Harding, N.C. 1954

Thesis, Univ. of Wisconsin

"Harding has made a gravity survey over the Barringer (Arizona) meteorite crater and has combined the data with results of a vertical-component, magnetometer survey made by J.J.Jakowski. Again, there is a regional negative anomaly of about 3/4 milligal, centered over the crater and the zone of brecciation. There is also evidence of a local positive residual gravity anomaly of about 1/4 milligal on the southwest flank of the crater. This could be caused by a fairly large fragment of the original meteorite which did not shatter or vaporize."

September 27, 1963

Mr. Brandon Barringer
2106 Girard Trust Building
Philadelphia 2, Pennsylvania

Dear Mr. Barringer:

Thank you for sending me the two reprints from "Radioactive Dating", which I am returning with this note.

In regard to the determination of the terrestrial age of a meteorite with high carbon content, it seems to me that the authors have stated the wrong reason for the difficulty. As you mentioned on the telephone, with more CO_2 to work with one could use a longer counter. This would also increase the counting precision. For example, our counters with active volumes of 4 liters have figures of merit (counting efficiently in relation to background) 20 times higher than the small one described by Kohman and Goel. To gain from this increased efficiency, however, one should also determine the "fall-time" value (from samples with known dates of arrival on earth) in a larger counter. But, this might be meaningless because of the scatter of values found for the fall times which may be due to basic variations such as different cosmogenic residences or travel times.

Without knowing too much about these matters, my guess would be that when a meteorite contains excessively high carbon, the real worry would be that not all of it is representative for dating purposes. Perhaps the meteorite was shielded better while in transit, or some such factor.

Sincerely yours,

Elizabeth K. Ralph

EKR:pc

THE BARRINGER CRATER COMPANY

Owner and Developer of the Meteor Crater of Arizona

BRANDON BARRINGER
President
2106 GIRARD TRUST BLDG.
PHILADELPHIA 2, PA.

September 30, 1963

Dr. Elizabeth K. Ralph
Department of Physics
University of Pennsylvania
Philadelphia 4, Pennsylvania

Dear Dr. Ralph:

Do appreciate your letter of September 27. Have I your permission to send it or to show it to Professor Kohman?

Nearly all iron meteorites, judging from other radioactive falls, are over a billion years old and most of them seem to have the supposed age of the solar system, some five billion years. In other words, they were formed by cosmic collisions or in cosmic bodies which were broken up by such collisions a very long time ago. Stony meteorites on the other hand have very much shorter apparent lifetimes.

The ones that are seen to fall are usually stony, and I don't know how many determinations have been made on fresh iron falls to get a zero point. The radiation could of course vary depending on whether or not the meteorite in question was in the center of a body which broke up when it hit the earth and thus was more protected against cosmic radiation and started with less cosmogenic C^{14}. I don't know just how good a base line of this sort Kohman has but will try to find out.

In addition to finding the age of the Barringer Crater, it would be particularly important to find whether there is any substantial variation for the individual meteorites which would give us a real lead as to whether there are pieces broken from a solid chunk or members of a swarm. In the latter case, they would of course have the same amount of residual C^{14} compared with ordinary carbon.

Do you accept material on a professional basis for dating purposes, and, if so, could we get you to make a determination for Carnegie Tech at our expense?

I have spoken to Dr. Rainey about a suggestion that we use the proton magnetometer to attempt to locate the residual mass, if any, of our meteorite. We believe it to lie upwards of 1,000' below the south rim of the crater and upwards of 600' below the southwestern part of the bowl and to weigh upwards of 1 million tons. If you think there is a reasonable chance that something worthwhile could be found from a survey and would be able to do so, we would certainly like to arrange one, again, of course, on a professional basis.

Sincerely yours,

Brandon Barringer

President

BB:lb
cc Dr. F. Rainey

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Branch of Astrogeology
Box 1906
Flagstaff, Arizona

COPY

October 7, 1963

Mr. Foster Thomson
Meteor Crater Enterprises, Inc.
P. O. Box 721
Winslow, Arizona

Dear Mr. Thomson:

Donald Elston has passed on to me for reply your letter concerning Brandon Barringer's query.

The technique used by Truman Kohlman for dating iron meteorites depends upon knowing the amount of cosmic ray-produced carbon 14 in each specimen. The nuclear reaction involved is spallation and is a function of the distance from the surface of the original body. It is, therefore, not possible to calculate an exact age from a carbon 14 determination on a meteorite specimen unless the position of the specimen with respect to the original meteoroid body is precisely known. Unfortunately, these positions for the specimens from Odessa or Barringer Craters are not known. The ages calculated by Dr. Kohlman are merely minimum ages, as he made clear in his published reports. That is to say, the Odessa Crater is 12,000 years old or older according to Kohlman's carbon 14 results.

With regard to the variation in stable carbon content, both the Odessa and Barringer (Canyon Diablo) meteorites show wide variation in carbon content. The carbon is present in graphite nodules and also in disseminated iron carbides, and there is no observed difference in carbon distribution between the meteorites from Odessa and the Barringer Craters.

The carbon 14 analysis which you made reference to in connection to the Barringer Crater was carried out in the U. S. Geological Survey carbon 14 laboratory. This analysis is very preliminary and was made on fresh water invertebrate shell fragments recovered from a sample from the lake beds in the No. 2 shaft. Some carbon 14 activity was observed, but the amount of activity was too low for a meaningful calculation of the age. Again, the age is a minimum age, not the true age of the Crater.

The geological evidence shows that both the Barringer and Odessa Craters are of middle to early Wisconsin age. In my opinion, there is a reasonable probability they were produced by the same fall.

Eugene M. Shoemaker, Chief
Branch of Astrogeology.

COPY

October 28, 1963

Mr. Branden Barringer
2106 Girard Trust Building
Philadelphia 2, Penna.

Dear Mr. Barringer:

Please forgive my tardiness in replying to your letter of September 30th. I had hoped to find time to study a bit about meteorites, but I haven't yet been able to. I don't mind if you send my comments to Professor Kohman, but I hope to have more precise remarks when I have read some of the recent publications on meteorites.

In regard to dating the Barringer Crater by C^{14}, I think that the very good commercial laboratory, Isotopes, Inc., (123 Woodland Ave., Westwood, N. J.) directed by Dr. Alan Walton, might be the best equipped one for this determination. They have recently been experimenting with the dating of steel from its carbon content and, therefore, have suitable combustion trains for the extraction of carbon from iron. Their charge is approximately $175 per sample. To date it here, we should have to build the special combustion train which would add to the cost.

In reference to the location of the residual mass of the meteorite, I think that the first step would be to study the surveys - gravity, etc. which have been made in order to obtain some idea of whether or not a ground survey with the proton magnetometer would be more sensitive for detection at this great depth. If you have copies of surveys made previously, I should like very much to look at them.

Sincerely yours,

Elizabeth K. Ralph

EKR/deh

THE BARRINGER CRATER COMPANY

Owner and Developer of the Meteor Crater of Arizona

BRANDON BARRINGER
President
2106 GIRARD TRUST BLDG.
PHILADELPHIA 2, PA.

October 29, 1963

Dr. Elizabeth K. Ralph
Department of Physics
University of Pennsylvania
Philadelphia 4, Pennsylvania

Dear Dr. Ralph:

Many thanks for your thoughtful letter of the 28th. At the moment, the Geological Survey seems interested in making the studies, but, if they don't, we'll certainly plan to use Isotopes, Inc..

In this connection, I think you will be interested in a letter from Dr. Eugene M. Shoemaker, first head of the Astrogeological branch (no less) of the Survey.

I shall try to get you a copy of the geophysical survey of the Crater made about 1931, and also of the later gravity survey.

Many thanks for your help.

