

UNCLASSIFIED

AD NUMBER

**AD847309**

LIMITATION CHANGES

TO:

**Approved for public release; distribution is unlimited.**

FROM:

**Distribution authorized to U.S. Gov't. agencies and their contractors; Critical Technology; 27 JAN 1969. Other requests shall be referred to U.S. Air Force, Attn: AFTAC/VELA, Washington, DC 20333. This document contains export-controlled technical data.**

AUTHORITY

**USAF ltr, 25 Jan 1972**

THIS PAGE IS UNCLASSIFIED

TR 69-5

AD847309

TECHNICAL REPORT NO. 69-5

LONG-PERIOD TRIAXIAL SEISMOGRAPH DEVELOPMENT

Quarterly Report No.10, Project VT/6706

NOTICE

THIS DOCUMENT IS SUBJECT TO SPECIAL  
EXPORT CONTROLS AND EACH TRANS-  
MITTAL TO FOREIGN GOVERNMENTS  
OR FOREIGN NATIONALS MAY BE MADE  
ONLY WITH PRIOR APPROVAL OF CHIEF,  
AFTAC.

*VEHA WASH, DC 20333*

DDC  
RECEIVED  
FEB 7 1969  
REGISTERED



GEOTECH

A TELEDYNE COMPANY

TECHNICAL REPORT NO. 69-5

LONG-PERIOD TRIAXIAL SEISMOGRAPH DEVELOPMENT  
Quarterly Report No. 10, Project VT/6706

by

B. M. Kirkpatrick  
and  
A. W. Simmons

Sponsored by

Advanced Research Projects Agency  
Nuclear Test Detection Office  
ARPA Order No. 624

Availability

Qualified users may request copies  
of this document from:  
Defense Documentation Center  
Cameron Station  
Alexandria, Virginia 22341

**NOTICE**

THIS DOCUMENT IS SUBJECT TO SPECIAL EXPORT CONTROLS AND EACH  
TRANSMITTAL TO FOREIGN GOVERNMENTS OR FOREIGN NATIONALS  
MAY BE MADE ONLY WITH PRIOR APPROVAL OF CHIEF, AFTAC.

GEO TECH  
A TELEDYNE COMPANY  
3401 Shiloh Road  
Garland, Texas

27 January 1969

IDENTIFICATION

|                       |                                               |
|-----------------------|-----------------------------------------------|
| AFTAC Project No.     | VELA T/6706                                   |
| Project Title:        | Long-Period Seismograph Development           |
| ARPA Order No.        | 624                                           |
| ARPA Program Code No. | 6F10                                          |
| Name of Contractor:   | Geotech, A Teledyne Company<br>Garland, Texas |
| Date of Contract:     | 15 June 1966                                  |
| Amount of Contract:   | \$396,247                                     |
| Contract No.          | AF 33(657)-16406                              |
| Program Manager:      | David B. Andrew<br>BR 1-2651, Area Code 214   |

## CONTENTS

|                                                                                              | <u>Page</u> |
|----------------------------------------------------------------------------------------------|-------------|
| ABSTRACT                                                                                     |             |
| 1. INTRODUCTION                                                                              | 1           |
| 2. TECHNICAL STATUS                                                                          | 1           |
| 2.1 Evaluation and modification of the long-period triaxial<br>borehole seismometer, task 1e | 1           |
| 2.2 Fabricate and test one prototype LP triaxial borehole<br>seismometer, task 1f            | 2           |
| 2.3 Field measurements with the prototype borehole<br>seismometer, task 1g                   | 3           |

# ABSTRACT

The redesigned triax seismometer module has been completed and transported to Fairbanks, Alaska for operational tests. A triax borehole facility has been prepared at the Murphy Dome ALPA site 3-4 approximately 30 miles northwest of Fairbanks. The improved module and two of the engineering prototype modules operated at UBSO have been installed at site 3-4 and field evaluation is now in process.

LONG-PERIOD TRIAXIAL SEISMOGRAPH DEVELOPMENT  
Quarterly Report No. 10, Project VT/6706

1. INTRODUCTION

This report describes the work performed by Geotech, A Teledyne Company, in accordance with the Statement of Work to be Done in AFTAC Project Authorization No. VELA T/6706, dated 11 March 1966. The project is under the technical direction of the Air Force Technical Applications Center (AFTAC) and the overall direction of the Advanced Research Projects Agency (ARPA). Work accomplished on Project VT/6706 during the period October 1968 through December 1968 is reviewed in this report.

2. TECHNICAL STATUS

The following paragraphs describe the work accomplished on each major task of this project during this reporting period and summarize the results of laboratory and field tests of the long-period triaxial seismometer that has been developed on this project.

