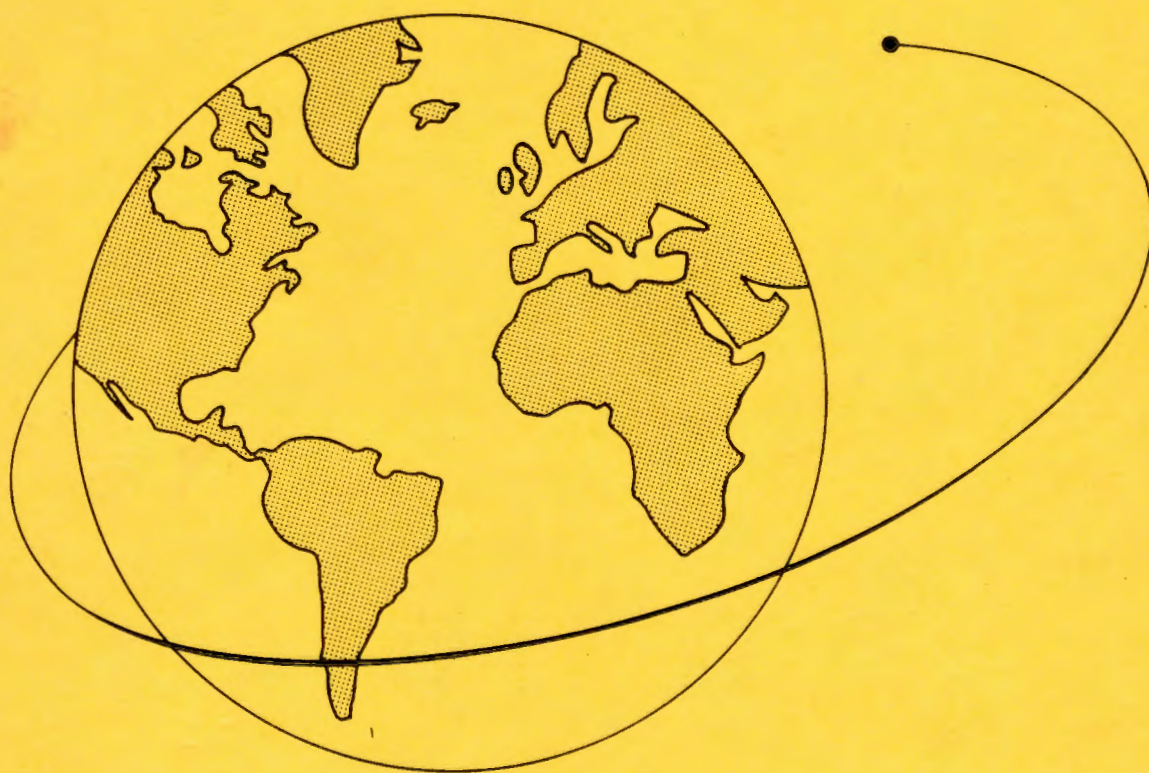


# ON THE DISTRIBUTION OF THE GIBEON METEORITES OF SOUTH-WEST AFRICA

ROBERT CITRON



Smithsonian Astrophysical Observatory  
SPECIAL REPORT 238

Research in Space Science

SAO Special Report No. 238

ON THE DISTRIBUTION OF THE GIBEON METEORITES  
OF SOUTH-WEST AFRICA

Robert Citron

March 30, 1967

Smithsonian Institution  
Astrophysical Observatory  
Cambridge, Massachusetts, 02138

## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
BIOGRAPHICAL NOTE . . . . .	iv
ABSTRACT . . . . .	v
1 INTRODUCTION . . . . .	1
2 GIBEON DISTRIBUTION . . . . .	2
3 RECENTLY RECOVERED GIBEON METEORITES . . . . .	7
3.1 The Lichtenfels Meteorite . . . . .	7
3.2 The Haruchas Meteorite . . . . .	8
3.3 The Donas Meteorite . . . . .	9
3.4 The Bethanie Meteorite . . . . .	10
3.5 The Keetmanshoop Meteorite . . . . .	10
3.6 The Kinas Putts Meteorite . . . . .	11
3.7 The Kamkas Meteorite . . . . .	12
4 POSSIBLE IMPACT CRATERS . . . . .	15
5 ACKNOWLEDGMENTS . . . . .	20
6 REFERENCES . . . . .	21
 <u>Appendix</u>	
A WEIGHT LIST OF KNOWN GIBEON METEORITES . . . . .	A-1
B GIBEON METEORITES IN MUSEUMS . . . . .	B-1
C PHOTOGRAPHS OF RECENTLY RECOVERED GIBEON METEORITES . . . . .	C-1
D PHOTOGRAPHS OF METEORITES IN PUBLIC GARDENS, WINDHOEK, SOUTH-WEST AFRICA . . . . .	D-1

## LIST OF ILLUSTRATIONS

<u>Figure</u>		<u>Page</u>
1	Map of known Gibeon meteorite distribution . . . . .	5
2a	Aerial view of Brukkaros crater . . . . .	16
2b	Ground view of Brukkaros crater . . . . .	17
3	Aerial view of Roter Kamm crater . . . . .	19
C-1	The Lichtenfels meteorite . . . . .	C-2
C-2	The Haruchas meteorite . . . . .	C-2
C-3	The Donas meteorite . . . . .	C-3
C-4	The Bethanie meteorite . . . . .	C-3
C-5	The Kinas Putts meteorite . . . . .	C-4
D-1	Twenty-seven Gibeon meteorites, whose total weight exceeds 10 metric tons, in the Public Gardens at Windhoek, South-West Africa . . . . .	D-2
D-2	Closeup views of individual Gibeon meteorites, Public Gardens, Windhoek . . . . .	D-4

## LIST OF TABLES

<u>Table</u>		<u>Page</u>
1	Known Gibeon meteorites . . . . .	6
2	Reports of other objects in the Gibeon area . . . . .	13
3	Old hearsay reports of unrecovered Gibeon meteorites .	14

## BIOGRAPHICAL NOTE

Robert A. Citron received a B.A. in Social Science from the University of the Philippines in 1956, and a B. S. in Aeronautical Engineering from Northrop Aeronautical Institute in Inglewood, California, in 1959.

