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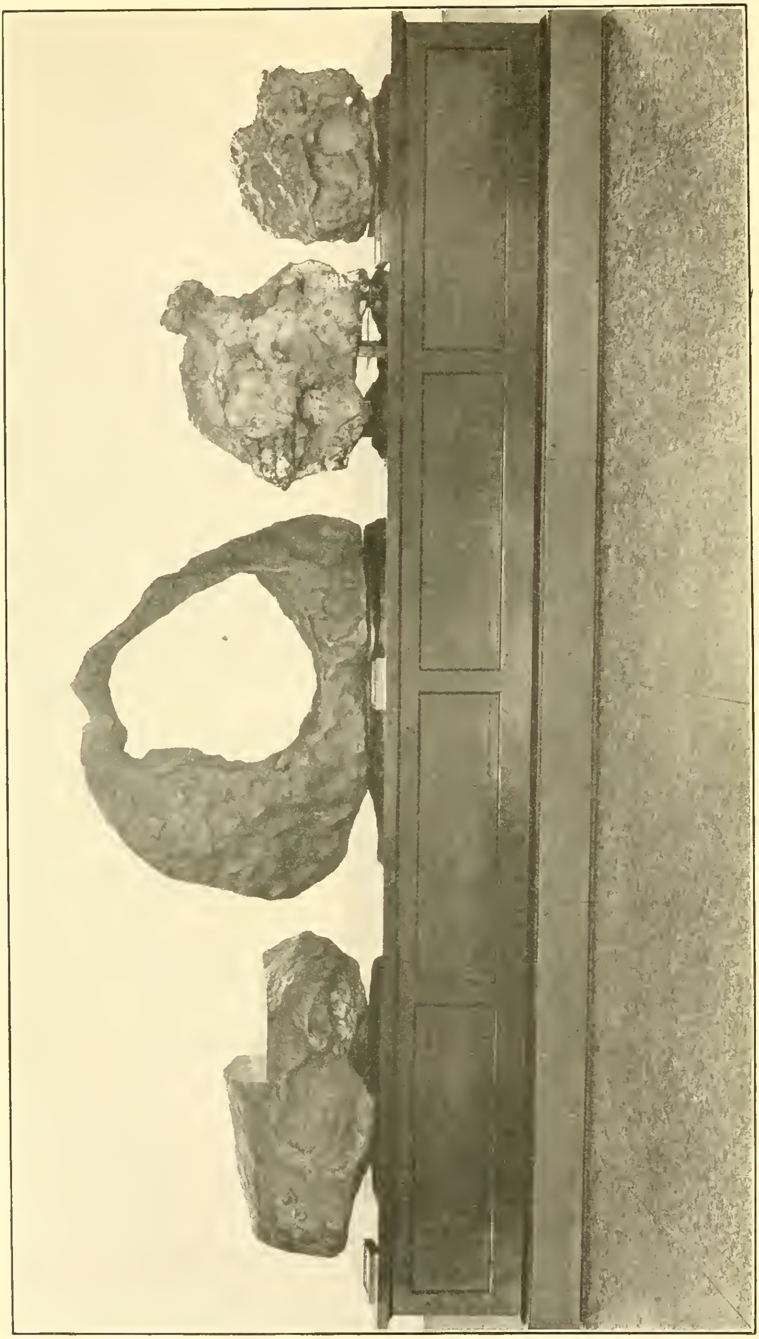

CASAS GRANDES, TUCSON, AND CANON DIABLO IRONS.

FOR DESCRIPTIONS SEE PAGES 51, 53, AND 163.

SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
Bulletin 94

HANDBOOK AND DESCRIPTIVE CATALOGUE OF THE METEORITE COLLECTIONS IN THE UNITED STATES NATIONAL MUSEUM

BY

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ADVERTISEMENT.

The scientific publications of the United States National Museum consist of two series, the *Proceedings* and the *Bulletins*.

The *Proceedings*, the first volume of which was issued in 1878, are intended primarily as a medium for the publication of original, and usually brief, papers based on the collections of the National Museum, presenting newly acquired facts in zoology, geology, and anthropology, including descriptions of new forms of animals, and revisions of limited groups. One or two volumes are issued annually and distributed to libraries and scientific organizations. A limited number of copies of each paper, in pamphlet form, is distributed to specialists and others interested in the different subjects, as soon as printed. The date of publication is printed on each paper, and these dates are also recorded in the table of contents of the volumes.

The *Bulletins*, the first of which was issued in 1875, consist of a series of separate publications comprising chiefly monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, and catalogues of type-specimens, special collections, etc. The majority of the volumes are octavos, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable.

Since 1902 a series of octavo volumes containing papers relating to the botanical collections of the Museum, and known as the *Contributions from the National Herbarium*, has been published as bulletins.

The present work forms No. 94 of the *Bulletin* series.

Richard Rathbun,
Assistant Secretary, Smithsonian Institution,
In charge of the United States National Museum.

Washington, D. C., *March 29, 1916.*

PREFACE.

The handbook and catalogue presented herewith is intended primarily for the use of the general public, but the subject matter is at the same time so arranged as to meet the needs of the student and investigator as well, though naturally an exhaustive discussion of some of the more abstruse problems is omitted. The descriptive matter is most complete regarding falls of which the collections contain what is considered a fair representation. Indeed, the exhibition portion of the collection is limited to specimens of upwards of 50 grams in weight, all under this weight being relegated to the drawer or study series. The entire collection numbers at the time this catalogue goes to press 329 falls and finds, and is accompanied by an equal number of thin sections for microscopic study.

The bibliography is intentionally brief, reference being made only to such publications as have furnished the information given in the abstract. Wülfing's *Die Meteoriten in Sammlungen und ihre Literatur*, 1897, is believed to make greater elaboration unnecessary.

Since the issue of the two previous catalogues, that by Dr. F. W. Clarke in 1889, and that by Mr. Wirt Tassin in 1902, the entire collection has been re-catalogued, independent of the mineral collection of which it had previously been considered a part, and is now treated as belonging more properly to petrology.

Inasmuch as the Shepard collection is given a case by itself, it has been thought advisable to list it here independently, as was done in Doctor Clarke's catalogue of 1889. That collection comprises 234 falls and finds, of which 83 are not represented in the National Museum collection proper. The combined collections, therefore, number 412 independent falls and finds.

JANUARY 1, 1916.

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HANDBOOK AND DESCRIPTIVE CATALOGUE OF THE METEORITE COLLECTIONS IN THE UNITED STATES NATIONAL MUSEUM.

By George P. Merrill,
Head Curator of Geology, United States National Museum.

PART I.

INTRODUCTION.

The name meteorite is given to the masses of metal and mineral matter which come to the earth from space in the form of falling bodies and which are commonly considered identical in nature with the meteors, or so-called shooting stars, which on clear nights may often be seen darting rocket-like across the sky. The origin of these bodies was for a long time in question, and even now we are quite in the dark concerning their ultimate source, though there is apparently little doubt that they are from regions outside of our solar system and come to us in the form of gradually disintegrating comets.

The elemental matter of meteorites is the same as that of the earth, though differing apparently in proportional amounts and certainly often in form of combination. The most abundant of the meteoric elements are, named in alphabetical order: Aluminum, Calcium, Carbon, Iron, Magnesium, Nickel, Oxygen, Phosphorus, Silicon, and Sulphur. More rarely and in smaller quantities are found Chlorine, Chromium, Cobalt, Copper, Hydrogen, Iridium, Lithium, Manganese, Nitrogen, Palladium, Platinum, Potassium, Ruthenium, Sodium, Titanium, and Vanadium, probably also Argon and Helium. The presence of Antimony, Arsenic, Gold, Lead, Strontium, Tin, and Zinc has from time to time been reported, but recent investigation has thrown doubt upon the correctness of the determinations.[1]

Meteorites vary in composition from those which are composed almost wholly of the silicate minerals, olivine and pyroxene, with perhaps a little feldspar, to those which are almost wholly of nickel-iron. Frequent gradations are met with, but nevertheless it is pos-

[1] Merrill, On the minor constituents of meteorites, Amer. Journn. Sci., vol. 35, 1913, p. 509.

sible, as a rule, to separate them into three somewhat ill-defined groups, as follows:

Aerolites or Stony Meteorites.	Consisting essentially of silicate minerals with minor amounts of the metallic alloys and sulphides.
Siderolites or Stony-iron Meteorites.	Consisting of an extremely variable network or sponge of metal. the interstices of which are occupied by the silicate mineral.
Siderites or Iron Meteorites.	Consisting essentially of an alloy of nickel-iron with iron phosphides and sulphides.

Examples of these are shown in the introductory series in the case.

Many attempts have been made at a more detailed classification than that given above, the one most generally accepted being that proposed by Dr. A. Brezina, formerly in charge of the meteorite collections of the Austrian Museum, in Vienna. It is altogether too technical for the general reader, and indeed the distinctions are often founded on matters of such minor importance that fragments from different portions of the same mass have been classed under quite different heads. It is, however, the form followed here, though without too great emphasis on what are believed to be matters of minor import. It may be well to state in advance that the term chondrule (Latin *Chondrum* and *Chondri*) refers to the peculiar spherical and oval shapes often assumed by the silicate constituents, the formation of which affords one of the most interesting puzzles in connection with the origin of meteorites, and further, that all known meteorites are of an igneous nature.

CLASSIFICATION.

I. Meteoric Stones: Aerolites.

A. Meteorites rich in calcium and aluminum-bearing minerals, poor in nickel-iron and without chondrules.

1. Angrite (A): Consisting essentially of a calcium rich augite with a little olivine and iron sulphide; structure crystalline granular.

2. Eukrite (Eu): Consisting essentially of augite and anorthite with a little iron sulphide; structure basaltic.

3. Shergottite (Sh): Consisting essentially of augite and maskelynite with a little magnesia; structure crystalline granular.

4. Howardite (Ho and Hob): Consisting essentially of augite, anorthite, bronzite, and olivine; structure in part tuff-like and in part crystalline.

B. Meteorites rich in magnesian minerals, poor in nickel-iron, and for the most part without chondrules.

1. Bustite (Bu): Consisting essentially of diopside and bronzite with sometimes plagioclase, nickel-iron, osbornite, and oldhamite; structure crystalline.

