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RONDOUT ASSOCIATES INCORPORATED

P.O. BOX 224

STONE RIDGE, NEW YORK 12484

Quarterly Research and Development Status Report

No. 7

1 April 1984 - 31 July 1984

|                                              |                                                                 |
|----------------------------------------------|-----------------------------------------------------------------|
| ARPA Order:                                  | 4493/1                                                          |
| Contractor:                                  | Rondout Associates Inc.                                         |
| Effective Date of Contract:                  | 1 October 1982                                                  |
| Contract Expiration Date:                    | 30 September 1984                                               |
| Contract Amount:                             | \$769,039                                                       |
| Contract Number:                             | F49620-83-C-0017                                                |
| Principal Investigators    Program Managers: | Dr. Paul W. Pomeroy<br>Dr. George H. Sutton<br>(914) 687-9150   |
| Title:                                       | Short Period Guided Waves Over<br>Oceanic and Continental Paths |

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## REPORT DOCUMENTATION PAGE

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| 1a. REPORT SECURITY CLASSIFICATION<br><u>Unclassified</u>                                                                                                                                                                                                                                                                                                      |                                                              | 1b. RESTRICTIVE MARKINGS                                                                                                                                                                                       |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 2a. SECURITY CLASSIFICATION AUTHORITY                                                                                                                                                                                                                                                                                                                          |                                                              | 3. DISTRIBUTION/AVAILABILITY OF REPORT<br>Approved for Public release; distribution unlimited.                                                                                                                 |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 2b. DECLASSIFICATION/DOWNGRADING SCHEDULE                                                                                                                                                                                                                                                                                                                      |                                                              |                                                                                                                                                                                                                |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 4. PERFORMING ORGANIZATION REPORT NUMBER(S)                                                                                                                                                                                                                                                                                                                    |                                                              | 5. MONITORING ORGANIZATION REPORT NUMBER(S)<br><b>AFOSR-TR- 84-0907</b>                                                                                                                                        |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 6a. NAME OF PERFORMING ORGANIZATION<br>Rondout Associates, Incorporation                                                                                                                                                                                                                                                                                       | 6b. OFFICE SYMBOL<br>(If applicable)                         | 7a. NAME OF MONITORING ORGANIZATION<br>Air Force Office of Scientific Research                                                                                                                                 |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 6c. ADDRESS (City, State and ZIP Code)<br>P. O. Box 224<br>Stone Ridge, NY 12484                                                                                                                                                                                                                                                                               |                                                              | 7b. ADDRESS (City, State and ZIP Code)<br>Physcial and Geophysical Sciences<br>Bolling AFB, DC 20332-6600                                                                                                      |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 8a. NAME OF FUNDING/SPONSORING ORGANIZATION<br>AFOSR                                                                                                                                                                                                                                                                                                           | 8b. OFFICE SYMBOL<br>(If applicable)<br>NP                   | 9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER<br>F49620-83-C-0017                                                                                                                                            |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 8c. ADDRESS (City, State and ZIP Code)<br>Bolling AFB, DC 20332-6600                                                                                                                                                                                                                                                                                           |                                                              | 10. SOURCE OF FUNDING NOS. <table border="1"><tr><td>PROGRAM ELEMENT NO.</td><td>PROJECT NO.</td><td>TASK NO.</td><td>WORK UNIT NO.</td></tr><tr><td>61102F</td><td>2309</td><td>A1</td><td></td></tr></table> |                     | PROGRAM ELEMENT NO. | PROJECT NO. | TASK NO. | WORK UNIT NO. | 61102F | 2309 | A1 |  |  |  |                                                                                   |  |
