TR 78-2

AD-A134 968

. . . . . contributing to man's understanding of the environment World

TECHNICAL REPORT NO. 78-2

SEMIANNUAL REPORT, PROJECT T/4703 SPECIAL DATA COLLECTION SYSTEMS

OCTOBER 1977 THROUGH MARCH 1978

DTIC ELECTE NOV 28 1983 S D B

APPROVED FOR PUBLIC RELEASE.
DISTRIBUTION UNLIMITED.

DTIC FILE COPY

TELEDYNE GEOTECH

83 11 28 187

TECHNICAL REPORT NO. 78-2

SEMIANNUAL REPORT, PROJECT T/4703
SPECIAL DATA COLLECTION SYSTEMS

October 1977 through March 1978

by

John R. Sherwin
and
George C. Kraus

Sponsored by

Advanced Research Projects Agency
ARPA Order No. 2897

DTIC
ELECTE
NOV 2 8 1983
S D
B

TELEDYNE GEOTECH
3401 Shiloh Road
Garland, Texas 75041

12 May 1978

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 78-2	2. GOVT ACCESSION NO. AD-A134 96	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Semiannual Report, Project T/4703 Special Data Collection Systems October 1977 through March 1978		5. TYPE OF REPORT & PERIOD COVERED Semiannual Report October 1977 through March 1978 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) John R. Sherwin & George C. Kraus		8. CONTRACT OR GRANT NUMBER(s) F08606-78-C-0011
9. PERFORMING ORGANIZATION NAME AND ADDRESS Teledyne Industries, Geotech Division 3401 Shiloh Road Garland, Texas 75041		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Technical Applications Center Alexandria, Virginia 22314		12. REPORT DATE 12 May 1978 13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE
DISTRIBUTION UNLIMITED

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Approved for public release. Distribution unlimited.

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Seismic Recording Systems
Seismic
Long-Range Seismic Measurements Program
VELA-Uniform

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The work performed under Project T/4703, Special Data Collection Systems, during the period from October 1977 through March 1978 is described. The present program is an extension of the program which began in 1973 under Contract F08606-74-C-0013.

At the start of this period SDCS systems remained in operation at five sites. These were Tatum Dome, Mississippi; Gasbuggy, New Mexico; Houlton,

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. Abstract (continued)

Maine; Red Lake, Ontario; and Oak Springs Butte, Nevada. The first two sites record short-period data on analog tape only. Both short-period and long-period data are recorded on analog and digital recorders at Houlton (KS-36000 system) and Red Lake (surface system). The Oak Springs Butte site records short-period data on both analog and digital recorders.

Additional sites were placed in operation during the period at Island Falls, Maine (November); Rio Blanco, Colorado (December); and Gold Meadows, Nevada (October). The Island Falls system (short-period data - analog recording) is being used to collect data from a site with more competent bedrock than that at the nearby Houlton site. Data from these two sites are to be used at the Seismic Data Analysis Center (SDAC) for studies of teleseismic signal differences. Data from the Rio Blanco station is to be used at SDAC to compare with that from the Gasbuggy site. The Gold Meadows data will be compared with that from OB2NV. These sites are located 13 kilometers apart on separate stocks on the Nevada Test Site.

Operations at the Gold Meadows site ceased on 31 December when heavy snow in the area prevented access to the remote site. The equipment remained on the site at the end of the period awaiting clearing and drying of the access roads. Operations at Oak Springs Butte were terminated on 14 February 1978, and the Red Lake and Tatum Dome stations were closed on 31 March 1978. Equipment from these sites was returned to Garland for checkout and storage.

Accession For
NTIS GRA&I ☑
DTIC TAB ☐
Unannounced ☐
Justification
By
Distribution/
Availability Codes
Dist | Avail and/or Special
A-1

CONTENTS

* * * * * * *

ILLUSTRATIONS

SEMIANNUAL REPORT, PROJECT T/4703
SPECIAL DATA COLLECTION SYSTEMS
October 1977 through March 1978

1. INTRODUCTION

The Special Data Collection System (SDCS) program, Project T/4703, is a continuation of work begun under the Long-Range Seismic Measurements (LRSM) program in 1960. This work is directed toward advancing the seismic detection, identification and location techniques necessary to detect and identify underground nuclear explosions.

