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G R MELLMAN ET AL. 26 FEB 86 N00014-85-C-0793

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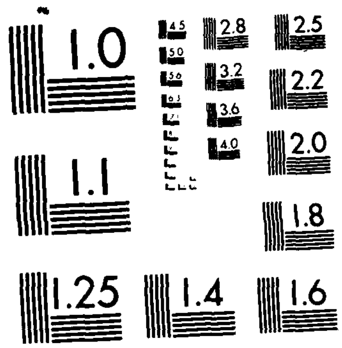

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R & D STATUS REPORT
NAVAL OCEAN RESEARCH & DEVELOPMENT ACTIVITY
(NORDA)

REVISION 1, REDISTRIBUTED 26 FEBRUARY 1986

ARPA Order No. 4152, Amendment 15

Contract No. N00014-85-C-0793

Contractor:

Sierra Geophysics, Inc.
15446 Bell-Red Road
Suite 400
Redmond, Washington 98052

Principal Investigator:

Dr. George R. Mellman
Vice President

Dr. Marilee Henry
Sr. Staff Geophysicist

Effective Date of Contract	August 13, 1985
Title of Work:	MSS Evaluation
Expiration Date:	August 13, 1986
Date of Report:	November 5, 1985
Date Due:	November 13, 1985

Contract Period Covered By Report: Aug 13, 1985 - Nov 13, 1985

Sponsored by
Defense Advanced Research Projects Agency (DoD)

Sierra

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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 on the Gould and Teledyne MSS recordings have been recorded and phases identified for the short period channels SZ, SB, and SE. General characteristics of the MSS events have been discussed in the report for contract ending March 1985, and plots of all the short-period vertical MSS data have been published in its appendix. The MSS hydrophone data is currently being analyzed for comparison with waveforms received on the borehole sensors. Interference from the Challenger's 12.5 kHz profiler is present on approximately half the hydrophone data (~ 17/40 hours).

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:

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. 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:

Analysis of the Wake Island hydrophone array data is just commencing, as well as synthetic waveform modeling of MSS-83, OBS, and hydrophone data. No OSS borehole data (MSS-82) has yet been received, and is necessary for comparison of oceanic site characteristics.

TASK 4: SNAP-D SYSTEMS EVALUATION:

Work for this task has not yet been initiated. Near completion of the preceeding tasks for MSS-83 borehole and OBS instruments will enable this task to be started soon.

B. SUMMARY OF PRELIMINARY FINDINGS

1) The MSS detection threshold for unfiltered teleseismic events is rather high at between 5.1 to 5.3 m_b for epicentral distances between 30 and 80 degrees at a reference depth of

60 km. Only P phases have been observed for 4 teleseisms, with pP and possibly P_n occurring on a 5th event. Application of a simple polarization filter has resulted in an average teleseismic signal enhancement of ~ 4 dB, implying a reduction of ~ 0.2 m.u. in the detection threshold. Three additional teleseisms have been detected after application of the polarization filter. If both horizontal components of the MSS instrument had been operational, we expect that application of a more sophisticated polarization filter would have had better results. (Detection thresholds calibrated to ISC magnitudes.) No S phases have been observed in any of the teleseismic events. We have no explanation for the remarkable lack of teleseismic detections. It is possible that raypaths are encountering anomalously low Q zones in the oceanic asthenosphere. However, estimates from the spectral slopes of P phases from deep events located in the nearby Tonga-Fiji trench give Q values of ~ 500 to 700 for the upper oceanic mantle at this site.

2) Approximately 180 regional events were recorded on the MSS, only 11 of which were published in the NEIS or ISC Bulletins. High frequency P_n and S_n phases were observed on all regional events (within ~ 22 degrees) and normal P phases were observed on events beyond ~ 20 degrees or at depths of ~ 300 km or greater originating in the Tonga-Fiji-Kermadec trench system. No normal mantle-refracted low frequency S phases were observed. T phases were seen associated with several of the largest shallow events. Surface waves were observed on two of the largest shallow events. The MSS detection threshold for unfiltered regional events originating in the nearby trench system was ~ 3.9 to 4.0 m_b for a reference distance of 10 degrees at depths of 450 and 60 km respectively, and ~ 4.6 m_b for 60 km depth at a reference distance of 20 degrees. Application of an optimal band-pass filter from 2.5 to 15.0 Hz improved the signal to noise ratio for the high frequency P_n phases by ~ 9 dB, thereby

lowering the detection threshold to ~ 3.6 m_b for shallow regional events. (Detection thresholds calibrated to ISC magnitudes.)

3) The absolute noise level measured on the MSS borehole instrument's vertical component was within ~ 4 dB (lower) of that measured on the OBS vertical component over the microseismic band (~ 0.2 to 0.4 Hz) but was ~ 10 dB lower than the OBS level over the signal band of ~ 0.4 to 6.0 Hz. The MSS horizontal noise level was between 7 to 22 dB lower than the OBS horizontal level for the microseismic band, and ~ 25 dB lower than the OBS for the signal band. MSS-83 vertical noise levels are lower by ~ 10 dB than those measured during MSS-81 in the North Atlantic for frequencies above the microseismic peak, but are still ~ 30 dB higher than the quietest land stations for frequencies below ~ 2 Hz. Between 2 to 9 Hz, the MSS-83 vertical noise level is ~ 10 dB higher than that measured at the quietest continental station at Lajitas, Texas.

