Scientists Fail to Solve Vela Mystery

The satellite may have spotted a nuclear blast, the President's panel says, or perhaps it saw a meteoroid

The puzzle created last fall by surveillance satellite Vela remains unsolved today even after an intense, 3-month analysis conducted by the White House science staff. The Vela, which was designed to spot atmospheric nuclear tests, reported on 22 September that it "saw" the explosion of a small nuclear device (2 to 4 kilotons) somewhere in the neighborhood of South Africa (*Science*, 30 November). The government claims it has found no supportive evidence for the message sent by this very reliable bomb-spotting device.

The President's science adviser, Frank Press, was planning to release a report in January concluding that the event that caused Vela to send its message is "technically indeterminate." That was the chief finding of a panel of nine scientists who had been assembled to make an independent review of the government's data. The group was chaired by Jack Ruina, professor of electrical engineering and computer science at the Massachusetts Institute of Technology.*

The scientists reached this conclusion despite the fact that they were presented with one strong piece of evidence—the sighting of a disturbance in the ionosphere—that suggested a bomb might have been detonated on the night that the Vela sent its message. The President's panel challenged some of the data submitted by the civilian astronomers who reported this disturbance. The latter are now preparing a formal defense of their work.

Thus, there is no proof that a bomb exploded, and no country has admitted to exploding one. Some nonproliferation officials in the State Department suspected last fall that South Africa or other would-be nuclear powers had conducted a surreptitious bomb test. Now, lacking firm evidence, a State Department expert says, "We are not in a position to accuse anybody of anything." He is less inclined than before to believe the Vela's message because the technical report "now tells us that what we thought was a unique signal [from Vela] was a *nearly* unique signal. We've opened up other possibilities."

The Press report, as it is called, summarizes the work that led the panel to conclude the satellite's message may have been wrong. The panel began by trying to find corroboration for the Vela. The best supporting evidence came from a health physics laboratory in New Zealand. It reported in mid-November that it had found some traces of short-lived fission products in rainwater. This would have been proof enough of a bomb blast, had it held firm. But it didn't. The national radiation laboratory in New Zealand disagreed with the findings. When the samples were tested a second time, no fresh radioactive pollution appeared to be present. The lab's theory is that the instruments in the first test were contaminated with radioactive material. In any case, the report was withdrawn. A U.S. government laboratory examined the samples and reached the same conclusion: there was no fresh radioactivity in the rainwater.

The United States surveyed countries in the Southern Hemisphere that might have detected an increase in atmospheric radioactivity. According to an official who worked on the report, none found any fresh fallout. This is significant, he said, because that part of the world is relatively clean. It is unlikely, although not inconceivable, that bomb fallout would escape detection.

Other monitoring systems apparently turned up no evidence of a blast. There were no seismic, airborne, or waterborne acoustic signals that could be linked exclusively with a bomb blast. But there was one other sighting made by chance at the radio observatory at Arecibo, Puerto Rico, suggesting that the Vela may have been correct. Scientists looking into space with the big radio telescope on the night of 22 September noticed a ripple moving through the ionosphere several hours after the Vela claimed to have seen a flash in the Southern Hemisphere. The observers were watching the upper atmosphere to gather baseline data for another experiment, in which they planned to watch an Atlas Centaur rocket rip a hole in the ionosphere during its launch.

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According to the scientist who saw the ripple, which he called a pattern of "ducted ionospheric disturbances," the movement appeared at the right time and from the right direction (from the southeast) to have been linked with the flash spotted by the Vela. A nuclear explosion might have sent a shower of electrons traveling outward through the ionosphere in such a way as to cause it to "bob up and down a little," as it did that night.

The ripple was rejected as corroborative evidence by the White House panel because it was not considered to be the exclusive signature of a nuclear blast. The same bobbing effect may be caused by earthquakes, electrical storms, sunspots, solar flares, and other natural events. Furthermore, according to Carter Administration officials, the fact that the observation was made several thousand kilometers from the supposed source of the disturbance made its significance doubtful. "Very little is known about how these disturbances travel,"

*The other panel members were Luis Alvarez of the University of California at Berkeley, William Donn of the Lamont-Doherty Geological Observatory, Richard Garwin of Harvard University, Riccardo Giacconni of the Harvard Smithsonian Center for Astrophysics, Richard Muller of the University of California at Berkeley, W. K. Panofsky of the Stanford Linear Accelerator Center, Allen Peterson of the Stanford Research Institute, and F. William Sarles of MIT's Lincoln Laboratory.

