(12)

R & D STATUS REPORT
NAVAL OCEAN RESEARCH & DEVELOPMENT ACTIVITY
(NORDA)

ARPA Order No. 4152,

Amendment 15

Contract No. N00014-85-C-0793

Contractor:

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Effective Date of Contract: August 13, 1985

Title of Work: MSS Evaluation

Expiration Date: August 13, 1986

Date of Report: May 13, 1986

Date Due: May 13, 1986

Contract Period Covered By Report: Feb 13, 1986 - May 13, 1986

Sponsored by
Defense Advanced Research Projects Agency (DoD)

Sierra

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY DARPA/TIO	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for Public Release Distribution Unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) R&D Status Report/Period Covered: 86 02 13 to 86 05 13	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Sierra Geophysics, Inc. 6b. OFFICE SYMBOL (If applicable) 4R088	7a. NAME OF MONITORING ORGANIZATION Defense Advanced Research Projects Agency
6c. ADDRESS (City, State and ZIP Code) 15446 Bel-Red Road, Suite 400 Redmond, WA 98052	7b. ADDRESS (City, State and ZIP Code) 1400 Wilson Boulevard Arlington, VA 22209-2308
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Naval Ocean Research & Development Act. (NORDA) 8b. OFFICE SYMBOL (If applicable) N00014	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER N00014-85-C-0793
8c. ADDRESS (City, State and ZIP Code) Department of the Navy 800 N. Quincy Street Arlington, VA 22217-5000	10. SOURCE OF FUNDING NOS. PROGRAM ELEMENT NO. / PROJECT NO. ARPA Order No. 4152, Amend.15 / TASK NO. / WORK UNIT NO.
11. TITLE (Include Security Classification) R&D Status Report (U)	
12. PERSONAL AUTHOR(S) Dr. George R. Mellman; Dr. Marilee Henry	
13a. TYPE OF REPORT Quarterly R&D Status 13b. TIME COVERED FROM 86 02 13 TO 86 05 13	14. DATE OF REPORT (Yr., Mo., Day) 86 05 13 15. PAGE COUNT
16. SUPPLEMENTARY NOTATION	
17. COSATI CODES FIELD / GROUP / SUB. GR.	18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) N/A
19. ABSTRACT (Continue on reverse if necessary and identify by block number) N/A	
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION N/A
22a. NAME OF RESPONSIBLE INDIVIDUAL J.A. Ballard, NORDA Code 340	22b. TELEPHONE NUMBER (Include Area Code) (601) 688-4599 22c. OFFICE SYMBOL N68462

Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
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Availability Codes	
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DD FORM 1473, 83 APR EDITION OF 1 JAN 73 IS OBSOLETE.

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SECURITY CLASSIFICATION OF THIS PAGE

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A. DESCRIPTION OF PROGRESS

Current project status on a task by task basis is as follows:

TASKS 1 & 2:

1) Identify events detected and phases observed in MSS data:

All events visible on the unfiltered Gould and Teledyne MSS recordings have been identified for the short period channels SZ, SB, and SE, as discussed previously. Recently, high-pass filtering of continuous MSS short-period data obtained during the Bottom Processing Package (BPP) phase, recorded simultaneously on the vertical and hydrophone channels, has enabled detection of ~ 30 small magnitude events not visible in the unfiltered data. Currently this data set is being analyzed for comparison of down-hole and hydrophone waveforms, S/N values, and relative detection thresholds.

2) Cataloguing of pertinent MSS information and preliminary analyses:

Compilation of MSS information is currently being done. Problems encountered during data analysis have been listed in the 1985 report, as well as preliminary analyses by these authors and references of work done by others.

3) Comparison of MSS and OBS data and site characteristics:

As discussed in last status report, the S/N, observed phases, noise levels, and implied detection thresholds have been measured and compared for simultaneously recorded earthquake and noise data for the MSS and OBSes at the South Pacific site. MSS site m_b bias calibrated to ISC and

AFTAC magnitudes have been completed. Values of t* and Q from various phases observed in MSS data have been estimated. Signal enhancement and detection threshold improvement using an optimal band-pass filter and a simple polarization filter for regional and teleseismic events on MSS and OBSes have been examined. Since orientations for several OBSes have recently been determined, application of a true polarization filter on these data are now possible and will be attempted. Currently, other signal enhancement techniques (such as stacking of water layer multiples) are being investigated for obtaining the best realistic detection thresholds on these instruments. Realization of this task will involve the use of various synthetic modeling techniques.

