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Physical Analyses

- Physical Analyses in Ten Cases of Unexplained Aerial Objects with Material Samples¹

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Abstract — A survey of ten cases of unexplained aerial phenomena accompanied by material residues shows a broad distribution of natural elements, many of which are metallic in nature. They can be roughly described as belonging in two categories: "light materials" of high conductivity such as aluminum, and "slag-like materials" reminiscent of industrial byproducts. Most of the cases under consideration strive to meet four criteria: 1) the literature gives sufficient ground to support the fact that an unusual aerial phenomenon occurred, 2) the circumstances of the actual recovery of the specimen are reported, 3) there is data to suggest that the specimen is in fact linked to the observed aerial object, and 4) physical analysis has been performed by a competent laboratory of known reliability. In several instances the sample is available for continuing study by independent scientists. In the absence of a firm chain of evidence and of professional field investigation, most cases cannot lead to a definite conclusion about the nature of the phenomena that gave rise to each specimen, but much can be learned from the methodology involved in such analysis. Furthermore, compilation of similar cases on an expanded basis may eventually lead to the discovery of underlying patterns.

Keywords: UFOs — UFO sightings — physical evidence — propulsion

Introduction

The combination of a reliable sighting of an unexplained aerial object with the recovery of a durable physical specimen is rare. While the media often allude to sensational finds and at least one former military intelligence officer has stated that he once had custody of advanced technology coming from a "crash," (Corso, 1997) the material is not available for independent study and the details of its composition are scanty and contradictory.

At a more modest level, in the course of their investigations of the phenomenon around the world, civilian researchers acting privately have patiently assembled the embryo of a sample collection, starting from physical specimens reportedly gathered at the site of a close encounter or "maneuver" type sighting.²

The present paper summarizes the data, stressing methodology while refraining from proposing premature explanations for the origin of the samples. We strived to find those cases where 1) the literature gives sufficient ground to

¹Presented at the Physical Evidence Related to UFO Reports Workshop, Tarrytown, New York, Sept. 30-October 3, 1997.

support the fact that an unusual aerial phenomenon occurred, 2) the circumstances of the actual recovery of the specimen are reported, 3) there is data to suggest that the specimen is in fact linked to the observed aerial object, and 4) physical analysis has been performed by a competent laboratory of known reliability. In several cases the sample is available for continuing study by independent scientists. In the present paper we will try to establish the frequency of such cases and the type of analysis they suggest. In conclusion we will examine hypotheses that may deserve further testing.

Statistical Frequency of Physical Sample Cases

In an excellent catalogue compiled by Mr. Larry Hatch³ and made available to researchers and to the general public one finds 15,181 unexplained aerial phenomena reports that have been tabulated in computer-readable form. We have broken down these cases according to the classification system used by this author (Vallee, 1990) in order to bring out the distribution of incidents across various situations. Under this classification, inspired from Hynek's definition of close encounters (Hynek, 1972), each case is given a type and a category. Hynek used a single digit representing the "kind" or type of incident, ranging from "1" for a simple sighting and "2" for physical effects to "3" for report of a lifeform or living entity. We have extended this typology using "4" in cases when witnesses experienced a transformation of their sense of reality (often corresponding to the popular characterization of the incident as an "abduction") and "5" in cases of lasting physiological impact, such as serious injury or death.

The categories to which the typology is applied range from "CE" for close encounters and "MA" for maneuvers (trajectory discontinuity) to "FB" for fly-by (no observed discontinuity in flight) and "AN" for simple anomalies in which no UFO was reported: unusual lights or unexplained entities fall into this last category.





















Using this classification we would speak of a particular case as a CE-3 incident, or a MA-2 incident, *etc.*, leading to the simple matrix of Table 1, which provides a convenient way for establishing a baseline in comparing reports from various countries or from various epochs.

When the Hatch catalogue is mapped into this classification the resulting distribution is that of Table 2, showing 3,175 cases of physical effects, or 21%

³The author is especially indebted to Dr. Peter Sturrock, Dr. Harold Pathoff, Dr. Robert Wood, Mr. Il-
obrand von Ludwiger and Mr. John Schuessler for help in analyzing materials or in communicating de-
tails of their own findings on various samples mentioned in this article. We owe recognition to pioneers
of this research, such as Dr. Olavo Fontès in Brazil and Jim and Coral Lorenzen in the U.S. Assistance
from Messrs. Robert Allen, Ricardo Vilchez, Richard Masilko and Mark Uriarte in securing access to
various specimens is gratefully acknowledged. Several correspondents, notably Robert Kincheloe,
Pierre Lagrange, James McCampbell, and Joe Roser, have called the author's attention to important doc-
uments and research ideas.

⁴Larry Hatch's computer catalogue is available from him in diskette format under the DOS operating
system running on standard IBM-compatible PCs. His address is 142 Jeter street, Redwood City, Califor-
nia 94062.

