May 23, 1980

(13C)

AD HOC PANEL REPORT ON THE SEPTEMBER 22 EVENT

Background

A panel of nongovernment scientists (listed in appendix) was convened by Dr. Frank Press, Science Adviser to the President and Director of the Office of Science and Technology Policy, to assist in determining the likelihood that the light signal recorded by a VELA satellite over the South Atlantic on September 22, 1979, was from a nuclear explosion. Specifically, the panel was asked to (1) review all available data from both classified and unclassified sources that could help corroborate that the VELA signal originated from a nuclear explosion and suggest any additional sources of data that might be helpful in this regard; (2) evaluate the possibility that the signal in question was a "false alarm" resulting from technical malfunction such as interference from other electrical components on the VELA platform; and (3) investigate the possibility that the signal recorded by our VELA satellite was of natural origin, possibly resulting from the coincidence of two or more natural phenomena and attempt to establish quantitative limits on the probability of such an occurrence.

The panel met three times; the last meeting was April 2-3, 1980. During the course of its work the panel (1) received numerous briefings by the Air Force Technical Applications Center (AFTAC)--the government agency responsible for detecting non-U.S. nuclear explosions and collecting and analyzing data from such explosions--and was particularly impressed with the analyses provided by AFTAC; (2) studied performance data, circuitry and hardware involved in the VELA satellite program; (3) initiated and reviewed results of statistical analyses of the hundreds of thousands of light signals that have been recorded previously by VELA satellites and of computer modeling of natural phenomena that might have generated the September 22 signal; (4) reviewed all available data that might tend to corroborate whether that signal was generated by a nuclear explosion; and (5) reviewed analyses made by government agencies that bore on the question of whether the September 22 signal was of nuclear origin. In addition a subgroup of the panel was briefed on available nontechnical intelligence that related to the September 22 event.

The Office of Science and Technology Policy (OSTP) also requested the Naval Research Laboratory to search worldwide for geophysical data that might bear on the origin of the September 22 event and do independent analyses of this data. NRL has not yet completed its task but has briefed the panel at its third meeting on its findings to date.

~~Review on May 23, 1986~~

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Summary of Conclusions

At its third meeting, the panel reviewed the most recently collected data and analyses. Its findings and conclusions are summarized as follows:

1. The light signal from the September 22 event strongly resembles those previously observed from nuclear explosions, but it was different from the others in a very significant way. The discrepancy suggests that the origin of the signal was close to the satellite rather than near the surface of the earth. In order to account for the September 22 VELA signal as coming from a nuclear explosion, one must hypothesize particularly anomalous functioning of the instruments (bhangmeters) that observed the event.

2. The bhangmeters on the VELA satellites have been triggered by and have recorded almost all previous nuclear explosions. They have also recorded hundreds of thousands of other signals, mostly from lightning and cosmic ray particles striking the light sensors. In addition they have been triggered several hundred times by signals of unknown origin, "zoo events." A few of these zoo events had some of the characteristics associated with signals from nuclear explosions, although they could be distinguished clearly from nuclear explosion signals upon examination of their complete time histories.

3. The search for nuclear debris and for geophysical evidence that might support the hypothesis that a nuclear explosion was the source of the September 22 event has so far only produced data that is ambiguous and "noisy." At this date, there is no persuasive evidence to corroborate the occurrence of a nuclear explosion on September 22.

4. Based on the lack of persuasive corroborative evidence, the existence of other unexplained zoo events which have some of the characteristics of signals from nuclear explosions, and the discrepancies observed in the September 22 signal, the panel concludes that the signal was probably not from a nuclear explosion. Although we cannot rule out the possibility that this signal was of nuclear origin, the panel considers it more likely that the signal was one of the zoo events, possibly a consequence of the impact of a small meteroid on the satellite.

Observed Bhangmeter Signals

Each VELA satellite carries two bhangmeters--devices that observe incident light and trigger a recording apparatus when light intensity changes rapidly. The two bhangmeters have different sensitivities so that a wide range of light intensities can be observed and recorded.

[redacted] 1.5(c)(d) Overall, the VELA bhangmeters have been triggered hundreds of thousands of times, mostly by light from lightning and energetic cosmic particles both of which have identifiable short time duration signals. The bhangmeters have also been triggered by calibration signals from internal light sources or, recently, ground based lasers, direct sunlight and "other" sources (referred to as zoo events) which are not satisfactorily understood and which have great variation in signal character.

It had been thought that the zoo events were due to passing meteoroids, but we have not been able to construct a satisfactory model to justify this explanation. More recently an explanation has been offered that these signals are from sun reflection from debris ejected from the satellite after a collision with a small meteoroid. This explanation seems more plausible to the panel but has yet to be fully developed.

Figures 1-5 shows some bhangmeter records from different events:

- Figure 1 shows a typical short duration signal identified as lightning.
- Figure 2 shows a typical low-yield nuclear explosion with its characteristic double-hump.
- Figure 3 shows the optical signature recorded by both the more sensitive (YC) and the less sensitive (YV) bhangmeter of the September 22 event.
- Figure 4 shows an example of one of the few zoo events in which a double-humped optical pulse is observed. However the detailed pulse shape is not consistent with what is observed from a nuclear explosion.
- Figure 5 shows an example of a long duration zoo signal which is obviously very different from a nuclear explosion signal.