2. Chassignite (Cha): Consisting essentially of olivine and a little chromite; structure crystalline granular.

3. Chladnite (Chl): Consisting essentially of a rhombic pyroxene; structure crystalline granular.

4. Amphoterite (Am): Consisting essentially of olivine and bronzite with a little iron sulphide and nickel-iron; structure sometimes granular, sometimes chondritic.

C. Meteorites rich in magnesium minerals and consisting essentially of olivine, bronzite, nickel-iron, and iron sulphide, with a fragmental or tuff-like base and chondritic structure.

1. Howarditic chondrite (Cho): A group intermediate between the chondrites and achondrites.

2. White chondrites: Consisting of a yellowish-white tufaceous base with chondrules mostly of the same color. This group is divided into three subgroups: (*a*) White chondrites (Cw); (*b*) veined white chondrites (Cwa), and (*c*) breccia-like white chondrites (Cwb).

3. Intermediate chondrites: A group including forms intermediate between the white and the gray chondrites. This group is divided also into three subgroups: (*a*) Intermediate chondrites (Ci), (*b*) veined intermediate chondrites (Cia), and (*c*) breccia-like intermediate chondrites (Cib).

4. Gray chondrites: Consisting of a yellowish to a bluish-gray tuff-like base, with variously colored chondrules which are firmly embedded in the groundmass. The group is divided into: (*a*) Gray chondrites (Cg), (*b*) veined gray chondrites (Cga), and (*c*) breccia-like gray chondrites (Cgb).

5. Black chondrites: Consisting of a dark gray to black, firm chondritic mass, the color of which is due in part to carbon and in part to iron sulphide; chondrules mostly of a light color.

6. Spherical (Kügelchen) chondrites: Consisting of numerous hard and well-formed chondrules in varying proportions, in a tuff-like or crystalline ground, sometimes so loosely imbedded as to break away from the ground and sometimes breaking with it. This group is divided into five subgroups, as follows: (*a*) Ornansite and Ngawite (Cco and Ccn); (*b*) spherical or Kügelchen chondrites (Cc); (*c*) veined Kügelchen chondrites (Cca); (*d*) breccia-like Kügelchen chondrites (Ccb); (*e*) crystalline Kügelchen chondrites (Cck).

7. Crystalline chondrites: Consisting of a crystalline groundmass with firmly imbedded chondrules. The group is divided into three subgroups: (*a*) Crystalline chondrites (Ck); (*b*) veined crystalline chondrites (Cka); (*c*) breccia-like crystalline chondrites (Ckb).

8. Carbonaceous chondrites (K and Kc): This includes a group of chondritic stones impregnated with carbon and containing little or no iron.

9. Orvinite (Co): A small group consisting of chondrules in a blackish ground, showing a fluidal structure. It has at present but one representative.

10. Tadjerite (Ct): Consisting of a dark, for the most part half glassy ground containing chondrules.

11. Ureilite (Cu): Consisting essentially of olivine, with sometimes chondritic and sometimes granular structure, of a dark, nearly black color, and often showing transition stages into the next class.

II. Stony-Iron Meteorites: Siderolites.

Meteorites consisting of silicate minerals in a more or less disconnected mesh or sponge of nickel-iron.

1. Lodhranite (Lo): Consisting of a crystalline granular mixture of olivine and bronzite in a fine, more or less disconnected network or sponge of metal.

2. Mesosiderite (Grahamite) (M): Consisting essentially of olivine, bronzite, plagioclase, and augite, sometimes chondritic, sometimes crystalline granular, in a more or less interrupted network or sponge of metal.

3. Siderophyre (S): Consisting essentially of bronzite and nickel-iron with accessory asmanite in a network of nickel-iron of octahedral crystallization and showing Widmanstätten figures.

4. Pallasite (P): Consisting of olivine in a continuous network or sponge of metal.

5. Meteoric iron breccia (Obc): Meteorites consisting of crystalline chondrules in a breccia-like mass of octahedral iron.

6. Meteoric iron of Netschaëvo (Omn): Meteorites consisting of crystalline chondrules in a mass of octahedral nickel-iron.

III. Nickel-Iron Meteorites: Siderites.

Meteorites consisting essentially of nickel-iron with iron sulphide and phosphide and usually graphite or other form of carbon.

1. Octahedral irons: Consisting essentially of nickel-iron alloys arranged in the form of plates parallel with the faces of an octahedron, and often interlaminated with thin plates of schreibersite. On etching with acid they show Widmanstätten figures. According to the thickness of the plates they are divided as follows: (*a*) Octahedral irons with lamellæ 0.1 mm. in thickness (Off); (*b*) octahedral irons with lamellæ 0.15 to 0.4 mm. in thickness (Of); (*c*) octahedral irons with lamellæ 0.5 to 1 mm. in thickness (Om); (*d*) octahedral irons with lamellæ 1.5 to 2 mm. in thickness (Og); (*e*) octahedral irons with lamellæ over 2½ mm. in thickness (Ogg); (*f*) breccia-like octahedral irons (Obz).

2. Hexahedral irons: Homogeneous masses of nickel-iron with evident cleavage parallel to the faces of a hexahedron and showing lamellæ due to the twinning of a cube on an octahedral face. On etching they show Neumann lines. These are divided into: (*a*) hexahedral irons (H); (*b*) brecciated hexahedral irons (Hb); (*c*) the Cape Iron group (Hca); (*d*) the Chesterville group (Hch).

3. Massive irons: Amorphous irons showing neither Neumann nor Widmanstätten lines or other structural features such as permit satisfactory classification. Doctor Brezina has divided them into five groups: (*a*) the Babb's Mill group (Db); (*b*) the Nedagolla group (Dn); (*c*) the Primitiva group (Dp); (*d*) the Senegal group (Ds); (*e*) the Tucson group (Dt).

MINERAL COMPOSITION.

Though the elemental matter of meteorites may be the same as in terrestrial rocks, the form of combination is at times radically different and of a nature to indicate that they formed under conditions quite unlike those existing on the earth to-day, and particularly so with reference to the presence of free oxygen and moisture.

The following list comprises meteoric minerals which are also constituents of terrestrial rocks: *Olivine*, the orthorhombic pyroxene *enstatite* (or *bronzite*), the monoclinic pyroxenes *diopside* and *augite*, the plagioclase feldspars *anorthite*, *labradorite*, or *oligoclase*, the phosphate *apatite*, the oxides *magnetite* and *chromite*, the sulphides *pyrite* and *pyrrhotite*, rarely the carbonate *breunnerite* and various forms of carbon including *graphite* and *diamond*. Those minerals found rarely if ever in terrestrial rocks are the various alloys of nickel and iron, to which the names *kamacite*, *taenite*, and *plessite* have been given, the nickel and iron phosphide *schreibersite*, the iron monosulphide *troilite*, the iron and chromium sulphide *daubreelite*, the iron protochloride *lawrencite*, the calcium and titanium (or zirconium) oxysulphide *osbornite*, the iron and nickel carbide *cohenite*, the carbon silicide *moissanite*, an isotropic mineral believed to be a re-fused plagioclase and called *maskelynite*, and *asmanite*, a form of silica. These are described in some detail, in alphabetical order, below:

Apatite.—The phosphoric acid reported in the numerous analyses of meteoric stones has usually been considered a constituent of the mineral apatite. As a matter of fact, crystals of this mineral in a meteorite have been actually observed only by Berwerth, in the stony portion of the Kodaikanal, India, siderolite. Recent investigations have shown that the prevalent phosphatic mineral is not apatite, but a mineral of nearly the same composition, differing in its crystallographic and optical properties, and perhaps identical with francolite. Its exact nature remains yet to be ascertained.

Asmanite.—This name was proposed by Maskelyne[1] for a mineral consisting essentially of silica, occurring in the meteorite of Breitenbach, of which it composed nearly one-third of the siliceous portion. The mineral, when pure, is colorless, with a specific gravity of 2.245, a hardness of 5.5, and is rhombic in crystallization. It is commonly believed to be identical with the tridymite of terrestrial rocks.

Breunnerite.—This is the name given by Haidinger to a ferriferous variety of magnesium carbonate found in terrestrial rocks and in a single instance in a meteoric stone, that of Orgueil, France. It is the only instance known of a carbonate compound occurring as an original constituent of meteorites.

Carbon.—Carbon as carbon monoxide (CO) or dioxide (CO_2), as a hydrocarbon or in the amorphous, or crystalline form of graphite, has been recognized as a constituent of certain meteorites, particularly meteoric irons, for many years. Berzelius recognized a carbon compound in the stone of Alais as early as 1838. Wöhler and Cloez in 1839 found compounds resembling residue from terrestrial organic substances in the meteoric stone of Cold Bokkeveld, while the French chemist Berthelot extracted hydrocarbons conformable with the petroleum series from the carbonaceous meteoric stone that fell in Orgueil, France, in 1864. The American chemist J. Lawrence Smith and others have since repeatedly reported the presence of carbon in both the amorphous and crystallized forms of graphite in numerous analyses of stone and iron meteorites.

Haidinger, in 1846, described a cubic form of graphite in the meteoric iron of Arva (Magura), Hungary, as pseudomorphic after pyrite, but which Rose suggested was pseudomorphic after diamond. In 1886 H. Carvill Lewis, after studying the matrix of the South African diamond, predicted the discovery of diamonds in meteorites. In 1888 Jerofeieff and Latschinoff found carbon with the hardness and form of the diamond in the Novo-Urei, Russia, meteoric stone. In 1889 was found the first colorless material, thought from its hardness and its burning into CO_2 to be diamond, in the Arva iron. In 1891 George A. Koenig of Philadelphia found a black vitreous substance, of a hardness beyond sapphire and believed to be diamond, in the meteoric iron of Canon Diablo. Material from this source was subsequently examined by O. W. Huntington and found to contain unmistakable, minute, colorless, octahedral crystals of diamond. Two examples of these are shown in Exhibit No. 473. The French chemist Moissan in this same iron found in addition carbon in the amorphous form, as graphite, and as black diamond or carbonado. *Moissanite*, a silicide of carbon, perhaps identical with artificial carborundum, was found by this chemist in the meteoric iron of Canon Diablo.

[1] Philos. Trans. Royal Soc. London, 1871, p. 361.

Chromite and *magnetite.*—The oxides of chromium and iron, or of iron alone, are common constituents of terrestrial rocks as well as of meteorites, and need no further mention here other than that they occur as small, usually microscopic disseminated crystals and crystalline grains.