Sincerely,

Brandon Barringer
jms

BB:jms

Enclosure

2106 GIRARD TRUST BLDG.
PHILADELPHIA 2, PA.

September 30, 1963

Dr. Elisabeth K. Ralph
Department of Physics
University of Pennsylvania
Philadelphia 4, Pennsylvania

Dear Dr. Ralph:

Do appreciate your letter of September 27. Have I your permission to send it or to show it to Professor Kohman?

Nearly all iron meteorites, judging from other radioactive falls, are over a billion years old and most of them seem to have the supposed age of the solar system, some five billion years. In other words, they were formed by cosmic collisions or in cosmic bodies which were broken up by such collisions a very long time ago. Stony meteorites on the other hand have very much shorter apparent lifetimes.

The ones that are seen to fall are usually stony, and I don't know how many determinations have been made on fresh iron falls to get a zero point. The radiation could of course vary depending on whether or not the meteorite in question was in the center of a body which broke up when it hit the earth and thus was more protected against cosmic radiation and started with less cosmogenic C^{14}. I don't know just how good a base line of this sort Kohman has but will try to find out.

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I have spoken to Dr. Rainey about a suggestion that we use the proton magnetometer to attempt to locate the residual mass, if any, of our meteorite. We believe it to lie upwards of 1,000' below the south rim of the crater and upwards of 600' below the southwestern part of the bowl and to weigh upwards of 1 million tons. If you think there is a reasonable chance that something worthwhile could be found from a survey and would be able to do so, we would certainly like to arrange one, again, of course, on a professional basis.

Sincerely yours,

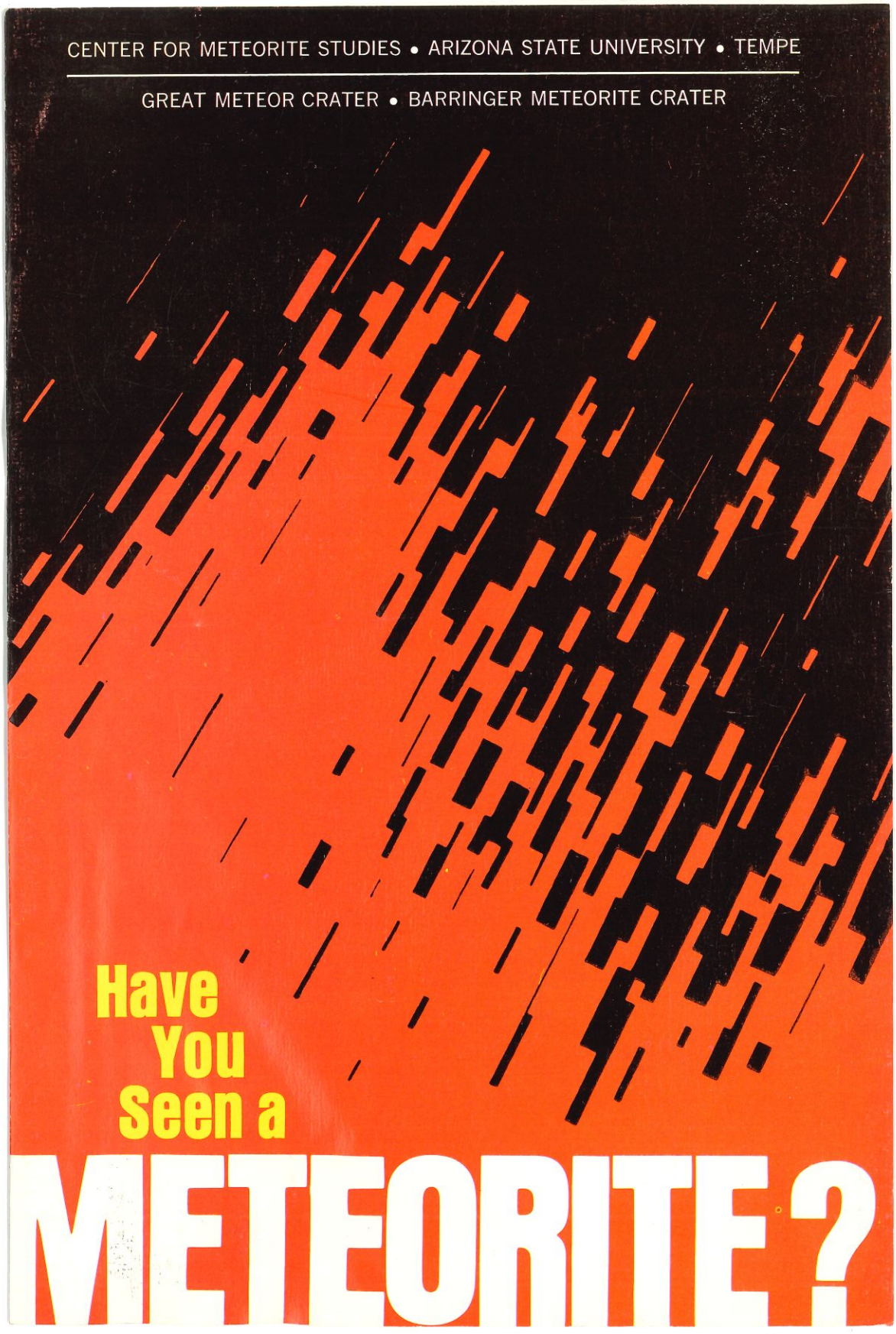
s/ Brandon Barringer

President

BB:lb
cc Dr. F. Rainey

CENTER FOR METEORITE STUDIES • ARIZONA STATE UNIVERSITY • TEMPE

GREAT METEOR CRATER • BARRINGER METEORITE CRATER



Have You Seen a METEORITE?

ORIGIN

Where Meteorites Come From — Most scientists believe meteorites are part of our solar system derived from the asteroid belt located between Mars and Jupiter. Meteorites may be captured by the Earth when they are pulled from their orbits by the gravitational attraction of the sun or planets or collide with each other.

Definitions — A **meteor** is an object in the sky that produces light upon entering the Earth's atmosphere. These bodies are usually quite small and are sometimes called "shooting" or "falling stars." Large, extremely bright meteors are called "fireballs" or "bolides" and can be as bright as the moon or sun. A **meteorite** is a solid body that has fallen on the Earth's surface from outer space.

FALLS

Falls and Finds — A **fall** is a meteorite that was picked up after it was actually seen to fall. A **find** is a meteorite that was not seen to fall, but was recognized by the diagnostic features described in this booklet.

Sight — When a meteor enters the Earth's atmosphere the resulting fireball produces light, due to the friction between its surface and the air. A smoke or dust trail is produced in the sky by the fireball caused by the removal of material from the surface of the meteorite.

Sound — Because the fireballs are traveling at high speeds, they sometimes produce a **sonic boom or whistling** heard over 30 miles or more from where the meteorite lands. Several booms may be succeeded by irregular sputtering sounds, comparable to an automobile backfiring.

TYPES

Composition — Iron meteorites are composed of almost 100% metal, a nickel-iron alloy. Stony meteorites contain about 75-90% silicate (stony) minerals and 10-25% nickel-iron metal and iron sulfide. A few meteorites are the in-between types called stony-irons with about 50% iron and 50% silicates.