He joined the Observatory in 1959 as an observer at the astrophysical observing station in San Fernando, Spain. Since then he has managed astrophysical observing stations in Florida, South Africa, and Ethiopia, as well as consulting with stations in Canada, India, and Norway.

In addition to the Gibeon meteorites, Mr. Citron has recovered specimens of the following dated meteorite falls for Smithsonian analysis: Ehole, Angola (1962), Monze, Zambia (1964), and Ankober, Ethiopia (1966).

## ABSTRACT

The Gibeon meteorites of South-West Africa have one of the widest distributions of any known group of meteorites on earth. An attempt is made to record what is currently known about their distribution from available literature and personal interviews with people who participated in the discovery and collection of these meteorites. Information is presented on two large possible impact craters that lie in or near the Gibeon area. Descriptions and photographs of six hitherto unreported meteorites are contained in this report. Possible locations of other unreported Gibeon meteorites are presented.



# ON THE DISTRIBUTION OF THE GIBEON METEORITES OF SOUTH-WEST AFRICA

Robert Citron

## 1. INTRODUCTION

In this paper I shall discuss what is currently known about the distribution of meteorites in the Gibeon district of South-West Africa. I visited a dozen farms and interviewed some two dozen persons in and around the main Gibeon fall area: Mariental, Gochas, Gibeon, Asab, Berseba, Keetmanshoop, Aroab, and Bethanie. I went to the farms where the great majority of Gibeon meteorites were discovered, including Kameelhar, Goamus, Korra Korrabes, Amalia, Groendorner, and Gibeon, and also the farms where single meteorites were found distributed over a wide area: Enos, Donas, Hunsruck, and Haruchas. I obtained information leading to the recovery of six additional Gibeon meteorites not previously reported in the literature. Research was done in the archives of the State Museum of Windhoek, South-West Africa, to obtain as much information as possible about where, when, by whom, and under what circumstances Gibeon meteorites had been recovered.

This paper also presents information on two very large possible impact craters: Brukkaros and Roter Kamm. The former lies almost in the center of the distribution of Gibeon meteorites, although about 45 miles from the main fall area. The latter lies 150 miles southwest of Brukkaros and nearly 200 miles from the main Gibeon fall area.

---

This work was supported in part by grant NsG 87-60 from the National Aeronautics and Space Administration.

## 2. GIBEON DISTRIBUTION

During the 94 years between 1836 and 1930, some 54 iron meteorites, whose total weight exceeds 15 tons, were found in and around the Gibeon district of South-West Africa (Alexander, 1838; Fletcher, 1904; Spencer, 1941). These meteorites are fine octahedrites, with an average nickel content of about 8% (Herschel, 1839). Most of the specimens weigh between 74.6 and 522.5 kg; more than 2/3 of them weigh between 150 and 340 kg, with their average weight being 245 kg (see Appendix A). Many whole meteorites and sample specimens are distributed in museums throughout the world (see Appendix B).

An interesting problem associated with these objects is their unusually wide distribution. Spencer (1941) states:

The distribution of these masses over an area of several hundred square miles, and the fact that they are all of considerable size, suggest that the shower was a swarm of meteorites rather than a single mass broken up in the earth's atmosphere, as in the case with showers of stones.....

The concept of a swarm of meteoroids traveling together in space is no longer accepted, however, by scientists studying the dynamics of the solar system. In all probability, therefore, the Gibeon irons do represent a single mass that fragmented during flight through the atmosphere. Spencer (1941) states further that

.... it is also evident that some of the large masses had been transported.

He believes it probable that the Kamkas, Lion River, and Bethanie (Wild) meteorites were transported from the main fall area. This is in disagreement with the statement by Zelle, the discoverer of the Kamkas meteorite, who believes that he found it in its original position. Fletcher (1904) was



of the opinion that the Lion River meteorite also was found in its original place. The Kamkas meteorite was found nearly 100 miles northwest of the main fall area; the Lion River meteorites, 140 miles south, and the Bethanie meteorite, 75 miles southwest (Spencer, 1941; Shepard, 1853; Cohen, 1900). Zelle states that the Bethanie (Berseba) meteorite "originally" came from Goamus and was brought by the Hottentots to Berseba, where it was found by a South African scientist. He says that "the Hottentots carried some meteorites with their ox wagons," but maintains that he discovered the Kamkas meteorite where it fell.

The problem of the distribution of the Gibeon meteorites was again raised when two additional objects (Kinas Putts and Donas) were recently reported to have been found in their original positions, 135 miles and 145 miles, respectively, southeast of the main Gibeon fall area (Citron, 1964a, b). A third object, Haruchas, was said to have been located in its original place 55 miles northeast of the area.

A sample specimen of the Karasburg meteorite was taken from the Johannesburg museum and sent to the Smithsonian Institution. Analysis has shown that there is a great likelihood that this meteorite, too, is of Gibeon origin. If this is true, the shower may have extended as far south as Karasburg, which is over 200 miles from the main fall area.

To date, at least 65 masses, whose total weight exceeds 20 tons, are known to have been found. The main fall area is centered around the Kameelhar farm, at latitude  $25^{\circ}10'$  S and longitude  $18^{\circ}00'$  E. At least 53 of the 65 recovered meteorites have been found within 20 miles of this position and within an area of 300 square miles. The remaining 12 meteorites were scattered over an extensive area, in all directions from the main fall area and up to 145 miles away. The maximum separation between two meteorites reported to have been found in their original positions is 230 miles: Kamkas and Kinas Putts.

The evidence appears strong that the Gibeon shower sprayed meteoritic material over a very extensive area. A thorough field investigation of this area would undoubtedly lead to the recovery of many additional tons of meteoritic material and the delineation of the boundaries of this enormous shower.

See Figure 1 and Table 1 for details of the locations of the samples, and other pertinent data.

