December 11, 1980
Letter from US Naval Research Lab Director Alan Berman on Hydroacoustic Evidence on the Vela incident

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Summary:

Alan Berman writes to US Office of Science and Technology Policy senior advisor John Marcum on hydroacoustic evidence on the Vela incident. Based on sounds recorded, it appeared that a large explosion occurred south of Ascension Island.

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Mr. John M. Marcum
Senior Adviser for Technology
and Arms Control
Executive Office of the President
Office of Science and Technology Policy
Washington D.C. 20500

Dear Mr. Marcum:

I have spent considerable time reviewing the Naval Research Laboratory's 3 December presentation to your Panel. It appears to me that in the course of the Panel's discussion, the existence of a useful set of well documented facts was somewhat obscured. Let me try to isolate these facts from their supporting arguments and summarize then as follows:

1. There was. a large impulsive release of energy which coupled acoustic energy into the deep South Atlantic Sound channel. This energy release was detected by three wide band hydrophones near Ascension Island around 0243 UT on 22 September 1979, was identified by visual inspection of the record, and was found to exhibit a signal-to-noise ratio of about 25 db (i.e., about 317 to 1).

2. Based on knowledge of the dispersion of nultipatb arrivals In the ocean and a comparison with the travel time dispersion observed after French shots in the Pacific, the path length of the signals received at Ascension at 0243 UT may be estimated to have been on the order of 10,000 km. Using an average acoustic velocity of propagation of 1500 m/eec, this implies a source or event time consistent with the VELA alert time which occurred at 0052:43.67 ± .05 UT on *11* September 1979. Specifically, the travel time of an acoustic signal over a path length of 10,000 km is about 1 hour and 51 minutes. If the path length was in fact exactly 10.000 km. then the event which generated the signal detected at 0243 UT at Ascension must have occurred at 0051 UT. This is remarkably close to the VELA time.

3. Based on an analysis of satellite coverage, the VELA alert footprint was confined to the southern hemisphere. The time sequence of arrivals at the Ascension hydrophones indicate that the 0243 UT signal arrived at Ascension Island from a bearing of 198° ± 10°.

4. There is an accepted model which predicts the generation of a line frequency structure of the hydroacoustlc signal generated by an explosion on, near, or in water 10 to 20 meters above a thin sediment layer overlying basalt. Such a line structure was seen in both the Ascension 0243 UT signals and in the signals from the French tests received over similar travel path lengths of 9500 km in the Pacific. The observed signals at Ascension were consistent with theoretical predictions for an explosion above a thin sedimentary layer.

5. The event which generated the 0243 UT Ascension signal must have been quite large to produce a signal 25 db above background at a range of about 10,000 km. Although it is difficult to estimate propagation loss with great precision. it la unlikely that the loss was significantly less than that due to cylindrical spreading (i.e., 3 db per distance doubled beyond about 1 km) • As « conservative minimum, ana may estimate that the loss over a propagation path of 10,000 km should have been at least 97 db. This implies a minimum signal level at the source of about 122 db (i.e.. 1.6×10^{12}) above the ambient noise background. In the vicinity of 10 hz, typical ambient noise backgrounds at low sea states are about 70 db re 1 micro Pascal. A 2 KT explosion in water is generally accepted to yield a signal of 194 db re 1 micro Pascal. Thus, under circumstances of good acoustic coupling to the ocean, the signal generated from a 2 KT explosion in water should be about 124 db above ambient noise. This analysis is consistent with observations of the French atmospheric nuclear detonations in the Pacific.

6. The acoustic yield of an explosion scales as W^1/3 . Thus the 36 KT French shot should have given an acoustic yield which was 4.2 db greater than the yield from a 2 KT shot. The signal from the French 38 XT shot, when detected at Guam at a distance of 9500 In from the source location was 13 db above the local ambient noise level. It may be hypothesised that the deficit of 16 db • (25 db - 13 db + 4 db) between the Ascension 0243 UT signal-to-noise ratio and the French signal-to-noise ratio was related to the poor acoustic coupling to the water of the French shot which, based on available intelligence, may have been as much as 500 meters above the water surface

7. If the energy release in question took place in air above deep water, then the absence of the Rayleigh wave coupling mechanism would have resulted in very weak coupling of acoustic energy into the ocean. Because of the strength of the observed signal, one must conclude that either the release of energy took place la air over shallow water underlain with sedimentary deposits over a hard rock basement, or the release took place underwater. If the energy release took place under water, then no signal would have been detected by the VELA satellite.

