/-)for bytes 73-88	-100
ishlo	4	I	73	Source coordinate X or Longitude (East positive)	Entered from survey information
ishla	4	I	77	Source coordinate Y or Latitude (North positive)	Entered from survey information
irlo	4	I	81	Group coordinate X or Longitude (East positive)	Entered from survey information
irla	4	I	85	Group coordinate Y or Latitude (North positive)	Entered from survey information
cunits	2	I	89	Coordinate units: 1 = metres, 2 = seconds of arc	2
wvel	2	I	91	Weathering velocity (metres(feet)/sec)	
swvel	2	I	93	Subweathering velocity (metres(feet)/sec)	
utimes	2	I	95	Uphole time at source	
utimeg	2	I	97	Uphole time at group	
sstati	2	I	99	Source static correction	
gstati	2	I	101	Group static	
tstati	2	I	103	Total static	
istime	2	I	105	Lag time A	*
ibtime	2	I	107	Lag time B	*
ictime	2	I	109	Delay recording time	*
mtimes	2	I	111	Mute time start	
mtimee	2	I	113	Mute time end	
length	2	I	115	No of samples in this trace	- for the final merged data, 'length' is calculated and inserted by plotsec_segy
isi	2	I	117	Sample interval in microseconds	- if field systems were capable of recording at this sample rate, they did so. For those that weren't they were resampled using plotsec_raw.
gaint	2	I	119	Gain type (1=fixed, 2=binary, 3=floating)	3
gc	2	I	121	Gain constant; data in nm/s = (tape data)*(10**gc)	
gidb	2	I	123	Instrument or initial gain in dB	
tcorr	2	I	125	Correlated 1=no, 2=yes	*
tsswee	2	I	127	* Start sweep frequency (Hz)	*
teswee	2	I	129	* End sweep frequency (Hz)	*
tsleng	2	I	131	* Sweep Length in ms	*
tstype	2	I	133	* Sweep type	*
tstts	2	I	135	* Sweep trace taper in ms at start	*
tstte	2	I	137	* Sweep trace taper in ms at end	*
tttype	2	I	139	* Taper type	*
aif	2	I	141	Anti alias filter frequency	- No filters have been applied to the raw data.
ais	2	I	143	Alias filter slope	- "
nif	2	I	145	Notch filter frequency	- "
nis	2	I	147	Notch filter slope	- "
flc	2	I	149	Low cut frequency	- "
fhc	2	I	151	High cut frequency	- "
slc	2	I	153	Low cut slope	- "
shc	2	I	155	High cut slope	- "
tyear	2	I	157	Year of start of trace	1995
tday	2	I	159	Julian day of start of trace	-->
thour	2	I	161	Hour of start of trace	-->
tmin	2	I	163	Minute of start of trace	-->
tsec	2	I	165	Second of start of trace	- Start of trace is indicated in original headers for all data types.
tbcode	2	I	167	Time basis code 1=local, 2=GMT	2
twf	2	I	169	Trace weighting factor	
ggrp1	2	I	171	Geophone group no on roll switch first position	
ggtp	2	I	173	Geophone group no trace position 1 on rec	
gglp	2	I	175	Geophone group no on last trace of filed rec	
gapsz	2	I	177	Gap size	
overt	2	I	179	Field LINE number	Updated in plotsec_update to be 0 = SAREX, 1 = Deep Probe Deployment 1, 2 = Deep Probe Deployment 2.
mst	4	I	181	Microseconds of trace start time	
charge	2	I	185	Charge size in kg or airgun size in litres	-Varies for each shot. Updated using plotsec_update.
syear	2	I	187	Shot or trigger time - year	-Varies for each shot. Updated using plotsec_update.
sday	2	I	189	Shot or trigger time - Julian day	-Varies for each shot. Updated using plotsec_update.
shour	2	I	191	Shot or trigger time - hour	-Varies for each shot. Updated using plotsec_update.
smin	2	I	193	Shot or trigger time - minute	-Varies for each shot. Updated using plotsec_update.
sseco	2	I	195	Shot or trigger time - second	-Varies for each shot. Updated using plotsec_update.
ssmic	4	I	197	Shot or trigger time - microsecond	-Varies for each shot. Updated using plotsec_update.
isin	4	I	201	Override for sample interval	0
geoazi	2	I	205	Azimuth of geophone orientation axis with respect to true north in minutes of arc	
geover	2	I	207	Angle between geophone orientation axis and vertical in minutes of arc	
ttrace	4	I	209	Static correction	
tapply	2	I	213	Flag to signal that ttrace has been used to modify trace start time	

