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VELA NETWORK EVALUATION AND
AUTOMATIC PROCESSING RESEARCH

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Texas Instruments, Incorporated

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VELA NETWORK EVALUATION AND AUTOMATIC PROCESSING RESEARCH

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1 November 1973 to 31 January 1974

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13. ABSTRACT

This first quarterly report summarizes progress under the VELA Network and Automatic Processing Research program, Contract No. F08606-74-C-0033, during the period 1 November 1973 to 31 January 1974. Work in the following areas is summarized:

- VLPE station evaluation
- Network analysis
- Signal detection
- Signal estimation
- First zone discrimination.

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SECTION I
INTRODUCTION AND SUMMARY

This first quarterly report summarizes progress made during the quarter from 1 November 1973 to 31 January 1974 on the VELA Network Evaluation and Automatic Processing Research program being conducted by Texas Instruments Incorporated at the Seismic Data Analysis Center in Alexandria, Virginia. The program has five tasks:

- Evaluate the Very Long Period Experiment (VLPE) stations
- Investigate the detection and discrimination characteristics of a seismic network using VLPE, NORSAR, and ALPA data
- Investigate signal detection techniques
- Investigate signal estimation techniques
- Investigate discrimination techniques using first-zone data.

The software required to perform the first two tasks was developed under a previous contract (Contract F33657-67-C-1063). Other software being used was developed under Contract F33657-72-C-0725. New software for some of the tasks is now being generated.

A set of 215 Eurasian events from January, February, and March, 1973 is being used for the VLPE evaluation and the combined VLPE-ALPA-NORSAR network analysis. A new list of events from the fall of 1973 is being compiled and will be submitted for approval.

Signal detection and signal estimation task efforts have been directed toward modification of present software and generation of new software. Data for these tasks are being selected.

The first-zone discrimination task effort has been directed toward the selection of data and a search of the literature for geological information on the area of study. Data has been requested from NORSAR.

SECTION II

VLPE EVALUATION

A. CURRENT STATUS

During the past quarter, the evaluation of the detection and discrimination capabilities of the individual VLPE stations has continued. Particular emphasis has been placed on obtaining results from the newer stations. This evaluation is based on an ensemble of 215 Eurasian events occurring in January, February, and March, 1973 with processing completed on about 60 percent of these. Parameters obtained during analysis include noise field statistics, interfering event statistics, data quality, $M_s - m_b$ values, and LQ/LR amplitude ratios. Evaluation of matched filters and the Three-Component Adaptive processor are still in progress.

Field data to the end of 1973 have been received from stations CHG, TLO, KON, KIP, ALQ, ZLP, and MAT. Data from 1974 are beginning to arrive. Data from OGD, CTA, and EIL are not available for much of November and December with the last tape from EIL having data to 4 October 1973. Overall data quality from the stations is considered to be good.

B. FUTURE PLANS

Routine processing and analysis of the present event ensemble will be completed. A second ensemble of events from the fall of 1973 is being compiled and will be submitted for approval. These events occurred during a period when data from most of the VLPE stations were available. A report is being prepared which discusses surface wave group velocities for selected Eurasian travel paths.

SECTION III NETWORK ANALYSIS

A. CURRENT STATUS

The various parameters obtained from the evaluation of the VLPE stations as well as similar results obtained from ALPA and long-period NORSAR data are being used to ascertain the detection and discrimination capability of a combined VLPE-NORSAR-ALPA network. As mentioned in the previous section, processing of the January, February, and March, 1973 event ensemble is about 60 percent complete for VLPE data and about 70 percent complete for ALPA and NORSAR data.

B. FUTURE PLANS

Routine processing of the winter 1973 event ensemble will be completed this quarter and processing of a new ensemble will be initiated.

SECTION IV

SIGNAL DETECTION TECHNIQUES

A. CURRENT STATUS

The Fisher detector program has undergone extensive modification this quarter. These changes permit the use of either edited data tapes or library tapes as input. Previous results have shown that longer averaging time may be desirable and changes to accomplish this also have been introduced. Other modifications have been made in the output displays.

The Fisher program operates as an automatic signal detector for surface waves arriving from any azimuth. Larger events often trigger multiple detections on several beams because of broad array beamwidth, overlapping beam coverage and long duration of the wavetrain. Several schemes are being investigated to reduce this problem.

B. FUTURE PLANS

Proper interpretation of a false alarm is related to the large signal multiple detection problem. Investigation will be made into definition of the criteria for a false alarm and a detection. The long-period Fisher program will also be modified to incorporate an adaptive beamformer so that comparisons between the Fisher, power, and ABF detectors can be made. A second version will be modified to accept short period array data.

SECTION V
SIGNAL ESTIMATION TECHNIQUES

A. CURRENT STATUS

During the first quarter of this contract, effort has been concentrated on developing a new floating-point ABF program which can apply ABF filters simultaneously to two samples while designing the filter coefficients using the sum of both data samples. This method seems to be the best technique for evaluating the performance of adaptive beamforming in the presence of interfering events. One sample contains an on-azimuth event (the signal) while the other sample contains an off-azimuth event (the noise). By keeping the two samples separate, the ABF and beamsteer outputs for both samples can be measured separately to determine signal degradation and noise reduction. The new program has the capability to design and apply adaptive filters at up to 20 different convergence rates in a single run, thus reducing the time required to process a single sample from approximately one month to the time needed to make a single computer run and receive the Calcomp trace outputs from the program. Currently, this program is about half finished and will hopefully be completed during the second quarter. A version of this program will be used to investigate the separation of interfering short-period signals.

Some of the present NORSAR short-period programs are being modified to incorporate envelope beamforming as well as conventional coherent beamforming. The performance of both types of beamformers will be measured on close signals ($< 20^\circ$) which have appreciable energy at frequencies above 2 Hz.

B. FUTURE PLANS

Work on the new ABF program will continue during the next reporting period. Preliminary evaluation of the new ABF algorithm, whose convergence rate slows down in the presence of a signal, should begin in the next quarter. Modification of the ABF program for short period data will begin as soon as the long-period version has been completed.

SECTION VI
FIRST ZONE DISCRIMINATION TECHNIQUES

A. CURRENT STATUS

Approximately 40 seismic events occurring in 1972 and 1973 and located at less than teleseismic distances from NORSAR were selected for the Near Field Study. The short-period NORSAR data were ordered from NORSAR and to date about 25% of these data have been received.

Further, during this quarter a literature search was conducted to obtain information concerning the geophysical and geological parameters pertinent to the area of study.

B. FUTURE PLANS

During this coming quarter, existing software will be modified and preliminary processing of both NORSAR long-period and short-period data for these events will be initiated.

SECTION VII
ENERGY REDUCTION MEASURES

Texas Instruments Incorporated personnel at the Seismic Data Analysis Center have made a concerted effort to reduce energy expenditures in their office facilities and have taken the following measures:

- During working hours, thermostats are set at 68°. At night and on weekends, the setting is 62°.
- Windows are kept closed.
- Lighting in most offices is reduced by approximately 50 percent. Hall lighting has been reduced by approximately 75 percent.
- Lights in storerooms, offices, and restrooms are turned off unless in use.
- Supplementary heating has been discontinued.