This report describes the work performed under the SDCS program during the period from October 1977 through March 1978, and is submitted in accordance with Sequence No. A004 of the Contract Data Requirements List. This research was supported by the Advanced Research Projects Agency of the Department of Defense and was monitored by AFTAC/VSC, Alexandria, Virginia 22314, under Contract No. F08606-78-C-0011.

2. FIELD OPERATIONS

2.1 GENERAL

The SDCS program under this contract is an extension of work which began in 1971. The basic instrumentation for the SDCS program consists of eleven units of the Portable Seismograph System, Geotech Model 19282. This system includes three-component long-period and three-component short-period seismographs recorded on slow-speed FM magnetic tape, plus necessary calibration, timing, and support equipment. The system is designed for quick deployment and is capable of collecting laboratory quality data using one qualified electronic technician as an operator. Other instrumentation assigned to the program inventory provides versatility and increased operating capability of the basic portable system. Examples of such instrumentation include three Model 36000 Borehole Seismograph Systems (KS-36000) and five digital data recording systems.

At the beginning of this program, operations of five SDCS units were continuing from the previous contract. These sites and basic instrumentation are as follows:

Team	Site and Designator	Instrumentation
52	Tatum Dome, Mississippi (TQ-MS)	Surface SP, analog recording
53	Gasbuggy, New Mexico (GB-NM)	Surface SP, analog recording
58	Houlton, Maine (HN-ME)	KS-36000, 40 m depth, SP & LP components, analog and digital recording.
59	Red Lake, Ontario (RK-ON)	Surface SP and LP, analog and digital recording.
60	Oak Springs Butte 2, Nevada (OB2NV)	Surface SP, analog and digital recording; also vertical SP outrigger (OB3NV).

In addition, three SDCS units were either enroute or were being prepared for installation at the following new sites:

Team	Site and Designator	Instrumentation
51	Island Falls, Maine (IF-ME)	Surface SP, analog recording
56	Rio Blanco, Colorado (RB-CO)	Surface SP, analog and digital recording.
57	Gold Meadows, Nevada (GQ-NV)	Surface SP, analog recording

The remaining three SDCS units (Teams 50, 54 and 55) are being maintained in storage at Geotech's Garland, Texas, facility. In addition, one of the five digital systems and other instrumentation are being retained in storage for future use.

2.2 FIELD LOCATIONS

The function of each SDCS is to record high quality seismic data. However, each location differs from the others in the equipment utilized, the data recorded and the environmental conditions under which it is operated. Figure 1 is a map showing the locations of the sites occupied during the period October 1977 through March 1978. Figure 2 is a map showing the more recent SDCS site locations on the Nevada Test Site (NTS). The following paragraphs summarize the site activities at each SDCS location occupied during this report period.