4) No teleseismic and only 5 shallow regional event P_n phases were recorded simultaneousy on the MSS-83 and OBS instruments. Results of S/N comparisons and detection thresholds for these five events are as follows. The signal to noise advantage on the MSS compared to the OBSes was ~ 12 to 18 dB for unfiltered vertical and ~ 18 dB for unfiltered horizontal signals, using the maximum signal amplitude occurring within 1 second of the apparent P_n onset and maximum noise amplitude within 2 seconds preceeding P_n onset. Application of the optimal band-pass filter enhanced the vertical OBS S/N greatly, decreasing the MSS S/N advantage for filtered vertical data to ~ 5 dB. Band-pass filtering enhanced MSS and OBS horizontal data equally well, with MSS S/N advantage for filtered horizontal data at ~ 20 dB. The average MSS vertical ground displacements as measured on the band-pass filtered data were ~ 3 dB lower than those measured on the OBSes, yielding MSS m_b values

~ 0.15 m.u. lower than those obtained from the OBS data. Application of the simple polarization filter to these shallow regional events enhanced MSS signal to noise ratios by 25 dB over those of the OBSes. The detection thresholds implied by these S/N values at a reference distance of 10 degrees and depth of 60 km are:

Unfiltered:	MSS ~ 3.6 m_b
	OBS ~ 3.8 to 4.5 m_b
Band-pass filtered:	MSS ~ 3.4 m_b
	OBS ~ 3.7 m_b
Polarization filtered:	MSS ~ 2.6 m_b
	OBS ~ 3.6 to 4.1 m_b

The above magnitudes have been corrected for the difference between MSS and OBS m_b's, and reflect the magnitude expected to be observed on the MSS instrument. Application of the polarization filter to larger data sets on MSS and OBS is currently in progress.

5) P_n codas on both MSS and OBSes are complex, with OBSes in many cases having higher amplitude arrivals occurring ~ 1.5 seconds after P_n onset, and are presumably sediment layer reverberations. Water multiples are of higher amplitude on OBS compared to MSS. Application of a water layer multiple stacking filter may greatly enhance OBS S/N and detection thresholds.

C. SUMMARY OF NEEDED DATA OR OTHER INFORMATION

1) HIG OSS data still has not been received. This is a very important data set for the comparison of oceanic site characteristics and detection capabilities, and also for comparison between sediment layer versus basalt layer instrument emplacement.

2) Russian catalogue of events during MSS-83 and MSS-82 requested through A. Ballard.

3) AFTAC catalogue of events will be requested for MSS-82 OSS data analyses whenever the necessary information becomes available.

D. PROPERTY & EQUIPMENT ACQUIRED

None

E. PERSONNEL CHANGES

None

F. TRAVEL

None

G. PLANS FOR NEXT REPORTING PERIOD

1) Observational analyses of hydrophone data.

2) Application of water layer multiple stacking filter for S/N enhancement.

3) Synthetic modeling for aid in filter design.

4) Compile results of polarization filter S/N enhancement for MSS and OBS shallow regional events.

H. RESEARCH TASKS FAILED OR TERMINATED

None

I. FISCAL STATEMENT

Of the total funds of $188,040 authorized for 12 months, approx-mately 20% of the work has been completed.

J. COST DATA

Cumulative Cost Data as of October 31, 1985:

Labor Elements	Planned Amount ($)	Actual Amount ($)
Scientist	$ 10,176	$ 10,941
Technical Support		
Total Labor	10,176	10,941
Other Expenses		
Material	-0-	42
Travel	1,080	-0-
Computer	4,200	1,762
Total Other Expenses	$ 5,280	$ 1,804
Overhead	$ 12,191	$ 11,606
G & A	$ 7,105	$ 5,333
Fee	$ 2,855	$ 2,439
GRAND TOTAL	$ 37,607	$ 32,123

K. PLANNING ESTIMATES

Revised Planning Estimate as of October 31, 1985
(Cumulative Costs)

	Reporting Period				
	1st*	2nd	3rd	4th	5th
Planned Percentage of Technical Completion	20%	40%	60%	80%	100%
Labor Elements	$	$	$	$	$
Scientist	10,941	20,352	30,528	40,705	50,881
Technical Support					
Total Labor	10,941	20,352	30,528	40,705	50,881
Other Expenses					
Material	42	-0-	-0-	-0-	-0-
Travel	-0-	2,160	3,240	4,320	5,400
Computer	1,762	8,400	12,600	16,800	21,000
Total Other Expenses	1,804	10,560	15,840	21,120	26,400
Overhead	11,606	24,382	36,573	48,764	60,955
G & A	5,333	14,210	21,316	28,421	35,527
Fee	2,439	5,710	8,566	11,421	14,277
GRAND TOTAL	$32,123	$75,216	$112,823	$150,431	$188,040

(*Actual)

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