TABLE I
Classification of Anomalies

	1	2	3	4	5	
AN ANOMALY						
FB FLY-BY						
MA MANEUVER						
CE CLOSE ENCOUNTER						
	Sighting	Physical Effects	Living Entities	Reality Transformation	Physiological effect	

of the catalogue, broken down as follows: 90 are associated with simple anomalies, 19 with a fly-by, 1,782 with maneuvers and 1,284 with close encounters. It should be noted that we are using the January 1997 version of the Hatch catalogue, which is an evolving entity. Statistics performed on other versions may differ from those given here.

In Table 2, "physical effects" may refer to soil disturbances, broken tree limbs, crushed grass, burned areas, or to a variety of electromagnetic effects.

TABLE 2
Incident Frequency in the Hatch Catalogue

Type	1	2	3	4	5		
Category	Sighting	Physical Effect	Lifeform	Reality Transformation	Physiological Effect		
AN Anomaly	323	90	103	78	56	650	4.3%
FB Fly-by	3,657	19	7	1	0	3,684	24.3%
MA Maneuver	4,551	1,782	139	412	89	6,973	45.9%
CE Close Encounter	1,158	1,284	593	530	309	3,874	25.5%
	9,689	3,175	842	1,021	454	15,181	100.0%
	63.8%	20.9%	5.5%	6.7%	3.0%	100.0%	

The Alleged Crash at Aurora (Texas): April 17, 1897.

In order to provide some background to the analysis that follows, it is interesting to note that allegations of extraterrestrial "crashes" are nothing new and did not even begin in the present century.

In the course of a survey of early aerial phenomena in the United States, Donald Hanlon and the author found numerous reports of sightings in the period 1896-1897, which has become known in the literature as the "airship wave." (Hanlon & Vallee, 1967) One of the most remarkable cases had been reported on April 17, 1897 in the small town of Aurora (Texas). The story, as told in a local newspaper, stated that an unidentified object "sailed over the public square and when it reached the north part of town collided with the tower of Judge Proctor's windmill and went to pieces with a terrific explosion, scattering debris over several acres."

Although Hanlon and this author regarded the story as an instance of early Americana and a probable hoax (in a context remarkably similar to that of Roswell, the press went on to state that the pilot of the ship, who "was not an inhabitant of this world," had died in the accident and that undecipherable papers were "found on his person"), our article re-awakened interest in the case. It was investigated again in 1973 by William Case, a journalist with the *Dallas Time-Herald*, and by personnel from the McDonnell Douglas aircraft company. While the 1897 story reported that the airship was "built of an unknown metal resembling somewhat a mixture of aluminum and silver," the fragment found by Case and his co-workers was determined to consist of aluminum (83%) and zinc (about 16%) with possible traces of manganese and copper. The combination could originate with numerous common aluminum alloys, according to the McDonnell scientists, but not prior to 1908.⁴

While we cite this case for completeness, it is not included in the overall analysis.

Case Studies

The cases that follow have been extracted from the small subset of physical effects cases where recovery of a material specimen was achieved under conditions that are of sufficient reliability to warrant serious follow-up. One case (the Council Bluffs incident of December 17, 1977) will be described in detail. Other incidents drawn from the literature and listed in chronological order will provide the relevant backdrop.

Case no. 1: 1933 or 1934. Ubatuba, near Sao Paulo (Brazil) — Classification: 1A-2

This incident came to light in 1957 through the efforts of Dr. Olavo Fontès

⁴Holliday, J. E.: McDonnell report on the Aurora case, unpublished, 13 August 1973. The on-site investigators were Ronald A. and N. Joseph Gurney (12 May 1973).

of Brazil and Jim and Coral Lorenzen, the founders of the Aerial Phenomena Research Organization, a now-defunct civilian research group in the U. S. Witnesses on the beach at Ubatuba are said to have reported seeing a disk that plunged toward the ocean at high speed, rose again to about 100 feet and exploded, showering the area with bright metallic fragments, some of which fell into shallow water. A few of the fragments were recovered and analyzed in Brazil by Dr. Luisa Barbosa at a laboratory specialized in mineral production studies. Dr. Barbosa identified the major component of the specimen as highly pure magnesium, more pure than commercially produced magnesium but possibly not as pure as multiply sublimed magnesium.

Subsequent work under the direction of Prof. Peter Sturrock has been conducted at Stanford University and at various laboratories in France, including Orsay University, confirming that the material was magnesium and magnesium oxide, with a very minute amount of impurities,⁵ primarily aluminum, calcium and iron. Analysis of this sample is still ongoing, with an effort to measure isotopic ratios that might help establish the origin of the material. (Lorin & Havette, 1986).⁶

The actual date of this event, often wrongly quoted in the literature as 1957, is actually imprecise. Dr. Pierre Kaufmann of Sao Paulo believes the original incident took place in 1933 or 1934 when a bolide indeed passed over Ubatuba and crashed at a nearby beach. The only aerial event to occur at or near Ubatuba in 1957 was the crash of a DC-3.