Daubreelite.—In 1876 J. Lawrence Smith gave this name to a black, lustrous, highly crystalline material found by him associated with the troilite in the meteoric irons of Coahuila, Mexico. Incomplete analyses made at the time showed 36.48 per cent of sulphur, some 10 per cent of iron, and a little carbonaceous matter, the undetermined portion being chromium. The true composition he announced as being, probably, sulphur 37.62 per cent; chromium 62.38 per cent.[1] Later he was able to isolate the material in larger quantity and greater degree of purity from the Coahuila iron, and in 1878 [2] he published new analyses and descriptions showing the mineral to have the probable composition: Sulphur, 44.29 per cent; chromium, 36.33 per cent; iron, 19.38 per cent; or the formula $FeS\ Cr_2\ S_3$. Actual analyses, however, showed: Sulphur, 42.69 per cent; chromium, 35.91 per cent; iron, 20.10 per cent; total, 98.70 per cent.

Feldspars and maskelynite.—From what is known regarding terrestrial basic igneous rocks, the feldspars of meteorites would naturally be assumed to belong to the more basic varieties, as labradorite and anorthite. Not many actual and complete analyses are available owing to the difficulty of securing a sufficient quantity of material in a fair degree of purity. Those quoted below show that in at least two instances the feldspar is oligoclase, a form characteristic of rocks of intermediate acidity, as the diorites. The name *maskelynite*, it should be stated, was given by Tschermak [3] to an isotropic, colorless mineral, abundant in the Shergotty meteorite, and commonly considered a re-fused feldspar. The mineralogist Groth, on the other hand, was inclined to believe it to be a species allied to leucite. The feldspars are common constituents of meteorites of the basaltic types, such as that of Juvinas in France, where they occur in elongated polysynthetically twinned forms as in terrestrial rocks. In the chondritic types they occur as scattered granules occupying the interspaces of the olivines and enstatites, and often quite lacking in crystal outlines or twinning bands, in which case their satisfactory determination is a matter of great difficulty. In many meteorites of the chondritic type, and in most pallasites, feldspars are wholly lacking.

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[1] Amer. Journ. Sci., vol. 12, 1876, p. 109.
[2] Idem, vol. 16, 1878, p. 270.
[3] Sitz. Akad. Wiss. Wien, vol. 65, 1872, p. 127.

Analyses of meteoric feldspars.

Constituents.	Sources.		
	Hvittis.[1]	Hessle.[2]	Shergotty.[3]
Silica	63.5	64.97	56.3
Alumina	22.2	22.06	25.7
Lime	4.0	3.01	11.6
Soda	9.2	9.96	5.1
Potash	1.1	....	1.3
	100.0	100.0	100.0

[1] Borgström, Bull Comm. geol. Finlande, No. 14, 1903.
[2] Lindström, Ofv. Kongl. Vet.-Akad. Forhandl., 1869, p. 723.
[3] Tschermak, Sitz. Akad. Wiss. Wien, vol. 65, 1872, p. 130.

From these analyses it would appear that 1 and 2 are to be classed as oligoclase and 3 as labradorite.

Gaseous constituents.—The fact that hydrogen was given off when the Lenarto (Italy) meteoric iron was heated in a vacuum was first noted by Thomas Graham in 1867. J. W. Mallet, in 1872, found the meteoric iron of Augusta County, Va., under similar circumstances yielded not merely hydrogen but also nitrogen and carbon monoxide (CO) and carbonic acid (CO_2). A. A. Wright, in 1875 and 1876, showed (1) that the stony meteorites differ from the iron in having oxides of carbon, chiefly as CO_2, as their characteristic gases, instead of hydrogen; (2) the proportion of CO_2 given off at low is greater than at high temperatures; (3) the amount of gases contained in a large meteorite, or cluster serving as a cometary nucleus, is sufficient to form the train; (4) the spectrum of the gases is closely identical with that of several comets.

Doubts which may have been thrown on these results as first announced were eliminated by the later investigations. In the stony (chondritic) meteorites the percentage of CO is conspicuously small compared with that of CO_2, while in the irons the conditions are reversed. Recent work by R. T. Chamberlin furnished data for the following summary of averages:

Type.	No. of analyses.	CO_2.	CO.	CH_4.	H_2.	N_2.	Total.
Stony meteorite	12	3.77	0.24	0.20	0.50	0.09	4.80
Iron meteorite	9	.21	.67	.02	1.67	.24	2.81

Subsequently Prof. William Ramsay, of London, detected the probable presence of argon and helium.

Lawrencite.—Protochloride of iron. The exudation of drops of ferrous chloride from freshly cut or broken surfaces of meteoric iron was early noted, but it was not until 1855 that J. Lawrence Smith found the material in the condition of a soft solid of a green-brown color in the meteoric iron of Tazewell County, Tenn.[1] In 1877[2] he also noted the occurrence of the substance in the iron of Rockingham County, N. C. In this same year Daubree noted its occurrence in the terrestrial iron of Ovifak, Greenland,[3] and proposed for it the name *lawrencite* in honor of its first discoverer. The material liquefies on exposure to the atmosphere, the iron passing over quickly to the condition of sesquioxide. It is this feature that brings about the rapid disintegration of so many irons and causes the stone meteorites to become rust-brown or freckled with rust-colored spots.

Metallic constituents; nickel-iron alloys.—These are essentially the same in all meteorites. They occur in varying proportions from a fraction of 1 per cent, as in the Bishopville stone, to upward of 90 per cent, as in the so-called iron varieties. In the stones the form is that of disconnected drops or stringers; in the pallasites that of a more or less disconnected mesh or sponge enfolding silicate minerals; and in the metallic forms constituting nearly the entire mass. Etching by means of a weak acid, the polished surface of a meteoric iron will in the majority of cases give rise to an interesting series of markings known under the name of Widmanstätten figures, after a German chemist who first brought them to public notice. They are due to the unequal solubility of the three alloys of iron and nickel which make up the mass of the material. Two of these alloys occur in the form of thin plates and are known by the terms *kamacite* and *taenite*. A third alloy, known as *plessite*, fills the space formed by the intersection of these plates (see etched slices of the Casas Grandes and Toluca irons, pls. 16 and 35). The composition of these alloys has not been absolutely determined, owing to the difficulty of separating them one from another, and it is considered probable that the so-called plessite is but a mixture or intergrowth of the other two. Davison gives the composition of the two first named as determined on separations made from the Welland, Canada, iron, as follows:

Constituents.	Kamacite.	Taenite.
	Per cent.	*Per cent.*
Iron	93.09	74.78
Nickel	6.69	24.32
Cobalt	.25	.33
Carbon	.02	.50
	100.05	99.93

[1] Amer. Journ. Sci., vol. 19, 1855, p. 154.
[2] Idem, vol. 13, 1877, p. 214.
[3] Compt. Rend., vol. 84, 1877, p. 66.

In the Casas Grandes, Toluca, and many other irons, these plates are arranged parallel with the faces of an octahedron, as shown in the examples in the introductory series. Such are known as octahedral irons. Other irons yielding no Widmanstätten figures give, on etching, lines which the mineralogist Neumann showed might result from a twinning of a cube about an octahedral face. These are known as hexahedral irons, an example of which is shown in the slice from Scottsville, Kentucky (No. 77), or in the large "Couch" iron. Still other irons have no regular structure, sometimes, indeed, being almost uniformly homogeneous. Such are classed as ataxites, an example of which is shown in the specimen from Deep Springs, North Carolina (No. 470). *Cohenite* is the name proposed by Weinschenk for an iron carbide of a tin-white color, found first in the meteorite of Magura and subsequently in other irons.

Oldhamite.—This name was given by Story-Maskelyne, in 1862, to a calcium sulphide found by him in the meteorite of Busti, and described in detail in the Philosophical Transactions of the Royal Society of London for 1870. The mineral is of a pale, chestnut-brown color when pure, though often covered on the outer surface by a gypseous oxidation product. It occurs in the form of rounded granules, with cleavages essentially rectangular, imbedded in the pyroxenic constituents. Between crossed nicols it is isotropic, and is considered to belong undoubtedly to the cubic, or isometric system. Its specific gravity was found to be 2.58. Boiled in water it was decomposed, yielding a bright yellow solution of calcium polysulphide and an insoluble residue.

Olivine.—A magnesium and iron silicate of the formula $(MgFe)SiO_4$; relative proportions of magnesia and iron are, however, somewhat variable, as shown in the following analyses:

Locality.	SiO_2.	MgO.	FeO.
1. Krasnojarsk, Siberia	40.24	47.41	11.80
2. Kiowa County, Kansas	40.70	48.02	10.79
3. Brahin, Russia	39.61	48.29	11.88
4. Atacama, Chile	36.92	43.16	17.21

The mineral rarely occurs in good crystal form except in the porphyritic chondrules. It is of all meteoric minerals perhaps the most abundant and widespread, sometimes, as in that of Warrenton, Missouri, composing a very large proportion (75 per cent) of the mass of the stone. It is rarely, if ever, wholly absent, even the iron meteorites showing in most cases included granules. It is a common and widespread constituent of terrestrial igneous rocks.

Osbornite.—This name is also one of Maskelyne's proposal. The mineral occurs in golden yellow microscopic octahedra, associated with the oldhamite in the Busti meteorite. Crystals are brittle and insoluble in acids, even resisting the fluxes potassium and sodium carbonates. Composition uncertain, but regarded as a titanium or zirconium oxychloride.

Pyroxenes.—Pyroxene is common in meteorites in both orthorhombic and monoclinic forms.

