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SEISMIC DATA LABORATORY
QUARTERLY TECHNICAL SUMMARY REPORT

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By

SEISMIC DATA LABORATORY

Under

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SEISMIC DATA LABORATORY

QUARTERLY TECHNICAL SUMMARY REPORT

April - June 1970

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ABSTRACT

This report summarizes the work done by the SDL during the period April through June 1970, and is primarily concerned with seismic research activities related to the detection and identification of nuclear explosions and earthquakes. Also discussed are the support tasks and data services performed for other government contractors and for participants in the VELA-Uniform and PRIME ARGUS projects.

TABLE OF CONTENTS

I. INTRODUCTION

This quarterly report summarizes the technical work, support effort, and service tasks completed during the period April through June 1970. Current and past work are mentioned only if related to the present discussions.

Reviews of technical reports completed during the reporting period are contained in Section II under descriptive headings. Section III is a summary of the support and service tasks performed for other government contractors and for VELA-Uniform and PRIME ARGUS participants.

II. WORK COMPLETED

A. Horizontal Array Response of Several Wavenumber Analysis Methods

This report describes the performance of a small array in terms of detection and identification of signals in frequency-wavenumber space. A two dimensional array is phased to form a one-dimensional array oriented in the direction of simulated signals. Signal discrimination is tested by varying the amplitude, velocity, frequency, and back azimuth of the generated signals. Numerous illustrations of f-k and k_x, k_y spectra plots show that, based on small array data, neither the standard nor the high resolution frequency-wavenumber analysis can successfully detect small P-waves in ambient P-wave noise. It is concluded that current f-k analysis techniques when used on data from small arrays can easily produce misleading results.

B. Preliminary Summary Report on MILROW

This report presents a preliminary evaluation of the nuclear explosion MILROW. The study is based on data available at the Seismic Data Laboratory on 10 December 1969. MILROW is the name given to the large underground nuclear explosion, reported yield of about one megaton, detonated on Amchitka Island in the Aleutians at 22:06:00.04Z, 2 October 1969.

The following conclusions are based on that study:

1. The initial location of MILROW made using 134 stations indicates a shift of 22.7 km at an azimuth of 339° from the actual epicenter. LONG SHOT epicenter was shifted 20.6 km at an azimuth of 345° using 328 stations.

Employing a common network of 73 stations for MILROW and LONG SHOT, epicenter shifts of 21.8 km and 22.7 km at azimuths of 333^{o} and 335^{o} were obtained.

Travel-time anomalies determined for MILROW and applied to LONG SHOT, and vice versa gave locations of about 1 km from the actual epicenters. Thus the location problems are identical to those encountered for LONG SHOT. However, LONG SHOT calibrated the Amchitka region in terms of travel-time anomalies and an accurate location of MILROW is possible with the use of telegraphic data. Further, we would expect little improvement with detailed redetermination of arrival times.

2. Relative excitation between body and Rayleigh waves for MILROW and LONG SHOT are similar and in terms of differences between P wave and Rayleigh wave magnitudes $(m_b - M_s) = (6.41 - 4.69) = 1.72$ (21 station averages) for MILROW and $(m_b - M_s) = (5.85 - 4.06) = 1.79$ for LONG SHOT.

3. In addition to P, PcP, and Rayleigh waves observed for LONG SHOT, long-period P, P'P', and Love waves are observed for MILROW. The presence of long-period P and P'P' would be expected since the yield of MILROW is an order of magnitude greater than LONG SHOT and the presence of Love waves suggests some type of tectonic strain release may have occurred.

C. <u>Surface-Wave Amplitude-Versus-Distance Relation in the Western United States</u>

This study describes a new correction factor for epicentral distances less than 15^{o} in the Western United States for use in the common Gutenberg formulation for surface-wave magnitude. The data on which this is based are 684 Rayleigh-wave amplitudes from Nevada Test Site explosions measured visually on seismograms recorded by LRSM mobile stations and VELA observatories. The need for the variable T (period) in the magnitude calculation is discounted on empirical evidence. Magnitudes at distances less than 15^{o} when recomputed using the new correction factor are in excellent agreement with teleseismic magnitudes and show less scatter among themselves than previously. An estimate from the data of the effective Q_R in the crust is about 130. Amplitude losses should reflect causes other than anelasticity, and this value is undoubtedly much lower than the real Q_R.