Case no. 2: June 21, 1947. Maury Island (Washington) — Classification: MA-2

On the afternoon of June 21, 1947 (three days before the Kenneth Arnold case) four people who were on a boat close to the shore of Maury Island near Tacoma, Washington, reported an observation which has puzzled and divided researchers ever since. According to the published story the witnesses were Mr. Harold Dahl (a salvage operator), his fifteen-year old son and two crewmen. They had a dog with them. They reported seeing a group of six large, flat doughnut-shaped objects flying at an estimated altitude of 2,000 feet. Their central holes were about 25 feet in diameter and they glistened with a gold-silvery color. One object suddenly started wobbling and dropped to an altitude of 500 feet above the boat. One of the disks came down (as if to "help" the one in difficulty, according to Dahl). A dull explosion was heard and numerous sheets of light, thin metal issued from the central opening in the troubled object. At the same time, the witnesses were showered with hot, dark fragments that resembled lava rock or slag compared to brass in color. The dog was reportedly hit by one of the fragments and died.

A man named Fred Crisman, to whom the incident was reported, allegedly

⁵Sturrock, Peter A.: "Brazil Magnesium Study," paper presented at the Third Annual Meeting of the Society for Scientific Exploration, Princeton (New Jersey).

⁶Sturrock, Peter A. "Material Isotopic Analysis," presentation at this conference.

vent to the shore and found it littered with a glassy material and silver foil. Military authorities and the FBI, in a very confused series of investigations, attributed the case to a hoax: "analysis of the fragments shows them to be from a Tacoma slag mill." ⁷ To this author's knowledge, however, the composition of the original samples, assuming that they were in fact studied by the FBI, was never released.

In a book he co-authored with Kenneth Arnold (whose own classic observation took place three days later, on June 24, 1947) popular writer Ray Palmer published an analysis of the original fragments, whose primary constituents were calcium, iron, zinc and titanium. Also found were aluminum, manganese, copper, magnesium and silicon, nickel, lead, strontium and chromium. Traces of silver, tin and cadmium were also reported.

Those investigators who regard the case as a hoax base their opinion on the fact that it was Crisman who initially sent the samples to Ray Palmer, linking them to alleged experiences involving the "Shaver Mystery," a science-fiction tale of underground beings. In their opinion it is only after the Kenneth Arnold observation had been published that the story was changed to involve the alleged UFO incident. For the purpose of this discussion we will keep this weak case in the present list, but it is clear that no firm conclusion can be drawn from the reported facts. As Ray Palmer commented: "There we have it. The samples first sent by Crisman and Dahl were not slag nor were they natural rock. What are they?"

Case no. 3: 1952. Washington (DC) — Classification: MA-2

According to journalist Frank Edwards a metallic fragment coming from an object that fell in 1952 was examined a few years later by a Canadian researcher, Mr. Wilbert Smith. The fragment had been sawed off from the recovered sample, representing about one third of its volume. Over one inch in size, it was remarkably hard and reportedly consisted of "a matrix of magnesium orthosilicate" composed of "particles of 15 microns." (Edwards, 1996) Interviewed by two civilian researchers, Messrs. C.W. Fitch of Cleveland (Ohio) and George Popovitch of Akron (Ohio), Smith stated that a Navy pilot had been chasing a flying disk when he saw a bright "scintillating" fragment detach itself and fall to the ground. It was recovered an hour later and weighed in at 10 grams. Smith reportedly showed the sample to Admiral Knowles. Unfortunately there is no report of an independent analysis in the literature, and the sample is not available for further study.

⁷ FBI teletype message dated August 5, 1947, on file. The Maury Island case is mentioned in many books and magazines, notably in Ronald Story: *The Encyclopedia of UFOs* (Garden City, NY: Doubleday, 1980). Details can be found in *Fate Magazine* no. 1, Spring 1948, p.31 and in the book by Kenneth Arnold and Ray Palmer, *The Coming of the Saucers*, pp. 105-108.

Case no. 4: December 14, 1954. Campinas (Brazil) - Classification: MA-2

According to American journalist Frank Edwards (Edward, 1996) numerous witnesses in Campinas observed three disk-shaped objects in flight over the city. Again, one of them started wobbling wildly and lost altitude. The other objects followed it down and it stabilized at an altitude of about 300 feet. At that point the troubled disk emitted a thin stream of silvery liquid. The material was reported to splatter over a wide area including roofs, streets, sidewalks, even clothes left outside to dry. An analysis by an unnamed Brazilian government laboratory is said to have identified tin (Sn) as the main component of the collected samples. An independent analysis by a private chemist, Dr. Risvaldo Maffei, reported that 10% of the material was composed of other substances than tin, but gave no precise measurements.

Case no. 5: November 11, 1956. Vaddö island, Sweden — Classification: CE-2

Prof. Sturrock has custody of a sample reportedly recovered by two witnesses of an aerial phenomenon (one of whom has since died). Although the material appears to be common tungsten-carbide, the original shape of the specimen was unusual and it has not been identified as an object serving a conventional use.