1. Orthorhombic pyroxenes: enstatite and bronzite. These minerals, next to the olivines, are the most common of the meteoric silicate minerals. The composition is somewhat variable, owing to the varying proportions of iron and magnesia, as in the olivines. A typical enstatite corresponds to the formula $MgSiO_3$, but through the assumption of iron this passes over into the bronzite variety $(MgFe)SiO_3$. So far as known, the highly ferriferous and pleochroic variety, hypersthene, never occurs in meteorites, though in at least one instance—that of Shalka, India—the percentage of iron is fully as high as in strongly pleochroic hypersthene. The name clino-enstatite has been given to a monoclinic variety with a smaller extinction angle on clinopinacoidal sections than other monoclinic pyroxenes, and which is characterized further by a marked tendency toward polysynthetic twinning. The varying composition of enstatite and bronzite from some of the best known meteorites is given below:

Locality.	SiO_2.	MgO.	FeO.	Na_2O.	K_2O.	CaO.	Al_2O_3.
Bishopville[1]	59.97	39.34	0.40	....	....	....	....
Busti[2]	58.44	38.94	1.18	0.36	0.33	1.68	....
Lodhran[3]	55.35	32.85	12.13	....	....	.58	0.60
Breitenbach[4]	56.05	30.85	13.44	....	....	....	....
Hainholz[5]	53.05	25.40	15.63	....	....	2.73	3.19
Hvittis[6]	59.05	37.10	.90	.68	.47	.98	1.09
Goalpara[7]	59.92	38.00	....	....	....	2.11	....
Molina[8]	57.8	39.22	.91	....	....	....	2.07
Shalka[9]	55.55	27.73	16.53	.92	....	.09	....
Rittersgrün[10]	57.49	25.78	10.59	1.45	....	2.12	2.08

[1] Smith, J. L., Amer. Journ. Sci., vol. 38, 1864, p. 225.
[2] Maskelyne, Philos. Trans. Roy. Soc. London, vol. 160, 1870, p. 206.
[3] Tschermak, Sitz. Akad. Wiss. Wien, vol. 61, 1870, p. 467.
[4] Maskelyne, Philos. Trans. Roy. Soc. London, vol. 161, 1871, p. 359.
[5] Rammelsberg, Monatsber. Akad. Berlin, 1870, p. 314.
[6] Borgström, Bull. Comm. geol. Finlande, No. 14, 1903.
[7] Teclu, Rammelsberg's Mineralchemie, 1875, p. 382.
[8] Meunier, Ann. Chem. Phys., vol. 17, 1869, p. 12.
[9] Rammelsberg, Monatsber. Akad. Berlin, 1870, p. 319.
[10] Winkler, Cohen's Meteoritenkunde, Heft 1, 1894, p. 281.

As with olivine, the mineral rarely occurs in good crystal form, excepting in the porphyritic chrondrites. A more common form, as noted later, is in that of radiating and cryptocrystalline kugels.

2. Monoclinic pyroxenes: diopside and diallage. These forms of pyroxene are, on the whole, less common in meteorites than are the orthorhombic forms, though it is possible that they are in reality more abundant than is generally supposed, their close resemblance in all but optical properties (which, owing to the small size and poorly developed crystallization, can not always be determined) rendering a sure discrimination somewhat difficult. The composition is, presumably, fully as variable as that of the enstatites. but few actual analyses of pure materials have been made, owing to the difficulty in separating them from the associated minerals. Of the following analyses No. I is by Maskelyne[1] and II by Tschermak.[2]

Constituents.	Source.	
	I. Busti.	II. Shergotty.
Silica (SiO_2)	55.49	52.34
Alumina (Al_2O_3)		.25
Ferric oxide (Fe_2O_3)	.55	
Ferrous oxide (FeO)		23.19
Magnesia (MgO)	23.33	14.29
Lime (CaO)	19.98	10.49
Soda (Na_2O)	.55	
	99.90	100.56
Sp. gr		3.466

As with other silicate constituents, the monoclinic pyroxenes are but poorly developed crystallographically, are nearly colorless, nonpleochroic, and with extinction angles rarely going beyond 25°. They are often intergrown with enstatites, and still more commonly occur in twinned forms grouped in chondrules.

Schreibersite.—This mineral, first described and named by Haidinger in 1847 as a constituent of the Magura iron, and since found as one of the commonest of the accessory meteoric constituents, is a phosphide of nickel, iron, and cobalt, corresponding to the formula $(FeNiCo)_3P$. It occurs commonly in thin angular plates of a tin-white color, sometimes lying parallel with the taenite-kamacite plates, sometimes in angular, jagged masses as in the Tombigbee iron (see specimen No. 252, also pl. 36), and in dendritic forms as in the iron of Arispe (see specimen No. 299 and pl. 33, fig. 2). In the pallasites it may occur in thin plates lying between the olivines and metallic mesh. It is magnetic, and difficultly soluble, the last feature rendering its separation from the other constituents a matter

[1] Philos. Trans. Roy. Soc. London, vol. 160, 1870, p. 202.
[2] Sitz. Akad. Wiss. Wien, vol. 65, 1872, p. 126.

of comparative ease. The material No. 475, separated from one of the Canon Diablo irons, is shown by Mr. Tassin's analysis to have the following composition:

	Per cent.
Iron	63. 04
Nickel	23. 07
Phosphorus	13. 80
Cobalt	. 03
	99. 94

The name *rhabdite* has been given to a very brittle phosphide of apparently the same composition as schreibersite and commonly regarded as a morphological variety of that mineral.

Troilite.—This name was given by Haidinger [1] to a monosulphide of iron first found in nodular masses in the meteorite of Albareto, and since shown to be an almost universal constituent of meteorites, (See Toluca iron, No. 347 and pl. 14.) The theoretical composition, as demanded by the formula FeS, is iron (Fe) 63.64; sulphur (S) 36.36. Actual analyses nearly always show traces of nickel and sometimes copper. The mineral was named in honor of Domenico Troili, one of the early enthusiastic defenders of the possibility of meteorite falls. Meunier and some others are inclined to regard the mineral as identical with pyrrhotite. Rose suggested the possibility that the sulphide in stony meteorites might be in the form of pyrrhotite and in the metallic as troilite. The present writer, as well as Ramsay and Borgström, have, however, shown that the sulphide in the stony meteorites may be the monosulphide troilite.[2]

CHEMICAL COMPOSITION.

A meteorite is a body of more than immediate mineralogical or petrographical interest. It furnishes tangible testimony of the nature of materials existing outside of our solar system, and affords, aside from the spectroscope, the only clue to the matter of which celestial bodies are composed. The German, Chladni, as long ago as 1794, advocated their cosmic origin, and designated them "Weltspäne" (world chips), or the remains of worlds gone to pieces, and from which other worlds might be built up. This idea with various modifications has been many times reasserted, and whatever theory one may accept as to world formation, the ultimate source of the materials remains the same. It is, therefore, of interest to compare the chemical composition of such materials as are now coming from space, or have come within historic times, with that forming the rocks of the earth's crust. In column I below is given the average

[1] Sitz. Akad. Wiss. Wien, vol. 47, 1863, p. 283.

[2] Merrill, A recent meteorite fall near Holbrook, Ariz., Smithsonian Misc. Coll., publ. 2140, vol. 60, No. 9, 1912, p. 4.

composition of stony meteorites as calculated from a large number of analyses,[1] and in column II that of the average composition of the igneous rocks of the earth's crust.[2]

It may be added incidentally that these meteoric stones, as will be noted from the analyses, belong to a very basic class of rocks—i. e., rocks low in silicic acid and correspondingly high in the basic constituents, iron and magnesia. From a terrestrial standpoint they would be classified mainly as peridotites, and a few as pyroxenites and basalts.

Constituents.	I.	II.
Silica (SiO_2)	38.68	59.93
Titanic oxide (TiO_2)	.18	.74
Tin oxide (SnO_2)	None.	
Zirconium oxide (ZrO_2)	None.	.03
Alumina (Al_2O_3)	2.88	14.97
Ferric oxide (Fe_2O_3)		2.58
Chromic oxide (Cr_2O_3)	.47	.05
Vanadium oxide (V_2O_3)	Trace.	.02
Iron (Fe)	11.98	
Nickel (Ni)	1.15	
Cobalt (Co)	.07	
Ferrous oxide (FeO)	14.58	3.42
Nickel oxide (NiO)	.48	.03
Cobalt oxide (CoO)	.06	
Lime (CaO)	2.42	4.78
Barium oxide (BaO)	None.	.11
Magnesia (MgO)	22.67	3.85
Manganous oxide (MnO)	.29	.10
Strontium oxide (SrO)	None.	.04
Soda (Na_2O)	.87	3.40
Potash (K_2O)	.21	2.99
Lithia (Li_2O)	Trace.	.01
Ignition (H_2O)	.75	1.94
Phosphoric acid (P_2O_5)	.26	.26
Sulphur (S)	1.80	.11
Copper (Cu)	.014	
Carbon (C)	.15	
Chlorine (Cl)	.08	.06
Fluorine (F)	(?)	.10
Carbonic acid (CO_2)	(?)	.48
	100.044	100.00

The most striking of the differences brought out by the analyses are (1) the excess of silica (SiO_2) and alumina (Al_2O_3) in the terrestrial rocks, (2) the presence of a considerable amount of free iron and proportionately large quantities of ferrous oxide (FeO)

[1] Merrill, On the composition of stony meteorites, etc., Amer. Journ. Sci., vol. 27, June, 1909, p. 469.

[2] Clarke, Data of Geochemistry, Bulletin 491, U. S. Geol. Surv., 1911, p. 27.

and magnesia (MgO) in the meteorites. The presence of many of the rarer elements tabulated as constituents of the terrestrial igneous rocks has not as yet been fully determined in those of meteoric origin. As has been noted, however, many of them have been found in amounts too small to estimate.

As already stated, the iron or metallic meteorites consist essentially of alloys of iron, nickel, and cobalt, with which are commonly associated the phosphide schreibersite and the sulphide troilite. In minute quantities there may be other constituents, as copper, chromium, and various silicate minerals. It is in these metallic forms also that have been found the rarer elements—platinum, palladium, iridium, ruthenium, and vanadium, and possibly gold. Farrington's tabulation of analyses seems to show that the nickel content varies with the texture, the higher percentages of this constituent being found in those of finest crystallization. The variation is, however, by no means constant. In the table on the following page is given a selected series of what are considered authentic analyses of the principal types of iron, and also, for purposes of comparison, two examples each of metal separated from the silicate portions of pallasites and stony meteorites.

METEORIC IRONS.

