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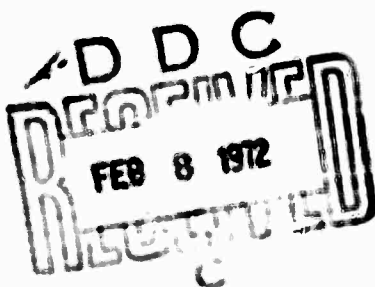
# **SEISMIC DATA LABORATORY QUARTERLY TECHNICAL SUMMARY REPORT OCTOBER - DECEMBER 1971**

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**TELEDYNE GEOTECH**  
ALEXANDRIA LABORATORIES

NATIONAL TECHNICAL  
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<b>13 ABSTRACT</b> <p>This report summarizes the work done by the SDL during the period October through December 1971, and primarily concerns the seismic research activities related to the detection and identification of nuclear explosions and earthquakes. The report also contains brief discussions of the support tasks and data services which were performed for other government contractors and for participants in the VELA-UNIFORM and PRIME ARGUS projects.</p>			
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SEISMIC DATA LABORATORY  
QUARTERLY TECHNICAL SUMMARY REPORT

October - December 1971

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## ABSTRACT

This report summarizes the work done by the SDL during the period October through December 1971, and primarily concerns the seismic research activities related to the detection and identification of nuclear explosions and earthquakes. The report also contains brief discussions of the support tasks and data services which were performed for other government contractors and for participants in the VELA-UNIFORM and PRIME ARGUS projects.

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## I. INTRODUCTION

This quarterly report summarizes the technical work, support effort, and data services completed during the period October through December 1971. 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 AGRUS participants.

## II. WORK COMPLETED

### A. Radiation of Rayleigh Wave Energy from Nuclear Explosions and Earthquakes in Southern Nevada.

In the first study completed during the quarter we analyzed amplitudes of Rayleigh waves generated by some southern Nevada nuclear explosions and cavity collapses. The Rayleigh amplitude radiation patterns for all the explosions and collapses investigated were found to be similar within the expected variation of 30% due to calibration and measurement errors. The primary factor affecting the Rayleigh amplitude radiation patterns of the explosions was found to be the effect of the earth structure along the travel paths from source to receivers, with the effect of any tectonic strain release being small. The amplitude correction for the travel path to each recording station was determined and used in the evaluation of the source mechanisms of four southern Nevada earthquakes. Use of the amplitude corrections can improve the estimate of surface wave magnitude.

### B. Time and Frequency Domain Solutions for Vertically Incident Waves in Multilayered Absorptive Media with an Application to Source Depth Determination

In another study we obtained solutions of the ray propagation equation for various boundary conditions, assuming vertical incidence in plane, parallel, equal-travel-time layers. The solutions are examined in both the time and frequency domains and certain properties derived. A complete discussion of frequency-domain synthesis techniques is given in connection with a treatment of the absorption problem. FORTRAN programs are given in the original study which compute any of the solutions in either the frequency or time domains, with or without absorption. The theory and programs are applied to the problem of source depth determination, and it is shown that the method of pP spectral nulls is somewhat unreliable.

C. An Empirical Match-Filter Study with Central Asian and South Pacific Events.

This study concerns match-filtering of two suites of events, one in the Tonga Islands and the other in the Hindu Kush, to determine relative enhancement in signal-to-noise ratio achieved by various procedures. It was found that match-filter S/N enhancement depends very little on the proximity of the reference event used as a match filter for distances as great as 600 km. For both regions, one event with high S/N ratio performed as well as many closer events in match filtering. Pre-whitening the real signals from zero to the folding frequency before using them as matched filters resulted in serious S/N decreases on the output unless band-pass filtering was applied simultaneously to the signal band, approximately 15 to 30 seconds. A linear chirp waveform worked as well as a real waveform for the Asian events, but it was inferior to real waveforms in the Pacific. A synthetic filter constructed using Canadian-Shield phase velocities worked nearly as well on Central Asian earthquakes as real reference events.