According to a summary of the case compiled by von Ludwiger⁸ the two witnesses, Stig Ekberg and Harry Sjöberg were building a house on the island of Vaddö, about 90 km NNW of Stockholm. At about 10 p.m. Ekberg was driving his Ford V8 pickup when they saw a bright flying object with the shape of a flattened sphere 8 m. wide and 3 m. high approaching from the right (from the east) against the clear night sky. They estimated that it flew about 1 km in front of them at an altitude of 100 meters. Suddenly it made a sharp turn towards them, at which time the truck engine sputtered and died and the headlights went out. The object started "slowly gliding down." It seemed to rock back and forth until it came to a stop in the middle of the road, about 100 m. in front of them, one meter above the ground. "It was illuminating the surrounding landscape with such a tremendous amount of light that even a barn, half a kilometer away, was visible as if the sun was shining." The air smelled like ozone and smoldering insulation.

After about 10 minutes the light of the object intensified, it lifted off the ground, moved to the left and up, made a sudden turn and accelerated away in the direction from which it came. At that point Ekberg was able to restart the truck normally, and the headlights came back on. Observing that the grass at the landing site had been flattened, they investigated further and found a shiny "rock" that was hot to the touch. It was a three-sided piece of metal about the size of a matchbox, and had a heavy weight.

After several unsuccessful attempts to have the sample studied, it was taken

⁸Von Ludwiger, I. *Investigating a Mystery* (unpublished book manuscript). Personal communication, courtesy of the National Institute for Discovery Science.

to the SAAB airline manufacturing company where Mr. Sven Schalin conducted a thorough analysis. Other tests were later run in laboratories in Sweden, Denmark and Germany. The general conclusion was that the object was composed of tungsten carbide and cobalt, consistent with manufactured products. According to von Ludwiger, "all industrial countries have companies which produce such hard metals, and the manufacturing technology is in principle the same ... The overall quality of the material was outstanding, but not unusual for the early 1950s."

Case no. 6: July 13, 1967, Maumee (Ohio) — Classification: CE-2

At 11:26 p.m. EST a collision reportedly took place near Maumee, involving a car driven by two men and an unidentified light. Both witnesses were young Navy veterans, one of them a radar specialist. In their report to police they stated they had unexpectedly encountered an intense source of light in the middle of the pavement while traveling West on Stitt road towards Whitehouse, Ohio. They could see no outline or structure in the object. The driver swerved to the left, skidding for about 70 feet and expecting a catastrophic collision. When they stopped, however, there was no trace of the object. The passenger confirmed the report, adding that the light appeared "bright as a welder's arc".

Following the event the two men drove to Waterville where they phoned police. They were instructed to proceed to the Maumee Police Station and await the arrival of the State Highway Patrol. They revisited the scene with two patrolmen. The car itself was examined, as well as the surrounding area, the road and planted crops. No tangible evidence was reported, except for skid marks made by the vehicle and some damage to the car bumper and hood. Some time later the driver reported finding two metal samples he retrieved in the middle of the road and some "fibrous" metal found on the car. This fibrous sample turned out to contain 92% magnesium, according to Lorenzen and Condon.⁹

Neither witness experienced any unusual sensation during the incident, and their health was not affected.

Case no. 7: Early 1970s, Kiana (Alaska) — Classification: MA-2

In this case, where Prof. Sturrock has also obtained one of the recovered fragments, an Eskimo is reported to have found two pieces of material on a river bank near Kiana following an aerial phenomenon. Each specimen is silvery, light-weight, and looks as if it had been poured in a molten state from a source close to the ground.¹⁰

⁹ The author is indebted to Mark Rodeghier of the Center for UFO Studies for details of the Maumee, Ohio incident. (Condon, E., 1969).

¹⁰ Sturrock, Peter A. Personal communication to the author. Quoted with permission.

Case no. 8: 1975 or 1976. Bogota (Columbia) — Classification: MA-2

Two students at the University of Bogota were about to take a cab at 4 a.m. that night when they heard a metallic sound overhead. They reported seeing a disk, about 12 feet in diameter, swinging in the air as if it had difficulty maintaining its altitude of 3,000 to 3,500 feet — obviously a very rough estimate since it is notoriously difficult to estimate the distance and size of luminous objects at night. Four other objects appeared, flying around the first one as if to provide assistance. Spouts of liquid were then ejected from the primary object. The witnesses took shelter under a tree and watched the liquid fall on the pavement, producing a vapor. The objects rose and disappeared into heavy rain clouds. After letting the material cool down for about ten minutes the witnesses were able to recover two metal chunks, about four inches by one inch and a quarter inch thick. The first analysis was performed in Central America by a mechanical engineer with a petroleum company. He concluded that the sample was an aluminum alloy with magnesium and tin. It was nonmagnetic and contained traces of unidentified materials. He also stated that the material was easy to cut and presented very fine granulation. In October 1985 the author was given a sample of this material by Mr. Ricardo Vilchez, a Latin American investigator, and brought it to the United States for analysis. Subsequent study led by Dr. Harold Puthoff and ourselves showed it to be formed mainly of aluminum (93.7%) with phosphorus (4.8%) and iron (0.9%) with traces of sulfur and an unexplained oxy-carbide layer.¹¹ The sample included no fluoride and no water, contrary to most aluminum samples: fluoride is a common by-product of aluminum production. One side of the specimen showed evidence of violent activity and bubbling, while the other side was flat, with some embedded material, possibly from the road asphalt. Its appearance was typical of an overheat and was indeed consistent with the blowup of a machine, although the hoax hypothesis could not be totally excluded.