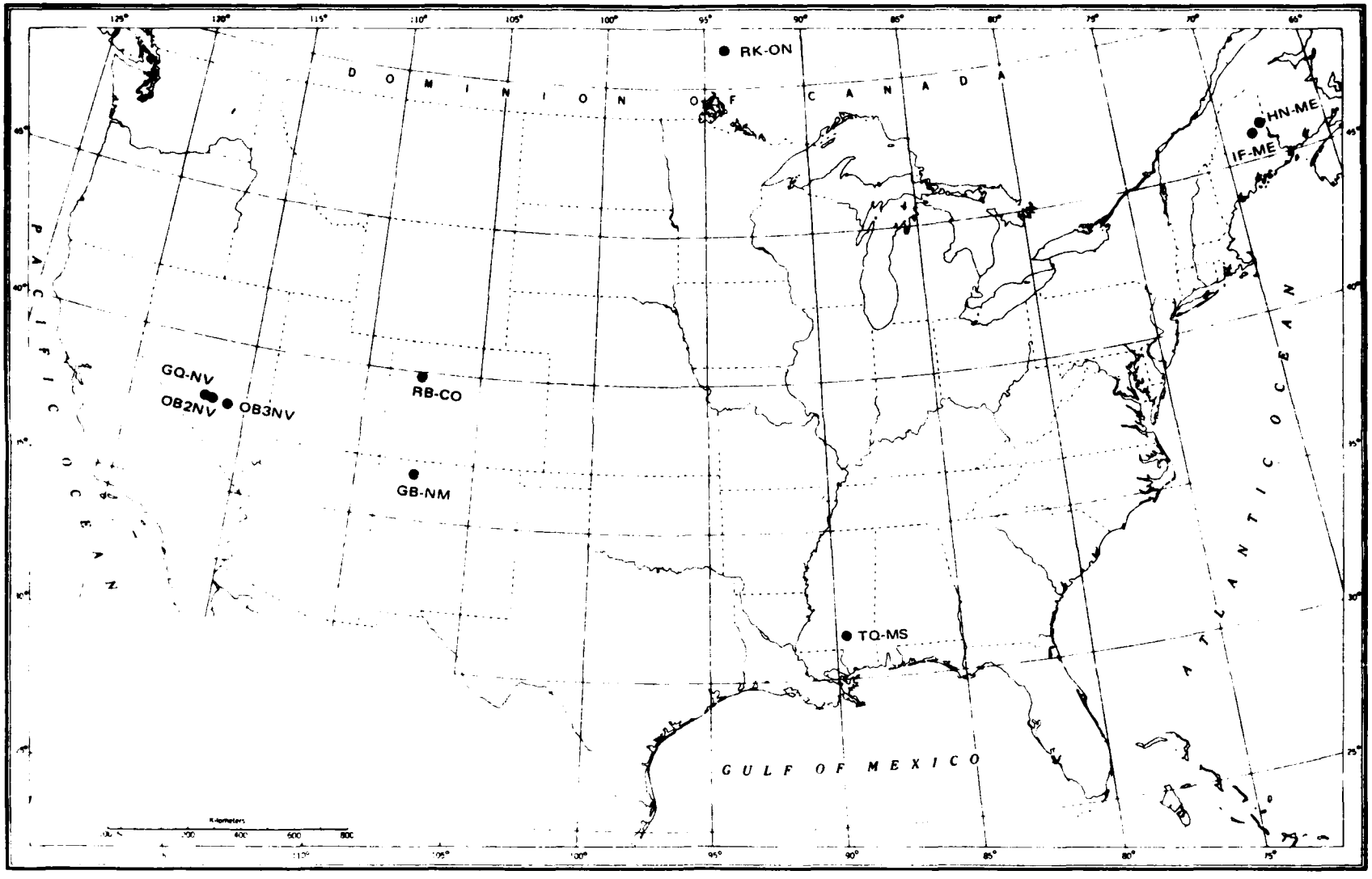

Figure 1. Sites occupied during the period
October 1977 - March 1978

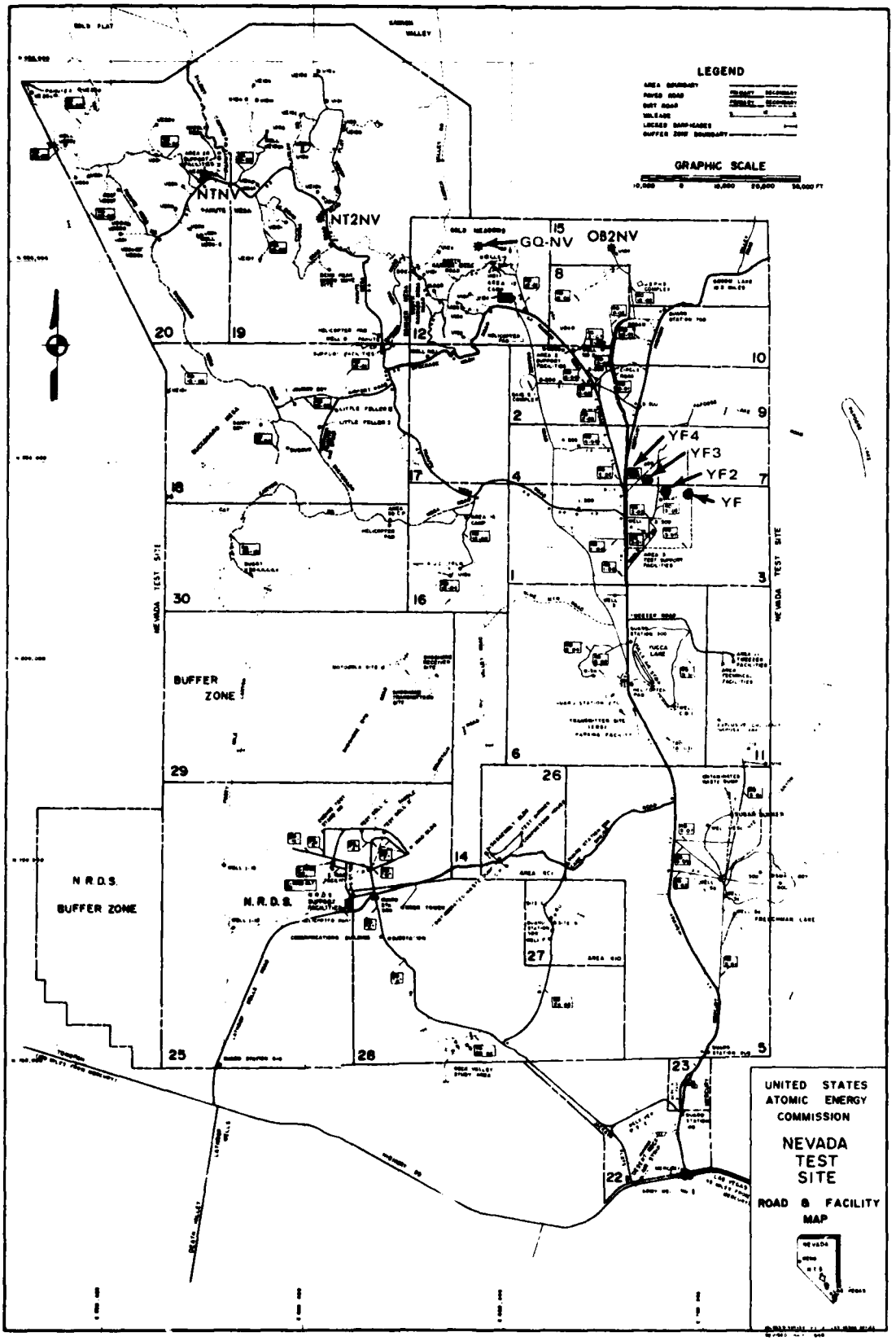

Figure 2. SDCS site locations on the Nevada Test Site

2.2.1 Team 51, Island Falls, Maine (IF-ME)

The Island Falls, Maine (IF-ME) site is located approximately 23 km (14.5 mi) southwest of the Houlton, Maine (HN-ME) site. The site was selected, permitted and prepared by the HN-ME site operator and is located on an intrusive igneous outcrop. This bedrock is more competent than the metamorphosed bedrock at the HN-ME location. Two 30-gallon oil drums were used as seismometer vaults rather than the temporary wooden box enclosures that are normally used on a temporary location as the site was expected to be operated for several months.

The recording of three component short-period data began on 30 November 1977 and continued virtually uninterrupted through the remainder of the report period. Data are recorded in the analog mode only as no commercial power is available on site to power a digital recorder.