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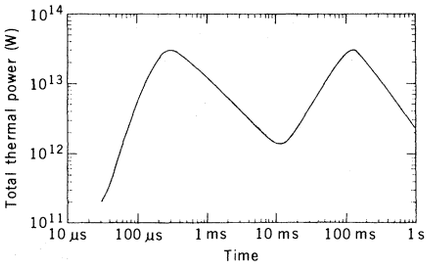
an official said. "Some people say you shouldn't see a signal [of a nuclear blast] more than a couple of hundred kilometers" from its source.

Richard Garwin, one of the panel members, said the ionospheric ripple was the most plausible of all the "candidate" verifications showing that there may have been a blast. It was "a striking observation and quite unusual" in that it moved from south to north. Most disturbances seen in the past have moved in the opposite direction. But, Garwin added, the record of the particularly sensitive kind of observation made at Arecibo is not long enough to permit many generalizations. He personally doubted that so large a ripple could have been created by a blast as small as the one Vela seemed to see.

The scientists who saw and analyzed the event, Richard Behnke and Lewis Duncan, are quite confident that their observations were correct. Some members of the President's panel challenged them, however, claiming that major errors in their calculations invalidated their findings that fixed the angle of arrival and speed of the ionospheric ripple. These panel members proposed another method of calculating the results. But Behnke and Duncan think their approach is correct. A meeting in Washington, D.C., with the expert panel, they said was "mass confusion . . . an exercise in distraction."

Duncan went on a "traveling road show" with his data in December, and was troubled to find himself swept into a vortex of controversy. Some people went overboard in reading too much into his report, and others were unreasonably critical. "It surprised me," Duncan said, "that people have tried as much as they have to discredit it." He is a bit annoyed that the critics failed to appreciate the sophistication of the instruments and methods used. Arecibo's incoherent-scatter radar is the most sensitive in the world, and it was using an observational technique on 22 September that had been on line for only 2 weeks. Duncan gets "a little upset" when people suggest that it could not have spotted traces of an event far from the source. The doubters seem to be using outdated assumptions. He points out that the traditional monitoring device at Arecibo—ionosonde—did not detect any disturbance that night.

Because of the ducted pattern of the ripple, Duncan feels confident that it must have come from a source at least 500 kilometers away. It was moving from the south and east—the only disturbance of this kind ever seen traveling in this direction above the equator. Most ionospheric ripples are caused by magnetic storms at the earth's poles, and they nearly always travel from the poles to the equator. This one created "an anomalous piece of data," because it may have crossed from the Southern to the Northern Hemisphere. Except for this event, it was a relatively quiet night in the ionosphere. Duncan is aware of no electrical or geomagnetic storms south of Puerto Rico that might have stirred up the electrons.



The double flash of a nuclear explosion as registered by a Vela-type sensor and recorded on a logarithmic scale. This one was produced by a 19-kiloton blast in Nevada in 1952. [Source: Los Alamos Scientific Laboratory]

The most controversial finding is Duncan's calculation that the disturbance was traveling at a rate between 600 and 750 meters a second—the typical speed, he claims, of ionospheric ripples. This variable determines whether the ripple may or may not be linked with Vela's sighting. Members of the White House panel took issue, arguing that the speed was much lower. Duncan says their assumptions are wrong.

Despite these differences, the Arecibo scientists agree with the President's panel on the main point: they say that their observations cannot be interpreted as confirmation that a blast occurred. It is just "a piece of the puzzle," they say. The official report simply notes that other events may have caused the ripple.

In looking for a solution to the big puzzle, Press's panel considered the possibility that the satellite might have malfunctioned. It was ruled out after a thorough reexamination of the hardware and its record of performance. Before and after the sighting, the satellite responded correctly to test pulses.

The problem remained the same: what nonnuclear event could have produced the double-humped signal (see graph) which is supposed to be the unique signature of a nuclear blast? As one official put it, the graph of the 22 September flash is the only one in thousands of signals received in the last 10 years that precisely fits the model of a nuclear event, but which appears not to have been made by a bomb. The satellite was designed not to be fooled by natural phenomena, and, after a "very extensive review," the panel eliminated nearly all of the obvious explanations. They ruled out cosmic rays, solar flares, sun glint, meteor flashes, lightning bolts, and super lightning bolts.

They turned in exasperation to a category of events referred to as the "zoo animals"—strange signals received over the years for which no satisfactory explanation has been forthcoming. These had been written off as effects caused by light reflected off small meteoroids passing in front of the satellite's sensors. Among them were some double-humped signatures, but none fitting the proportions of a nuclear blast signature. The experts ran a computer study to see whether it was physically possible for a meteoroid to cause a nuclear glint in the eye of the satellite. They found that it was.

For the time being, this is how the Vela sighting is being explained. A meteoroid or piece of debris from a satellite, the hypothesis goes, floated into the satellite's vision, sending a sudden glint into the register. Then, as the debris rotated, a facet on the surface may have caused the glint to darken and then grow bright again, creating the exact replica of a nuclear bomb flash.