The sample was subjected to analysis with a scanning electron microscope (SEM) which produces an X-ray fluorescence spectrum, leading to the above composition findings. It was further analyzed with a scanning ion mass spectroscope (SIMS) which uses an electron beam in a vacuum, boring at various points into the material. This test found a surface layer of carbon, oxygen and nitrogen, beyond which we encountered aluminum as well as magnesium (as reported by the initial analysis in Central America), with potassium, sulfur, sodium and silicon. Phosphorus and iron also showed up in trace amounts.

Case no. 9: December 17, 1977. Council Bluffs (Iowa) — Classification: MA-2

In this incident (which is described at more length in the next section) two residents of Council Bluffs (Iowa) saw an object that crashed to the ground in the vicinity of a dike in Big Lake Park on the northern city limits. The time

¹¹The analysis of the Bogota sample conducted with Dr. Puthoff was first published in Vallee, J. F.: *Confrontations*, 1990, pp. 44-45.

was 7:45 p.m. A bright flash was observed, followed by flames eight to ten feet high. When the witnesses reached the scene they found a large area of the dike covered with a mass of molten metal that glowed red-orange, igniting the grass.

As opposed to many of the previous cases, where few exact times and detailed witness accounts are available, the present incident offers an abundance of information. Police and firefighters reached the scene within minutes of the event. One law officer described the molten mass "running, boiling down the edges of the levee" over an area of about four by six feet. The central portion remained warm to the touch for another two hours. There were eleven witnesses in all, eliminating the hoax hypothesis. Two of the witnesses had independently seen a hovering red object with lights blinking in sequence around the periphery. Inquiries made at Eppley Air Field and Offutt Air Force Base disclosed that no engine failure had taken place and there was no aircraft operation in the area.¹²

The recovered residue was analyzed at Iowa State University and the Griffin Pipe Products company, leading to the determination that the metal was chiefly iron with small amounts of alloying metals such as nickel and chromium. This composition excludes a meteoritic origin.

Case no. 10: Circa 1978. Jopala, near Puebla (Mexico) — Classification: MA-2

While in Mexico in November 1978 the author was told by local investigators of the fall and recovery of a metallic residue following an observation of an unknown aerial phenomenon in the mountains near Puebla. The object was reportedly composed of iron with silicon (1.13%) and traces of manganese (0.84%), chromium (0.77%) and carbon (0.28%).¹³

Analysis of the Council Bluffs Case

The weather in Council Bluffs the evening of Saturday, December 17, 1977 was overcast with a 2,500 foot ceiling, visibility 10 miles, temperature 32 degrees Fahrenheit. Wind was from the WNW at 16 mph, with gusts to 25 mph. The town is located on the southeastern shore of the Missouri river in Iowa, cross from the city of Omaha (Figure 1.) The object hit the ground in the vicinity of "Gilbert's Pond" in Big Lake Park, across the Missouri from Eppley airport. The exact street address is 1900 N. Eighth street. It fell at a point 16 feet from the paved road and 6 feet from the top of the levee, burning an area 4 feet wide by 9 feet long. There was a secondary burn area 27 feet away on the side of the dike, measuring about 2 by 4 feet.

Some samples of the material were embedded in the ground in both areas but no crater was discovered. There was an indentation 2 to 3 inches deep and many metal spherules were found scattered about the area, particularly toward

¹²Telephone conversation with investigators, September 1978.

¹³Personal investigation.