instru	2	I	215 Recording instrument type: 0 = PDAS, 1 = PRS1, 2 = SCR, 7 = SGR, 9 = PRS4, 13 = RefTek	- updated as necessary.
cor	2	I	217 Millisecond of timing correction	
azimut	2	I	219 Azimuth of receiver from shot in minutes of arc	Calculated using routine from SAC as modified by John Amor

CHARACTER INFORMATION

scrs	4	C	221 Recording instrument name	PDAS, PRS1, SCR, SGR, PRS4, REF
spname	4	C	225 Shotpoint name	copied from 'espn'
rstnam	4	C	229 Receiver site name	copied from 'tnofr'
shotid	4	C	233 Shot site name	copied from 'espn'
geopin	4	C	237 Geophone mnemonic	

Updated: 9/7/05

Appendix 6

SNORE'97 Tape File Summary

Data are available from two locations, the ***LITHOPROBE*** seismic archive in Canada and the IRIS Data Management Center in the USA.

LITHOPROBE Seismic Processing Facility
Department of Geology and Geophysics
University of Calgary
2500 University Drive
Calgary, AB T2N 1N4

Web: www.litho.ucalgary.ca
Tel: 403-220-7923
Fax: 403-284-0074

IRIS Data Management Center
1408 NE 45th Street, Suite 201
Seattle, WA 98105
USA

Web: www.iris.washington.edu
Tel: 206-547-0393
Fax: 206-547-1093

from approximately May 2003
GSC/LITHOPROBE Seismic Data Archive
Geological Survey of Canada
Room 202, 615 Booth Street
Ottawa, ON K1A 0E9

Web: TBA

LITHOPROBE Seismic Processing Facility

The final merged version of the SNoRE'97 is available on compact disk in two forms.

(1) SEG-Y data: reduced at 8 km/s and limited in time (generally 55 seconds).

(2) Plotsec data (ps_data.out and head.dmp files) containing all data that has been merged. The head.dmp files are in ASCII format and will allow any casual viewer the chance to examine the SEG-Y headers for the data. For information on the plotsec program package, see http:www.geop.ubc.ca/amor/plotsec.

There are 36 shots in the SNoRE'97 data set (1100-1105, 1107-1113, 2101, 2102, 2104-2109, 2201-2204, 2206-2210, 3101-3107).

Contact the LSPF for more details.

IRIS Data Management Center

The US data stored here will be in two formats.

(1) Merged data for each individual shot, unreduced with the full record length.

(2) Merged data for each individual shot, reduced and resampled so that the interesting part of the signal fits in a 32000 sample trace (an official SEG-Y requirement.)

Appendix 7

Plots of Z Component Data

Notes:

(i) Sections are trace normalized.

(ii) For all sections, distances to the south and west of the shot point are negative and those to the north and east of the shot point are positive.

(iii) A 1 – 20 Hz bandpass filter has been applied to all traces with the exception of those for Shot 1113 where the bandpass is 3 – 12 Hz.

(iv) For display purposes, the minimum trace separation is 2 km on the distance plots and 0.5 degrees on the azimuth plots.

(v) Some noisy traces have been killed or a portion muted.

Appendix 8

Selected Horizontal Sections

Notes:

(i) Sections are trace normalized.

(ii) For all sections, distances to the south and west of the shot point are negative and those to the north and east are positive.

(iii) A 1 – 10 Hz bandpass filter has been applied to all traces.

(iv) For display purposes, the minimum trace separation is 2 km.

(v) Some noisy traces have been killed or muted.

(vi) In three cases (2102-N, 3101-E, 3105-E), a second plot focuses on later arrivals.