PHOTO BY JOHN W. FOSTER

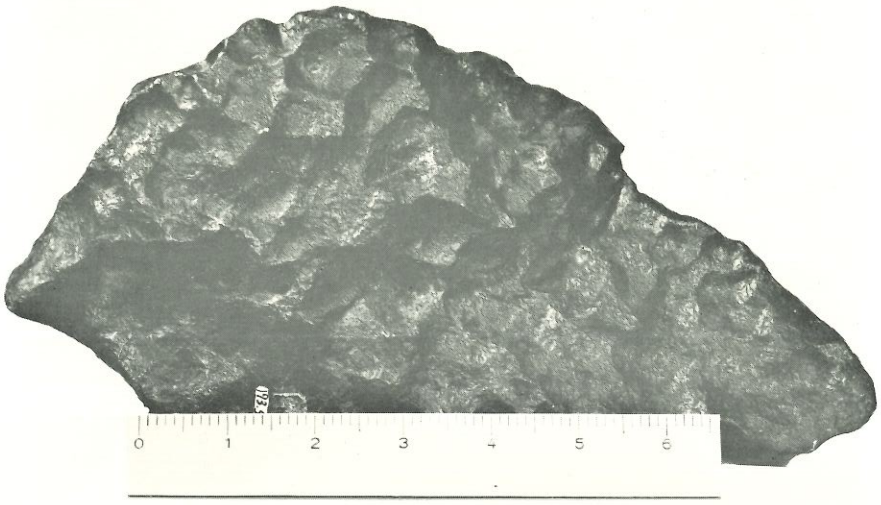


Fig. 1. An iron meteorite showing "thumbprints."

Size — Meteorites vary from pieces of microscopic size to large masses measuring several feet or more in diameter. The average person is most likely to find a meteorite that measures from two inches to two feet.

Weight — Meteorites are generally heavier than ordinary rocks. Iron meteorites are very heavy, usually weighing about three times as much as ordinary rocks of the same size. Stony meteorites are not quite one and a half times as heavy as ordinary Earth rocks.

Shape — In most cases meteorites are very irregular in shape. Some meteorites take the shape of flat cones. **They are seldom round.**

Crust — The surface of many freshly fallen meteorites is usually fairly **smooth** and featureless. Some meteorites show flow lines, furrows, shallow depressions, deep cavities, and smooth pits (thumbprints). The iron meteorites show characteristic smooth pits or thumbprints, resembling imprints of fingers on soft clay (Fig. 1).

The crust of a freshly-fallen meteorite is generally black (Fig. 2) but weathering on the Earth changes this black surface to brown. On

Fig. 2. The black crust and grainy interior of a stony meteorite.

very old finds the crust may have disappeared altogether.

Tests — The best single test for an object suspected to be a meteorite is to grind off a small corner on a carborundum wheel. Inspect the ground surface for evidence of metallic specks. Iron meteorites will give an appearance of freshly cut iron (Fig.3). A strong magnet will attract the surface of an iron meteorite.

A stony meteorite will show **silvery appearing flecks** scattered in a compact stony mass (Fig. 4). These stony meteorites will be attracted only slightly by a strong magnet. A few stony meteorites will not be attracted by a magnet.

Interior — It is not advisable to break, hammer, or cut open a possible meteorite, as this rough treatment destroys some of the material and lessens its scientific value. Only a small corner should be ground off in order to test the specimen (as described in the preceding section on "Tests"). DO NOT USE AN ACETYLENE TORCH FOR CUTTING, the extreme heat destroys the meteorite's interior.

Iron meteorites have a dense, silvery appearing interior (Fig. 3). Stone meteorites vary considerably in appearance from dense, grainy

Fig. 3. Iron meteorite. Polished and etched section and uncut specimen.

rocks (Fig. 2) to very broken looking mixtures of materials. The color ranges from **white to black** but is most often a light to dark **gray** in stony meteorites.

METEORITES AND EARTH ROCKS

Objects Mistaken For Meteorites — Objects commonly confused with meteorites include furnace and smelter slag, iron oxide concretions, and pieces of manufactured iron.

Furnace and smelter slag sometimes contain free iron, but often in rounded pellets or drops. Slag will generally be very porous or spongy. **Meteorites have neither of these properties.**

Hematite (a dark red, heavy iron oxide) and magnetite (a heavy, steel gray, magnetic iron oxide) are sometimes mistaken for meteorites. On a ground surface these oxides **will not** show metallic specks.

Some old rusted iron tools are sometimes thought to be meteorites. We can make a simple chemical test for nickel that will distinguish them from meteorites.

Fig. 4. A polished section of a stony meteorite showing the silvery specks scattered in a compact stony mass.

The meteorites described above are typical of most falls. There are **rare** types of meteorites that have no metal. These may be hard or quite soft and range from white to black in color. Any object suspected to be a **recent fall** should be brought or sent for inspection.

THE IMPORTANCE OF METEORITES

Why Study Meteorites — Meteorites are scientifically important and worthy of careful study because they have come from the solar system beyond our own planet. They are becoming increasingly important as our country engages in its space program.

Our Collection — The Center For Meteorite Studies at Arizona State University has the large and famous Nininger Meteorite Collection. This collection of over 800 different meteorite specimens was assembled by the life-long efforts of Dr. and Mrs. H. H. Nininger and was purchased from them by Arizona State University. The collection is being actively used for space oriented research by scientists of Arizona State University and many other investigators throughout the United States. We are always anxious to add new specimens to the collection by gifts, purchases or exchanges.

WHAT TO DO IF YOU THINK YOU HAVE A METEORITE

Field Information — If you are fortunate enough to see a meteorite fall and can recover it, or if you find one in the field, do the following: note carefully its location, take photographs of the meteorite and its location, then contact us immediately. We will examine the specimen and estimate its value.

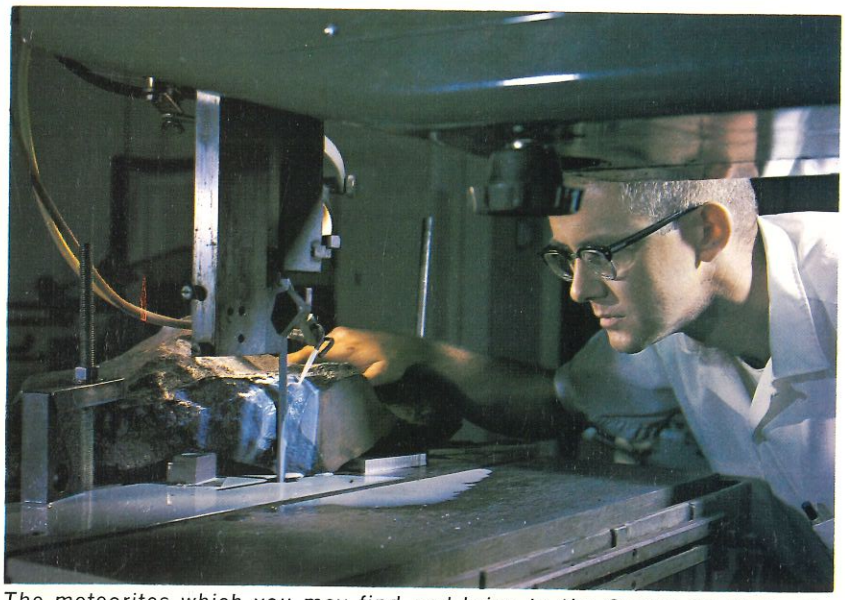
Check List

	Yes	No
1. Is the specimen heavy?	☐	☐
2. Is the specimen solid and compact?	☐	☐
3. Is the specimen attracted by a magnet?	☐	☐
4. Is the specimen black or brown and rather smooth on the outside?	☐	☐
5. Does the specimen show metallic iron specks on a cut surface?	☐	☐

If you check "Yes" to all the above questions, the object is very likely to be a meteorite. In some cases, some answers can be "No," and the object may still be a meteorite. If all the answers are "No," the object is probably not a meteorite.