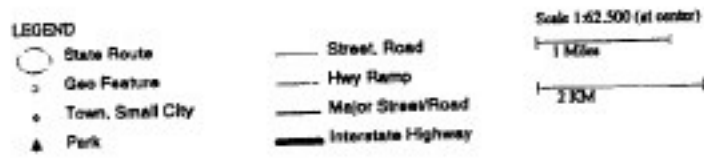
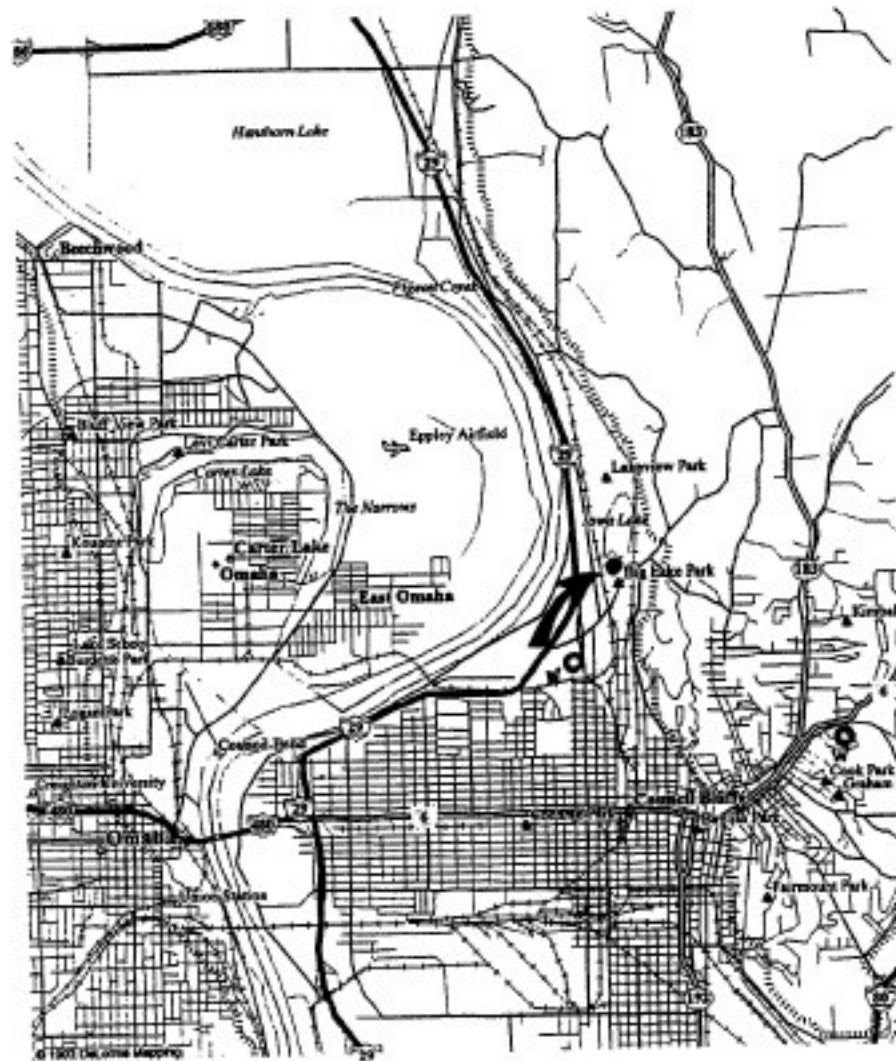


Fig. 1. A city map of Council Bluffs.

many metal spherules were found scattered about the area, particularly toward the Northeast.

The initial witnesses were Kenny Drake and his wife Carol, and Kenny's 12-year old nephew Randy James. Two other witnesses, Mike Moore and his wife Criss, reported seeing a hovering red object with lights as they crossed 16th street on their way downtown along Broadway avenue. Criss reported "a big round thing hovering in the sky below the tree tops. It was hovering. It wasn't moving." She added that she saw red lights around the perimeter of the object, blinking in sequence. A middle-aged couple who saw the event spoke to the investigators by telephone, stating that they had seen "a bright red object rocket to the ground near Big Lake" but refused to be identified. Four teenagers in a small foreign car spoke to the Drakes at the time of the incident but did not make a report.

Secondary witnesses who observed the metal were Jack E. Moore, assistant fire chief (who took the 911 call from Kenny Drake), police officer Dennis Murphy and Robert E. Allen, who had served in the Air Force and wrote a weekly astronomy column for a local newspaper. Mr. Moore stated that the center of the metal mass was too hot to touch when he arrived on the scene about 8 p.m., only 15 minutes after the initial incident, and that it remained so for about an hour.¹⁴

Investigation proceeded as follows: Measurements taken at the impact point by Robert Allen indicate the object was traveling from the Southwest to the Northeast. Samples of the object were sent to the Ames Laboratory at the Iowa State University, and others were taken to the Griffin Pipe Products Company.

The material was determined to be carbon steel, "probably man-made," of a type common in manufacturing. The following four hypotheses were examined:

A. Hoax by Unknown Persons Pouring Molten Metal on the Ground

A check was made with every metal firm in the metropolitan area which has the remotest possibility of maintaining metal in a molten state. Griffin Pipe is the only company which has the capability for producing a similar product. Mr. Linton Stewart, Works Manager there, stated that they "drop the bottoms" from their cupolas on Friday afternoon and do no pouring until Monday. The melting point is close to 2500 F, which would require transporting in a brick oven of 6 inch thickness with a large truck, keeping the material at the melting point. Conclusion: negative.

B. Hoax by Unknown Persons Using Thermite and Ordinary Metal

Prof. Frank Kayser, of Iowa State University, observed that one might "collect the splatters from a casting or welding operation involving carbon steel."

¹⁴"Mystery Flaming Object Definitely not Meteorite," *Omaha World-Herald*, 20 December 1977.

surround it with thermite powder and ignite it, heating the metal to the 1000 degrees C range. A cooling rate appropriate to wrought-iron microstructure could be achieved by spraying water on the mixture. However the material was in a molten state when the witnesses arrived. The surface of the ground was frozen to a depth of at least 4 inches and the air was at 32 F. Under such conditions, cooling by water spraying would have generated considerable amounts of ice. A check made with chemical and construction firms in the area disclosed no source of thermite. Negative conclusion.