2.1 EVALUATION AND MODIFICATION OF THE LONG-PERIOD TRIAXIAL BOREHOLE SEISMOMETER, TASK 1e

The data acquisition and control system proposed for the Alaskan Long-Period Array (ALPA) with the redesigned module as the controlled device, was tested during the month of October. Before the tests were discontinued, the system automatically performed the following functions under software control:

- a. Mass position monitor;
- b. Mass position correction if out of tolerance;
- c. Determination of seismometer free period;
- d. Correction of seismometer free period if out of tolerance;
- e. Produce a 10 point amplitude vs frequency response of the system.

All of the functions were observed to operate correctly.

The redesigned module was prepared for shipment to Alaska during the latter part of October. Previous to shipment, temperature tests were performed on the redesigned module. These tests checked the performance of the locking system, the power supply and oscillator boards, and the leveling and period

adjust motors at temperatures down to  $-20^{\circ}\text{C}$ . The module was observed to properly unlock, level, adjust free period, and lock, at the reduced temperature. The tests were repeated several times and the module performed correctly each time.

The redesigned module was shipped to Fairbanks, Alaska, during the first week in November. Inspection of the module upon arrival showed that there was no visible damage in shipment. The module was subsequently unlocked and leveled under control of the portable controller. The free period was adjusted and the module relocked for installation in the shallowhole at the Murphy Dome facility.

Water seepage into the shallowhole delayed operational tests of the redesigned module as a part of a seismograph. Operational tests did begin early in December after a bridge plug was set in the hole and the hole pumped dry.

The redesigned module has continued to operate successfully throughout the month of December. This module is positioned as module No. 1 in the string of three and, as such, is sitting directly on the bottom of the hole.

High seismic background noise made setup and calibration of the seismographs very difficult. The downhole instruments have operated, however, with a minimum of adjustments. The uphole instrumentation has required several adjustments and minor changes to make the system compatible with the existing advanced long-period system.

The performance of the redesigned module indicates that it is at least as reliable as the best of the engineering model seismometer modules. The mass position and free period of the module have been stable and the character of the seismic data obtained is apparently identical with that of the engineering modules. Operating experience with the redesigned module thus far indicates that it can be accepted as a reliable substitute for anyone of the engineering modules.

## 2.2 FABRICATE AND TEST ONE PROTOTYPE LP TRIAXIAL BOREHOLE SEISMOMETER, TASK 1f

The drawing package required to fabricate the production prototype seismometer was released to production early in October. Approximately 97 percent of the parts required to fabricate the seismometer have been completed. Delivery of the remaining parts is expected within the next few days.

Delivery of all purchase parts has been completed with the exception of the stepping motors and the magnets. Delivery of these items is scheduled within the next 2 weeks. Delay in the delivery of the few remaining items is not presently delaying the assembly progress. The seismometer is expected to be completely assembled by the first part of February 1969.

Work on the procurement drawing package is continuing. The assembly experience is being watched closely to make sure that the drawings reflect any changes required to facilitate assembly. Completion of the package is expected during the month of January 1969.



### 2.3 FIELD MEASUREMENTS WITH THE PROTOTYPE BOREHOLE SEISMOMETER, TASK 1g

The engineering model of the long-period triaxial seismometer was removed from its operating position in the Sandia shallowhole facility at UBSO early in October and packed for shipment to the Murphy Dome site in Alaska.

A 16 in. diameter borehole at the Murphy Dome site was drilled to a depth of 225 ft. Problems were encountered while lowering the casing into the borehole that resulted in a completed borehole 178 ft deep instead of 200 ft. Fractured schist from approximately the 50 ft level continued to break away and fall into the borehole while the casing was being driven and eventually prevented the casing from being driven below a depth of 178 ft. The drilling contractor requested permission to cement the casing in the hole at the 178 ft depth. Permission to cement the casing at this depth was granted, after discussions with the Project Officer, providing that the drilling contractor would guarantee to meet the following requirements:

- a. 175 ft of clear, cased hole;
- b. A gauge 12 inches in diameter x 10 feet long must be run down the hole and back out without encountering any restrictions;
- c. A Totco tilt log must show that the hole does not deviate more than 3 degrees from vertical;
- d. There must be no concrete between the casing and the borehole above the 25 feet depth;
- e. The cased hole must exhibit a time constant of at least 24 hours.

On site inspection by the installation crew showed that the drilling contractor had complied with the above requirements.

During the week of 27 October 1968, the LP triax installation crew unpacked and inspected all of the LP triaxial instruments and equipment and found that seismometer module No. 1 had been damaged in shipment. One of the quartz booms was broken and the auxiliary mass assembly was loose. Due to the extent of the damage and since it was the first damage experienced with these modules during shipment, the seismometer module was air shipped to Geotech's Garland plant to determine the cause of the damage and for repair.

Inspection of the damaged module upon its arrival at Geotech has led us to believe that the unit was damaged because its mass was not completely locked prior to its shipment from UBSO.

A coupling-adaptor plate was welded to the top of the well casing and the well was pressured to 10 psi. The cased hole maintained this pressure within 1/4 lb for 36 hours. The borehole was then checked and found to be dry and ready to receive the LP triaxial instrument.