Name.	Class.	Fe.	Ni.	Co.	Cu.	P.	S.	Mn.	Si.	Cr.	Cl.	C.	Misc.
Hex River	Hexahedrite	93.59	5.68	0.66	0.04	0.23	0.08	....	....	0.02	....	....	Insol. res. 0.03.
Canon Diablo	Coarse octahedrite	93.425	7.335	.51	Trace.	.159	.08	None.	0.032	....	0.097	0.465	Pt. and Ir. traces.
Casas Grandes	Medium octahedrite	90.47	7.422	.604	0.012	.166	.029	None.	.01	None.	Trace.	.177	
Kokstadt	do	91.21	8.01	.63	.02	.22	Trace.	....	....	None.	0.05	.03	
Ranchito	do	85.54	9.40	.98	.02	.12	0.02	....	....	[1] 0.01	.02	.01	
Bethany	Fine octahedrite	91.37	7.97	.50	.02	.03	.02	....	....	.04	....	.05	
Cowra	Finest octahedrite	85.265	13.23	1.02	.02	.225	.01	Trace.	.01	....	....	.025	Pt. and Ir. traces; Sn (?) trace.
Perryville	do	89.15	9.66	.545	.025	.365	.002	None.	.003	....	....	.015	Pt., Pa., Ir., and Ru. traces.
METAL FROM PALLASITES.													
Mount Vernon	Pallasite	82.52	14.044	0.949	0.104	0.390	0.288	0.151	0.808	0.300	Traces.	0.5	Va. trace.
Krasnojarsk	do	89.90	9.52	.60	None.	.085	None.	None.	....	....	....	....	
METAL FROM STONY METEORITES.													
Cullison	Spheruliticchondrite	89.70	9.207	0.507	0.04	0.07	Trace.	0.08	0.129	0.16	....	0.088	
Indarch	Carbonaceous chondrite	90.44	8.26	0.18	....	.08	....	.04	....	....	....	....	

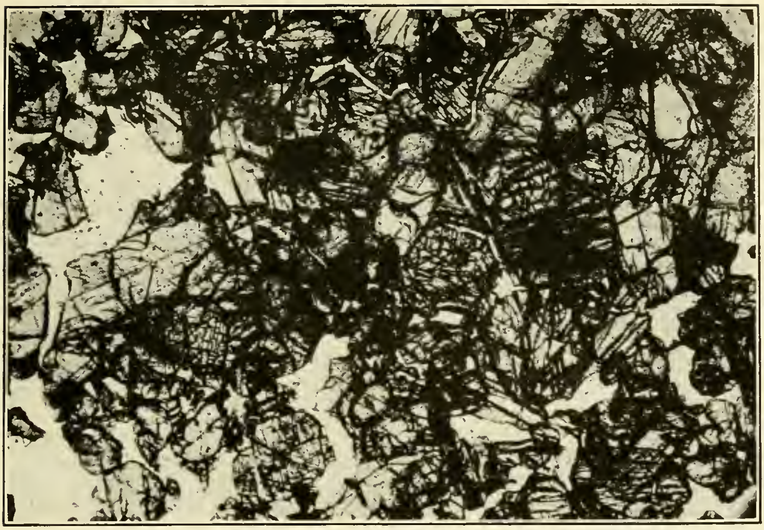
[1] Chromite.

1

2

Microstructure of (1) Juvinas and (2) Shergotty Stones.

For descriptions see page 17.



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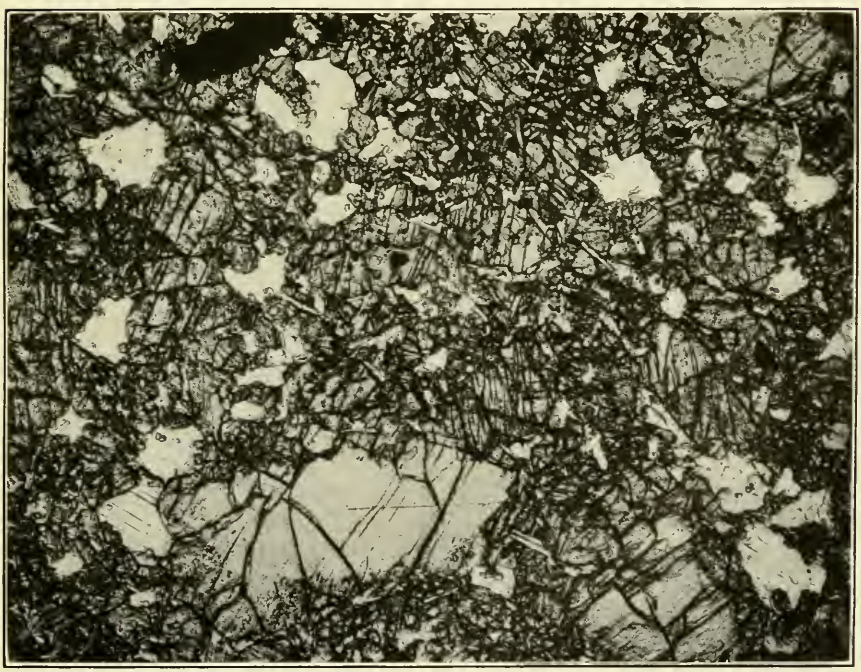


2

MICROSTRUCTURE OF (1) EL NAKHLA STONE AND (2) ESTHERVILLE MESOSIDERITE.

FOR DESCRIPTIONS SEE PAGES 17 AND 18.

STRUCTURE.

As noted under the head of Classification, meteorites fall into three general groups: (1) Metallic, in which the structure is due to the varying crystallization of metallic alloys; (2) the stony-irons or siderolites, which consist of a more or less connected mesh or sponge of metal inclosing silicates, the structure of the metallic portion being essentially the same as those which are all metallic; and (3) the stony forms, which vary from holocrystalline or basaltic types to those which are fragmental and tufaceous. It is in this last group, and with particular reference to their included chondrules, that meteorites depart most widely from known structures in terrestrial rocks.

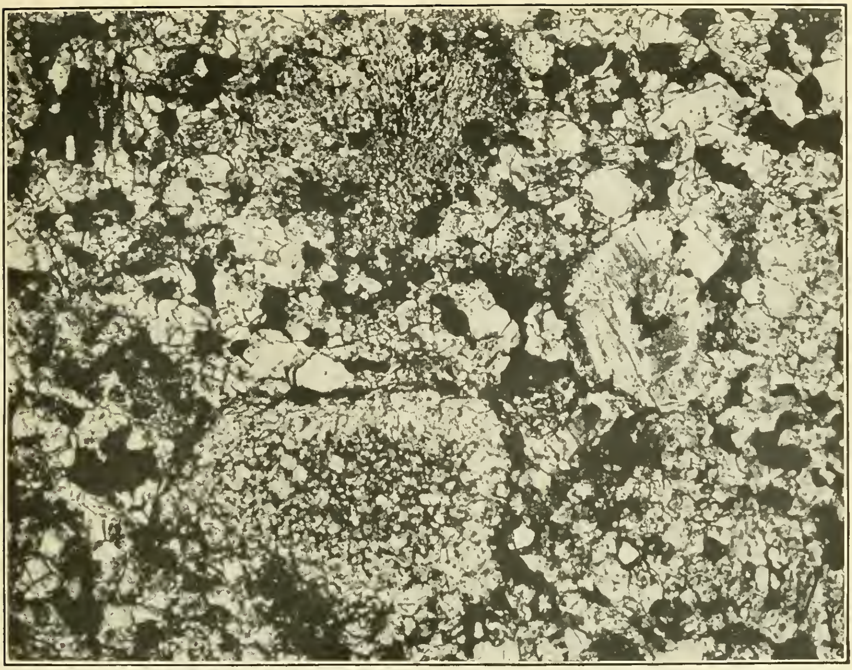
The crystalline structure of the purely metallic forms has been sufficiently dwelt upon under the head of the *Metallic constituents* of meteorites, and may be best comprehended by referring to Plates 12, 14, and 16. That of the stony-irons is shown in Plates 9 and 28. It is to be noted that there are two widely distinct types of the latter, one in which the included silicates have apparently undergone quiet crystallization even to the extent of development of recognizable crystalline facets, and the other in which the silicates, after crystallization, have become shattered and in which the metal serves as a cement or binding constituent to the angular particles. This type of structure or brecciation is well shown in the Admire pallasite (pl. 9, fig. 2), in which the dark portions are olivine and the light metal. This figure is about natural size. An enlarged portion of a metalliferous area is shown in figure 1 of the same plate. In this the dark outer portion is again olivine and the light (1) metal. The dark interior area (3) is a spongy aggregate of iron with inclosures of lawrencite and troilite. The acicular forms (4) extending into this sponge are of nickel iron. Between the nickel iron (1) and the spongy portion is commonly a thin plate of schreibersite (2) which can not be differentiated in the illustration.

The microscopic structure of stony meteorites of the holocrystalline type most nearly resembling terrestrial rocks of the basalt, pyroxenite, or peridotite group is shown in Plates 2 and 3. In the eukrite of Juvinas (pl. 2, fig. 1) will be noted the elongated or plagioclase feldspars in a crystalline granular ground of olivines and pyroxenes, as in the gabbros, with metal in the interstices. In figure 2, from the stone of Shergotty, the structure is more nearly that of a diabase or basalt, consisting of large plates of pyroxene in a light ground, which, in this case, is isotropic, the so-called maskelynite, supposed to be a fused feldspar. In figure 1 of Plate 3 is shown the structure of the recently fallen stone of El Nakhla. This consists of a crystalline aggregate of green pyroxene and in small quantities a reddish-brown olivine with a little interstitial feldspar, and scattering granules of titanic iron and chromite. The structure is comparable with that of a terrestrial pyroxenite. In figure 2 is shown that of the holocrystalline siliceous portion of the mesosiderite of Estherville, Iowa, consisting of olivine, orthorhombic and monoclinic pyroxene, and a plagioclase feldspar.

A very large portion of the stony meteorites consists wholly or in part of rounded and oval granules called chondrules, embedded in a crystalline or tuffaceous ground, and it is in these forms, both in relation to structure of the spherules themselves and the ground in which they are embedded, that interest chiefly centers. (See pls. 4, 5, and 6.) Figure 1 of Plate 4 shows the structure of a crystalline chondrite from Estacado, Texas. This, as will be observed, consists of the rounded and irregular chondrules embedded in a crystalline ground. Figure 2 of this same plate shows a tuffaceous form from Selma, Alabama, a stone consisting of chondrules in all degrees of preservation down to mere fragments embedded in a tufaceous ground.