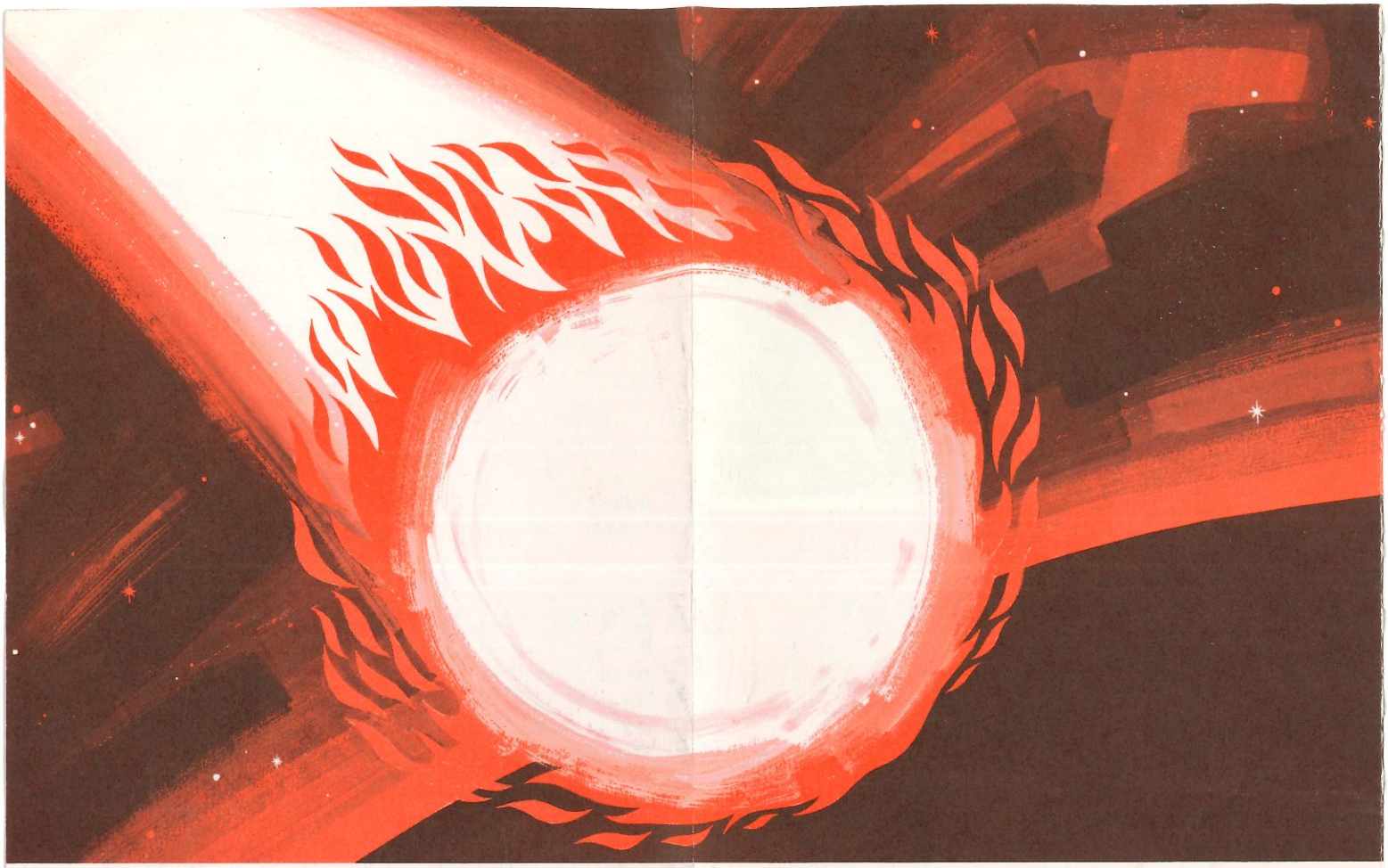
Send this check list and the suspected meteorite (or if it is too large, send a small piece) to us, and we will examine it. If the specimen is a meteorite, we will estimate its value and make an offer for its purchase. If the specimen is not a meteorite, it will be returned to you. This service and any testing is **free of charge.**

Send to:
Dr. Carleton B. Moore, Director
Center for Meteorite Studies
Arizona State University
Tempe, Arizona 85281



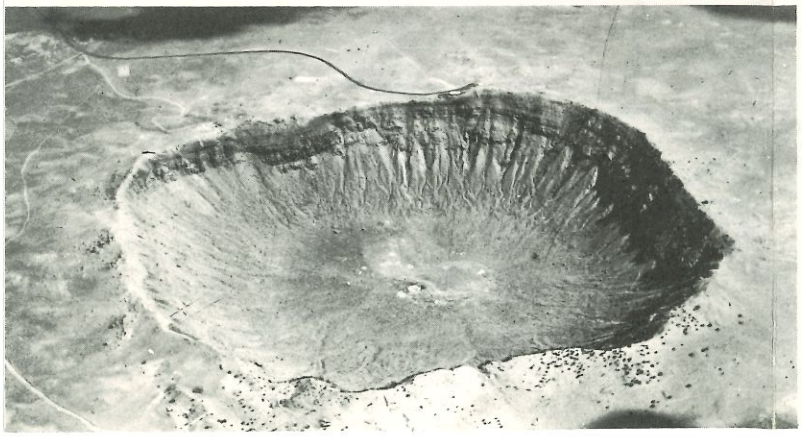
The meteorites which you may find and bring to the Center for Meteorite Studies will be studied by scientists to learn more about the geochemistry of the earth and other astronomical bodies. The above photograph shows a meteorite being cut in preparation for study. Several types of studies are made. Only two examples are mineralogical studies by microscopic examination and many types of chemical analyses.

Atomic absorption analysis instrument in the Center for Meteorite Studies.



VISIT ARIZONA'S DRAMATIC

METEOR CRATER



THE GREAT COLLISION

Meteor Crater — the world's first proven meteorite crater — is 4,150 feet from rim to rim, three miles in circumference and 570 feet deep. Such man-made wonders as the Washington Monument and the massive Great Pyramid of Cheops of Egypt are dwarfed by its giant dimensions.

The meteoritic mass from outer space that gouged out Meteor Crater — 92% iron, 7% nickel, traveling at 30–33,000 miles per hour, struck the earth here with a force of a multi-megaton hydrogen bomb, splashing nearly half a billion tons of rock from the crater and probably destroying all plant and animal life within a 100-mile area.

PREHISTORIC MAN

If early man lived in Northern Arizona at the time, and it is very possible he did, he probably watched in fear and awe the blinding flash and earth-shaking explosion of the meteorite's impact here. Recent dating tests using the new radioactive carbon isotope method indicate that the meteorite, weighing perhaps more than a million or more tons, struck here about 22,000 years ago — a time when great glaciers still covered much of the northern part of our continent. More recently, Meteor Crater has been a familiar landmark to both ancient and modern Indian tribes for more than 1,500 years and is linked with their tribal customs and legends.

DISCOVERY

Meteor Crater, also known as Barringer Crater, was first discovered by white men in 1871 and for many years was thought to have been of volcanic origin. However, in 1903, a Philadelphia mining engineer, Daniel Moreau Barringer, acquired the crater and initiated a series of intensive scientific studies that shortly before his death in 1929 led to full scientific recognition of the fact that the crater was actually the result of the impact of a huge meteoritic mass from outer space. This, in turn, spurred scientific investigations at the crater and, through identification of its peculiar features, such as shatter cones, and rare minerals formed by the impact, coesite and stishovite, led to the discovery of a number of other craters of meteoritic origin in various parts of the world. These craters, mostly less conspicious because many of their distinctive features have disappeared through erosion, range in size and age from the Vredevert Ring in South Africa, 130 miles in diameter and 250 million years old, to the Sikhote-Alin group of 200 craters and pits, formed by meteoritic shower in Siberia in 1947.

ASTRONAUTS

Each group of American Astronauts has used Meteor Crater as an important training area. Here they are taught the geology of impact structures in simulated lunar "walks." This stems from Meteor Crater's uniqueness as the only geological formation on earth that closely approximates in size and structure the great craters that scar the

Gift Shop & Refreshment Area

bleak, airless surface of the moon. Scientists have generally accepted the idea that the lunar craters were also the result of the impact of thousands of meteorites over the 4.5 billion years the moon is estimated to have orbited the earth. The astronauts have already made intensive studies of Meteor Crater so that they will be better prepared to recognize and cope with similar geologic features that have already been found on the moon.