D. Influence of Number and Spacing of Sensors on the Effectiveness of Seismic Arrays

The objective of an array is to enhance the signal-to-noise ratio and thus to maximize the intelligence that can be derived from a given signal. The design of the array will be a function of the signal characteristics, of the direction and velocity of the noise in the bandpass of the signal, and of the site geology.

It has been demonstrated that in a practical sense the optimum array processing is represented by precise beam forming by which we mean simple delay and summing. Increasing the number N of sensors within a given area decreases the inter-element spacing and may increase the coherency between noise samples at adjacent sensors, thus yielding poorer results compared to $\sqrt{N}$ improvement one expects to get. Increasing the number of sensors by proportionately increasing the area is liable to result in signal deterioration also yielding an unfavorable comparison to $\sqrt{N}$ improvement in signal-to-noise. These two effects, together with economical factors, combine to limit the number of sensors that can be used.

III. SUPPORT AND SERVICE TASKS

In addition to the research described above, the SDL performed the following task:

A. Data Cataloging, Classifying, and Retrieval

The library contains digitized seismograms, digital and analog magnetic tapes, 16 and 35 mm film data. Station logs corresponding to each data set are arranged chronologically either in loose-leaf binders or in file cabinets.

At the end of the second quarter of 1970 the library contains approximately:

15,197	digitized seismograms;
4,504	digital magnetic tapes;
29,951	analog magnetic tapes;

as well as 16 mm film data recorded at seismic observatories during the period September 1960 to the present, and 35 mm film data recorded at LRSM stations during the interval September 1961 to the present.

Although the proportion of digital tapes assigned to a specific function changes constantly, the library consisted of the following groups at the end of the reporting period:

279	UBO multiplexed;
45	UBO demultiplexed;
1,611	LASA multiplexed;
582	LASA demultiplexed;
353	TFO-37 multiplexed;
84	TFO-37 demultiplexed;
98	TFO-37 permanent data;
1,450	Scratch, save and A/D.

The analog magnetic tape library consisted of the following groups at the end of June:

8,688	compressed;
2,642	uncompressed (6 months intentional backlog);
486	composites;
17,777	save;
0	shipped;
358	received.

B. Equipment Modifications

No equipment modifications were made during the quarter.

C. Maintain and Operate Equipment

Equipment maintenance engineers were on duty two full shifts each day and were on standby for the remaining shift. During the reporting period their tasks included preventive and corrective maintenance.

Preventive maintenance was performed daily on all equipment in accordance with equipment maintenance manuals. The digital system received three additional performance checks on a monthly basis.

Corrective maintenance was performed on the main frame of the 1604-B computer, the disk file, and on the 606 tape transports.

D. Digital Programming

Flow charts and descriptions of programs completed during the quarter have been delivered to the authorized government representative.

E. VELA and PRIME ARGUS Data Copies

During the period 01 April 1970 through June 1970, the SDL supplied data services to the following:

Lawrence Radiation Laboratory
Phoenix College
MIT, Lincoln Laboratory
Teledyne Geotech
U.S. Geological Survey

F. Analog Tape Compression

During the second quarter of 1970 we compressed 1,262 field tapes, and returned 700 tapes to the Dallas facility.

G. LASA Data Service

LASA weekly event summaries as well as film and tape copies were made and distributed. During the interval 01 April 1970 through June 1970, no LASA and LAMA data requests were received or filled.

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This report summarizes the work done by the SDL during the period April - June 1970, and is primarily concerned with seismic research activities related to the detection and identification of nuclear explosions and earthquake phenomena. Also discussed are the support tasks and data services performed for other government contractors and participants in the VELA-Uniform and PRIME ARGUS projects.

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