FIGURE 1

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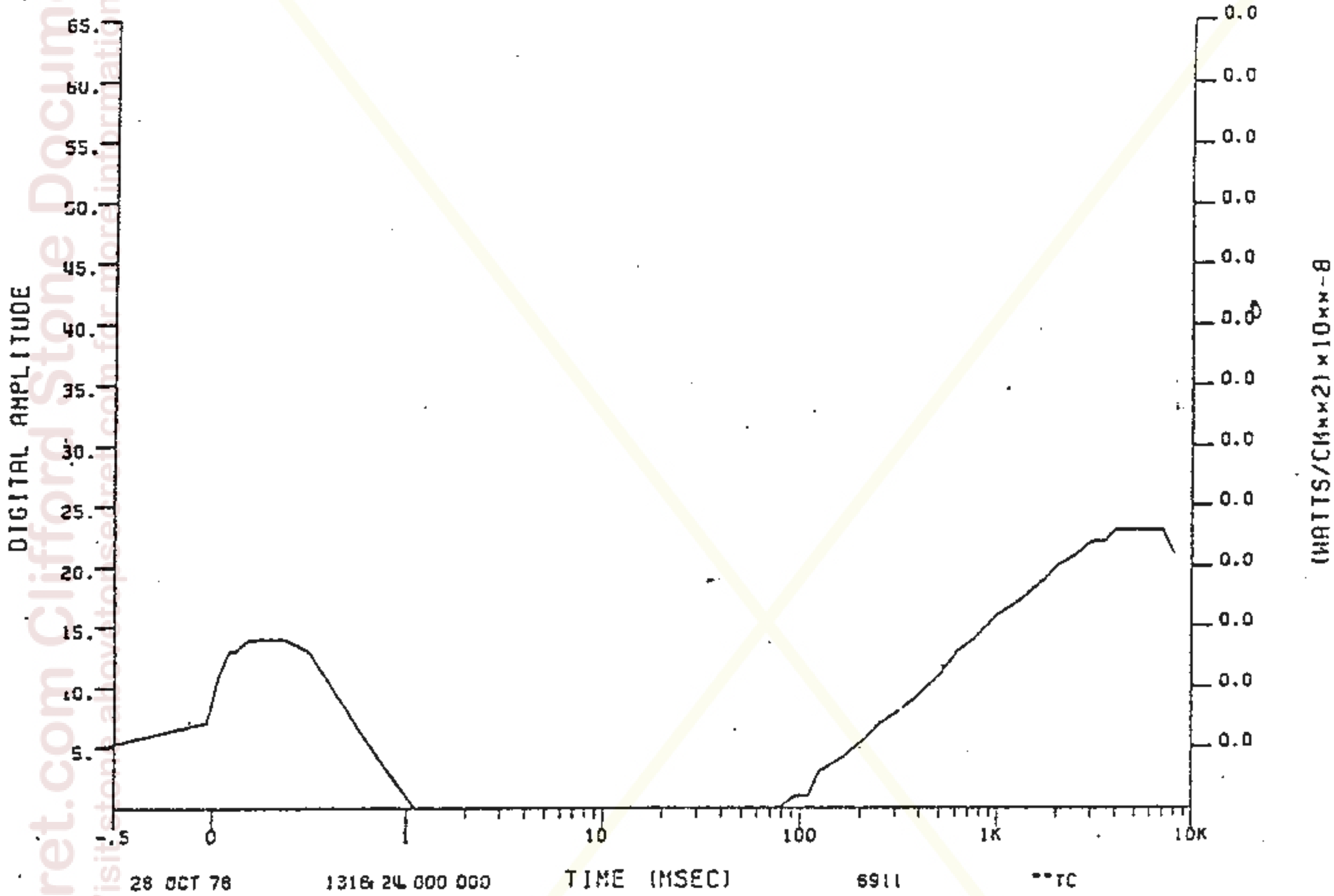