The individual chondrules occur in a surprising number of forms. Borgström and Ramsay enumerate 19 types of composition and structure in the stone of Bjurböle, and it is a safe assumption that this large number could be recognized in others should a sufficiently detailed study be made. In shape they vary from almost perfect spheres (pl. 5, fig. 1), often with a slight indentation on one side, through oval and elongated, rarely angular (unless fragmental), forms. Internally they may be of glass, crypto- or holo-crystalline, with a radiate, barred, or grate-like structure, of single or many individuals imbedded in a glassy or fibrous base. Occasionally they show a border of later formed crystals as in figure 5 of Plate 5. In some instances chondrules in a more or less perfect condition make up almost the entire mass of the stone as in the case of that of Allegan, Michigan, or Selma, Alabama (pl. 4, fig. 2). Or, again, they may be few and scattered throughout a crystalline ground, as in the case of the stone of Estacado, Texas (pl. 4, fig. 1). They may be so loosely attached as to fall away when the stone is broken, or so firmly imbedded as to break with it. Olivine (or forsterite) and pyroxene, either enstatite or a monoclinic form, are the more common constituents, more rarely feldspars. A border of nickel-iron or iron sulphide about a chondrule is not uncommon, the metal sometimes penetrating more or less into the interior (pl. 6, fig. 1).

Origin of the chondritic structure.—H. C. Sorby, writing in 1877, advanced the idea that the individual chondrules were originally detached molten drops like fiery rain and their internal crystalline or amorphous condition due to conditions of cooling. Reichenbach, as



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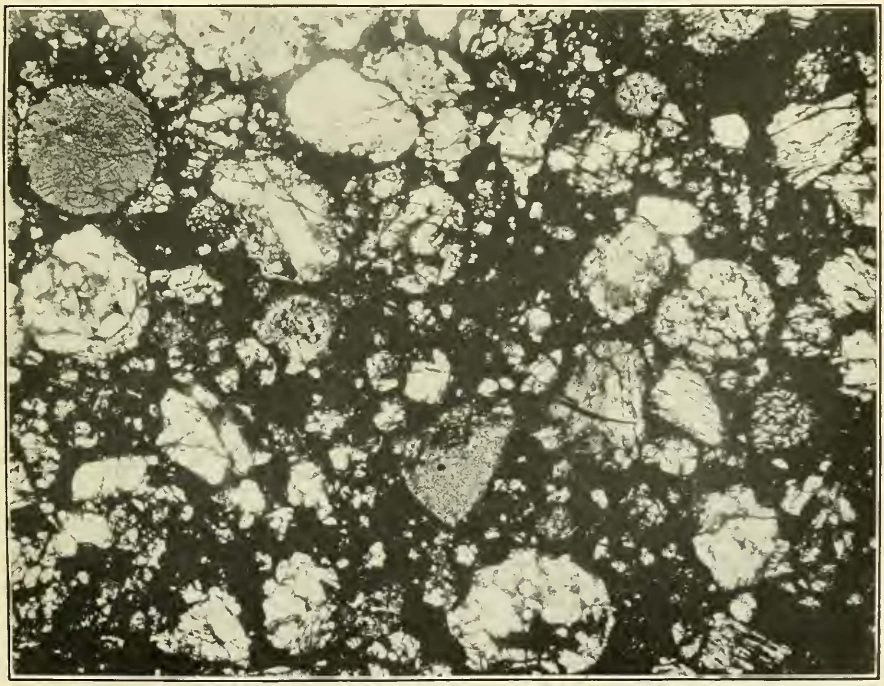
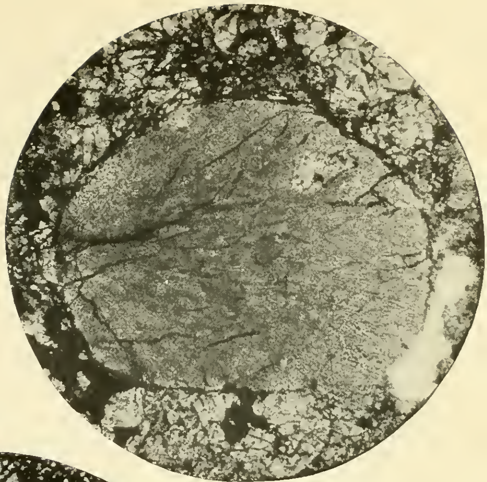


2

Microstructure of (1) Estacado and (2) Selma Stones.

For descriptions see page 18.

1



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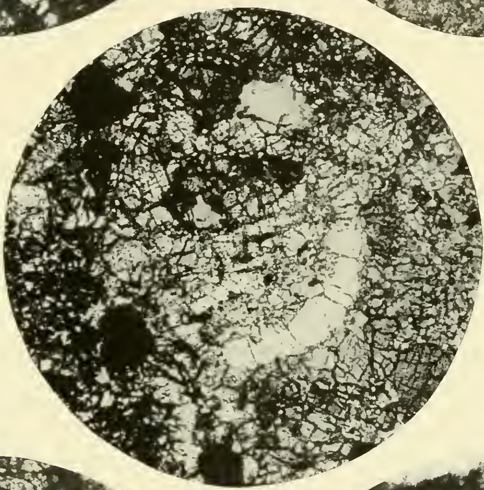

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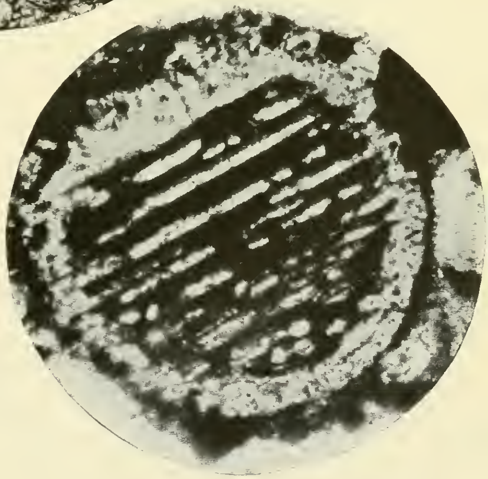


5

Microstructure of (1) Enstatite Chondrule in Elm Creek Stone, (2) Enstatite Chondrule in Hendersonville Stone, (3) Enstatite Chondrule in Coon Butte Stone, (4) Enstatite Chondrule in Tennasilm Stone, (5) Barred Olivine Chondrule in Beaver Creek Stone.

For descriptions see page 18.

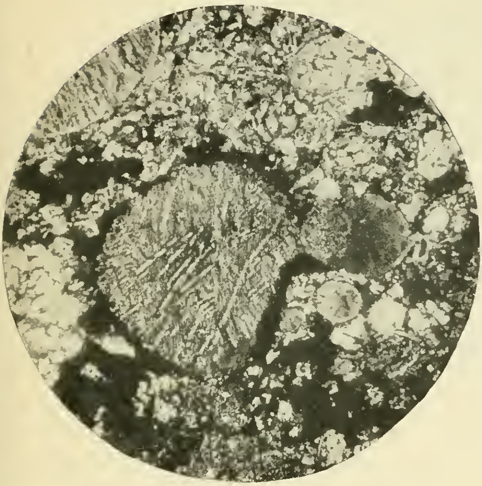
quoted by Lockyer, believed each chondrule to have been an "independent crystallized individual," a stranger in its host, and imbedded like a shell in limestone. Tschermak compared the chondrules to the spherulitic forms occurring in the trachytic tuffs of Freudenthal, and more especially to the olivine spherules of Kapfenstein and Feldbode in Styria. These tuffs he thought to be due to trituration in the volcanic throat. Writing with especial reference to the Gopalpur stone, he argued that it must be considered to have been a cooled mass, which through friction was broken into powder, the more tenacious particles remaining as kugels which were again gathered into a loose aggregate. Reusch also considered the chondrules as developed in the Tysnes meteorite due largely to attrition of consolidated particles, though perhaps modified to some extent by the corrosive action of the iron. He would account for the structure of the bronzite kugels, in which the radial point lies without the periphery, by assuming that originally they all had a like conical form such as is common in radiating nodular pyrite, the upper surface of the nodule forming the base of the cone. When such were worn down by attrition the point would naturally break away. Berwerth has also arrived at the conclusion that the chondritic meteorites originate through the partial refusion of meteoric tuffs. Brezina, and after him, Wadsworth, seem to have considered the structure of meteorites in general, and incidentally that of the chondrules, as due to hasty crystallization, a conclusion which so far as it relates to certain types seems well founded. Still other suggestions have been offered, as through condensation of vapor, or the refusion of original garnets. Concerning the last, it may be said that it merits no serious consideration. The views of the present writer were presented in detail in his description of the stone of Allegan, Michigan, in 1900, and it will be sufficient to repeat here the substance of the matter there given.

The general structure of stones of the Allegan type can be accounted for only by regarding them as agglomerates of chondrules imbedded in a fragmental groundmass or matrix, the materials for which were derived from the trituration of other chondrules. One fact which has always militated against a theory which would account for the peculiar structure of a meteorite of this type, on the assumption of hasty crystallization, has been the absence of a glassy base in any but the chondritic portions. Obviously if the stone were a product of crystallization, in mass, the chondrules would be products of the earliest consolidation, and should, judged by the standard of terrestrial petrography, be the most highly crystalline, while the base in which they are imbedded might be glassy or crystalline, according to conditions. As a matter of fact, the reverse is the case, the chondrules being more or less glassy, or at least imperfectly crystallized, as in the barred and fan-shaped forms, while the groundmass of the stone is of crystalline particles and of particles of the chondrules themselves.