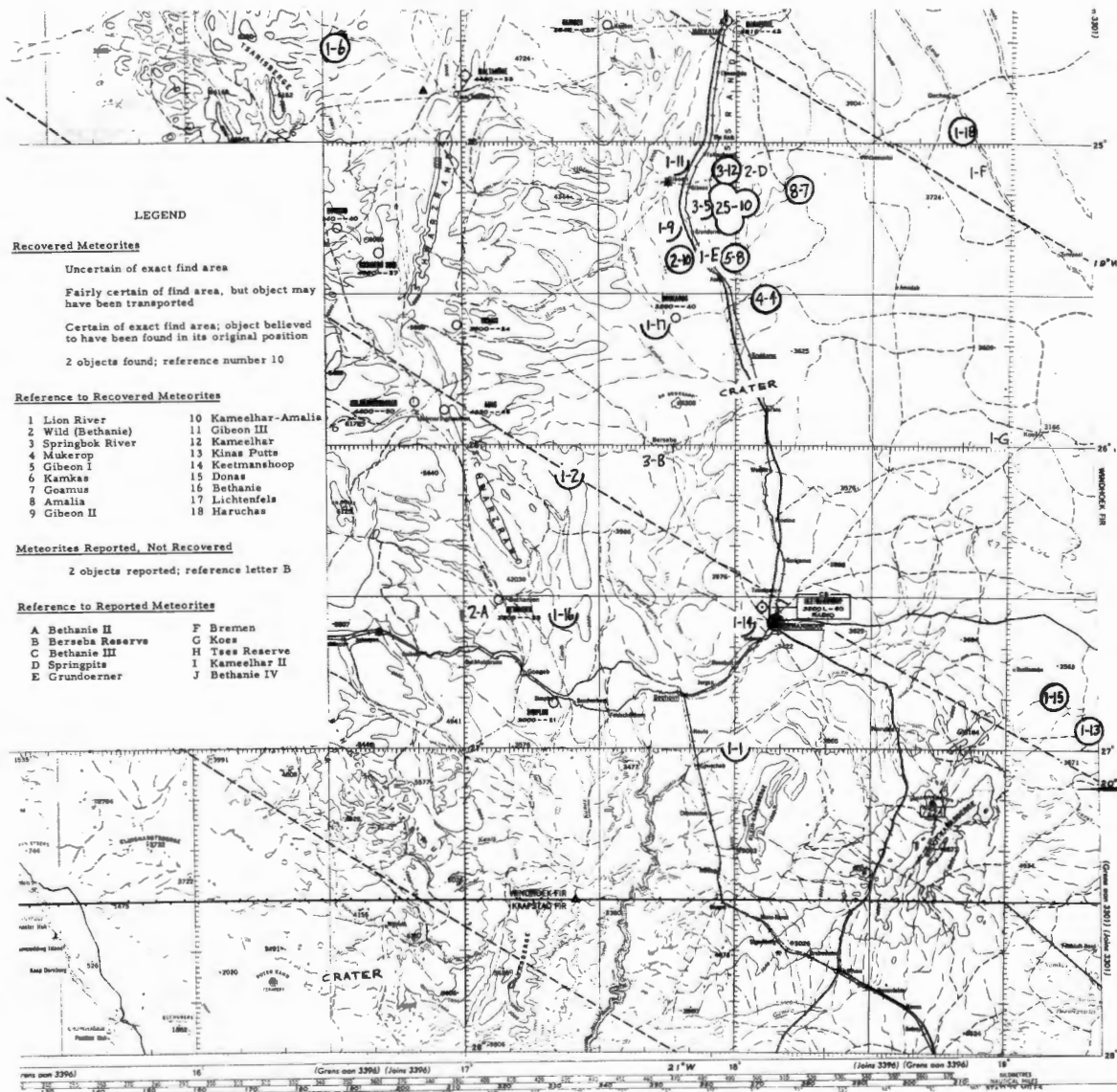


Figure 1. Map of known Gibeon meteorite distribution.

Table 1. Known Gibeon meteorites

Reference Number	Name	No. of objects	Weight (kg)	Location of discovery	Latitude longitude	Date of discovery	Discoverer	Reported by year	Where Now	References **
1	Lion River	1	66	Plain near Lion River	27° S 18° E	1852	J. Gibbs	C. U. Shepard 1853	Amherst College, Mass., USA	a, b, c
2	Wild	1	191.7	Mountains between Bethanie and Berseba	26°10' S 17°20' E	1857	Wild	E. Cohen 1900	Capetown Museum	a, b, d, e
3	Springbok River	1	Fragment (9 grams)	Springbok River area	Unknown	1874	Unknown	L. Fletcher 1904	Various museums	a
4	Mukerop	4	146, 149 244, 413	Mukerop farm	25°30' S 18°10' E	1899	Unknown	Brezina/Cohen 1902	Bonn Museum; various museums	a, b, f
5	Gibeon I	3	348, 255, 209	Gibeon district	Unknown	1903	Unknown	E. Cohen 1905	Hamburg Museum	b, g
6	Kamkas	1	168 (?)	Kamkas farm	26°40' S 16°36' E	1906	E. Zelle	L. Spencer 1941	America; specimen, SI	b This report
7	Goamus	8	334, 269, 251, 231, 221, 209, 198, 187	Farms Goamus, Amalia, and Kameelhar	25°10' S 18°15' E	1910-1912	Unknown	F. Rinne/ W. Schauf 1912	Berlin, Frankfurt, Hamburg, Stuttgart	h, i, j
8	Amalia	5	1385*	Amalia farm	25°20' S 18°00' E	1910	Unknown	W. Schauf 1912	Windhoek	b, k, l
9	Gibeon II	1		Gibeon	Unknown	1912	Unknown	P. Range 1912	Windhoek	b, k, m
10	Kameelhar-Amalia	27 <sup>††</sup>	10, 376 <sup>†</sup>	Farms Kameelhar, Amalia, Goamus, Korra Korrabes	25°15' S 18°00' E	1911-1912	P. Range and farmers	P. Range 1912	Public Gardens, Windhoek	b, k, m
11	Gibeon III	1	195 grams	Gibeon area	Unknown	1929	P. James	L. Spencer 1941	British Museum	b
12	Kameelhar	3	164, 157, 108	Kameelhar farm	25°15' S 18°00' E	1930	Unknown	W. Edlinger/ V. Zsibvy 1932	In America; cut into pieces	b, m
13	Kinas Putts	1	159	Enos farm	27°00' S 19°20' E	1923	Hartung	R. Citron 1964	Johannesburg; specimen, SI	h
14	Keetmanshoop	1	168	Keetmanshoop area	Unknown	1940 (?)	DeWitt (?)	R. Citron 1964	Specimen, SI	h
15	Donas	1	216	Donas farm	26°50' S 19°10' E	1940	D. Winston	R. Citron 1965	Keetmanshoop; specimen, SI	n
16	Bethanie	1	601	Hunsruck farm area	26°35' S 17°25' E	Unknown	Unknown	R. Citron 1965	Keetmanshoop; specimen, SI	n
17	Lichtenfels	1	~149	Lichtenfels farm area	Unknown	Unknown	P. Hallenbeck (?)	R. Citron 1966	Lichtenfels farm; specimen, SI	This report
18	Haruchas	1	31	Haruchas farm	24°55' S 18°50' E	1905	C. Berger	R. Citron 1966	Haruchas farm; specimen, SI	This report