Appendix 9

FIELD EXPENSES

Scouting for shot and receiver locations		
Vehicle rental/gasoline	$8,267	
Food/accommodation/airfares	14,715	
		$22,982
Drilling and Explosives		
Drilling (76 holes, 3615 m[1])	$466,340	
Explosives (Hydromex T-3, 68,785 kg)	263,186	
Clean-up	24,015	
		753,541
Recording and Shooting		
Meals/accommodation/travel - home base to field site[2] (~1900 person-days)	$153,153	
Vehicle rental/insurance/gasoline	89,020	
Freight/customs	14,046	
Space rental	3,395	
		259,614
Sub-contracts		
First Nations[3]	$84,059	
McLeod Geotechnical[4]	12,621	
Salary for onsite hire	2,455	
		99,135
General Expenditures		
Miscellaneous costs (maps, rentals, supplies)	$4,848	
Communication (long distance and satellite, installation)	4,638	
		9,486
Total Expenditure		**$1,126,758**

Notes:

[1] Approximately 10% of the total footage was due to abandoned holes, essentially all in the Cordillera.

[2] Expenses of GSC personnel paid by GSC.

[3] To provide personnel and vehicles for drilling phase and personnel for deployment.

[4] To monitor and interpret ground motion for shot point adjacent to Alaska Highway bridge as required by Yukon government.

Appendix 10

SNORE '97 Personnel

University of British Columbia

John Amor	Charly Bank	Ron Clowes
Sheila Clowes	Wendy Drysdale	Bob Ellis
Colin Farquharson	Gabriela Fernandez	Andrew Frederiksen
Andrew Gorman	Phil Hammer	Dave Hildes
Alan Hubbard	Jeff Kavanagh	Alison Malcolm
Holger Mandler	Greg Oldenborger	Stephane Rondenay
Baljit Samrai	Kim Welford	

University of Victoria

Marcus Csaky	Mark Fallat	Travis Ferbey
Nilanjan Ganguly	Yangpeng Mi	Melanie Reineckie
Randy Shinduke	George Spence	Marla Weston

LITHOPROBE Secretariat

Peter Carroll	Tim Cartwright

LITHOPROBE Seismic Processing Facility

Kevin Hall	Elissa Lynn	Rolf Maier
Arie van der Velden	Kris Vasudevan	

University of Saskatchewan

Alex Bezdan	Zoli Hajnal	Maurice Kinal
Balazs Nemeth	John Oteruelo	Pal Redly
Harold Roncin	Darren Schmidt	Javed Syed
Laura Thingelstad		

Geological Survey of Canada

Isa Asudeh	Karen Hendry	Ian Kay
Sylvia Lehman	MJ Mancini	Brian Roberts
Charlie Roots	Bob Schieman	

University of Western Ontario

Joyia Chakungal	Greg Clarke	Tyler Hayes
Jackie Hope	Claire Perry	Marianne Quat

University of Wisconsin-Eau Claire

Lee Delcore	Brian Henning	Heather Golding
Bob Hooper		

University of Manitoba

Lingxiu Jiao	Fanle Meng	John Ristau

Laurentian University

Kirsty Tomlinson

First Nations

Loren Jules	Roland Sydney	Mike ???
Ringo ????	Rick ????	Daryl ???

IRIS/PASSCAL

Bruce Beaudoin	Dean Childs	Sid Hellman
Bill Koperwhats	Russell Sell	Marcos Alvarez