That certain conditions of crystallization would give rise to spherulitic forms of the enstatite is undoubted. The subject of their development in liparite has been worked out by Cross and Iddings,[1] and while it is easy to conceive of the abrupt transition from a wholly or partly crystalline spherule to a glassy base, as sometimes seen in the spherulites of obsidian, it will, in the present state of knowledge, puzzle any petrographer to account for an equally sharp transition from a glassy spherule (chondrule) to a base composed wholly of crystalline particles, as shown in many meteorites. Even could one account for such anomalies of crystallization as these, the presence of plainly fragmental chondrules—chondrules which were fragments at the time of the final consolidation of the stone—would still remain to be explained. That many of the chondrules in this stone were the results of earlier fracturing is shown conclusively by the dull and abraded character of the fractured surface. With reference to the porphyritic forms in the glassy and fibrous ground, shown by some of the chondrules, one can assume that after the phenocrysts had become secreted the magma was resolved into spherical drops which cooled too rapidly for further crystallization, while in the radiated forms crystallization may have taken place in some cases prior to the assumption of the globular form, and in some subsequent thereto. Such forms lend support to the theory of Sorby, already quoted. It is possible to conceive that these, first as blebs of molten matter and then as consolidated particles, may have been triturated in the deep throat of some volcano. The spherical form, however, is not regarded by the present writer as due to trituration like volcanic lapilli, but rather to a previous molten condition. While it may be possible to account for the present condition of the chondritic meteorites, as regards degree of consolidation, on the theory that they are tuffs more or less metamorphosed by high temperatures, the chondrules can not themselves be thus accounted for, since a heat sufficient to render crystalline the pisolites in a tuff, as argued by some, would certainly produce a more marked degree of metamorphism in the surrounding matrix. There is apparently no escape from the idea that so far as the spherical chondrules are concerned, they are independently formed, though, it may be, greatly corroded and mechanically abraded prior to their ingathering into the stony masses coming to earth from space. That many of the external forms now presented are due to mechanical causes is self-apparent, and it is possible that not all have a common origin.

Other structural features.—The position occupied by the metallic constituent in a stony meteorite or pallasite is such as to indicate

[1] Bull. Philos. Soc. Washington, vol. 11, 1891.



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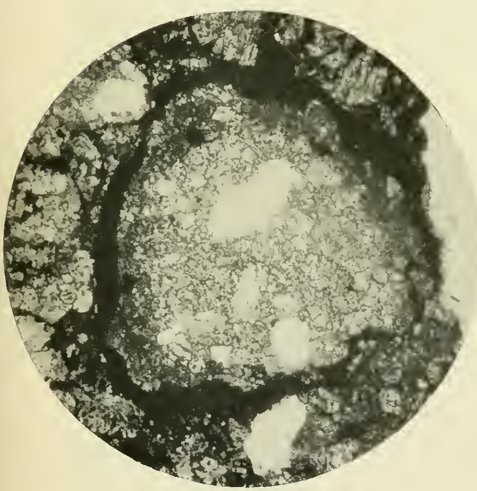

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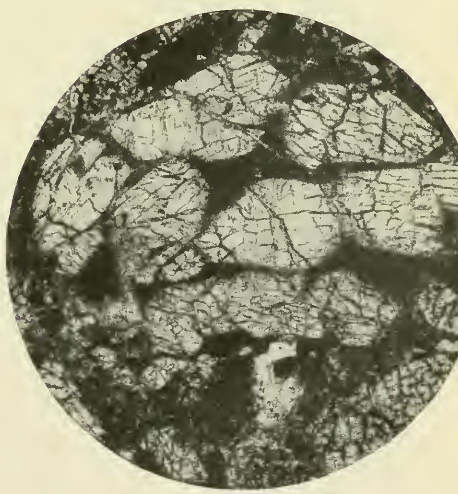
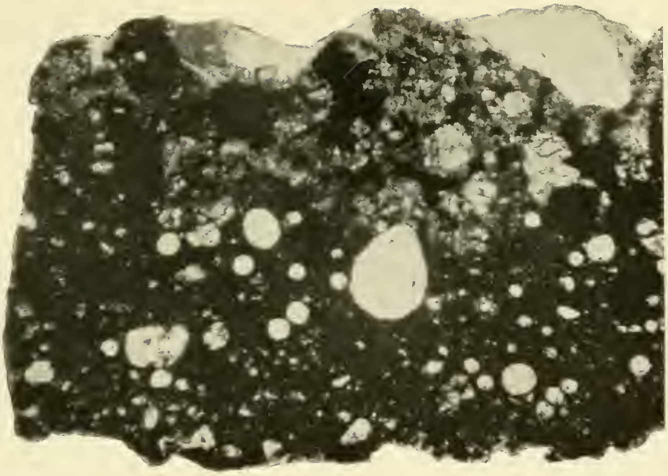


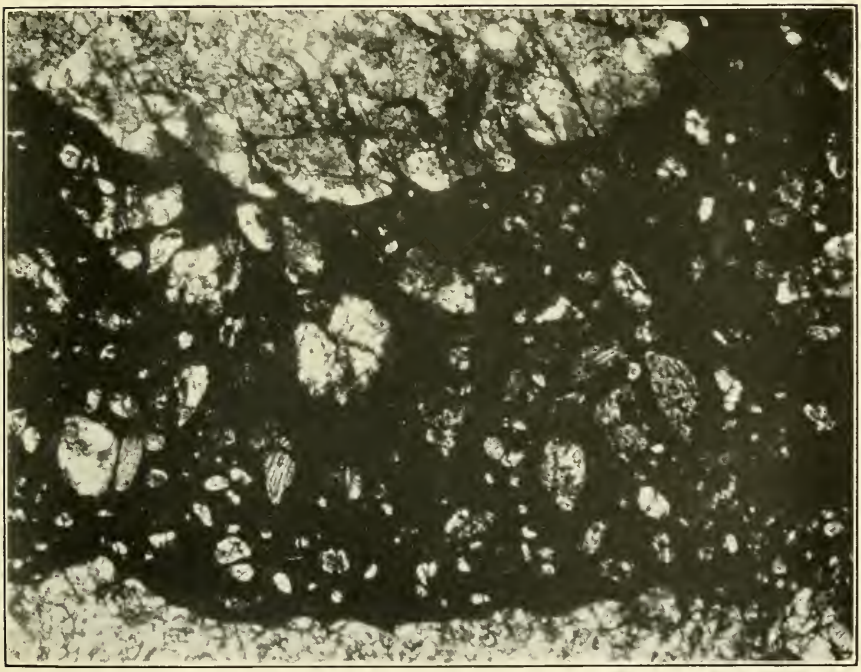
4

CHONDRITIC STRUCTURES IN (1 AND 4) CULLISON, (2) TENNASILM, AND (3) PARNALLEE STONES.

FOR DESCRIPTIONS SEE PAGE 18.



1



2

MICROSTRUCTURE OF (1) BLACK CRUST ON ALLEGAN STONE AND (2) OF BLACK VEIN IN BLUFF STONE.

FOR DESCRIPTIONS SEE PAGE 21.

plainly its secondary origin or introduction after the consolidation of all other constituents except the sulphides. While its melting point (about 1,500° C. or 2,732° F.) is somewhat lower than that of the associated silicates, the manner in which it frequently penetrates the fractures of these constituents (see Admire pallasite) is so strikingly like that of the native copper in the siliceous breccia of the Lake Superior region as to suggest that it results not from a condition of dry fusion, but rather from the reduction of some easily reducible iron-rich compound like lawrencite. Such a reduction, as noted by Nordenskiold[1] and others, must have taken place outside of our atmosphere and in an atmosphere deficient in oxygen. It may be noted, incidentally, that the average amount of metallic iron in stony meteorites, as shown by Merrill, is 11.98 per cent, which is equivalent to 16.55 per cent of magnetite or 27.16 per cent of purely ferrous lawrencite.

The black crust coating the surface of the stony meteorites is, as already noted, a more or less perfect glass, due to the fusion of the various constituents from the heat generated during the passage of the stone through the atmosphere. This, as shown in thin section (see pl. 7, fig. 1), is rarely of more than a few millimeters in thickness. It consists, as in the case of the Allegan stone figured, of a "black glass interspersed with numerous residuary particles of unfused silicates, which passes down gradually into the unaltered granular stone. Sections of the thick blebby glass from the lower surface show air vesicles and numerous crystallites imperfectly secreted from the glassy base, and too small to be seen in the figure, together with the residuary unfused particles of the original minerals."

Many of the stony meteorites are traversed by small, black, thread-like veins, which are plainly due to a fracturing of the stone prior to its entrance into our atmosphere. A greatly enlarged section of one of these from the Bluff, Fayette County, Texas, meteorite is shown in figure 2, Plate 7. The filling material of the vein is of a nearly coal black color, opaque, and of an undetermined nature, while the white and gray particles are fragments of the minerals composing the body of the stone. Occasionally a slight movement between the walls of these veins has developed a structure known as slickensides in terrestrial rocks. In the illustration shown no such movement has taken place, and it will be noted that the black vein material penetrates into the walls in the form of small veinlets on either hand.

One other feature which may be mentioned is the occurrence of a colorless, limpid, interstitial mineral, nearly or quite isotropic, which forms one of the principal constituents of the meteorite of Shergotty,

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[1] Zeits. d. D. geol. Ges., 1881, p. 25.

but quite common in small, microscopic quantities in other stones. This has been regarded by Tschermak as a fused feldspar, though others have considered it a distinct mineral species allied to leucite. The index of refraction supports the view of Tschermak. It occurs filling interstices, without form of its own, and is apparently one of the last, if not the last, constituent to assume a solid condition.

It has been shown by Messrs. Allen and others[1] of the Geophysical Laboratory, that an orthorhombic pyroxene, like enstatite, may be transformed into a monoclinic form by heating to a high temperature, and, further, that the parallel growths of the two varieties, so characteristic of meteorites, can be reproduced by rapidly cooling a molten mass of pure magnesian silicate. The more rapid the cooling the greater the preponderance of the monoclinic form. It seems probable that further study of the association of the two, as seen in thin sections, will lead to interesting and important developments in the preterrestrial history of meteoric stones.

EARLY RECORDS AND OPINIONS REGARDING METEORITE FALLS.

There was at first, and very naturally, a great deal of scepticism shown by both the popular and scientific minds regarding the possibilities of stones falling from space. So great was this scepticism that, as stated by Chladni in his celebrated work published in 1819, the examples preserved in public museums were hidden or discarded, the custodians fearing to make laughing-stock of themselves through acquiescing in the possibility of their extra-terrestrial origin. In the few early recorded cases where meteorites were seen to fall and recovered, they were regarded as objects of reverence and worship. A stone which fell in ancient Phrygia in Asia Minor about 200 years before Christ was worshiped as Cybele, the mother of the gods. Another, of which the history goes back to the seventh century, is still preserved at Mecca where it is built into the northeast corner of the Karaba and revered as one of the holiest of holy relics. The great Casas Grandes iron (pl. 15), in the national collections at Washington, was found in an ancient Mexican ruin swathed with mummy cloths in a manner to indicate that it was held in more than ordinary veneration by the prehistoric inhabitants. Meteoric iron has been found also upon a brick altar in prehistoric ruins in Ohio, and it is on record that a stone weighing about a pound, which fell in East Africa in 1853, was secured by the natives, anointed with oil, clothed, decorated, and finally installed in a specially prepared temple.