| PROGRAM ELEMENT NO.                                                                                                                                                                                                                                                                                                                                            | PROJECT NO.                                                  | TASK NO.                                                                                                                                                                                                       | WORK UNIT NO.       |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 61102F                                                                                                                                                                                                                                                                                                                                                         | 2309                                                         | A1                                                                                                                                                                                                             |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 11. TITLE (Include Security Classification) Short Period Guided Waves Over Oceanic and Continental Paths                                                                                                                                                                                                                                                       |                                                              |                                                                                                                                                                                                                |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 12. PERSONAL AUTHOR(S)<br>Paul W. Pomeroy & Dr. George H. Sutton                                                                                                                                                                                                                                                                                               |                                                              |                                                                                                                                                                                                                |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 13a. TYPE OF REPORT<br>Quarterly                                                                                                                                                                                                                                                                                                                               | 13b. TIME COVERED<br>FROM 1 May 84 to 31 Jul 84              | 14. DATE OF REPORT (Yr., Mo., Day)                                                                                                                                                                             | 15. PAGE COUNT<br>6 |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 16. SUPPLEMENTARY NOTATION                                                                                                                                                                                                                                                                                                                                     |                                                              |                                                                                                                                                                                                                |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 17. COSATI CODES <table border="1"><tr><td>FIELD</td><td>GROUP</td><td>SUB. GR.</td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></table>                                                                                                                                                  |                                                              | FIELD                                                                                                                                                                                                          | GROUP               | SUB. GR.            |             |          |               |        |      |    |  |  |  | 18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) |  |
| FIELD                                                                                                                                                                                                                                                                                                                                                          | GROUP                                                        | SUB. GR.                                                                                                                                                                                                       |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
|                                                                                                                                                                                                                                                                                                                                                                |                                                              |                                                                                                                                                                                                                |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
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| 19. ABSTRACT (Continue on reverse if necessary and identify by block number)<br>1. Evaluate the usefulness of Pg and Lg to estimate yield for Eurasian and Africa events.<br>2. Investigate possible causes of amplitude variation (i.e. source and recording site geology).<br>3. Analyze the regional phases for use in discrimination and yield estimation. |                                                              |                                                                                                                                                                                                                |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 20. DISTRIBUTION/AVAILABILITY OF ABSTRACT<br>UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS <input type="checkbox"/>                                                                                                                                                                              |                                                              | 21. ABSTRACT SECURITY CLASSIFICATION<br>Unclassified                                                                                                                                                           |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |
| 22a. NAME OF RESPONSIBLE INDIVIDUAL<br>Dr. Henry R. Radoski                                                                                                                                                                                                                                                                                                    | 22b. TELEPHONE NUMBER<br>(Include Area Code)<br>202-767-4906 | 22c. OFFICE SYMBOL<br>NP                                                                                                                                                                                       |                     |                     |             |          |               |        |      |    |  |  |  |                                                                                   |  |