United States Geological Survey

Don Farrell	Brian Laird

Other Personnel

Fraser Birnie	Mike Hayden	Taimi Mulder
Bob Potts		

Terranes and Tectonic Elements of Northwestern North America

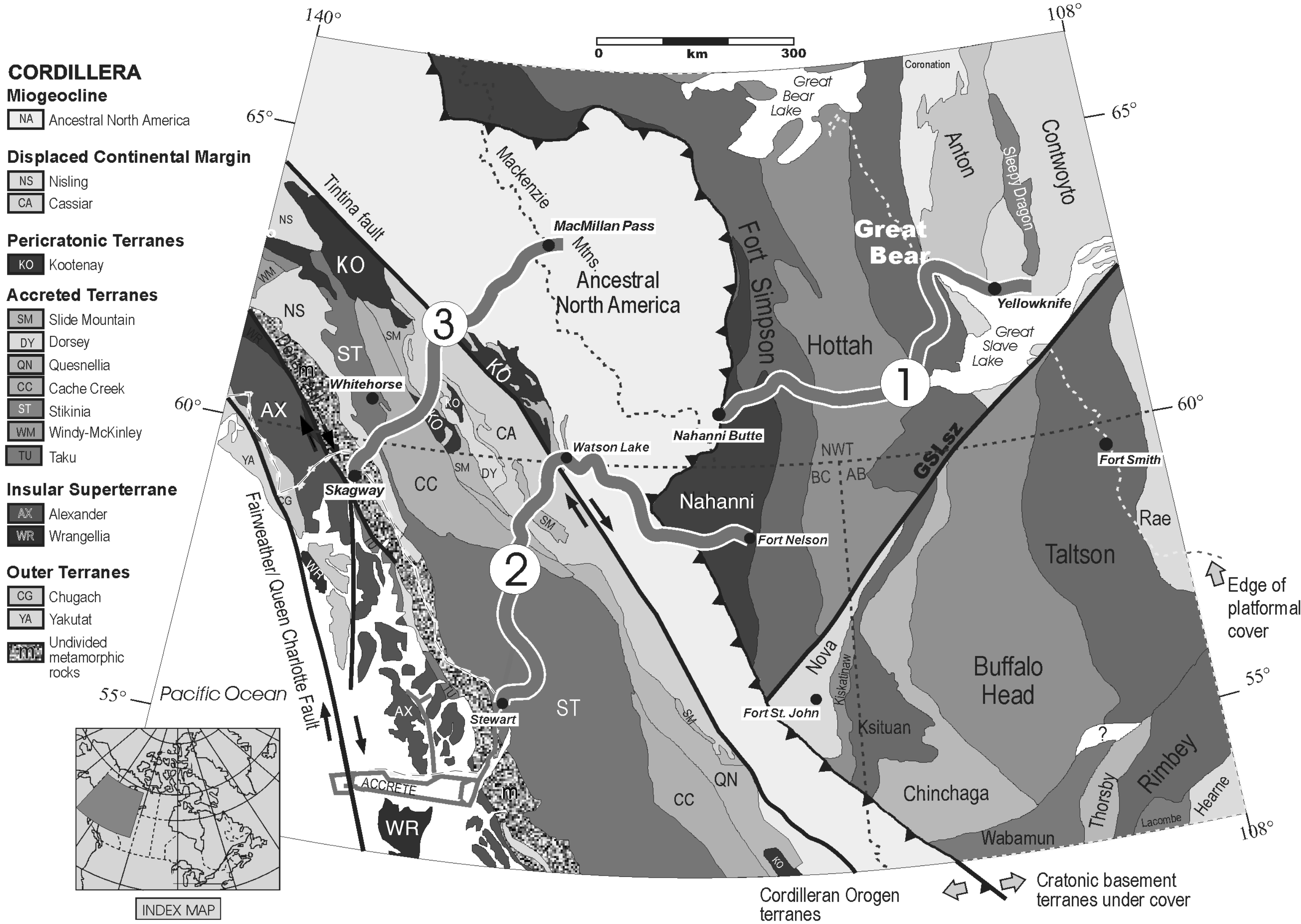

Fig. 1. SNORCLE Transect Corridors 1, 2, and 3 on a map of the terranes and tectonic elements of northwestern North America. Faults are heavy black lines; teeth on upper plate for thrust faults. Note that two fundamental breaks, the Great Slave Lake shear zone (GSLsv) and the Tintina fault are crossed. Note also the ship tracks of the ACCRETE experiment (after Clowes 1997).