The improved version of the LP triaxial seismometer module was received, inspected, and checked out at the Murphy Dome site and attached to the seismometer assembly as the No. 1 module. The seismometer was lowered into the borehole on 18 November and left overnight to stabilize. An attempt to unlock and level the masses on 19 November was unsuccessful. A system check revealed low insulation resistance in the lines to the downhole instrument. Further checks indicated that there was moisture in the lines and possibly in the instrument itself. A visual inspection disclosed water in the borehole above the instrument. The instrument was then pulled from the borehole and a plumb line was lowered into the borehole. It was determined that there was 12 ft of water in the bottom of the borehole. A bridge plug was obtained from Halliburton Company in Kenai, Alaska, and installed in the borehole by A&L Drilling Co. The borehole was then pumped dry and allowed to stand for 48 hours to insure that there was no further seepage. The seismometer, after being subjected to -45 degrees temperature, was again lowered into the borehole on 30 November and left overnight. During the first week of December, all seismometers were unlocked and leveled in preparation for initial and operational tests and evaluation. Local seismic activity was a problem while setting up and calibrating the system. Two local, high magnitude, events occurred during the first week of December causing a high background noise level during this period.

After the system checkout was complete, the installation team instructed the LRSM team in the operation and calibration procedures for the triaxial system and departed for Dallas on 7 December 1968. The LP triaxial system has been in operation at the Murphy Dome site since the first week of December. The redesigned module has operated well with a minimum of adjustment. The uphole instrumentation has undergone some minor changes and adjustments during the month of December to make the response of the triaxial system more comparable to that of the ALPS operating at the same location.

UNCLASSIFIED

Security Classification

## DOCUMENT CONTROL DATA - R &amp; D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified.)

|                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                             |                                                                                                         |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|--|
| 1. ORIGINATING ACTIVITY (Corporate author)<br>Geotech, A Teledyne Company<br>3401 Shiloh Road<br>Garland, Texas 75040                                                                                                                                                                                                                                                                                                             |                                                                             | 2a. REPORT SECURITY CLASSIFICATION<br><b>UNCLASSIFIED</b>                                               |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                             | 2b. GROUP                                                                                               |  |
| 3. REPORT TITLE<br>Quarterly Report No. 10, Project VT/6706<br>LONG-PERIOD TRIAXIAL SEISMOGRAPH DEVELOPMENT                                                                                                                                                                                                                                                                                                                       |                                                                             |                                                                                                         |  |
| 4. DESCRIPTIVE NOTES (Type of report and inclusive dates)<br>Quarterly Report, 1 October to 31 December 1968                                                                                                                                                                                                                                                                                                                      |                                                                             |                                                                                                         |  |
| 5. AUTHOR(S) (First name, middle initial, last name)<br>Kirkpatrick, B. M.<br>Simmons, A. W.                                                                                                                                                                                                                                                                                                                                      |                                                                             |                                                                                                         |  |
| 6. REPORT DATE<br>27 January 1969                                                                                                                                                                                                                                                                                                                                                                                                 | 7a. TOTAL NO. OF PAGES<br>9                                                 | 7b. NO. OF REFS                                                                                         |  |
| 8a. CONTRACT OR GRANT NO.<br>AF 33(657)-16406                                                                                                                                                                                                                                                                                                                                                                                     | 8b. ORIGINATOR'S REPORT NUMBER(S)<br>TR 69-5                                |                                                                                                         |  |
| 8c. PROJECT NO.<br>VT/6706                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                             |                                                                                                         |  |
| 8d.                                                                                                                                                                                                                                                                                                                                                                                                                               | 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) |                                                                                                         |  |
| 10. DISTRIBUTION STATEMENT<br>Qualified users may obtain copies of this report from the Defense Documentation Center, Cameron Station, Alexandria, Virginia 22314. This document is subject to special export controls and each transmittal to foreign nationals may be made only with prior approval of the Chief, AFTAC.                                                                                                        |                                                                             |                                                                                                         |  |
| 11. SUPPLEMENTARY NOTES                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                             | 12. SPONSORING MILITARY ACTIVITY<br>HQ USAF (AFTAC/VELA Seismological Center)<br>Washington, D.C. 20333 |  |
| 13. ABSTRACT<br><br>The redesigned triax seismometer module has been completed and transported to Fairbanks, Alaska, for operational tests. A triax borehole facility has been prepared at the Murphy Dome ALPA site 3-4 approximately 40 miles northwest of Fairbanks. The improved module and two of the engineering prototype modules operated at UBSO have been installed at site 3-4 and field evaluation is now in process. |                                                                             |                                                                                                         |  |

DD FORM 1 NOV 61 1473

UNCLASSIFIED

Security Classification

| 14. KEY WORDS                               | LINK A |    | LINK B |    | LINK C |    |
|---------------------------------------------|--------|----|--------|----|--------|----|
|                                             | ROLE   | WT | ROLE   | WT | ROLE   | WT |
| Long-period borehole seismometer<br>VT/6706 |        |    |        |    |        |    |