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FIGURE 2

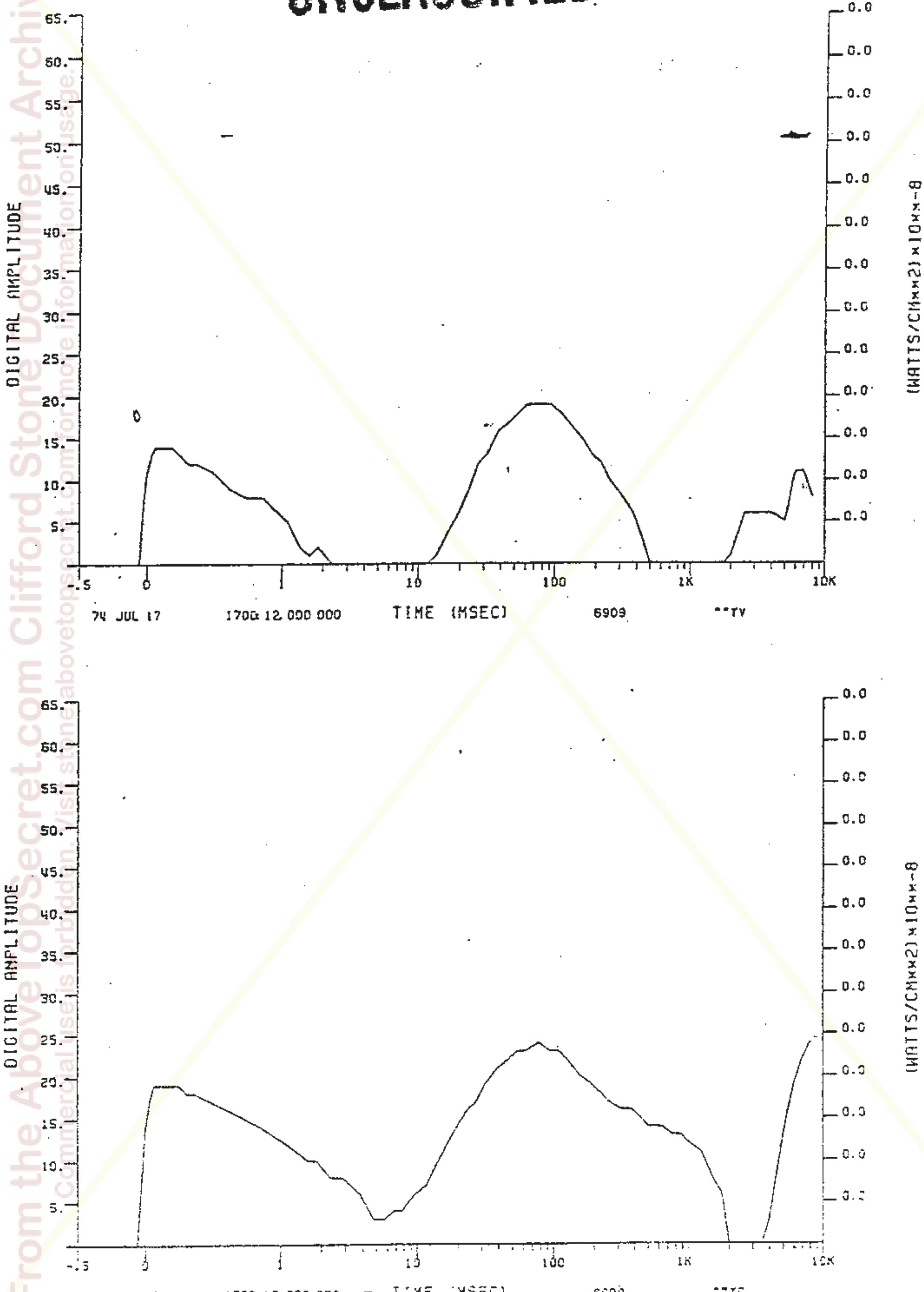

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FIGURE 3

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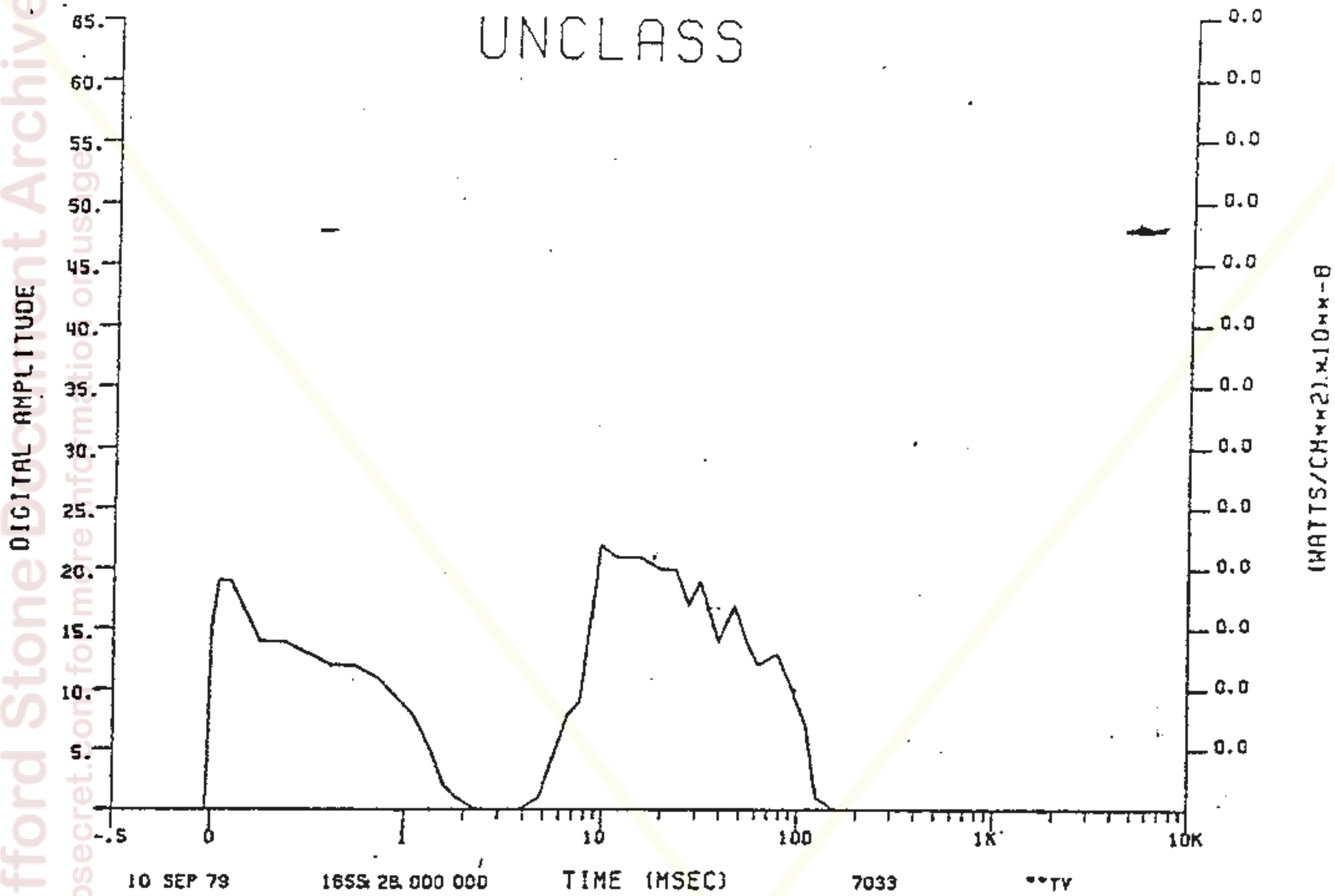