\* Total weight; individual weights not available.

† Total weight. Includes weights of meteorite nos. 9 and 8, 3 objects of no. 7 (weighing 221, 209, and 198), and 2 objects of no. 5 (weighing 255 and 209).

\*\* a) Fletcher, 1904; b) Spencer, 1941; c) Shepard, 1853; d) Herschel, 1839; e) Cohen, 1900; f) Brezina and Cohen, 1902; g) Cohen, 1905; h) Citron, 1964a; i) Rogers, 1915; j) Rinne, 1910; k) Range, 1913; l) Schauf, 1912; m) Range, 1912; n) Citron, 1964b.

†† See Appendix D for photographs of the meteorites.

### 3. RECENTLY RECOVERED GIBEON METEORITES

Following are data on the individual recovered meteorites. Table 2 lists other objects in the Gibeon area, and Table 3 presents information on unrecovered Gibeon meteorites. See Appendix C, Figure C-1.

#### 3.1 The Lichtenfels Meteorite

The Lichtenfels meteorite was found on or near the Lichtenfels farm, about 10 miles north of the crater Brukkaros in the Berseba Reserve. It is located about 20 miles southeast of the main fall area.

Type: Iron, Gibeon

Weight: About 149 kg

Size: 36 × 14 × 18 inches

Fall date: Unknown

Discovery date: Unknown

Discoverer: Unknown

Place of Discovery: The Lichtenfels farm (?)

Present owner of the farm: Peter Hallenbeck

Present owner of the meteorite: Peter Hallenbeck

Present location of the meteorite: The Lichtenfels farm

Specimen sent to Smithsonian Institution, Washington, January 16, 1965.

### 3.2 The Haruchas Meteorite

The Haruchas meteorite was found approximately 1 mile south of the Haruchas farmhouse and about 100 yards west of the road that passes through the farm. This meteorite was located about 60 miles northeast of the main fall area. See Appendix C, Figure C-2.

Type: Iron, Gibeon

Weight: 31 kg

Size: 12 × 8 × 8 inches

Fall date: Unknown

Discovery date: 1900

Discoverer: Carl Berger, German missionary

Place of discovery: The Haruchas farm, south of Gochas, South-West Africa, at latitude 24°55' S and longitude 18°50' E.

Present owner of the farm: Theo Berger

Present owner of the meteorite: Theo Berger

Present location of the meteorite: The Haruchas farm

Specimen sent to Smithsonian Institution, Washington, January 16, 1965.

Mr. S. Berger states that there is a much larger meteorite partly buried in the sand dunes on the Bremen farm, owned by Mr. P. J. Bottman, about 10 miles to the south. This is confirmed by Mr. E. Zelle.



### 3.3 The Donas Meteorite

The Donas meteorite was found approximately 2 miles southwest of the Donas farmhouse and about 100 yards northwest of a small dirt road that originates at the farmhouse.

The Donas meteorite was found about 12 miles due northeast from the Kinas Putts meteorite. Both objects were located at least 150 miles east of the Bethanie meteorite. See Appendix C, Figure C-3

Type: Iron, Gibeon

Weight: 216 kg

Size: 28 × 18 × 9 inches, approximately

Fall date: Unknown

Discovery date: 1940

Discoverer: David Winston, herdboyer

Place of Discovery: The Donas farm, near Aroab, South-West Africa,  
at latitude 26°40' S and longitude 19°10' E.

Present owner of the farm: Frederick Descande

Present owner of the meteorite: Frederick Descande

Present location of the meteorite: Keetmanshoop, South-West Africa

Specimen sent to Smithsonian Institution, Washington, November 1964.

### 3.4 The Bethanie Meteorite

The exact location of the Bethanie meteorite is unknown; it was found at least 150 miles west of the Donas and Kinas Putts meteorites. See Appendix C, Figure C-4.

Type: Iron, Gibeon

Weight: 60 kg

Size: 12 × 12 × 8 inches, approximately

Fall date: Unknown

Discovery date: Unknown

Discoverer: Unknown

Place of discovery: Bethanie area

Present owner of the meteorite: Mr. Byleveld

Present location of the meteorite: Keetmanshoop, South-West Africa

Specimen sent to Smithsonian Institution, Washington, November 1964.

### 3.5 The Keetmanshoop Meteorite

The Keetmanshoop meteorite was picked up on a farm in the Keetmanshoop area of South-West Africa. It is now in the possession of the local high school. Unfortunately, very little information is known about the object.

Type: Iron

Weight: 168 kg

Size: Unknown

Fall date: Unknown

Discovery date: Unknown

Discoverer: Unknown

Place of discovery: Keetmanshoop area

Present owner of discovery area: Unknown

Present owner of the meteorite: Keetmanshoop High School

Present location of the meteorite: Keetmanshoop, South-West Africa

Specimen sent to Smithsonian Institution, Washington, July 24, 1964.  
Specimen weight, 622 g.

### 3.6 The Kinas Putts Meteorite

The Kinas Putts meteorite was found about 12 miles due southwest of the Donas meteorite, on the farm Kinas Putts. See Appendix C, Figure C-5.