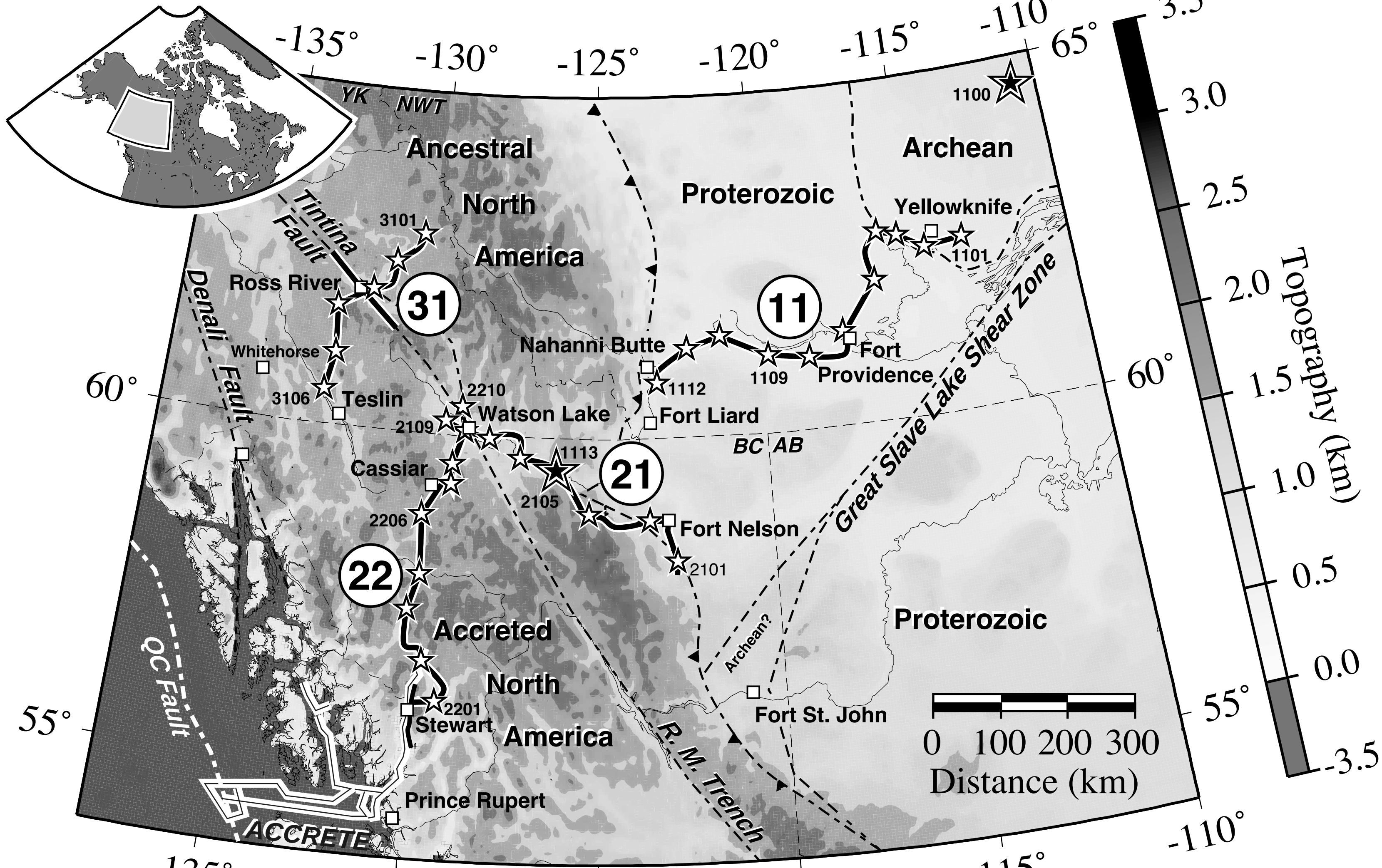

Fig. 2. Location of the four refraction profiles (11, 21, 22 and 31) of SNoRE'97 and the ACCRETE profile (Morozov et al. 1998; Hammer et al. 2000) . Shading indicates the topography and the stars show the locations of the 34 sites at which 36 shots were detonated for SNoRE'97. The insert map shows the study area with respect to North America.