FIGURE 4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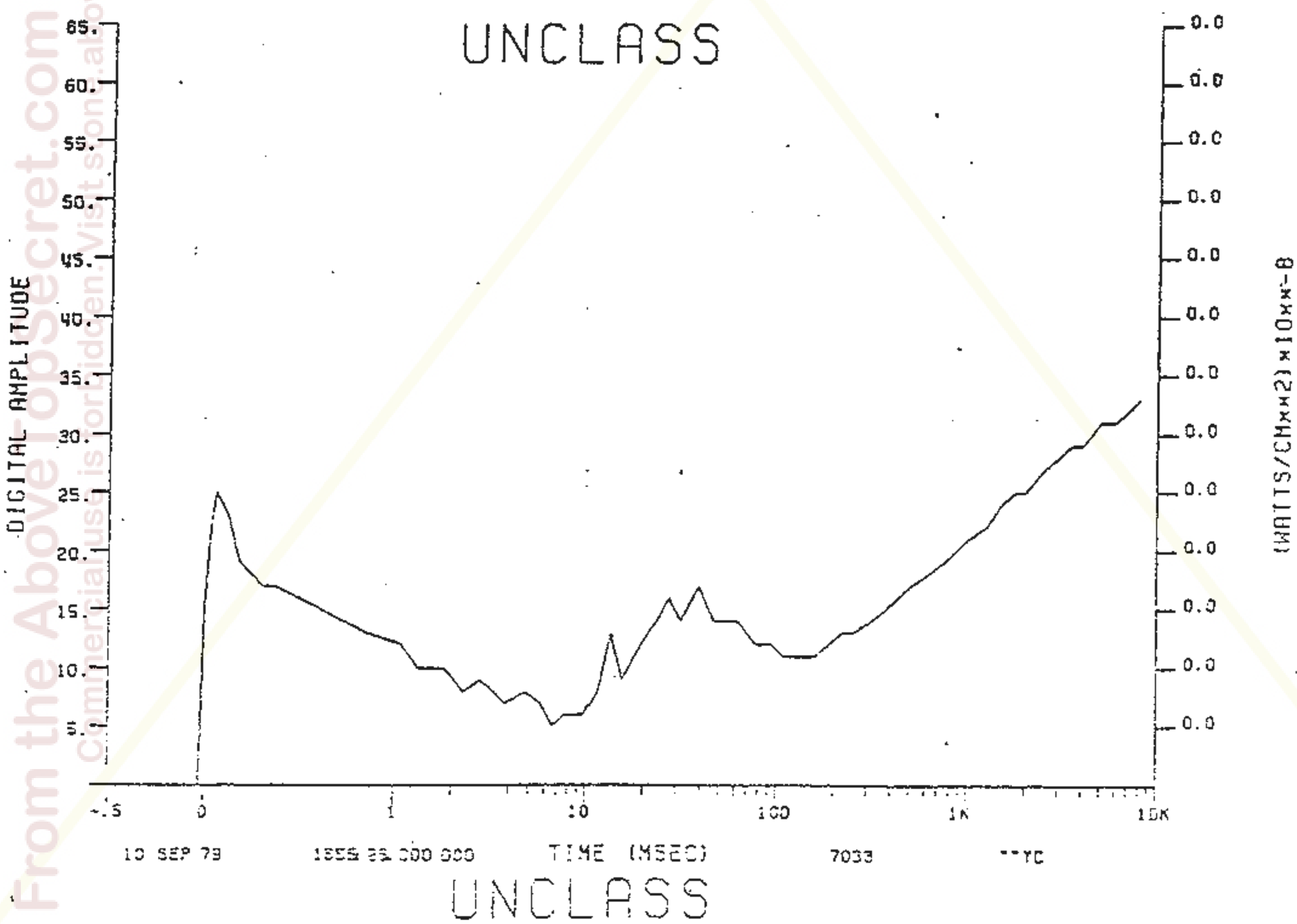
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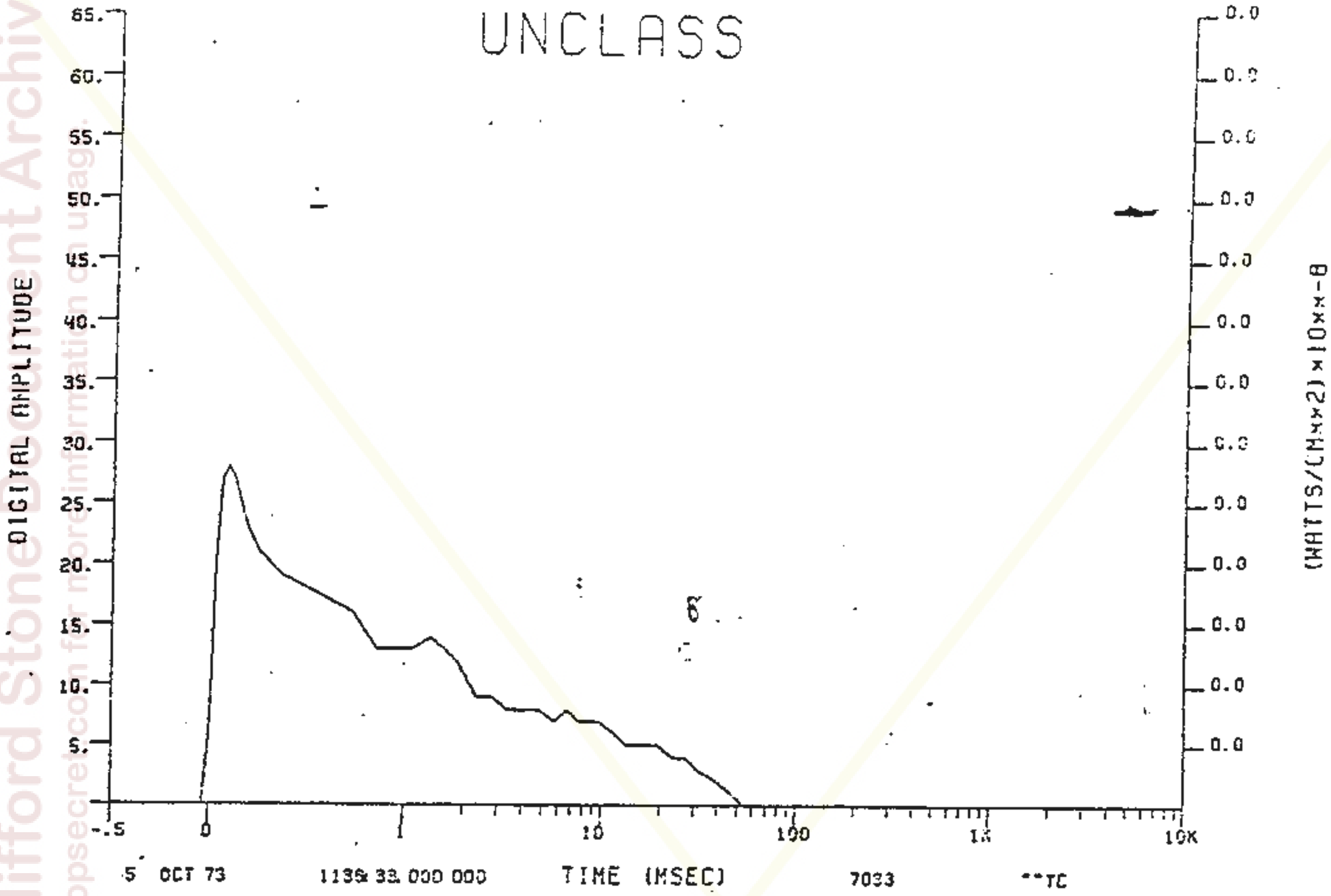
FIGURE 5