C. Piece of Equipment from Aircraft

Because of the proximity to Eppley Air Field it was thought the object could have fallen from an aircraft landing on the runway heading 320 degrees. However a check with the airport indicated no abnormal aircraft activity at the time. All airlines operating into Eppley Field responded that they had no arrival using that runway which would bring an aircraft within the vicinity of the impact site (Braniff had landed at 7:32 p.m.) Furthermore the aircraft would be low and the metal could not be heated by the air to the melting point while falling. Negative conclusion.

D. Meteoritic Impact

There was no significant crater, the material remained in a molten state quite long, the composition is not compatible with meteoritic nature as noted above (very low nickel element in particular) and the spectrographic analysis did not disclose any metal components which should be an integral part of meteoritic materials. Negative.

The material sent to Ames Laboratory at Iowa State University was analyzed by Dr. Robert S. Hansen, director of the Ames Energy and Mineral Resources Research Institute. The material was found to consist of solid metal, slag and white ash inclusions in the slag. These were examined by X-ray fluorescence, electron beam microprobe and emission microscopic techniques under the supervision of Edward DeKalb of the analytical spectroscopy section.

Ames' findings were as follows: "The metal is chiefly iron with very small amounts (less than 1%) of alloying metals such as nickel and chromium. The slag is a foam material containing metallic iron and aluminum with smaller amounts of magnesium, silicon and titanium." The white ash was found to be calcium, with some magnesium.

In the course of research and follow-up for this paper the author contacted Mr. Robert Allen, who confirmed that the case had remained unsolved after twenty years.¹⁵ He kindly supplied us with copies of his correspondence with Air Force Space Systems, who had stated that in their opinion the material was

¹⁵Author's telephone conversations and correspondence with R. Allen, September 1997.

not space debris from a man-made object, citing four reasons: (1) reentering spacecraft debris does not impact the Earth's surface in a molten state, (2) the 35- to 40-pound mass left no crater or indentation, (3) reported visual sighting was at an altitude of only 500 to 600 feet, where reentering debris would not be glowing and (4) the lack of structural indications is inconsistent with space debris.

Discussion of Element Frequency

The samples described in the ten cases we have reviewed are summarized in Table 3. They belong, broadly speaking, in two major classes: samples resembling slag or industrial residue, and light silvery alloys, with one incident (case no. 2, Maury Island) involving both types of materials. Unfortunately, as we have seen, the analysis of the original samples in this particular case was never released by authorities, and we can only refer to sources of dubious reliability.

In incidents involving slag-like material one primarily finds iron with traces of chromium, manganese and silicon, notably in Jopala and in Council Bluffs.

In cases involving light silvery material we find references to magnesium (cases 1, 3 and 6) and aluminum (cases 1 and 8), with iron mentioned in trace amounts. Some of the details of the composition remain puzzling: We cannot account for the very high degree of purity of the Ubatuba magnesium sample, or for the absence of water and fluoride in the Bogota specimen.

We have encountered no case of unknown elements and no case with advanced technology materials exhibiting an unusual structure. However the samples, as analyzed, appear to be consistent with the accounts given by witnesses, lending credibility to the reports in spite of their sometimes extraordinary details.

In summary, the analysis supports the thesis that an unidentified phenomenon has been repeatedly observed in various parts of the world over a long period, that it manifests through a physical, material support, and that it is amenable to scientific study. On the other hand, the patterns observed in the composition of the samples at our disposal do not point to any clear hypothesis for the nature of the phenomenon.

The fact that no exotic composition was found in these ten cases cannot be used to negate the theory that an advanced technology of unknown origin may have generated the samples. In the case of our own automobile industry, for example, environmentally-compliant engines produce more mundane exhaust (such as pure water) than older models, where one could find complex combination of gases.

Liquid Metal Technology

The similarities between many of the above cases point to a common scenario for the generation of the recovered samples: metal is observed to be ejected in molten form by an unidentified aerial object, commonly described

TABLE 3
Summary of Sample Composition

Case No.	Location	"Slag"		"Light Silvery Alloy"	
		Primary	Secondary	Primary	Secondary
1	Ubatuba		none	Mg	Al,Ca,Fe
2	Maury Is.	Ca, Fe, Zn, Ti	Si, Cu, Ni, Pb, Cr, Al, Mg, Mn, Sr	Ag, Sn, Cd	
3	Washington		none	Mg, Si	
4	Camplinas		none	Sn? (90%)	
5	Sweden	W(94.9%),	Co (4.1%) Zr(0.6%), Fe(0.3%)	none	
6	Maumee		none	Mg(92%)	
7	Kiana		none	YES	
8	Bogota		none	Al(94%)	P(5%),Fe(1%)
9	Council Bluffs	Fe	Ni,Cr,Mn,Si,Ti	none	
10	Jopala	Fe	Si(1%), Mn(0.8%) Cr(0.8%),C(0.3%)	none	

as a disk, occasionally as a vehicle flying in an unstable condition. The material, in liquid form, falls over a fairly wide area where it takes minutes to hours to cool down. When analyzed, it turns out to be made up of common terrestrial elements, often in a form resembling ordinary industrial byproducts.