Meteor Crater has aided science in many other ways. Geologists from all over the world have visited the crater and studied its unique features. Members of the U.S. Geological Survey's new space age Branch of Astrogeology, headquartered in nearby Flagstaff, have learned much new knowledge of the earth itself and of meteorites and lunar geology through researches they are conducting at Meteor Crater.

METEOR CRATER

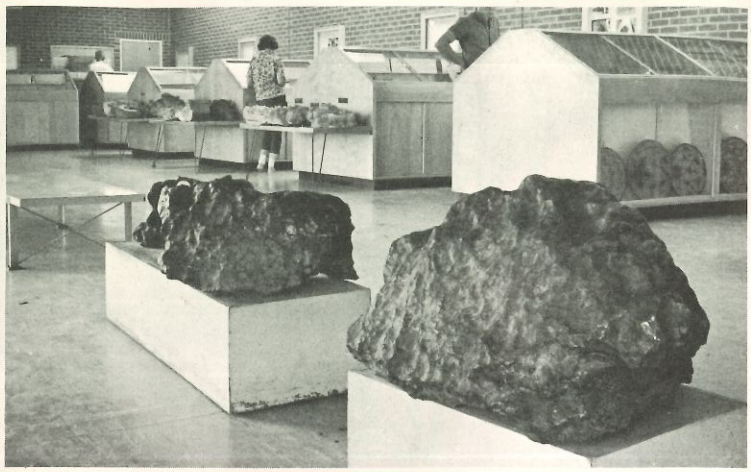
MUSEUM AND GIFT SHOPS

THE BARRINGER CRATER COMPANY
c/o Brandon Barringer, President
2106 Girard Trust Building
Philadelphia, Pennsylvania 19102

METEOR CRATER ENTERPRISES, INC.
P. O. Box AC
Winslow, Arizona

P. O. Box 879
Flagstaff, Arizona

NORTHLAND PRESS



Interesting & Educational Museum

POINTS OF INTEREST

Meteor Crater's museum is open from 8:00 a.m. to sunset 365 days a year. To further the visitor's understanding of this natural wonder, a brief explanation is given in the museum and on its veranda overlooking Meteor Crater, of the crater and its history. Diagrams and a large collection of meteorites and minerals are displayed in the museum, which also features an outstanding exhibit of fluorescent minerals housed in the ulra-violet-lighted Chameleon Room. Samples of these minerals, including fragments of meteorite, may be purchased in the museum's Gift Shop, one of the most unique in the American Southwest.

A second brief lecture on the crater and on the unique and fascinating area surrounding Meteor Crater is given at the summit of Moon Mountain, the highest point on the crater's jagged, blast created rim. A high-powered telescope, located on this summit, provides a superlative view of surrounding points of interest — the many-hued Painted Desert, the towering, often snow-capped San Francisco Peaks, the remote Hopi Mesas and many other unusual sights.

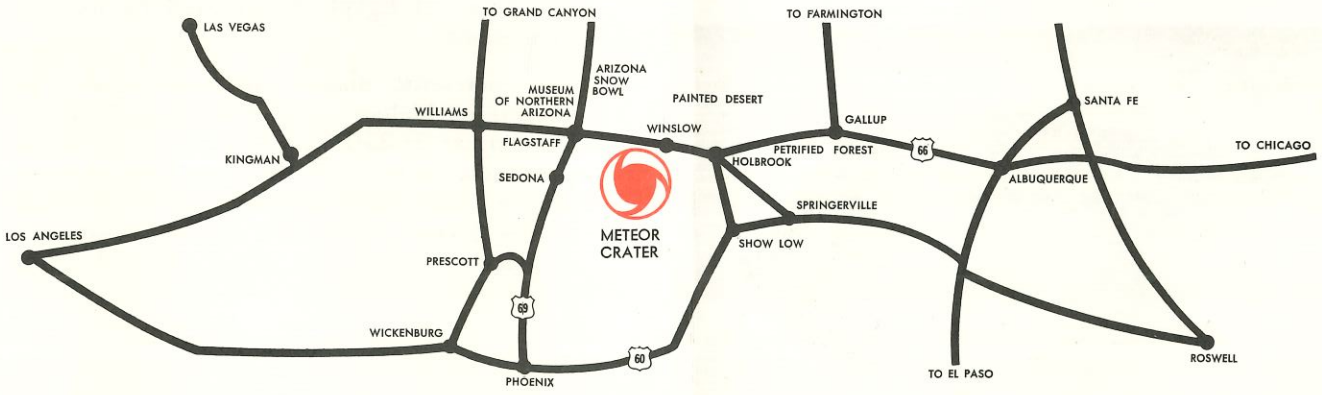
A trail winds around the three-mile rim of Meteor Crater, a brief but pleasant hike, and trails also lead from the museum to the bottom of the crater, a somewhat more strenuous walk. In connection with the museum, a lounge area and gift shop offers Indian arts and crafts, including handmade pottery, jewelry and other artifacts, as well as a complete selection of souvenir and gift items and camera supplies. An automated snack bar provides sandwiches, soft drinks, coffee, beer and ice cream.

CENTRALLY LOCATED

The great Meteor Crater of Arizona, one of the natural wonders of the world, is almost centrally located amid Northern Arizona's other great scenic wonders — the mighty Grand Canyon to the northwest, the fantastic Petrified Forest-Painted Desert National Park to the northeast. In addition, no less than 13 national monuments, marking extensive prehistoric Indian ruins, are within easy driving distance of Meteor Crater.

The crater itself is on the southern edge of the sprawling Navajo and Hopi Indian reservations. Include a stop at Meteor Crater when planning to visit this great natural wonderland.

Meteor Crater is easily reached by an all-weather, paved access road from U.S. Highway 66 between Flagstaff and Winslow, Arizona.



called + Told him
you were familiar
with this already
VS 10/7
1965

BRANDON BARRINGER
INVESTMENT ADVISER
2106 GIRARD TRUST BUILDING
PHILADELPHIA, PENNSYLVANIA 19102

Arch. Techniques

PHILADELPHIA
LOcust 7-3676

October 6, 1965

Dr. Froelich G. Rainey, Director
The University Museum
33rd and Spruce Streets
Philadelphia, Pa. 19104

Dear Froe:

The following is an excerpt from THE INTERAMERICAN, a newsletter put out by Carl B. Compton of Denton, Texas, with which you may be familiar.

"GREAT PYRAMID: Dr. Fathi Bediewi of Ein Shams University in Egypt and Dr. Luis W. Alvarez of California's Lawrence Radiation Laboratory will attempt to "X-ray" the Pyramid of Cheops by means of cosmic rays. They want to find out if the big structure contains any cavities or passages not know heretofore. The use of cosmic rays for such a purpose is an innovation which could very well be an important archaeological tool, if it works as these scientists hope."

I am writing to Dr. Alvarez for details as to the process. Since I don't think man knows how to make a cosmic ray, I suspect it may be a question of measuring the number of cosmic rays going through the Pyramid to see whether any concentration of them would indicate that at that point they had had an easier passage, due to a cavity.

If there is anything in the idea, it might be used in the Sillsbury Hill "project" you wrote me about the other day.

With personal regards,

Sincerely,

Brandon

BB:jms

February 8, 1967

Dr. A. R. Barringer
Barringer Research Ltd.
Toronto, Ontario
Canada

Dear Dr. Barringer:

In the Proceedings of the 3rd Symposium on Remote Sensing of Environment, October 1964, I read your report entitled "Recent Progress in Remote Sensing with Audio and Radio Frequency Pulses." I have been unable to obtain a copy of the Proceedings of the 2nd Symposium, so would appreciate it very much if you could send me information or articles published about your truck-mounted apparatus.

Do you think that there is any possibility of detecting buried walls or building foundations (usually less-conducting than the surrounding earth) with your pulsed equipment? I have enclosed a reprint from Science in which some of our work and problems are described, especially on p. 6 ff.