From mid-December 1977 through March 1978 site access was possible only by snowmobile or other snow vehicle. No significant access problems were experienced. The severe weather conditions resulted in few periods of lost data. In one instance, heavy frost formed between the magnetic and calibration coil in the short-period vertical instrument. The remaining data outages were due to heater failures in the site instrumentation shelter allowing the temperature of the recorder environment to fall below operating limits. The site coordinates are:

46° 01' 39" N

68° 12' 28" W

Elevation 232 meters (760 ft)

2.2.2 Team 52, Tatum Dome, Mississippi (TQ-MS)

Team 52 was operational at the Tatum Dome site until 31 March 1978, when operations were terminated and the system returned to Garland, Texas. Routine recording of surface, three component short-period data continued throughout the period. In December 1977, a Model 23900 short-period borehole seismometer was installed in Well E-7 at a depth of 285 meters (934 feet). At this depth, the seismometer was in the anhydrite caprock of the Tatum salt dome.

The surface recording was routine but the lack of competent bedrock and an abundance of tall trees limited the operating magnification that could be obtained. Heavy rains flooded the vault on several occasions which required the seismometers and connectors to be dried. Several drainage schemes were tried to prevent this problem but all were unsuccessful.

The operation of the borehole seismometer was marginal. No satisfactory frequency response of the instrument could be obtained as the leakage in the downhole cable was excessive due to cross-talk between the data and calibration lines. Cross-talk also caused errors in the daily magnification calibration. Also, the holelock would not actuate during installation and the instrument had to be operated resting on the bottom of the hole and not locked into the casing. Overall, operation of this instrument resulted in a reduction of wind noise by 6 to 12 dB (as compared to surface data) but there was little improvement in detection capability at this relatively noisy site.

2.2.3 Team 53, Gasbuggy, New Mexico (GB-NM)

The recording of three-component short-period data at the Gasbuggy, New Mexico, location continued throughout the report period. During February and March 1978, the recording was interrupted on several occasions when the operator could not reach the site to re-supply the propane for the thermo-electric generators (TEGs) which supply power to the site. The access road to the site was closed on several occasions due to heavy snow cover and then by deep mud. There were no major equipment failures or malfunctions during this report period.

2.2.4 Team 56, Rio Blanco, Colorado (RB-CO)

The Team 56 equipment was moved from the NTS in October 1977 to the general area of the Rio Blanco site. Site selection and permitting were completed in November 1977 after a delay in obtaining a satisfactory site leasing agreement.

The RB-CO site coordinates are:

39° 48' 46" N

108° 21' 21" W

Elevation 1996 meters (6550 feet)

The site installation was completed on 14 December 1977 when analog recording of three-component short-period data was begun. Digital recording was delayed until 27 December as a digital system failure for which no spare parts were readily available occurred when system checkout began.

Site operations have been routine with only a short period of outage due to a short in the amplifier and control unit in March 1978. The system remained operational at the end of this report period.

2.2.5 Team 57, Gold Meadows, Nevada (GQ-NV)

Team 57 was moved from Yucca Flat, Nevada (YF4NV) on the NTS to the Gold Meadows area on Rainier Mesa also on the NTS on 01 October 1977. The site coordinates for the Gold Meadows, Nevada, site are:

37° 13' 45" N

116° 12' 20" W

Elevation 2057 meters (6750 feet)

The site is located on a quartz monzonite stock similar to the Climax Stock on which the Oak Springs Butte, Nevada (OB2NV) site is situated.

The site records three-component short-period data in analog format only. Power was supplied by TEGs which required readjustment to provide for efficient combustion at the high altitude at GQ-NV. Once the TEGs were satisfactorily adjusted, there were no major equipment problems at the site.

In December, heavy snow on Rainier Mesa made site access increasingly difficult until at the end of the month the snow cover was so deep that site access by reasonable effort could not be achieved. The site remained inaccessible for the remainder of the report period. The site has been inoperative since late December 1977 and site operations at GQ-NV will not be resumed. The equipment will be removed from the area as soon as practical, returned to Garland, Texas, for checkout and placed into storage.