A. Major Accomplishments

The Work Statement for this contract reads as follows:

Task A:

- 1.- Evaluate the usefulness of Pg and Lg to estimate yield for Eurasian and Africa events,
2. Investigate possible causes of amplitude variation (i.e. source and recording site geology), and
3. Analyze the regional phases for use in discrimination and yield estimation;

Task B:

- 1.- Continue the analysis of data from Wake Island Hydrophone Array in cooperation with personnel at Hawaii Institute of Geophysics and assist in guiding the operation of the array,
2. Conduct comparative studies of (long-range) oceanic Pn/Sn and continental Lg (Pg) using, especially, data from the Catskill Seismic Array and the Wake Array, in comparison with theoretical seismograms for different source types, focal depth, and velocity structures, and
3. Evaluate the Wake and Catskill Arrays in terms of signal coherence and detection capability; also compare them with other high quality continental stations and the DARPA/NORDA MSS.

Task C:

- 1.- Install, maintain, and operate high quality three component broad band digital seismographs in the Stone Ridge, New York area.

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2. Develop analysis techniques and software to obtain source and propagation path characteristics from broad band three component digital data.

#### Task A

During this reporting period, the  $m_{bLg}$  study was expanded to include WWSN station GOL.  $Q$  was calculated for the path from NTS to GOL so that additional data could be included in our yield determinations. The distance from NTS to GOL is about 1000 km and  $Lg$  is evident on most records. Using the predominant frequency versus time in the coda to determine  $Q$ , we found for  $Q=Q_0 f^\zeta$  that  $Q_0=345$  and  $\zeta=0.3$ .

Event  $m_{bLg}$ 's were calculated using the CSS program LSMF for 31 events which occurred between 1966 and 1982 with yields ranging from 100-200 kt.

We found that there can be a large bias (.5 magnitude units or as much as several hundred kt) when the station composition of the data set used to determine the calibration curve differs from that of the data set whose yields are being calculated. The problem remains when the same stations are used but the proportion of data points from the different stations differs.

This is a result of two factors. First, even after the  $Q$  correction is made,  $m_{bLg}$  u's at each station are characteristically higher or lower than at other stations. Second, LSMF does not correct this since too few data points from certain stations can be included. For lower yields on the calibration curve, closer stations provide more data and for larger yields farther stations contribute more. Thus, no matter the yield range of interest, the station composition will differ from that of the entire calibration curve. This problem originally caused us to underestimate the yields, some by as much as 80%.

To avoid this problem, we calculated a new station  $m_{bLg}$ -log yield curve for WSSN station BKS using six events used in our original curve plus an additional 19 events. These additional events occurred between 1965 and 1982 with yields of 10-1100 kt. They were chosen to have certain similarities in the geology of their source areas. BKS is a particularly good station because its distance (550 km) and magnification (25K) provide good data for a wide yield range.

Using the redetermined station calibration curve, yields were recalculated for 22 of the 31 events with yields of 100-200 kt for which we had BKS  $m_{bLg}$ 's. In this way, yield estimates were obtained within  $\pm 50\%$  of the official yields.

Currently, we are considering better ways to correct for station set bias as well as the effects of these problems on the transportability of calibration curves to other areas.

#### Task B

During this contract period, research under Task B concentrated on testing of programs that have been modified for use on the computers at the Center for Seismic Studies for generation of synthetic seismograms. Programs for generating full wave seismograms using the trapped mode method of Harvey are being employed for synthesizing signals from explosions and earthquakes in continental (Eastern U.S.) and oceanic velocity structures. Strong effects of focal depth for shallow depths have been observed in synthetic generated in previous contract periods. We are investigating these effects as functions of velocity structure and source mechanism in order to evaluate their use as a depth related discriminant between earthquakes and explosions. Some numerical stability problems have been encountered, especially with oceanic models

containing sediments with low shear wave velocity. These are being investigated.

#### Task C

This task is being supported by the U.S. Nuclear Regulatory Commission.

During this work period of the contract, the installation of the broad band digital seismic station has been completed. Construction of the vault was finished in May and the seismometers were installed shortly thereafter. Data has been recorded continuously since then except for a two week period at the beginning of June when a thunder storm destroyed some of the electrical components. The damage was repaired and protection was added to prevent further electrical storm damage.

Work on calibration of the instruments to determine their response to absolute ground motion is under way. Calibration pulses (a step of acceleration) are sent daily from the recording site at RAI headquarters to the seismometers. A complete calibration will be done in the near future.

- B. A Teledyne-Geotech Helicorder single channel recorder was added to the recording system for the broad band seismographs operated at Stone Ridge under Task C of this contract.
- C. No changes in key personnel associated with this contract have been made during this reporting period.
- D. Not applicable.
- E. No problems or areas of concern are apparent at this time.
- F. No deviation in the planned effort to achieve the objectives of the contract are anticipated.

G. Fiscal Status

1. Amount Currently Provided in Contract: \$769,039.00
2. Expenditures and Commitments to Date (31 July 1984): \$710,085.55
3. Estimated Funds Required to Complete this Work: \$58,953.45 i.e. the Contract Amount
4. Estimated Date of Completion: 30 September 1984 (All Tasks)