8. If one makes the additional ad hoc assumption that tbe 0243 UT Ascension signal was generated at the VELA alert time, then the locus of posslble points or origin of the signal passes through the vicinity of the Prince Edward and Marion Islands. Another candidate shallow water source location on this locus is in the vicinity of Clarence island. The analysis of satellite data cannot preclude an event occurring at either of these locations*

The hardest conclusion which may be drawn from the combination of these faces is, that a large explosion occurred above a sedimentary bottom at a great range (- 10,000 ka) south of Ascension Island. Without any ad hoc assumptions, the time of origin of this event is determined to be tons latent with the VELA alert tine and the VELA footprint.

I do not see how additional information about the noise background detected by the Ascension Island hydrophones could change these conclusions. More knowledge of ocean background noises may change the significance of the conclusions, but not the conclusions themselves.

To the extent that I could follow the Panel's concerns on the issue of the statistical significance of the background data, a number of comments arc la order. We examined 60 days, or 5,184,000 seconds of data on the three hydrophone channels. Be looked for events which:

(a) Were detected on all three channels within travel time constraints

(b) Had pairwise, statistically significant cross-correlation coefficients for all possible pair combinations

(c) Had a signal duration of more than 8 seconds and loss than 32 seconds

(d) Were physically realisable within travel time constraints between hydrophones

(e) Exhibited a consistent line structure at all three hydrophones

(f) Exhibited signal-to-noiae ratios of 22 db or greater in the frequency band 12.5 ± 1.5 Hz on all three hydrophones.

In toto, we saw exactly one event in 3 x 5,184,000 seconds of data which satisfied criteria (a) through (f). the Panel's concern appeared to relate to their view that criteria (a) through (f) were unduly restrictive and that these criteria defined too narrow a class of possible background signals. If one were to attempt to alleviate the concerns of the Panel, it would apparently be necessary to relax these criteria and still not find any other candidate signals.

My personal view is that only one of the six criteria nay be relaxed. Specifically, criteria, (f) night be Modified to read:

(f1) Exhibited signal-to-nolse ratios greater than 16 db on all three hydrophones in the frequency band 8-18 Hz.

Since acoustic signals are assumed to be attenuated at the rate of 3 db per distance doubled, relaxing the threshold level by 6 db is equivalent to considering signals which originated at all ranges out to 40,000 km. Alternatively, since the acoustic yield scales as W^1/3, a relaxation of 6 db could be considered to be equivalent to reducing the threshold of detectability to include acoustic signals from explosions that are a factor of 64 less than the 0243 UT event. Since the threshold in criteria (f) was set for background levels equivalent to a 2 KT shot, criteria (f1) would correspond to the energy release from a .03 kt detonation. The backwidth limits of 8 and 18 Hz must be sec at the low end by the rapid increase in ambient noise with decreasing frequency due to surface waves and at the high end by the need to exclude 20 Hz signals known to be generated by whales and other large marine animals.

If tasked, I would be willing to reexamine the Ascension Island background data subject to criteria (a) through (a) and (f1) vice (f). However, as an industrially funded laboratory, NRL will require adequate funding to cover the cost of such a reexamination of the data. The possible reexamination of the data discussed above will be expensive and will take a considerable length of time.

My enthusiasm for undertaking a further analysis of the background data 1* somewhat dampened by my possibly unfounded perception that the results of such an analysis are unlikely to be sufficiently incontrovertible as to cause the Panel to come to a position that is significantly different from its present view of the available evidence. Therefore, I would suggest that before NRL is tasked to undertake further efforts in this matter, you discuss the issues with the Panel and determine what their conclusions might be, given any one of a number of reasonably postulated outcomes of such a reexamination of the back-around data.

Sincerely yours.

Alan Berman

ALAN BERMAH
Director of Research

Copy to:

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