2.2.6 Team 58, Houlton, Maine (HN-ME)

Site operation at Houlton, Maine, continued routinely throughout the report period with no major equipment or site problems. Three-component short-period and long-period data from the Model 36000 borehole seismometer in both analog and digital formats continued uninterrupted throughout the report period.

On 04 November 1977, the recording of surface short-period vertical data was begun. A Model 18300 short-period vertical seismometer was installed in a small metal vault located near the borehole. Data recording from this instrument continued uninterrupted throughout the remainder of the report period.

2.2.7 Red Lake, Ontario (RK-ON)

The site at Red Lake was operated routinely until 30 March 1978 when operations were terminated. The recording of three component short-period and long-period data in analog and digital formats had continued virtually uninterrupted until site close out.

The major equipment problem at RK-ON concerned power generator malfunctions. At one time, both units were in for repair and a rental unit had to be used. Although the generators seemed to be the source of many operational difficulties, they are considered to be reliable units. They have been in continued use since March 1975 and were operating satisfactorily when the site closed. The major problem was the distance from the site to the repair shop and then the delay in receiving replacement parts.

The severe winter weather also hampered operations at RK-ON but no data were lost due to weather. Some digital data may have been lost due to site inaccessibility but analog recording continued uninterrupted. The extreme cold and heavy snow required frequent snow plowing of the access road and considerable modification of an operating schedule so that site access was achieved whenever possible but not always according to a schedule.

The Red Lake site had been occupied for several different operations over the past several years and the site lease and seismometer vaults and bunker had been left intact for possible occupation in the future. However, when the site was vacated after this operation, arrangements were made to have the site restored to its original condition. The bunker and vaults, generator shelter and concrete pads, fuel tanks and operating shelter were to be removed and the site area graded, bermed and reseeded. Our site lease will be terminated when this work has been completed.

2.2.8 Team 60, Oak Springs Butte, Nevada (OB2NV, OB3NV)

The operations at Oak Springs Butte consisted of recording three-component short-period data from OB2NV and recording short-period vertical data from OB3NV. The data were recorded in both analog and digital format. Both OB2NV and OB3NV were located on the quartz monzonite of the Climax Stock.

No major malfunctions or failures were experienced with the equipment during the operational period continuing from 1 October 1977 through 12 February 1978 for the digital system and until 14 February 1978 for the analog recorder. The system was returned to Garland and was being used for equipment checkout at the end of this report period.

3. ENGINEERING SUPPORT

3.1 GENERAL

The engineering support function in Garland routinely provides for control of government property and replacement or repair of parts for SDCS operations. In addition, changes to system hardware are developed to improve operation or to correct deficiencies. In the following paragraphs, engineering support activities during this period are discussed.

3.2 DIGITAL RECORDING SYSTEMS

Digital recording systems operated routinely at four sites during this period. One unit was returned to the Garland office because line power was not available at the GQ-NV site. All systems operated without major difficulty during the period. The only reported problem was occasional shut down of the RB-CO unit which was traced to noisy start and stop switches on the Kinemetrics DDS-1103 system. The switches are not required for the system (start and stop commands are generated in the Interface Unit) and were therefore removed from the circuit. The incidence of shutdown decreased significantly.

The circuitry of the DDS-1103 was studied to develop a modification in order to collect data at rates other than the present format. The present interrupt mode format (4 channels at the selected rate followed by up to four channels at one-twentieth of that rate) can be easily changed to accommodate an alternate format (one channel at the selected rate and four at one-tenth of that rate). The alternate format can be implemented by addition of one inverter and four wiring changes. The intended application is to collect one channel of high-frequency data at 60 sps and four channels of intermediate-period data at 6 sps for a special program (see paragraph 5.2 below). At these rates, the 12-second records and one tape per day features can be retained.