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Administration officials concede that the probability of this having happened is "very low." But the likelihood of an atmospheric blast failing to leave any physical trace is also very low. It is impossible, a White House official said, to compare the relative probability of the occurrence of these two very unlikely events.

The experts seemed to find some justification for the meteoroid theory in one unusual aspect of the satellite's signal. The Vela picked up this event with two light sensors, one more sensitive than the other. Both registered precisely the same double-humped pattern of a nuclear blast, but they differed in the amount

of light measured. The duller sensor apparently recorded a greater total volume of light than did the sensitive one. To the experts, this suggested that a meteoroid may have passed the satellite in a trajectory that took it closer to one of the sensors.

Outside the government, this explanation is met with skepticism. The authors of the Press report realize that the scenario described is in the rare event category, but they have nothing better to offer. The evidence supporting the Vela's message is still too flimsy, they think, to prove that someone tested a bomb.

The President's science staff will continue to study the Arecibo sighting and the characteristics of Vela's zoo animals. They hope these will provide a definite answer to the problem sometime.

—ELIOT MARSHALL

Psychotherapy Works, But for Whom?

People improve with therapy, but the clinical studies are too uneven to explain how or why

Less than 20 percent of the money spent on mental health care in the United States pays for psychotherapy, according to the American Psychological Association. Yet this form of treatment (involving structured talk rather than drug therapy) seems to draw the heaviest critical fire. This may be because psychotherapy, of all forms of mental health care, resembles the practice of physical medicine the least. It usually does not require the use of hospitals, drugs, or machinery, although it is often used in connection with them. The most important distinction may be that psychotherapy is governed by very few common standards. Thus it is difficult to make any generalizations about its effectiveness.

The field's most insistent critic at the moment is Congress, which has begun to demand hard clinical proof of psychotherapy's accomplishments before agreeing to finance it under Medicare (*Science*, 4 January). This demand and other demands from within the field for standardization of research have put new stress on attempts to demonstrate that psychotherapy really works. Many projects are afoot to increase the credibility of the field's scientific claims, the latest being a proposed $1 million clinical trial of the treatment of depression, to be managed by the National Institute for Mental Health (NIMH).

Here a note of definition is needed. The dictionary says that psychotherapy is simply the treatment of a mental or emotional disorder "by psychological means, especially involving verbal communication." The practitioners themselves use slightly more specific terms, stressing the importance of the therapist's credentials. One classic definition says psychotherapy is:

> the informed and planful application of techniques derived from established psychological principles, by persons qualified through training and experience to understand these principles and to apply these techniques with the intention of assisting individuals to modify such personal characteristics as feelings, values, attitudes, and behaviors which are judged by the therapist to be maladaptive or maladjustive.*

As the definition suggests, the trick is in knowing how to apply the established psychological principles. There is no consensus on this point; responsible reviewers have guessed that there may be 100 to 140 schools of psychotherapy—all of them in the mainstream.

Psychologists are annoyed when asked, "Does psychotherapy work?" Gary VandenBos, a policy official at the American Psychological Association, says "It is a stupid question. It's like asking, 'Does surgery work?' " He thinks the question is too broad to be answered meaningfully. "Does surgery work in treating the common cold?" he asks. VandenBos is annoyed also because he thinks it is unfair to demand that psychotherapy pass a hard scientific test of efficacy before it wins reimbursement in public health programs. He claims that techniques used in physical medicine are not required to pass such rigorous screening before winning reimbursement. And finally, he finds it ironic that what he considers to be the most progressive form of treatment—psychotherapy—is taking the greatest heat. He says that the more common practices of tranquilizing and hospitalizing mental patients would prove less effective than psychotherapy, or even harmful, if they were subjected to the same critical review.

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Jerome Frank, professor emeritus of psychiatry at the Johns Hopkins School of Medicine and a noted expert on the evaluation of therapies, argues that there is little point in conducting clinical trials. In a speech given last year before the American Orthopsychiatric Association, Frank said that success depends more on the abilities of the therapist than on the methods used. It is futile, he thinks, to codify rules of treatment: "To try to determine by scientific analysis how much better or worse, let us say, gestalt therapy is than transactional analysis is in many ways equivalent to attempting to determine by the same means the relative merits of Cole Porter and Richard Rogers. To ask the question is to reveal its absurdity." Frank thinks that a good therapist, like a good artist, is unique.

Despite their discomfort at doing so, practitioners do offer up general answers to the question of efficacy. One recent study cited as proof that psychotherapy works was conducted in 1977 by Mary Smith and Gene Glass at the University of Colorado in Boulder. Their ambitions

*J. Meltzoff and M. Kornreich, *Research in Psychotherapy* (Atherton, New York, 1970).

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