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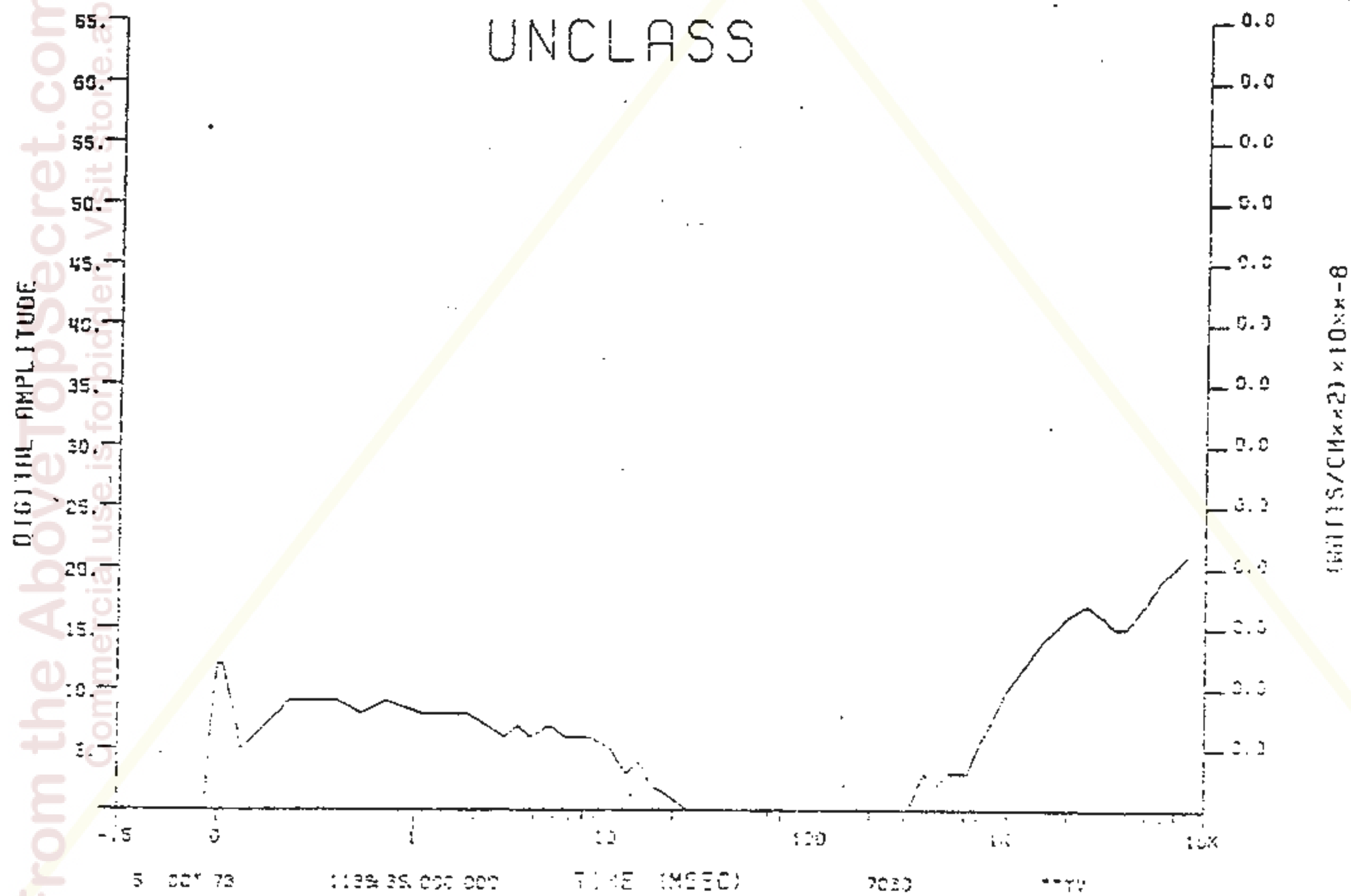

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The September 22 Event

On September 22, 1979, the two "bhangmeters" on board a VELA satellite observed a flash of light consistent with that observed from a nuclear explosion on or near the earth's surface. Identical or very similar bhangmeters are also on board other VELA and DSP satellites. However, these other satellites were looking at different parts of the earth and due to weather conditions had very little coverage overlap on the surface of the earth with the VELA satellite that observed the light flash. None of these others observed the light signal that was recorded by these bhangmeters.

The September 22 event has many of the features of signals from previously observed nuclear explosions. It has the right duration and the characteristic double-humped shape was recorded by both bhangmeters. The three separate yield determinations, which are normally derived from the time of the maximum and minimum of the pulse shape, are in rough agreement. (They agree about as well as one might expect, given experience with past low-yield events.) These results and the signal characteristics are consistent with a determination that the September 22 signal was from a nuclear explosion. But in making such a determination it is also necessary to show that the signal has no additional characteristics that rule out the nuclear origin hypothesis, or that there is not another class of signals for which it is more likely that the one of September 22 is a member.