3.3 TIME RECORDING ON FM MAGNETIC TAPE

All SDCS stations record standard format VELA time in binary-coded decimal (BCD) on channel 14 of the FM magnetic tape system. This BCD time is used during processing for tape search and event timing. During this period a study was made to determine the causes of variable and intermittent BCD signal levels from several field sites. It was determined that such fluctuations could be caused by poor quality or damaged tape, misadjusted tape tension across the record heads, or improper electronic drive levels.

All teams were instructed to perform mechanical and electronic checks and to adjust all parameters to original specifications. After these adjustments, tape data were checked in Garland. One station (RB-CO) had continuing problems with intermittent BCD playback and was instructed to recheck all parameters. The other stations had BCD signals with relatively constant amplitudes and adequate high-to-low level signal ratios. However, the amplitudes varied from station to station over a two to one ratio, apparently due to oxide characteristics on tape from various manufacturers. Such variations should not be a

problem but do indicate that the magnetic tape characteristics vary significantly. This test program showed that proper tape tension is the most significant factor in properly recording BCD time. Therefore, checks will be made at all stations on a regular basis.

3.4 SEISMOGRAPH CALIBRATION EQUIPMENT

The Control Monitor, Model 19823, is used to perform magnification calibration for the SDCS system. During this reporting period, procedures were developed to correct a wiring error in all these units which was discovered in December at the TQ-MS site. The problem was that the calibration circuit was improperly grounded which placed the seismometer calibration coils at several volts above ground during calibration; even minor calibration-to-data circuit leakage caused severe crosstalk. A modification memo was sent to all teams and all had completed the work by February.

Another problem with the unit at RK-ON was discovered in late January. Personnel at the Seismic Data Analysis Center (SDAC) in Alexandria, Virginia, requested a check of the calibration parameters at OB2NV and RK-ON. The reason was that the ratio of event magnitudes had shown a drift of about 0.1 mag units over several months. The short-period seismometer motor constants (Gs) were checked at both sites. The Gs at RK-ON were too high by 6.9 percent and those at OB2NV were within standard tolerance. Since these parameters are usually very stable, it was assumed that the calibration meter was in error. A calibrated meter and shunt assembly was sent to RK-ON. The SP Gs were rechecked and found to be within routine tolerances. Therefore, calculated magnifications for all RK-ON seismographs (short-period and long-period) were too high by 6.9 percent for an indeterminate period through 3 March 1978. As a precaution, calibrated meter and shunt assemblies will be sent to all teams on a regularly scheduled basis.

3.5 CHECKOUT OF RETURNED SDCS UNITS

The established procedures for SDCS and related equipment returned from a field assignment are to check out the system completely, perform any required maintenance, and store the completely operational unit in the warehouse. This assures that the equipment is ready for immediate deployment as required without the necessity of extensive repairs. The OB2NV system was returned to Garland in February and set up in the laboratory. This system will remain completely operational in place for use in system tests and development of system changes. The SDCS units being returned from TQ-MS, RK-ON and GQ-NV will be checked out and stored in the warehouse.

3.6 SDCS SUPPORT FOR OTHER PROJECTS

The SDCS program has routinely supplied equipment on a loan basis to support other government projects as directed by the Project Office. During this period, equipment was provided to the 1155th TCHOS to verify the effectiveness

of hardware items designed to allow operation of the KS-36000 sensor in a large (11-3/4 in.) diameter borehole. The following equipment was supplied in November 1977:

Borehole Seismometer System, Model 36000	1 each
Cable, Type 12 J46SB	800 feet
Filters, Short-Period, Model 38850	3 each
Gyrosurveyor Probe System, Humphrey Model GP07-0901	1 each

All equipment is to be returned to Garland in April 1978 at the conclusion of the test.

4. DATA PROCESSING

The data processing tasks under this contract include routine analog tape quality control and special playouts of data as required. Digital tape quality control and event processing tasks are performed in Alexandria, Virginia, under the SDAC Contract.