Type: Iron

Weight: 159 kg

Size: 22 × 16 × 8 inches, approximately

Fall date: Unknown

Discovery date: Unknown. Probably between 1908 and 1923.

Discoverer: Mr. Hartung

Place of discovery: The Kinas Putts farm, Aroab, South-West Africa,  
at latitude 27°00' S and longitude 19°10' E.

Present owner of the farm: J. J. Brits

Present owner of the meteorite: A. H. L. Smit

Present location of the meteorite: Johannesburg, South Africa

Specimen sent to Smithsonian Institution, Washington, July 24, 1964.  
Specimen weight 93 g.

### 3.7 The Kamkas Meteorite

The Kamkas meteorite was found on the Kamkas farm on a hard ledge of a small flat river in the Fish River series, about 3 miles from the Kamkas farmhouse. The Kamkas farm is 100 miles northwest of the main Gibeon fall area.

Type: Iron, Gibeon

Weight: Estimated at 131 kg

Size: 20 × 14 × 10 inches, approximately

Fall date: Unknown

Discovery date: 1906

Discoverer: E. Zelle

Place of discovery: The Kamkas farm, west of Maltahohe, South-West Africa, at latitude 26°40' S and longitude 16°36' E.

Present owner of the farm: Unknown

Present owner of the meteorite: Unknown

Present location of the meteorite: America

Specimen sent to Smithsonian Institution, Washington, January 16, 1965.

Table 2. Reports of other objects in the Gibeon area

<u>Reference letter</u>	<u>No. of objects</u>	<u>Area</u>	<u>Reported by</u>	<u>Remarks</u>
A	2	Bethanie II	Dr. Nel	Both small pieces, have not been moved
B	3	Berseba Reserve	Mr. Byleveld	Still in ground, have not been moved
C	1	Bethanie III	Mr. Liebenberg	Weights about 300 kg
D	2	Springpits	B. Abrams	370 and 110 kg
E	1	Groendorner	B. Abrams	About 110 kg
F	1	Bremen	S. Berger E. Zelle	Over 370 kg
G	1	Koes	Mr. Byleveld	
H	Group	Tses Reserve	Mr. Zelle Mr. Smit	Small ones. 20-25 kg
I	Many	Under the Kalk at Kameelhar	Mr. Zelle	Look for burnt limestone
J	Few	Northwest of Bethanie	Mr. Zelle	West of farm Umub

Table 3. Old hearsay reports of unrecovered Gibeon meteorites

<u>Where</u>	<u>How many</u>	<u>Remarks</u>	<u>Date seen</u>	<u>Date reported</u>	<u>Told by</u>	<u>Reported by</u>	<u>Reference*</u>
Far up the Great Fish River 3 days journey Northeast from Bethanie	Large masses	Hills from which malleable iron could be cut	Before 1836	1836	Balli of Henkrees, South-West Africa	J. E. Alexander	a, b
Between Bethanie and Berseba	Great number	Natives used the metal to make weapons	Before 1848	1904	Dr. P. D. Hahn Bethanie	Miss W. Wilman, Capetown Museum	a, b, c
In the bed of the Fish River	Heavy masses of native iron	Weight from 168 to 373 kg; tough, fibrous fracture, suitable for forging tools		1860	Mr. A. Thies, Namaqualand	Mr. C. Zerrenmer	
East of Great Fish River at 25°5' S, 18°5' E	Masses of native iron	Scattered over surface of considerable area	1836	1838	J. E. Alexander	Sir John Herschel	
Northeast of Bethanie, near Great Fish River; on a plain	Large masses of iron on plain	Require several men to lift them	1836	1838	Hearsay	J. E. Alexander	a, b
Northeast of Bethanie, 26° S, 19°5' E	Inexhaustible quantities of iron found	So pure and malleable that natives converted it into balls for guns		1856	C. J. Anderson	Charles John Anderson	b, c
East bank of Great Fish River, opposite Berseba	"Alexander" masses			1885		Dr. Adolf Schenk	b
Near Lion River	One or more masses	Too heavy to transport; used by Namaquas for arrowheads and assegais		1852		One purchased by Prof. Tenmast, London	b

\* a) Alexander, 1838; b) Fletcher, 1904; c) Spencer, 1941.



#### 4. POSSIBLE IMPACT CRATERS

Two craters located in and around the Gibeon meteorite area warrant further investigation. The first, Brukkaros (see Figures 2a and b) lies nearly in the center of the distribution area, although some 45 miles to the southeast of the main fall area. Spencer (1941) states:

There is in this region a remarkable topographical feature which may possibly have some connection with these meteorites. This is the large crater Brukkaros, which has been described in some detail by A. Rogers . . . . The crater is 1.3 miles across and the flat bottom is 1500 feet below the highest point of the rim. . . . No volcanic material has been found. . . . There are no volcanic rocks in the neighborhood. . . but there are many Kimberlite pipes [in the area].

I. H. Halbrich of the Geological Survey of South-West Africa states:

You have a crater consisting only of breccia, which again consists of country rock. . . and radiating fractures which radiate out from the crater for several miles in the country rock, and these fractures are filled with dolomitic and calcitic material and nothing else, which is not, from a geological standpoint, a criterion which points to volcanic origin. It is feasible that the calcitic and dolomitic material in such fractures or dike-like structures might have been pressed up or intruded from below by a kind of impact which mobilized the dolomitic strata about 1000 meters below the surface.

Professor H. Martin of Capetown University states:

Brukkaros is related to the kimberlite volcanism. Brukkaros itself has got blocks on the north and south sides with kimberlitic material and with carbonitite. There certainly is no reason to believe that it might be an impact crater.