Sincerely yours,

Elizabeth K. Ralph

Encl: As stated
EKR/gm

BARRINGER RESEARCH LIMITED

304 CARLINGVIEW DRIVE
REXDALE, ONTARIO, CANADA
PHONE: 416-677-2491
CABLE: BARESEARCH

February 14, 1967

Miss Elizabeth K. Ralph,
Museum Applied Science Center
for Archaeology,
University of Pennsylvania,
33rd and Spruce Streets,
Philadelphia, Pennsylvania 19104,
U.S.A.

Dear Miss Ralph:

Further to your letter of February 8th, 1967, enclosed herewith please find a copy of Dr. Barringer's paper "The Use of Audio and Radio Frequency Pulses for Terrain Sensing". Also enclosed is a paper entitled "Developments Towards the Remote Sensing of Vapours as an Airborne and Space Exploration Tool" which may be of interest to you.

Dr. Barringer is presently out of town, however, upon his return I am sure he will reply personally.

Yours very truly,

BARRINGER RESEARCH LIMITED

J. Barker

encl.

(Miss) J. Barker
Secretary to
Dr. A. R. Barringer

March 1, 1967

Dr. A. R. Barringer, President

Barringer Research Ltd.
304 Carlingview Drive
Rexdale, Ontario, Canada

Dear Dr. Barringer:

Thank you very much for your informative letter of February 20th and for the accompanying literature.

We have tried out the Fisher M scope and various other portable commercial and obsolete military metal detectors, but without much success. With these, the depth penetration for the comparatively small objects or deposits which we seek is not adequate. In fact, we have found them useful only at historical sites in eastern U.S.A. and Canada where there are sometimes large deposits of iron objects near the surface.

Upon the completion of the tests of your helicopter-borne electromagnetic detection system, we should very much like to receive an evaluation of its penetration for various sizes of metal objects. I don't suppose there would be any hope of finding a small hoard of bronze Greek coins buried under five meters of clay.

May I trouble you also to tell me the cost of the GM-102 Portable Proton Magnetometer?

Sincerely yours,

Elizabeth K. Ralph

EKR/gm

August 26, 1969

Barringer Research
304 Carlingview Drive
Rexdale, Ontario
Canada

Dear Sirs:

Please send us details of the induced polarization technique as shown on the front cover of "Barringer Research," Spring 1969 issue.

Thank you.

Sincerely yours,

Elizabeth K. Ralph

EKR/arb

F-10 ASCA

BARRINGER RESEARCH

BARRINGER RESEARCH LIMITED
304 CARLINGVIEW DRIVE
METROPOLITAN TORONTO
REXDALE, ONTARIO, CANADA
PHONE: 416-677-2491
CABLE: BARESEARCH

October 16, 1969

Improved metal detectors

Mrs. Elizabeth K. Ralph
Museum Applied Science Center
for Archaeology
The University Museum
University of Pennsylvania
33rd & Spruce Streets
Philadelphia, PA 19104

Dear Mrs. Ralph:

We have already designed and built a reduced size portable version of our electromagnetic pulse system (INPUT^{R}) for ground geophysical operations. However, its size is still too large for it to be considered useful in the detection of objects as small as a mass of 10 kilograms at a depth of one metre. This would require a further reduction of an order of magnitude in the scale of our instrument. Since an instrument of this size would have little or no application in geophysics it would be mainly of interest to salvage or archaeological people. This does not mean that we are not interested in pursuing this matter since our instrumentation has many applications at the salvage, archaeological and treasure hunting level. However, our efforts towards these ends are scaled in accordance with the degree of return which it is likely to bring to our company. We are also investigating currently, some electromagnetic continuous wave instruments which would probably be the most suitable instruments of all in the role which you describe. These are being primarily designed for underwater applications but could certainly be used above ground. As our developments in these areas continue I will keep you informed of the form and status of them, and I look forward to hearing from you in the future.

Yours very truly

BARRINGER RESEARCH LIMITED

R. M. Watts

RMW:lc

R. M. Watts, P. Eng.
Manager
Commercial Products Division

West Chester State College

West Chester, Pennsylvania 19380

School of Social and Behavioral Sciences
Department of Anthropology, Sociology, and Social Welfare

215-436-2657

22 August 1975

Dr. Elizabeth K. Ralph
MASCA
The University Museum
The University of Pennsylvania
Philadelphia PA 19174

Dear Dr. Ralph:

Thank you very much for being so kind as to review my proposal regarding neutron activation analysis of steatite and related rocks from Crete. Your support as well as the encouragement given by others at MASCA have been invaluable in furthering my efforts. Any suggestions or corrections which you might wish to offer would be very much appreciated.

Enclosed is a copy of the rough budgetary figures for the two phases of the project. The second phase, which is entirely contingeant on the success of the first, is a bit less certain, and does not include expenses for travel to various museums in this country should permission be granted to take samples from their Minoan vessels. The policy of Cost Sharing at West Chester has been in effect for some time and is particularly suited to this project inasmuch as no additional space, students, secretaries, or computer time will be required.

I've spoken with Keith DeVries about taking samples from the vessels at the University Museum and he was justifiably hesitant to grant permission, but did say that he would consult with his colleagues. The University Museum would appear likely to be the first institution to participate in such a project as they are in the front ranks of scientific archaeological research. I'm certain that once the people in the Classical section realize that the sample size is nearly microscopic, and that no evident damage to the specimens will result, that they will be more than glad to co-operate in the project. Perhaps I could call you in early September and arrange an appointment to go over these various points.

Sincerely,

Marshall Becker

Marshall Joseph Becker
Professor of Anthropology

Tues. June 29th
loaned Geohm & gradiometer

14 East 63rd Street
New York, N.Y.
June 15, 1965

TE 2-8243

mid-July thru Oct.

Miss Elizabeth Ralph
The University Museum
University of Pennsylvania
Philadelphia, Pa.

Dear Miss Ralph:

Would it be convenient for you to meet with me on Friday or early next week? I would like to discuss the application of several new instruments to archaeology, especially the proton magnetometer.

Late in May I had the pleasure of discussing with Dr. Rainey and Dr. Kidder a project which I am planning together with Dr. Chavez Ballon of Peru. We plan to investigate certain limestone areas near Cuzco in which there are believed to be underground constructions which we intend to identify by the use of modern electronic equipment rather than random excavation.

When I explained that we intend to rely principally on measurements made by a magnetometer, Dr. Rainey very kindly offered to lend us the Museum's during the latter half of this year. He suggested that I should contact you in the middle of this month to discuss the Museum's experience with the magnetometer and, perhaps, other instruments.

I have written to Littlemore seeking any additional information they can provide on the "Elsec" model as well as a circuit diagram to facilitate repairs.

I will call you at the Museum Thursday to arrange a time when it will be convenient for us to meet.

Sincerely yours,

Donald A. E. Beer

Donald A. E. Beer

hold for Ralph
Hidden humor about this
720

14 East 63rd Street
New York, New York
May 24, 1965

Dr. Froelich Rainey
Director of the University Museum
University of Pennsylvania
Philadelphia
Pa.

Dear Dr. Rainey,

Our discussion Friday about the results of the Museum's magnetometer investigations in Italy encourages me that Dr. Chavez Ballon and I might obtain even better results than we had anticipated. We will be working in a limestone area in which there are external suggestions as well as old reports that subsurface tombs and passages exist. Your description of the Etruscan site indicates that there are many similarities. Hopefully, our measurements will contribute some further understanding to your observed magnetic anomalies associated with underground tomb cavities.

Your kind offer to loan us the Museum's "Elsec" magnetometer is greatly appreciated. I am writing to Littlemore Scientific Engineering Co. to obtain specific familiarity with the electronic circuitry of this model and its specifications as well as their experience with tolerance and breakdowns. I will get in touch with Elizabeth Ralph shortly concerning the magnetometer and the Museum's specific experience with it as well as any other recently developed instruments she feels we might use advantageously.