4.1 DATA PROCESSING AT GARLAND

4.1.1 Magnetic Tape Playouts on 16-mm Film

The requirement to play out magnetic tape from selected SDCS operations were continued from the preceding contract. In general, playouts were to be made from those stations not equipped with digital recorders (and others as requested) and were to be used by SDAC personnel for preliminary analysis and selection of data segments for detailed computer analysis. The playouts as made using the SDCS facilities in Garland. The film recorder operates at six times normal short-period (SP) film speed (180 mm/min) and the tapes are reproduced at 20 times real-time (0.6 ips). The resulting film presentation is a compression of the SP data by 3.33 as compared to normal SP films and the resolution has been found to be adequate.

During this period, playouts were routinely made of the data from IF-ME, TQ-MS, GB-NM, and OB2NV. In addition, portions of most tapes from RB-CO, HN-ME, and RK-ON were played out (approx. 24 hour-segments), primarily for quality control checks of the field data. All film data were reviewed in Garland and a brief log containing information relative to the processing was prepared. Films, tapes, and all logs were then routinely sent to the SDAC for storage and processing.

By the end of the period, the film production had been established as a routine task and films were being produced as the tapes were received. Tapes and film are generally shipped from Garland within one or two weeks of receipt from the field teams.

4.1.2 Quality Control of the Analog Tapes at Garland

The quality control (QC) function has received more emphasis during this period than in the past. For this reason, 16-mm films have been made for those sites not specifically required for the SDAC analysis effort, such as HN-ME. In these cases, both SP and LP playouts are made of the last one or two days of each ten-day tape. These improved QC procedures have generally improved data quality and will be continued.

4.2 DATA PROCESSING AT THE SDAC

The SDAC at Alexandria, Virginia, provides all digital tape QC and data analysis support for this program under the SDAC contract. In addition, digital tapes for use at the SDCS sites are provided by the SDAC. At the end of the reporting period, digital systems were operating at only two sites - RB-CO and HN-ME. Quality Control checks are being made on an infrequent basis but routine data processing using the digital data has shown that all systems are operating properly.

5. SPECIAL PROJECTS

5.1 EVENT DETECTOR FOR THE SDCS DIGITAL RECORDERS

Work on the previous contract demonstrated that a signal detection algorithm based on one developed by USGS would be useful for the SDCS digital recorders. Such a system would decrease tape usage at the field sites and would eliminate the overtime which has been necessary to change digital tapes seven days per week. With the approval of the Project Office, a program to develop such a unit was begun in October.

Preliminary specifications and programming were completed in early November for the microprocessor-based event detecting circuit. Because the algorithm is complex, the circuitry required to implement it was considerably more expensive than originally anticipated. For example, it was determined that a separate microprocessor would be required for each channel to be processed (three were envisioned) and another would be required to control the subsystem. When this complexity was determined the circuitry of the Kinemetrics DDS-1103 digital recorder was studied in detail. This study showed that the DDS-1103 control circuitry could not be easily adapted to that of the event detector. It was also found that continuous recording of the long-period samples while routing SP data through the event detector would be an expensive task. Therefore, efforts under this project were suspended.

5.2 COLLECT HIGH FREQUENCY DATA

A Task Change Proposal (P-3020) was submitted in January outlining a program to use SDCS equipment and personnel to collect special high-frequency (HF) and intermediate frequency (IF) seismic data at a site near McKinney, Texas. The proposed program would be a cooperative effort with Southern Methodist University (SMU), Dallas, and would use both SDCS- and SMU-assigned equipment. The purpose of the experiment is twofold; first, the KS-36000 should be operated in the HF seismic band (5 to 20 Hz) to determine its usefulness as an HF seismometer and second, HF and IF data need to be studied to determine whether they can be used for discriminating between earthquakes and explosions at near-regional distances of 150 to 650 km.

At the end of the reporting period, approval to proceed had not been received. However, preliminary planning to staff the operation and modify the SDCS equipment was underway.