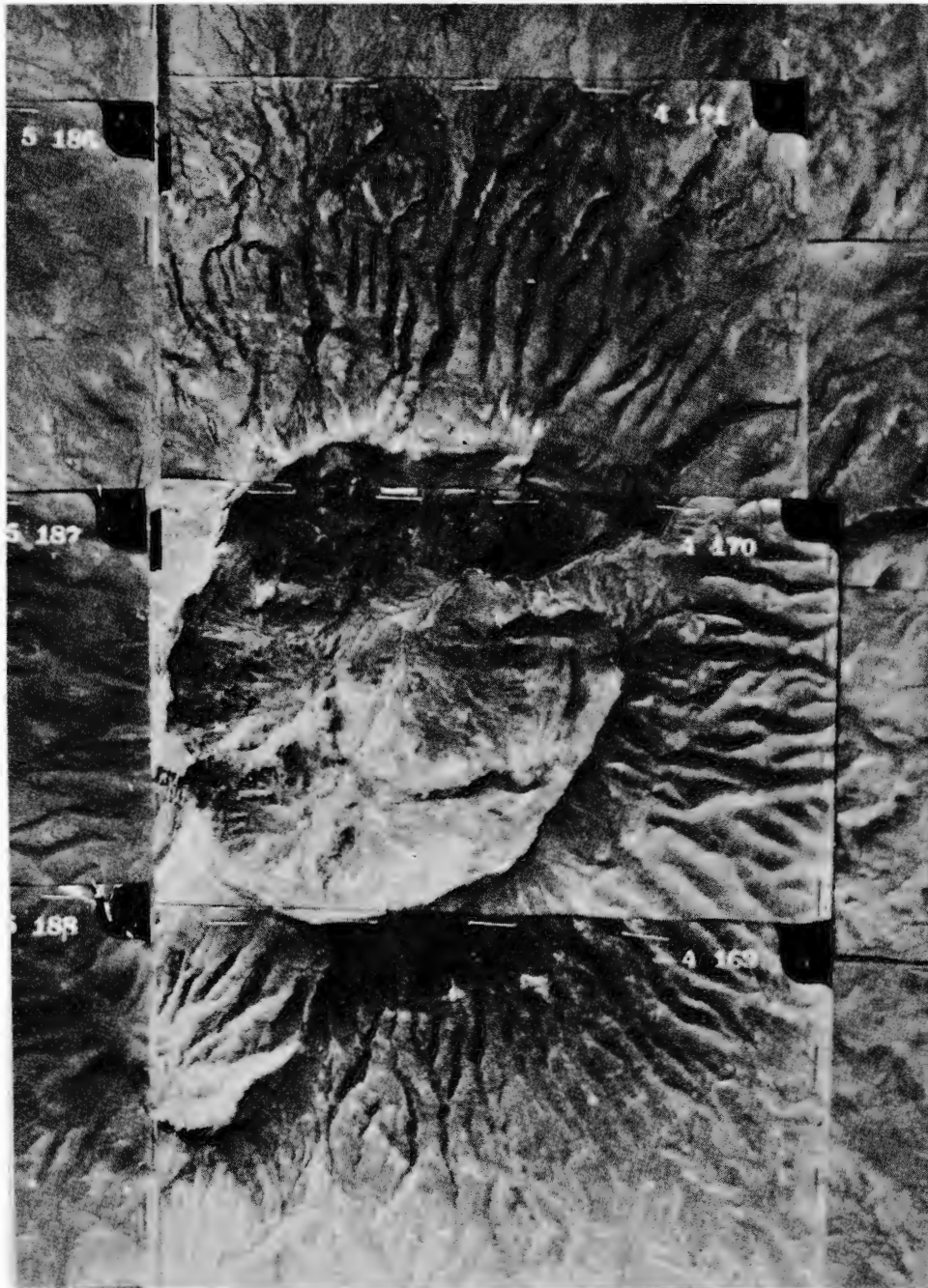


Figure 2a. Aerial view of Brukkaros crater.



Figure 2b. Ground view of Brukkaros crater.

Halbrich, however, feels that "the whole question should be reconsidered, especially because no volcanic material has been found in the crater itself."

The second crater, Roter Kamm (see Figure 3), lies 150 miles southwest of Brukkaros and some 200 miles southwest of the main Gibeon fall area. Dr. Dietz (1965a, b; 1966) of the U. S. Coast and Geodetic Survey believes that this crater may be meteoritic in origin. Professor Martin (1965) of Capetown University sees no reason to believe that the Roter Kamm crater has any relationship with the Gibeon meteorites, but does think there is a good likelihood that it is an impact crater. He states:

The crater is 1.5 miles in diameter. The rim is 300 feet higher than the surrounding area. There is no erosion gap through the rim. The deepest part of the crater is 400 feet below the top of the rim. The crater is filled with dune sand, as are the surroundings. The only exposures are on the rim itself. The rim consists, for the most part, of broken basement gniess which are more or less radial breccia veins with material that looks like pseudo tachylite. No shatter cones were observed... no gravitational anomalies were observed.... I think there is a good possibility that the crater is meteoritic in origin; there is no indication of volcanic material.





Figure 3. Aerial view of Roter Kamm crater.

## 5. ACKNOWLEDGMENTS

The author wishes to thank Mr. H. Janecke, Windhoek Museum Archives, for his translations of important papers written in old German script; to Mr. Krynaauw, Secretary, Historical Monuments Commission, South-West Africa; to Mr. E. Zelle, Chief Meteorologist, South-West Africa, 1907-1916; and especially to Mr. L. K. Marshall for his considerable encouragement and assistance during the investigation.



## 6. REFERENCES

ALEXANDER, J. E.

1838. Report of an expedition of discovery, through the countries of the Great Namaquas, Boschmans and the Hill Damaras, in South Africa. *Journ. Roy. Geogr. Soc. London*, vol. 8, p. 24.

BREZINA, A., AND COHEN, E.

1902. Über ein meteorischen von Mukerop, Bezirk Gibeon Grossnamaland. *Jahresh. Ver. vaterländ Naturk. Württemberg*, vol. 58, pp. 292-302.

CITRON, R. A.

- 1964a. Report on the investigation of meteorites, possible meteorite craters, and fireballs in the northwest Cape area, South Africa. *Smithsonian Astrophys. Obs. Field Report*, July.
- 1964b. Report on the recovery of two additional meteorites in the Keetmanshoop area, South-West Africa. *Smithsonian Astrophys. Obs. Field Report*, December.

COHEN, E.