Sub-tasks not yet started include measurement of stability of phases across OBS array, calibration of MSS and OBS regional event magnitudes to P_n codas, and separation of near-source from near-receiver propagation effects.

TASK 3: SYSTEMS/SITES COMPARISON:

1) Analysis of the Wake Island hydrophone array data has begun for the period of time corresponding to the MSS South Pacific site recording period. Continuous Wake data are not available, only time windows surrounding expected or observed events (a total of ~ 77 "events"). The identification of P, P_n, S_n, and T phases, S/N measurements on spectra and time domain data, and noise levels are currently being compiled.

2) Two tapes of OSS borehole seismometer data (Kamchatka 1982 site) have been received from Hawaii and are currently being analyzed for noise level, S/N, and detection level comparisons with MSS, OBS, and hydrophone data.

TASK 4: SNAP-D SYSTEMS EVALUATION:

Work for this task will be initiated upon completion of the above mentioned analyses for MSS-83 and OSS-82 borehole data, OBS data, and Wake Island and MSS-83 hydrophone data.

B. SUMMARY OF PRELIMINARY FINDINGS SINCE LAST STATUS REPORT:

1) The hi-pass filtered continuous short-period MSS BPP data revealed ~ 30 regional events having S/N << 1 in the original data. These events, recorded simultaneously on the vertical, horizontal, and hydrophone channels, had previously gone undetected in the unfiltered data. Individual events were hi-passed at 4.0, 6.0, and 11.0 Hz to find optimal S/N. The high-pass filter at 6.0 Hz was found to be optimal in most cases, though the hydrophone channel occasionally showed larger S/N on the data high-passed at 11 Hz. At this time, a direct comparison of S/N between the borehole and hydrophone channels has not been taken, as we do not possess the MSS hydrophone instrument response function, and it is unclear, since these are small magnitude events, whether time shifts are present between these channels. In general, the vertical borehole channel appears to show P_n onset more clearly than the hydrophone channel, whereas conversely, the hydrophone channel consistently shows higher amplitude water multiples, and occasionally larger P_n coda amplitudes compared to the borehole channels. Magnitudes measured on the vertical HP 6 Hz data for seven of these events with the best S/N ranged from 2.4 to 3.1 m_b at apparent distances of 7.3 to 8.9 degrees. When corrected to S/N ~ 1 and a reference distance of 10 degrees, the implied average detection threshold obtained was ~ 2.6 m_b.

2) In an attempt to verify the distance corrections derived for the MSS site for shallow regional events originating in the Tonga-Kermadec source region from MSS data, 32 events of a similar nature recorded on the OBSes during a different time period were calibrated to the same global array. Unfortunately, these data were found to range over only ~ 1 degree of distance and displayed a very high average a magnitude bias of ~ 1.5 m.u. This large scatter in observed OBS versus published m_b's may be due to the vaguaries of sediment response given the presumed unusual mode of P_n propagation. In comparison, MSS m_b's calibrated to this global array resulted in an average delta m_b < 1 m.u. over ~ 4 degrees of distance, and displayed an obvious trend with distance.

The detection threshold implied for this group of events recorded on the OBSes in trigger mode calibrated to the global array was ~ 3.9 m_b on band-passed data at the reference distance of 10 degrees. Comparatively, the MSS detection threshold obtained for a different group of 14 shallow regional events was ~ 3.5 m_b on band-passed data.

3) Preliminary analyses of a total of 77 recording windows of Wake Island hydrophone data have resulted in detections of 32 P and 22 P_n phases. (S_n and T phases have also been detected but have not yet been completely tabulated.) These events cover distances of ~ 20 to 70 degrees. Band-pass filtering improved S/N for both P and P_n phases, regional and teleseismic, with apparent optimal band-passes of 0.5 to 2.0 Hz for P, and 1.0 to 8.5 Hz for P_n phases. The average P phase delta m_b as calibrated to ISC magnitudes was ~ 0.5 m.u. (observed Wake magnitudes are high). (This in part may be due to imprecise knowledge of the instrument and telemetering cable responses.) No trends in magnitude bias with distance or azimuth are evident. The detection thresholds implied for Wake Hydrophone P phases measured on