We are sincerely grateful for your contribution to our proposed expedition.

Sincerely yours,

Donald A. E. Beer

Donald A. E. Beer

BARRINGER RESEARCH LIMITED

304 CARLINGVIEW DRIVE
REXDALE, ONTARIO, CANADA
PHONE: 416-677-2491
CABLE: BARESEARCH

February 20, 1967

Miss Elizabeth K. Ralph,
Museum Applied Science Center
for Archaeology,
University of Pennsylvania,
33rd and Spruce Streets,
Philadelphia, Pennsylvania 19104,
U.S.A.

Dear Miss Ralph:

I was most interested to receive your letter of February 8 and to read the enclosed article. I can see that there is quite a field for "Archaeological Prospecting".

I believe that our pulse system could have an application in detecting sub-surface artifacts, but unfortunately the equipment would require very extensive modification and re-engineering before being suitable for high resolution semi-portable use on archaeological sites. This would not be a cheap operation and I doubt whether it would be warranted.

Have you investigated the use of portable pipe locators like the Fisher M Scope? These instruments lie midway between the mine detectors used by the military and airborne electromagnetic equipment used for base metal prospecting. They are cheap and require no physical contact with the ground.

One item of possible interest that we are developing is a helicopter-borne electromagnetic detection system that will detect small metal objects many feet below the surface. This unit is traversed over the ground by a helicopter and will shortly be made available to airborne survey companies for use in contract surveys.

We are carrying out tests with this equipment at frequent intervals during the course of its development, and if you feel it would be of any possible interest, we would gladly evaluate its penetration for various sizes of metal objects. Our interest is mainly in finding

conductive mineral deposits, and also in developing the instrument as a military tool for detecting buried arms caches of the type used by the Viet Cong. I will enclose a brief note on this equipment.

I will also enclose some literature on our proton magnetometers in case this is of interest.

Yours very truly,

BARRINGER RESEARCH LIMITED

Dictated by

A. R. Barringer
President

ARB:jb
encl. - GM-102A Data Sheet
- Helicopter Note
- AM-101A Data Sheet

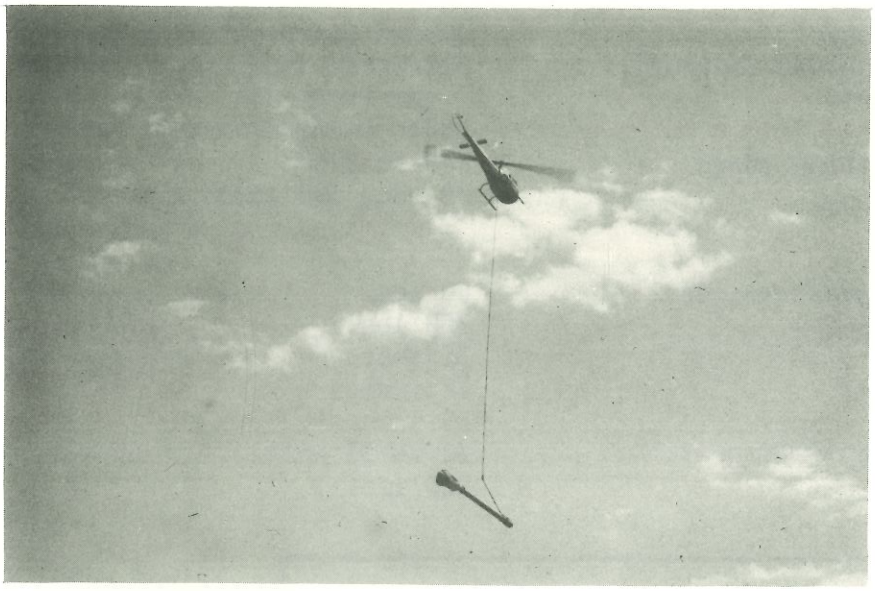
Signed in his absence by
A. Barringer V.P.

BARRINGER RESEARCH LIMITED

304 CARLINGVIEW DRIVE
REXDALE, ONTARIO, CANADA
PHONE: 416-677-2491
CABLE: BARESEARCH

TECHNICAL BULLETIN NO. AS-1040

E.M. ARMS CACHE DETECTING SYSTEM MINIMUM COUPLED



The prototype version of a new airborne EM detection system has successfully completed initial tests. The system is shown in its helicopter configuration but is also available for fixed wing installations as an integral component of the aircraft. The system has shown significant improvement in the airborne detection field with typical signal-to-noise ratios of 70/1 and received sensitivities of approximately 7 ppm of the transmitted signal.

A 400 Hz transmitter and receiver is mounted in the EM Bird towed by the helicopter. The bird contains transmitting and receiving coils and associated electronics, with the coils in a unique minimum-coupled configuration mounting. When the transmitter is energized, the fields associated with induced ground currents are sensed by the receiver coils, amplified by the receiver (in the helicopter) and displayed on a chart recorder. The output appears as a two phase signal, in-phase and out of phase, with respect to the transmitting coil signal.

APPLICATIONS

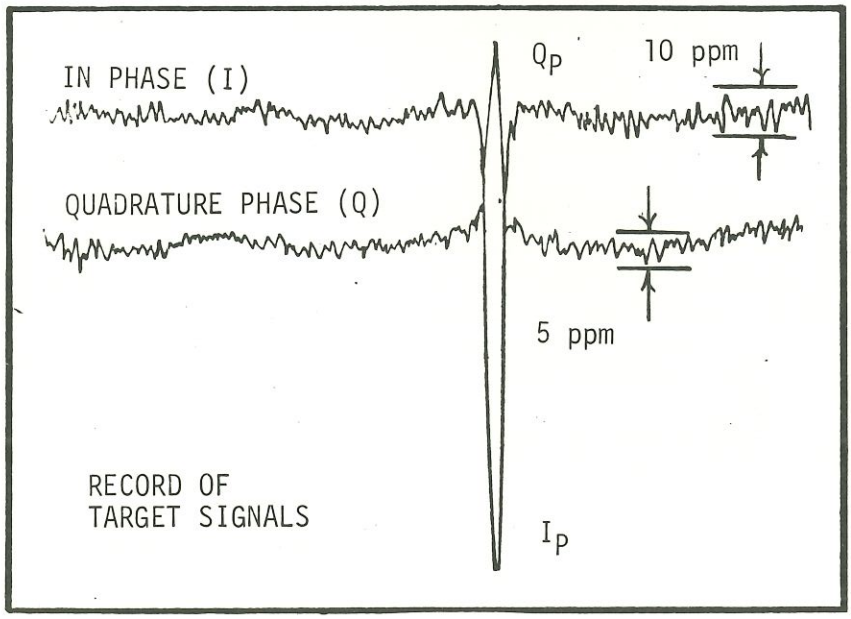
The system can be used to detect concentrations of metallic objects, such as, concealed arms caches, fuel drums and motor pools. It can also be used to detect the presence of tunnels. The principle used is the ability of the system to discriminate between the water content of soil above tunnels compared to normal soil overburden. Provision has been made for a quick release mechanism to drop the cable and bird in the event the bird becomes snagged.

JAMMING

The system is subject to localized jamming, however, the emitting source is easy to locate and can be passivated. It would be difficult to provide a saturation jammer, working at 400 Hz, which could effect blanket coverage for even modest areas.