D. Preliminary Analysis of the Queen Creek, Arizona (QCAZ) Strain System Including Comparison with the TFO Long-Period Array.

The objective of this analysis was to compare the recordings of seven earthquakes from the TFO long-period horizontal array with the sum of the horizontal strain and pendulum recordings at QCAZ. The performance of both systems was severely limited by noise of non-seismic origin. Within the limits, the performance of the two systems is about equal. This report is preliminary in the sense that the installation of instruments at QCAZ was not complete at the time the data were obtained. A lower level of non-seismic noise is expected when installation is complete.

E. A Contour Routine with Auto-Interpolation.

This study describes an efficient contour-plotting routine which is based on a scanning algorithm of Cottafava and LeMoli and employs bi-linear interpolation. An auto-interpolation scheme is developed which automatically adjusts the number of interpolations in any data square to produce smooth line segments. A program listing and examples are given in the original text.

F. Applications of the Joint Epicenter Determination Method.

In this study we show that the Joint Epicenter Determination (JED), a least squares method of estimating earthquake epicenters and station corrections, is unstable for some teleseismic nets in that estimated locations and station corrections change substantially when a few readings from a large set are omitted. Locations are also shown to change if different travel-time tables are used. The result is established both for a North American and world-wide net, using an epicentral

region ranging 30° along the Aleutian Islands. If the suite of epicenters were to be spread over the earth, a case not discussed in this study, JED may be stable. However, in that case it would appear to be impossible, using JED, to discover the corrections to the average earth travel time tables caused by geology at the source or in the mantle. Thus JED could not be used to determine station corrections which would result in teleseismic locations accurate to 2-4 kilometers.

JED does seem to be a suitable method for simultaneously determining improved locations and an improved travel time table in a region where the travel-time table is poorly known. An example of such an application for a local Alaskan network is given in this study.

### III. SUPPORT AND SERVICE TASKS

In addition to the research studies discussed above the SDL completed the following support and service tasks:

#### A. Data Cataloging, Classifying and Retrieval

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

At the end of the fourth quarter of 1971 the library contained approximately:

19,722	digitized seismograms;
4,264	digitized magnetic tapes;
32,030	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 LRSN 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	U80 multiplexed;
1,657	LASA multiplexed;
558	LASA demultiplexed;
432	TFO-37 multiplexed;
98	TFO-37 permanent data;
1,240	Scratch, save and A/D (approximate).



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

8,763	compressed;
488	composites;
18,007	save (uncompressed)
4,770	uncompressed field tapes (March 1970 through September 1971)

B. Equipment Modifications

Modifications to the SDT system hardware were made in accordance with instructions from the government.

C. Maintain and Operate Equipment

Corrective maintenance was required on all major components of the system. The card reader, disk file, and the 604 tape drive were particularly troublesome and required extra care to keep them operational.

D. Digital Programming

Flow charts, descriptions of programs, and up-dated seismicity lists completed during the quarter will be delivered to the authorized government representatives by 15 January 1972.

E. VELA and PRIME ARGUS Data Copies

During the past year the SDL supplied data or computer services to the following:

Air Force Cambridge Research Laboratory  
Air Force Office of Scientific Research  
American Electronic Laboratories  
Brown University  
California Institute of Technology  
General Atronics Corporation  
IBM  
Lawrence Livermore Laboratory  
MIT, Lincoln Laboratory  
National Oceanic Atmospheric Administration  
Pennsylvania State University  
Stanford University  
Wright-Patterson Air Force Base

F. Analog Field Tape Supply

We returned 600 analog tapes to the field during the fourth quarter of 1971.

G. Array Data Service

LASA weekly event summaries through 25 December 1971 were distributed during the period.

In mid-December we resumed distribution of the LASA/SAAC weekly event summary. Recipients of the bulletin have been asked to confirm their desire to receive copies of future listings.