1900. The meteoritic iron from Bethanie, Great Namaqualand. *Ann. South African Museum*, vol. 2, pp. 21-29.
1905. Meteoritenkunde. III. Heft. Klassifikation und Nomenklature: Kornige bis dichte Eisen; Hexaedrite, Oktaedrite mit feinsten und feinen Lamellen. Chap. I-XVI, 419 pp., Stuttgart.

DIETZ, R.

- 1965a. Private communication.
- 1965b. Roter Kamm, Southwest Africa: Probable meteorite crater. *Meteoritics*, vol. 2, pp. 311-314.
1966. Addendum to paper on Roter Kamm. *Meteoritics*, vol. 3, pp. 33-34.

FLETCHER, L.

1904. On various masses of meteoric iron reported to have been found in Great Namaqualand and the adjacent region. *Mineralog. Mag.*, vol. 14, pp. 28-36.

HERSCHEL, A. S.

1839. Notice of a chemical examination of a specimen of native iron from the East Bank of the Great Fish River, in South Africa. *Phil. Mag.*, vol. 14, pp. 32-34.

MARTIN, H.

1965. Private communication.

RANGE, P.

1912. Geologie des deutschen Namalandes. *Beitr. Geol. Erforsch. Deut. Schutzgeb.*, vol. 2, pp. 67-70.
1913. Meteoriten aus Deutsch-Südwestafrika. *Mitt. Deut. Schutzgeb.*, vol. 26, pp. 341-343.

RINNE, F.

1910. Ein meteoreisen mit oktaeder und würfelbau (tessera-oktaedrit). *Neues Jahrb.*, vol. 1, pp. 115-117.

SCHAUF, W.

1912. Die grossen eisenmeteorite aus Deutsch-Südwestafrika. *Ber. Seuchenb. Naturforsch. Ges. Frankfurt, M.*, pp. 214-221.

SHEPARD, C. U.

1853. Notice of meteoritic iron near Lion River, Great Namaqualand, South Africa, and of the detection of potassium in meteoric iron. *Amer. Journ. Sci.*, vol. 15, pp. 1-70.

SPENCER, L. J.

1941. The Gibeon shower of meteoritic irons in S. W. Africa. *Mineralog. Mag.*, vol. 26, pp. 19-35.

## APPENDIX A

## WEIGHT LIST OF KNOWN GIBEON METEORITES

<u>Number</u>	<u>Weight (kg)</u>	<u>Name</u>	<u>Where Now</u>
1	0.195 g	Gibeon II	British Museum
2	31	Haruchas	Haruchas farm
3	60	Bethanie	Hunsruck farm
4	66	Lion River	Amherst College
5	71	K, A, G, KK*	Windhoek
6	85	K, A, G, KK*	Windhoek
7	108	Kameelhar	America
8	110	K, A, G, KK*	British Museum
9	146	Mukerop	Bonn Museum
10	149	Mukerop	Various Museums
11	157	Kameelhar	America
12	159	Lichtenfels	Lichtenfels farm
13	159	Kinas Putts	Enos farm
14	164	Kameelhar	America
15	168	Keetmanshoop	Stolen, 1964
16	168	Kamkas	America
17	187	Goamus	Frankfurt
18	191	Bethanie	Capetown
19	197	Goamus	Windhoek
20	204	K, A, G, KK*	Windhoek
21	209	Goamus	Windhoek
22	209	Gibeon	Windhoek
23	216	Donas	Keetmanshoop
24	221	K, A, G, KK*	Windhoek
25	221	Goamus	Windhoek
26	222	K, A, G, KK*	Windhoek
27	228	K, A, G, KK*	Windhoek
28	231	Goamus	Hamburg
29	243	K, A, G, KK*	Windhoek
30	244	Mukerop	Various Museums
31	246	K, A, G, KK*	Windhoek
32	247	K, A, G, KK*	Windhoek

<u>Number</u>	<u>Weight (kg)</u>	<u>Name</u>	<u>Where Now</u>
33	249	K, A, G, KK*	Windhoek
34	251	Goamus	Berlin
35	252	K, A, G, KK*	Windhoek
36	252	K, A, G, KK*	Windhoek
37	252	K, A, G, KK*	Windhoek
38	255	Gibeon	Windhoek
39	258	K, A, G, KK*	Frankfurt
40	269	Goamus	Windhoek
41	275	K, A, G, KK*	Windhoek
42	281	K, A, G, KK*	Windhoek
43	282	K, A, G, KK*	Windhoek
44	283	K, A, G, KK*	Windhoek
45	284	K, A, G, KK*	Windhoek
46	298	K, A, G, KK*	Windhoek
47	300	K, A, G, KK*	Windhoek
48	312	K, A, G, KK*	Windhoek
49	324	K, A, G, KK*	Windhoek
50	325	K, A, G, KK*	Windhoek
51	328	K, A, G, KK*	Windhoek
52	332	Goamus	Berlin
53	333	K, A, G, KK*	Windhoek
54	337	K, A, G, KK*	Windhoek
55	348	Gibeon	Hamburg
56	356	K, A, G, KK*	Windhoek
57	378	K, A, G, KK*	Windhoek
58	411	K, A, G, KK*	Windhoek
59	413	Mukerop	Various Museums
60	426	K, A, G, KK*	Windhoek
61	434	K, A, G, KK*	Windhoek
62	493	K, A, G, KK*	Windhoek
63	534	K, A, G, KK*	Capetown Museum
Total:	15,442		

\*The Kameelhar, Amalia, Goamus, and Korra Korrabes farms.