It is interesting to note that the total light intensity observed on September 22 was considerably larger than expected for a hypothesized explosion with this measured yield. This could only be explained if the signal had been transmitted through "clear skies"--e.g., if the region where the signal originated was essentially cloud free. Yet heavy cloud cover and local rainout seem necessary to explain the absence of nuclear debris. However, these facts could be reconciled if the light were transmitted through a small local gap in cloud cover.

But more important, careful examination reveals a significant deviation in the light signature of the September 22 event that throws doubt on its interpretation as a nuclear event. The deviation is seen in the examination of the relative intensity of signals recorded in the two bhangmeters YC and YV. While the ratio of light recorded by YC and YV is not necessarily constant, it is expected to be reproducible, i.e., if at one time the bhangmeters recorded YC = 20, YV = 10 on a linear scale, then at a later time if YC = 20 again, one expects to see YV = 10 again, although YC may not be twice YV for other values. A "scatter plot" in which amplitude readings for the two bhangmeters are plotted against each other, should show a narrow locus for the recorded signals.

Actual data recorded for ground-based events does not completely conform to these ideal characteristics because of time differences between triggering of the two channels and changes in background (termed "tailup" and "taildown") during data recording.

Figure 6 shows YC versus YV plots for twelve known nuclear events and the September 22 event, all recorded by the VELA satellite that observed the September 22 event. To obtain this plot small time-shift corrections to the original data have been made to compensate for the fact that the two bhangmeters operate independently and do not trigger at precisely the same time. In addition, each time history has been truncated at the onset of tailup or taildown effects.

In the resulting plot, the discrepant behavior of the September 22 event in relation to known nuclear events is evident. All of the nuclear events fall within a narrow band, but the second hump of the September 22 event causes it to fall distinctly outside the nuclear band. Qualitatively, this means that during the second hump, the ratio of the bhangmeter signals is significantly different from what would be expected from a nuclear explosion near the surface of the earth. Such anomolous behavior was never observed in bhangmeter recordings of previous nuclear explosions. Thus, although the September 22 event displays many of the characteristics of nuclear signals, it departs in an essential feature.

It is very difficult to account for such a departure if the source of the September 22 signal was at a great distance from the bhangmeters, i.e., on the surface of the earth. On the other hand if the source of the September 22 signal were close to the satellite sensors, the relative intensity of the light incident on the two bhangmeters could be quite different from cases where the source is far away. That is, an object passing near the satellite might be more in the field of view of one sensor than the other, whereas at a distance the field of view of both sensors is essentially the same.

If the September 22 event were a zoo member rather than a nuclear explosion, then the deviation from the nuclear signal region in the YC/YV scatter-plot is not surprising. Many zoo events show large deviations in the scatter plot. Figure 7 illustrates this deviation for the zoo event in figure 8.

FIGURE 6

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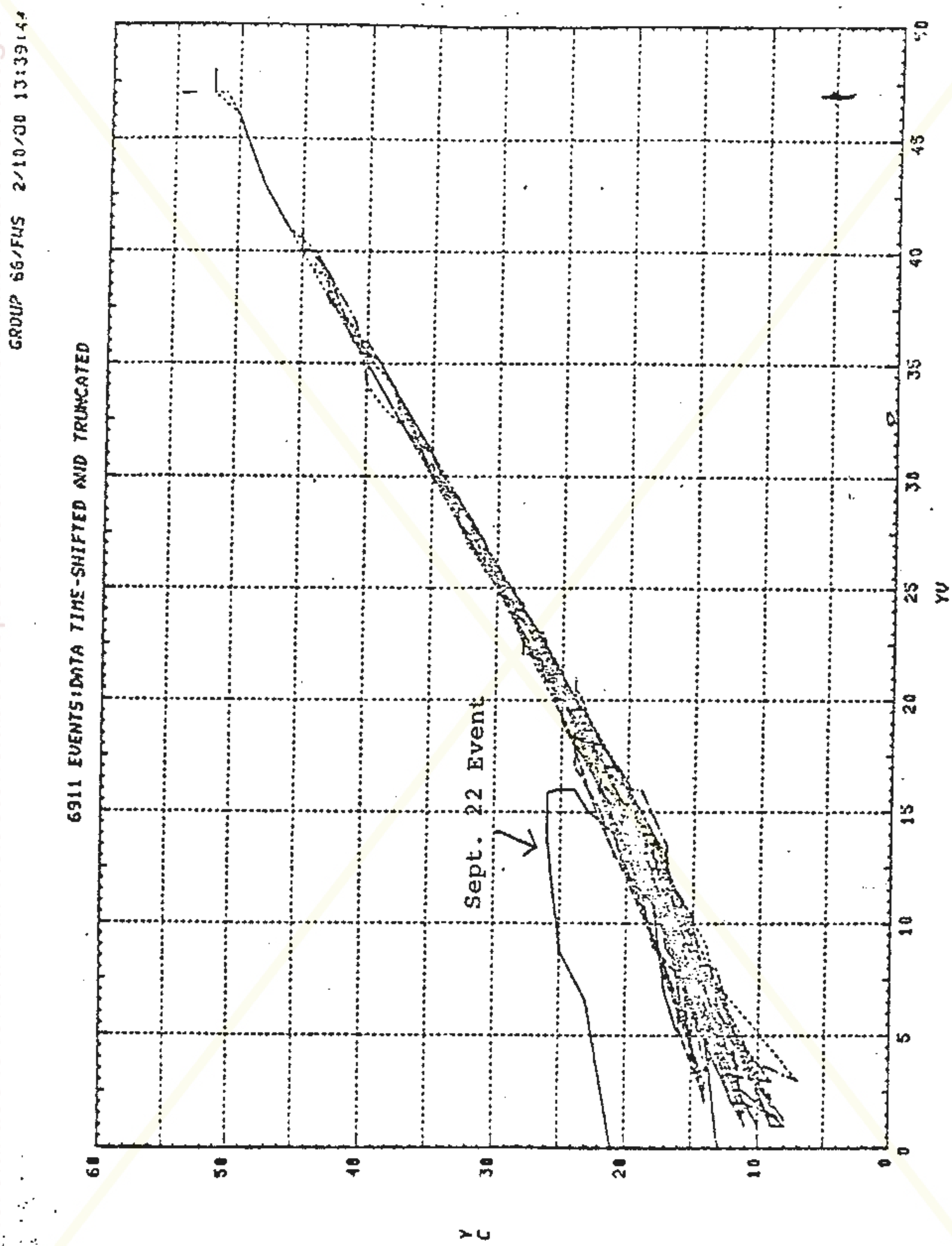