the filtered data are ~ 5.0 m_b at 40 degrees and 5.3 m_b at 60 degrees at a reference depth of 60 km and S/N ~ 1. The results obtained previously for the MSS teleseismic data were ~ 5.0 to 5.3 m_b for distances ranging from 40 to 80 degrees at a reference depth of 60 km. It therefore appears that for a single station, the Wake hydrophones and the MSS borehole instrument are nearly identical in their teleseismic P phase detection capabilities. Application of other signal enhancement techniques such as beam-forming and water-multiple stacking are expected to improve the hydrophone capabilities further.

The preliminary detection threshold obtained for the P_n phase on the band-pass-filtered Wake data was ~ 4.4 m_b at 20 degrees distance range and ~ 60 km depth, using distance corrections from the standard tables. Since no events in this study occurred at less than ~ 20 degrees from the Wake array, a direct comparison of the detection threshold at regional distances to that of MSS is not obtainable. The MSS recorded only 2 events at 20 to 22 degrees distance, and using the standard tables for distance corrections for a reference depth of 60 km, a detection threshold of ~ 4.6 m_b was obtained using S/N values from unfiltered data. Though sparse, these results concur with those of the teleseismic P phases in implying that the single station MSS and Wake hydrophone first arrival detection capabilities are very comparable for distances of 20 to 60 degrees.

C. SUMMARY OF NEEDED DATA OR OTHER INFORMATION

1) Miscellaneous gain correction and instrument response functions are needed for Wake Hydrophone and OSS data. This will be arranged with U. of Hawaii personnel.

2) Any additional time periods needed for the AFTAC catalogue will be requested through Al Ballard in the near future.

3) The MSS hydrophone channel instrument response is needed. Problems also appear to exist with the MSS borehole instrument phase response. Inquiries have been made to Scripps Institution of Oceanography personnel, and will also be made to Gould.

D. PROPERTY & EQUIPMENT ACQUIRED

None

E. PERSONNEL CHANGES

None

F. TRAVEL

None

G. PLANS FOR NEXT REPORTING PERIOD

1) Complete observational analyses of Wake Island hydrophone data, including application of beam-forming and water-multiple-stacking signal enhancement techniques.

2) Complete observational analyses and signal enhancement studies on OSS data.

3) Design multiple-stacking filter for MSS, Wake hydrophone and OBS data.

4) Application of a polarization filter to OBSes with known orientations, and to OSS data where applicable.

H. RESEARCH TASKS FAILED OR TERMINATED

None

I. FISCAL STATEMENT

Of the total funds of $188,040 authorized for 12 months, approximately 80% of the work has been completed.

J. COST DATA

Cumulative Cost Data as of April 30, 1986:

Labor Elements	Planned Amount ($)	Actual Amount ($)
Scientist	$ 30,528	$ 39,906
Technical Support		
Total Labor	30,528	39,906
Other Expenses		
Material	-0-	208
Travel	3,240	497
Computer	12,600	12,289
Total Other Expenses	$ 15,840	$ 12,994
Overhead	$ 36,573	$ 52,445
G & A	$ 21,316	$ 32,949
Fee	$ 8,566	$ 11,365
GRAND TOTAL	$112,823	$149,659

K. PLANNING ESTIMATES

Revised Planning Estimate as of April 30, 1986
(Cumulative Costs)

	Reporting Period				
	1st*	2nd*	3rd*	4th	5th
Planned Percentage of Technical Completion	20%	40%	60%	80%	100%
Labor Elements	$	$	$	$	$
Scientist	10,941	25,876	39,906	40,705	50,881
Technical Support					
Total Labor	10,941	25,876	39,906	40,705	50,881
Other Expenses					
Material	42	208	208	-0-	-0-
Travel	-0-	497	497	4,320	5,400
Computer	1,762	5,844	12,289	16,800	21,000
Total Other Expenses	1,804	6,549	12,994	21,120	26,400
Overhead	11,606	29,124	52,445	48,764	60,955
G & A	5,333	13,244	32,949	28,421	35,527
Fee	2,439	6,146	11,365	11,421	14,277
GRAND TOTAL	$32,123	$80,939	$149,659	$150,431	$188,040

(*Actual)