SPECIFICATIONS

Electrical	
Operating frequency	400 Hz (optional, chosen for application)
Transmitter RMS power, (output)	300 watts input to coil (NIA 5000 amp. turns-ft.^{2})
System noise level	7 ppm (typical)
Readout method	chart recorder, light sensitive paper(optional)
Temperature operating range	-45 to 120°
Power Supply	28 vdc, 390 watts
Mechanical	
Electronics equipment weight	50 lbs.
Total bird weight	350 lbs.
Bird length	31 feet
Mean bird diameter	12 inches
Transmitter coil diameter	25 inches
Bird towing speed	30 to 85 knots
Cable length	125 feet



Target - 20' x 10' x 10'
Aluminum truck
Airspeed - 35 knots

Bird altitude - 20'
(20' to one side)

Noise envelope - I = 10 ppm
Q = 5 ppm

BARRINGER RESEARCH LIMITED

304 CARLINGVIEW DRIVE
REXDALE, ONTARIO, CANADA
PHONE: 416-677-2491
CABLE: BARESEARCH

April 18, 1967

Miss Elizabeth K. Ralph
Associate Director
Museum Applied Science Center for Archaeology
The University Museum
University of Pennsylvania
33rd and Spruce Streets
Philadelphia, Pennsylvania 19104
U.S.A.

Dear Miss Ralph:

Further to your earlier correspondence with Dr. Barringer, we have just last week completed demonstration tests with our helicopter-borne electromagnetic detection system for various military and Government groups, and are sending a brief bulletin prepared for general release which may be of interest. We can say that we could detect the aluminum truck mentioned at target to 'bird' distances of over 100 feet. Your target of a small collection of bronze coins is indeed small, but as our progress and testing continues, we will certainly keep you informed of developments.

Attached is our data sheet and price list for the GM-102A proton magnetometer, which is available from stock. A higher sensitivity (1 γ) portable instrument should be available in approximately six months, with advanced specifications as attached.

Thank you for your interest.

Yours sincerely,

BARRINGER RESEARCH LIMITED

D. A. Whiteman
Vice-President

DAW/ch
Encls.-Tech. Bulletin AS-1040
GM-102A brochure
Price List
GM-103 Advance Specs.

April 21, 1967

Mr. D. A. Whiteman, Vice-President
Barringer Research, Ltd.
304 Carlingview Drive
Rexdale, Ontario, Canada

Dear Mr. Whiteman:

Thank ypu very much for your letter of April 18th and enclosures.

I shall look forward to receiving the results of more tests of your electromagnetic detection system, especially, with smaller targets.

Sincerely yours,

Elizabeth K. Ralph

EKR/gm

BARRINGER RESEARCH

BARRINGER RESEARCH LIMITED
304 CARLINGVIEW DRIVE
REXDALE, ONTARIO, CANADA
PHONE: 416-677-2491
CABLE: BARESEARCH

replied 10/2/69

September 9, 1969

Miss Elizabeth K. Ralph
Museum Applied Science Center for Archaeology
The University Museum
University of Pennsylvania
33rd and Spruce Streets
Philadelphia, PA 19104

Dear Miss Ralph:

Since Barringer Research does not manufacture the equipment that is used in induced polarization surveys I have enclosed some technical literature provided by Huntec Ltd. who are the manufacturers. Although this material is not slanted towards archaeology I think you will find it of interest and if it does not satisfy your requirements please contact me again and I will attempt to locate more detailed information from our geophysical interpretation group.

In addition to this system we have developed a portable version of our airborne INPUT ^{R} technique which we feel may become more important than the induced polarization system. This new method is a pulsed electromagnetic system and we feel will have great applications for geophysics and metal detection and archaeology. If you would like to be kept updated on this and other detection systems developed by Barringer Research which might have an application in archaeology either on land or undersea we would be more than glad to keep you informed. I have included for your interest a data sheet describing our oceanographic magnetometer which has been considered for use in archaeological work off the island of Bimini, Florida. Looking forward to hearing from you again in the future.

Yours very truly,

BARRINGER RESEARCH LIMITED

R. M. Watts, P. Eng.
Manager
Commercial Products Division

RMW:pt
Encls.

October 1, 1969

Mr. R. M. Watts, Manager
Commercial Products Division
Barringer Research Ltd.
304 Carlingview Drive
Rexdale, Ontario, Canada

Dear Mr. Watts:

Thank you very much for your letter of September 9th and for the enclosures. The induced polarization system is intriguing, but I cannot think of any applications for it in archaeological searching.

Some time ago we had thought of trying an experiment - namely to put a D.C. current in the ground to find out if it would enhance small magnetic anomalies which could then be detected more readily with megnetometers. However, we haven't yet done the experiment. Perhaps, you know the answer already.

Your electromagnetic pulse system could be useful to us if it were possible to miniaturize it for ground-based portable operation and maintain the same sensitivity of detection. I feel pretty sure that with aerial coverage a tomb containing bronze pots at a depth of one meter would be missed. With your present system, if used on the ground, would it be possible to detect 10 kg or less of bronze at a depth of one meter or deeper?

Thank you too for the information about your oceanographic magnetometer.

We shall appreciate it very much if you will keep us updated on any new detection systems developed by Barringer Research which might have applications in archaeology.

Sincerely yours,

Elizabeth K. Ralph

EKR/mck

cc to Fro

BARRINGER RESEARCH

BARRINGER RESEARCH LIMITED
304 CARLINGVIEW DRIVE
METROPOLITAN TORONTO
REXDALE, ONTARIO, CANADA
PHONE: 416-677-2491
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October 16, 1969

Improved metal detectors

Mrs. Elizabeth K. Ralph
Museum Applied Science Center
for Archaeology
The University Museum
University of Pennsylvania
33rd & Spruce Streets
Philadelphia, PA 19104

Dear Mrs. Ralph:

We have already designed and built a reduced size portable version of our electromagnetic pulse system (INPUT^{R}) for ground geophysical operations. However, its size is still too large for it to be considered useful in the detection of objects as small as a mass of 10 kilograms at a depth of one metre. This would require a further reduction of an order of magnitude in the scale of our instrument. Since an instrument of this size would have little or no application in geophysics it would be mainly of interest to salvage or archaeological people. This does not mean that we are not interested in pursuing this matter since our instrumentation has many applications at the salvage, archaeological and treasure hunting level. However, our efforts towards these ends are scaled in accordance with the degree of return which it is likely to bring to our company. We are also investigating currently, some electromagnetic continuous wave instruments which would probably be the most suitable instruments of all in the role which you describe. These are being primarily designed for underwater applications but could certainly be used above ground. As our developments in these areas continue I will keep you informed of the form and status of them, and I look forward to hearing from you in the future.

Yours very truly

BARRINGER RESEARCH LIMITED

RMW:lc

R. M. Watts, P. Eng.
Manager
Commercial Products Division

25th September, 1973

Mr. Edward Johnson, Manager
Marketing and Sales
Barringer Research Ltd.
304 Carlingview Drive
Metropolitan Toronto
Rexdale,,Ontario
Canada M9W5G2

Dear Mr. Johnson,

In regard to building or upgrading two cesium magnetometer readouts, I find it difficult to put our requirements on paper in a coherent way. However, here are some thoughts that I had in 1970 plus some of today.

With this information, if you could give us a "ball park" estimate, then perhaps we could get together to discuss the details.

Sincerely yours,

Elizabeth K. Ralph

Station mag — shallow ocean work ~17 lbs.
$4500

BARRINGER RESEARCH

BARRINGER RESEARCH LIMITED
304 CARLINGVIEW DRIVE
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REXDALE, ONTARIO
M9W 5G2 CANADA
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CABLE: BARESEARCH
TELEX: 06-968743

December 7, 1973

Dr. Elizabeth G. Ralph,
David Rittinhouse Lab.,
University of Pennsylvania,
19174

Dear Dr. Ralph;

Thank you for your letter and enclosures detailing your magnetometer design requirements.

The specifications have been reviewed and we do not feel that we would be able to do justice to the project due to our present manufacturing requirements.

Thank you for your interest in Barringer Research. Hopefully, we can be of future service to you or your organization.

Yours truly,

BARRINGER RESEARCH LIMITED,

E. A. Johnson,
Manager, Marketing and Sales

EAJ/nl

Negative bid