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PAGE 12

- FIGURE 7 -

1.5 (g)

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PAGE 13

- FIGURE 8 -

1.5 (g)

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These deviations are explainable by light reflections from material sufficiently close to the bhangmeter (within about 30 meters) so as to be out of the primary field-of-view of one or both of the optical sensors. In fact the obvious discrepancy between the two bhangmeter signals was responsible for these events once being labelled "meteoroids." It is impossible to make the zoo events lie in the narrow range seen for earth-based signals (such as the known nuclear events shown in figure 6) by adjusting the time delay between the YC and the YV channels.

In light of the consistency of all known nuclear event data when presented in YC/YV parameter space, the discrepant behavior of the September 22 event assumes major significance. If it is a nuclear event, some source for the increase in YC signal (or decrease in YV signal) must be determined. VELA instrument malfunction has been examined as a possibility but appears highly unlikely. Background changes arising from spurious reflections from the optical detector baffling surfaces has been advanced as a cause; some evidence presented late in our meetings indicates that this possibility should be pursued (it may be testable experimentally) but it is unlikely that such a reflection can account for the discrepancy.

The alternative explanation is that the September 22 event is not of earth origin. Viewed only in terms of YC/YV ratios, the September 22 event more closely resembles the zoo events than it does the known nuclear events. If no other mechanism for the YC/YV discrepancy can be determined, a near-by origin for the event must be considered more likely than an earth-based nuclear origin.

Alternate Explanations of the September 22 Event

The panel has examined a number of possible alternative sources of the bhangmeter signals on September 22, including unusual astronomical events, ordinary lightning, superbolts of lightning, sunlight reflection from other satellites, sunlight reflections from meteoroids near the satellite, and sunlight reflected from particles ejected from collision of meteoroids upon impact with the spacecraft. Lightning and superbolts produce single light peaks and have rise times too short to be confused with nuclear events. Meteoroids of sufficient size are too rare and travel too rapidly through the field of view to generate the observed time sequences. Unusual astronomical signals would have been observed by other sensors. Other satellites are too distant to reflect enough light to trigger the VELA bhangmeters. For these reasons, except for meteoroid impacts, all of the above have been ruled out as likely causes of the September 22 signal.

At present a meteoroid impact with the VELA satellite appears to be the best candidate for a nonnuclear origin of the signal. Such an impact could generate secondary particles with a much greater mass than that of the meteoroid itself and moving with a low velocity relative to that of the satellite. The number of particles emitted can be quite large. These features provide a mechanism for generation of the complicated time histories seen in the unexplained zoo events as well as in the September 22 event. The short initial pulse could be accounted for by the entry of the first or first several particles from the ejecta into the field of view, and the long duration second-pulse from the large mass of ejecta which would soon follow. The event could be triggered by a meteoroid much smaller in size than would be required if the light signal had to be explained by reflection from the original meteoroid itself. Estimates made at SRI International show that such a collision can reasonably lead to the observed signal during the 10 years or so that the VELA system has been in operation.

There is additional indirect evidence from the Pioneer 10 spacecraft observations which supports this model. This spacecraft had both optical and impact sensors for meteoroid detection, but the frequency of signals recorded by the optical sensors on Pioneer 10 is two orders of magnitude greater than the detection rate recorded by its impact sensors. Interestingly, the Pioneer 10 optical observations are in reasonable agreement with the VELA zoo events, both being much more common than meteoroid impact measurements would suggest. By taking into account the much greater reflectivity of the large amount of material ejected from impact than that of the original meteoroid, one concludes that the satellite should observe large optical signals from the abundant small meteoroids that hit the satellite, rather than from close encounters with large meteoroids. Thus, the meteoroid impact model may account for both the zoo events and the high rate of optical observations of meteoroids by Pioneer 10.

Search for Supporting Data

Nuclear explosions produce fission products not otherwise found in the atmosphere and generate a variety of geophysical disturbances including hydroacoustic waves, acoustic waves, seismic signals, traveling ionospheric disturbances, electromagnetic pulses (EMP), and magnetic signals. Detection of radioactive fallout can be immediately confirmatory for a nuclear event. In contrast, geophysical signals from both natural and other artificial sources may resemble those from explosions. For low-yield explosions these geophysical signals are usually "noisy" and therefore by themselves cannot lead to unambiguous conclusions. At this time no data on EMP or magnetic disturbance that can be correlated with the September 22 signal are known to the panel. We describe below our assessment of the search for nuclear debris and data from the other geophysical sources.

a. Debris Collection

The efficiency of debris collection from a nuclear explosion is affected by the weather near the explosion site. Unstable weather and rain can significantly reduce the probability of debris collection due to rapid precipitation of debris. Weather data indicate broken clouds or overcast in much of the area of interest. [redacted] 1.5(g)

Since there was considerable uncertainty in the source location, debris collection missions were flown against air trajectories from four postulated locations (Kalahari Desert, Prince Edward Island, and two ocean locations representing possible sources of infrasonic-acoustic and hydroacoustic signals). In addition, more general search missions were flown to intercept the easterly air flow from other parts of the area of interest.