Given this scenario, it is appropriate to ask under what conditions one might want to use liquid metal in a flying vehicle. In the words of J. R. Bumby of the University of Durham, "the high conductivity of liquid metals makes them an attractive means of current collection for homopolar machines." (Bumby, 1983) Bumby goes on to cite a number of such machines, both superconducting and non-superconducting, that have been built (Watt, 1958; Doyle, 1974; Chabrerie *et al.*, Mailfert, 1972) and one that is commercially available (Lewis, 1971). Similarly, liquid metal designs have been proposed for magneto-hydrodynamic (MHD) generators, for the decomposition of toxic wastes and for superconducting airborne platforms (Southall & Oberly, 1979). However the composition of the liquids used in such machines is radically different from the list of elements found in Table 3. As noted by Bumby, "At room temperature the only pure liquid metal is mercury, although at slightly higher temperatures gallium (29.8 degrees C) and sodium (97.8 degrees C) become liquid." Actual machines are using sodium-potassium and gallium-indium mixtures as current conductors, thus minimizing wear and friction. The latter

is liquid above 15.7 degrees C. Yet none of these elements has been identified among the samples we have reviewed.

A different approach has been proposed by J. Roser in correspondence with the author. Noting the composition of the Bogota specimen as mentioned in our earlier publication¹⁶ he hypothesized a nuclear design for the object's power plant, utilizing direct energy conversion rather than a heat driven mechanical prime mover. "A closed cycle MHD generator using a liquid metal working fluid with no vapor staging pumping could be configured in a torus or circular shape and would make very little noise due to the lack of moving parts," he wrote, adding that the nuclear process known as beta decay might allow the design to extract a surplus of power in the form of free electrons.

Assuming a working fluid of Aluminum 27 plus some percentage of Phosphorus 31 (solitary stable isotopes of their respective elements) Roser speculates that depleted fluid might need to be occasionally ejected: "This discarded material would contain Al.27, P.31, iron from original melt or housing erosion, plus isotopes of nuclei close to aluminum and phosphorus such as Mg, Na, Si and S." Accordingly he suggests isotopic analysis of the Bogota sample to determine if it reveals anomalous isotopes such as Si.32 (half-life 280 years) which would indicate a nuclear-based power source.

Conclusion

Reports of unusual metallic residue following the observation of an unexplained aerial phenomenon are detailed enough for a comparative study to be undertaken. This research is hampered, however, by several problems of methodology where lack of money or analytical resources is only a secondary obstacle. The primary concerns have to do with inaccuracies in data gathering, lack of information about exact dates and times, lack of detailed, critical field investigation, and failure to provide an irrefutable chain of evidence in the collection, transportation and examination of the samples.

In spite of these shortcomings (which could be addressed through the setting up of better standards and through collaborative agreements among investigators) this paper has shown that significant progress had been made towards the analysis of a number of relevant incidents. In one case at least (Council Bluffs) the conditions of witness availability and reliability, on-site testimony by law enforcement officers, chain of custody and timely analysis were met. Other cases, such as Ubatuba and Bogota, are sufficiently intriguing to encourage investigators to expand their work in the field.

Over the years discussions of the UFO issue have remained narrowly polarized between advocates and adversaries of a single theory, namely the extraterrestrial hypothesis (ETH), defined as contact with an alien civilization originating in another solar system in our universe. This fixation on the ETH has narrowed and impoverished the debate, precluding examination of other

¹⁶Vallee, J. E.: *Confrontations*, 1990, pp. 44-45.

possible theories of the phenomenon. To the extent that recovered samples did not show an exotic composition or complex structure supporting their preconceived hypothesis, both sides of the extraterrestrial argument lost interest in the cases. In the view of the present author such lack of follow-up is unfortunate, because much could be learned from comparative analysis of such material even if it is mundane. Therefore our hope is that further field research may be stimulated by publication of the present survey.

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Afterword (October 2008)

Following publication of this paper, I have become aware of other studies of metallic samples correlated with sightings of unexplained objects.

I am indebted to N.A. Reiter and Patricia Mason for information about a case that took place in Newark, Ohio in the summer of 1996. Mr. Bennie Foggin observed a box-like, dark object glide low over his house. It was silent, except for a scraping sound, and was the size of a large jetliner.

The object dropped a "blob of solidified and still hot aluminum." It was 10 years before the sample could be properly analyzed at Frontier Analytical Services in Cleveland, where Phyllis Budinger and colleagues performed infrared spectroscopy and energy dispersive spectroscopy.

The sample was primarily aluminum with secondary elements including Silicon, carbon, magnesium and calcium. An X-ray scan shows a homogeneous internal structure with some small (under 1 mm) spots or speckles that appear to be bubbles.

The National Institute for Discovery Science (NIDS) reported in 1996 that an analysis of a sample recovered in Nevada by Las Vegas businessman Bob White after an observation of a large, bright object close to the road showed a composition of 85% aluminum, 9% silicon and minor constituents including iron (2%), and calcium (0.9%).

This brings to twelve the number of metallic samples recovered and analyzed following close encounters with unidentified flying objects.