APPENDIX B

GIBEON METEORITES IN MUSEUMS

<u>Number</u>	<u>Weight (kg)</u>	<u>Museum</u>
1	650	Capetown
1	230 (Wild)	Capetown
37	12,613	Windhoek
1	253 (Mukerop)	Bonn University
1	305 (Goamus)	Berlin
2	328/228 (Goamus)	Frankfurt
1	424 (Gibeon)	Hamburg
1	123 (Gibeon)	Copenhagen
Piece	6.25 (Amalia)	Washington Natural History
Piece	14 (Mukerop)	Washington Natural History
Piece	9 (Gibeon)	Washington Natural History
Piece	10 (Goamus)	Prague
Piece	7 (Mukerop)	Prague
	236	Harvard
Piece	13 (Mukerop)	Schoenenwerd
Piece	138 (Mukerop)	Stuttgart
Piece	61 (Mukerop)	Vienna
Piece	45 (Mukerop)	Chicago
Piece	9 (Amalia)	Chicago
1	66 (Lion River)	Amherst College
1	410 (Gibeon)	Pretoria
1	320 (Gibeon)	Pretoria
Piece	3 (Amalia)	New York Natural History
Piece	7.8 (Bethanie)	New York Natural History
Piece	10.8 (Gibeon)	New York Natural History
Piece	3 (Mukerop)	Philadelphia
Piece	11 (Mukerop)	Rio de Janeiro
Piece	15.8 (Unknown)	Budapest
Piece	6 (Unknown)	Dublin
Piece	4 (Unknown)	Nininger Collection
	136 (Gibeon)	British Museum
	195 grams (Gibeon)	British Museum
Sample specimens:	Kamkas, Kinas Putts, Keetmanshoop, Donas, Bethanie, Lichtenfels, Haruchas	Smithsonian

APPENDIX C  
PHOTOGRAPHS OF RECENTLY RECOVERED  
GIBEON METEORITES





Figure C-1. The Lichtenfels meteorite.

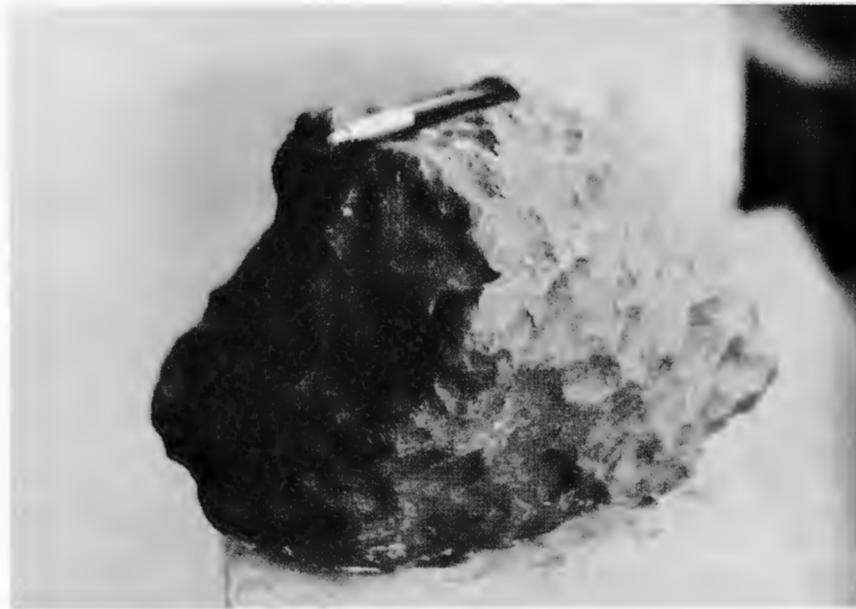


Figure C-2. The Haruchas meteorite.



Figure C-3. The Donas meteorite.



Figure C-4. The Bethanie meteorite.



Figure C-5. The Kinas Putts meteorite.

APPENDIX D

PHOTOGRAPHS OF METEORITES IN PUBLIC  
GARDENS, WINDHOEK, SOUTH-WEST AFRICA





a.



b.

Figure D-1. Twenty-seven Gibeon meteorites, whose total weight exceeds 10 metric tons, in the Public Gardens at Windhoek, South-West Africa.



c.



d.

Figure D-1 (Cont.)





a.

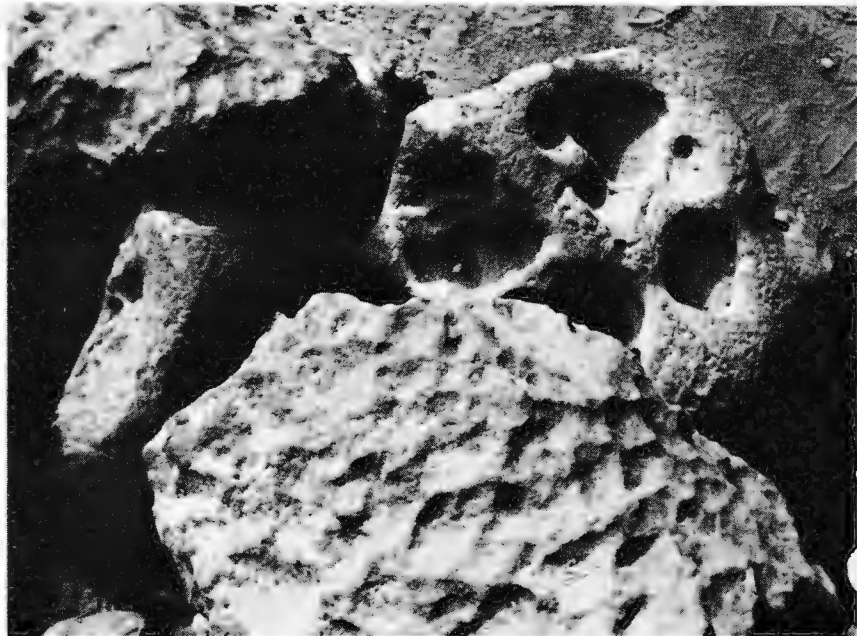


Figure D-2. Closeup views of individual Gibeon meteorites, Public Gardens, Windhoek.



## NOTICE

This series of Special Reports was instituted under the supervision of Dr. F. L. Whipple, Director of the Astrophysical Observatory of the Smithsonian Institution, shortly after the launching of the first artificial earth satellite on October 4, 1957. Contributions come from the Staff of the Observatory.

First issued to ensure the immediate dissemination of data for satellite tracking, the reports have continued to provide a rapid distribution of catalogs of satellite observations, orbital information, and preliminary results of data analyses prior to formal publication in the appropriate journals. The Reports are also used extensively for the rapid publication of preliminary or special results in other fields of astrophysics.

The Reports are regularly distributed to all institutions participating in the U. S. space research program and to individual scientists who request them from the Publications Division, Distribution Section, Smithsonian Astrophysical Observatory, Cambridge, Massachusetts 02138.