Attempts to locate debris were made both by aircraft and an extensive program of ground-based sample collections. Background radiation is generally low in the Southern Hemisphere. A tentative positive result in New Zealand was subsequently shown to be erroneous. All other collections were negative, some of them indicating unusually low levels of background radiation.

Positive results from the debris collection effort would provide conclusive evidence of a nuclear explosion. However, the negative results actually obtained do not provide conclusive evidence that no nuclear explosion occurred.

b. Acoustic Data

An acoustic signal was recorded at a distant recording site in the northern hemisphere at an appropriate time. A second site in the same region had negative results for this event as did sensors in Australia. On the basis of expected propagation models for the season a better sound channel would be expected from the region of interest toward Australia than toward the northern hemisphere. Also, on the basis of AFTAC statistics for low-yield nuclear explosions, no signal would be expected at any of the above sites. In addition, there is a substantial probability of an uncorrelated signal arriving within the large time window allowed, since the position of the signal's origin is unknown. Thus, the acoustic data available are considered unrelated to this event.

c. Hydroacoustic Data

In a very preliminary analysis, a search by NRL has shown weak signals at SOSUS sites [redacted] 1.5(d) Signals a few decibels above background noise occur at these sites at times appropriate for direct arrivals from a source near Prince Edward Island and for rays reflected from the Antarctic ice shelf. These data were analyzed by a filtering procedure that is not normally used with SOSUS data, [redacted] 1.5(g)

In the case of [redacted] 176 signals occurred above background during a 156-hour period. Similar information was not yet available for [redacted] This entire study is still too incomplete to apply to the event because no determination of background signal amplitude and occurrence have been furnished to resolve the question of ambiguity in signal identification and source locations. 1.5(d)

d. Traveling Ionospheric Disturbance (TID)

A TID consisting of a few aperiodic waves was observed by the Arecibo radar in Puerto Rico as traveling from SE to NW during several hours in the early morning of September 22. A S to N trace velocity of 1200 ±300 meters per second (m/s) was reported. The true velocity is a function of the direction of propagation which was reported to be such as to give a value of 500 to 750 m/s, which are values typical of large-scale TIDs. Although a South-to-North propagation of large-scale TIDs from natural sources is considered unusual in low northern latitudes, only 120 hours of observation were available for this very sensitive instrument, providing a very weak data base. In this regard, weather satellite data of September 22 indicates that there was a tropical storm a few hundred miles from Arecibo at the time of interest and ionospheric disturbances are known to be generated by such storms. Longer observation at Arecibo may show such events more frequently. Also, a significant error in direction can reduce the true velocity to 150-200 m/s which is the realm of medium-scale TIDs. Arrival from the SE is not a rare event for the much more common medium-scale TIDs. In view of the inadequate data base, uncertainty in signal analysis, and alternative natural explanations, we do not at this time consider the Arecibo data as useful evidence related to the September 22 VELA signal.

Comments on the Nature of the Problem and Our Conclusions

The panel was charged with evaluating the significance of a single satellite observation combined with extensive additional data which were searched for and examined in consequence of that single observation. Specifically, the issue is to evaluate the likelihood that these observations provided persuasive evidence for the occurrence of a nuclear explosion. In concluding that it did not do so it is not necessary, and may in fact not be feasible, to provide a specific credible alternate explanation. This is not an unusual situation in ordinary scientific experience: many scientific investigations leave a residue of unexplained events. In particular, in approaching interpretations of a problem initiated by a single observation, the totality of available data may not provide a single persuasive explanation.

The preceding remark is intended to counter the concern that, "Well if it is not a nuclear explosion, then what is it?" We consider the alternative explanation of the September 22 signal as light reflected from debris ejected from the spacecraft as reasonable, but we do not maintain that this particular explanation is necessarily correct.

We do in fact find that the VELA signal of September 22, 1979, contains sufficient internal inconsistency to cast serious doubt whether that signal originated from a nuclear explosion or in fact from any light source not in the proximity of the VELA satellite. Moreover, AFTAC provided the panel with hundreds of signals which constitute a family of unexplained zoo events clearly not generated by nuclear explosions. The September 22, 1979, event may be considered as a possible member of that group.

As discussed elsewhere, the search for supplementary evidence on the nature of the September 22, 1979, event has provided extensive data of varying relevance to the problem. The panel recognizes that there is evidentiary value both in the paucity of such ancillary data as well as in the content of the data obtained.

For example, one could, in this case, gather individual pieces of information that suggest the September 22 event was a nuclear explosion, assign a false alarm probability to each source of information, then multiply these probabilities. This method necessarily results in a small number and is then taken as corroborative evidence of the nuclear origin of the signal. But this method fails to take into account all relevant information--e.g., data that conflicts with the hypothesis that a nuclear explosion occurred as well as the absence of data from certain sensors or locations. We surmise that had a search been made for corroborating data relevant to a nonexistent event chosen to occur at a random time, such a search would have provided "corroborative data" of similar quantity and quality to that which has been found during analysis of the September 22 signal.

Although the panel is not able to compute the likelihood of the November 22, 1979, event being a nuclear explosion, based on our experience in related scientific assessments, it is our collective judgment that the September 22 signal was probably not from a nuclear explosion.

APPENDIX

AD HOC PANEL ON THE SEPTEMBER 22 EVENT

Panel members:

Dr. Jack Ruina, Chairman	Department of Electrical Engineering Massachusetts Institute of Technology
Dr. Luis Alvarez	Department of Physics University of California, Berekely
Dr. William Donn	Lamont-Doherty Geological Observatory Columbia University
Dr. Richard Garwin	Thomas J. Watson Research Center IBM
Dr. Riccardo Giacconi	Harvard/Smithsonian Center for Astrophysics Harvard University
Dr. Richard Muller	Department of Physics University of California, Berekely
Dr. Wolfgang Panofsky	Stanford Linear Accelerator Center Stanford University
Dr. Allen Peterson	Department of Electrical Engineering Stanford University
Dr. F. Williams Sarles	Lincoln Laboratory Massachusetts Institute of Technology