The earliest known undoubted meteorites still preserved are those of Elbogen, Bohemia, and Ensisheim, Upper Alsace, Germany, the first mentioned an iron, the second a stone. The iron was found some-

[1] Amer. Journ. Sci., vol. 22, 1906, pp. 385–438.

where about the year 1400 of our era, but its meteoric nature seems not to have been fully established until 1812. It has, however, for several hundred years been preserved in the Rathhaus at Elbogen. The Ensisheim stone was seen to fall on November 16, 1492, between the hours of 11 and 12 in the forenoon, the fall being accompanied with a loud crash like thunder, heard for a great distance. On striking the ground the stone buried itself to a depth of some 5 feet. When exhumed, it weighed 260 pounds, the portion now remaining weighing some 155 pounds. (See No. 506.)

Occurrences so well authenticated as the last would, it seems, have gone a long way toward convincing the scientific world, at least, but such was not the case, and as late as 1772, a committee, one of whom was the celebrated chemist, Lavoisier, presented to the French Academy a report on the examination of a stone seen to fall at Lucé, four years previously. In this they took the ground that the supposed sky stone was but an ordinary terrestrial rock that had been struck by lightning.

In 1794, E. F. F. Chladni, a German scientist, brought together all available accounts of the supposed meteorites, calling the attention of the scientific world to the fact that several masses of iron had in all probability come to our earth from outer space. He referred especially to the now well-known Pallas iron, which was found by a Cossack in 1749, among schistose rock, and in the highest part of a lofty mountain near Krasnojarsk in Siberia. It was regarded by the native Tartars as a holy thing fallen from heaven, which fact would certainly seem to indicate that it was seen to fall. Chladni argued that this iron could have been formed only under the influence of fire. The absence in the vicinity of scoriæ, the ductility of the iron, the hard and pitted surfaces, and the regular distribution of the included olivine, to his mind precluded the idea that it could have been formed where found, or by man, electricity, or an accidental conflagration. Hence, he inferred that it had been projected from a distance, and, as there were no volcanoes known to eject iron and as, moreover, there were no volcanoes in the vicinity, he was compelled to look for an extraneous source, and to regard it as actually having fallen from the sky. Incidentally, he argued, the flight of such a body through the atmosphere would give rise to all the phenomena of the fireball or shooting star.

It was, as has been remarked, as if to direct attention to Chladni's work that there occurred during this same year an observed shower of meteoric stones near Siena, Italy. In December of the following year also a 56-pound stone fell out of a clear sky almost at the feet of a laborer near Wold Cottage in Yorkshire, England, and again in 1798, under similar conditions, many stones fell at Krakhut, near Benares, in India.

The scientific mind was, however, slow in accepting these proofs. Fortunately there occurred about this time (April, 1803) a shower of stones, upward of 3,000 in number, in the neighborhood of L'Aigle near Paris. The circumstances of this fall were fully investigated under the auspices of the French Academy of Sciences, the report of which was of so conclusive a nature as forever to set at rest all doubts concerning their extra-terrestrial origin.

PHENOMENA OF FALL.

The fall of a meteorite is usually accompanied by noises variously described as resembling the fire of musketry, cannonading, or even thunder. If the fall takes place during periods of darkness it is also accompanied by a flash of light and followed by a luminous rocket-like trail. These phenomena are due to the rapid passage of the objects through the air, and the consequent rise in temperature which is sufficient to produce fusion of the outer surface and even ignition, thus giving rise to the thin, dark, glass-like crust which is found coating all stony meteorites. The time of passage through the atmosphere is, however, too short to permit the heat to penetrate to great depths, and nearly all meteorites are quite cool, or scarcely warm, on reaching the surface of the ground. It is to the sudden rise in temperature and pressure of the atmosphere, too, that is due the breaking up of a meteorite and its reaching the earth as a shower of fragments rather than a single individual.

We have little to guide us in estimating the speed at which a meteorite reaches the earth and its consequent power of penetration. The velocities as given by various observers vary between 2 and 45 miles a second. These last, however, are the initial velocities, the velocities possessed by the meteors on entering our atmosphere and while still at considerable altitudes—in some instances 50 or 60 miles—and which become very materially reduced by atmospheric friction long before reaching the earth. Indeed, from the calculations of Schiaparelli and others, it is commonly assumed that a meteorite reaches the surface at the speed of an ordinary falling body. A. Herschell, as quoted by Flight,[1] calculated the velocity of the Yorkshire (England) meteorite at the time it reached the ground as but 412 feet a second. The Guernsey (Ohio) meteorite was estimated by Prof. E. W. Evans[2] to have reached the earth while traveling at a speed of 3 or 4 miles a second; that of Weston, Connecticut, while at a height of some 18 miles, was estimated by Prof. Bowditch[3] to have a velocity of 3 miles a second. Newton[4] calculated

[1] A Chapter on the History of Meteorites, 1887, p. 219.
[2] Amer. Journ. Sci., vol. 32, 1861, p. 30.
[3] Mem. Amer. Acad. Arts and Sci., vol. 3, 1815, p. 213.
[4] Amer. Jour. Sci., vol. 33, 1862, p. 338.

the speed of the fireballs which passed over the Ohio and Mississippi Valleys in August, 1860, at 30 to 35 miles a second, and stated[1] that the Stannern, Moravia, stone came into our atmosphere with a velocity of 45 miles a second. These higher velocities are, doubtless, those of bodies pursuing a retrograde course about the sun.

The evidence afforded by actual falls and impacts is extremely contradictory. Nordenskiold states that, in the case of the Hessle fall, stones so friable as to be readily broken if simply thrown against a hard surface were not broken or even scarred on striking the frozen ground. Stones weighing several pounds which struck on ice a few inches in thickness rebounded without breaking the ice or being themselves broken. The 70-pound stone that fell at Allegan, Michigan, in 1899, penetrated the sandy soil to a depth of about 18 inches and was itself considerably shattered. Like that of Hessle, this was an unusually friable stone. It is evident that its speed did not exceed that of a projectile from an old-time piece of heavy ordnance. The 260-pound stone that fell at Ensisheim, Germany, in 1492, is reported to have buried itself to a depth of 5 feet.

The greatest depth of penetration of a meteoric stone which has come under the writer's observation is that of Knyahinya, Hungary, as described by Haidinger. In this instance a 660-pound stone, striking the ground at an angle of some 27° from the vertical, penetrated to a depth of 11 feet. The hole was nearly circular in outline, and fragments from the interior were thrown back and scattered to a distance of some 180 feet (*dreiszig Klafter*). The stone was found broken in three pieces, and the earth beneath it compacted to stony hardness.

On the other hand, still heavier masses have been found under such conditions as to lead one to infer they scarcely buried themselves. Peary's giant Cape York iron, weighing 37½ tons, was found only partially covered; but, as it lay on a bed of gneissic bowlders, this is not strange. It should be remarked, however, that an examination of the iron reveals no such abrasions of surface as might be expected had it fallen with a speed of miles per second, or, indeed, any abrasions whatever that can be ascribed to such a cause. It is, of course, possible that this fall took place when the ground was deeply covered with ice and snow, and its speed was thus checked before coming in contact with the stony matter.[2]

The Willamette iron, weighing 15.6 tons, seemingly lay without question as it originally fell, and in a region of no appreciable erosion—rather, one of organic deposition, for it was found lying in a

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[1] Amer. Journ. Sci., vol. 36, 1888, p. 11.

[2] It is stated that lead bullets from a modern rifle may be completely checked in traversing a few feet of light snow. and this, too, without the slightest appreciable deformation or surface abrasion.

primeval forest; yet the mass was not deeply buried, a small projecting portion leading to its discovery.

The Bacubirito iron, weighing at a rough estimate 20 tons, lay in a soft soil, with its surface but little below the general surface of the field around it.

It is a noteworthy fact that the members of different meteor showers exhibit visible features which in certain cases are quite dissimilar. This arises from the circumstance that the various showers encounter the earth at different angles, and their apparent speed depends in a great measure upon this. Thus the meteors of November 13 (Leonids) are moving in a direction opposite to the earth; hence their velocity is very great, being about 44 miles per second. But the meteors of November 27 (Andromedes) are moving in nearly the same direction as the earth, and hence have to overtake us, so that they apparently move very slowly, their speed being only 11 miles per second. The Leonids above referred to, together with the Perseids of August 10 and the Orionids of October 18–20, are good examples of the swift-moving meteors, and they are almost invariably accompanied by phosphorescent streaks. The slow meteors, of which the Andromedes are a type, throw off trains of yellowish sparks.[1]

In conclusion, the result of the investigation may be said to have created a strong presumption in favor of the following general deductions:

(*a*) That the velocities of meteorites are materially changed by the resistance of the atmosphere, and, in general, by a fractional part of the velocity which is independent of the velocity of approach.

(*b*) That the superior limit for incandescence is probably about 150 miles above the earth's surface.

(*c*) That no iron meteor the original weight of which was less than 10 to 20 pounds reaches the earth's surface, and that when a meteor does so the temperature of its center is not in general above that of liquid air (assuming the temperature of space to be zero).[2]

All statements relative to the temperature of meteorites immediately after reaching the ground must be accepted guardedly owing to their extremely contradictory character. According to Haidinger, some stones which fell in Styria in 1859 continued in a state of incandescence for from five to eight seconds, and for a quarter of an hour were too hot to be handled without burning. Beinert, in his account of the Braunau iron, states that for six hours it also remained too hot to be handled. On the other hand, the Dhurmsala stone is stated to have been intensely cold when picked up immediately after falling.

The reports of the setting of fires by the falling of meteorites must also be taken with the same degree of allowance. In the cases of both the Allegan and Winnebago falls the stones struck on the dried grass, which, though pressed closely against the surfaces, was not charred in the least. Indeed, one of the Winnebago stones fell on a stack of dry straw, but without igniting it.

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[1] Handbook of Descriptive and Practical Astronomy, by George F. Chambers, Sun, Planets, Comets, ed. 4, vol 1, p. 635.

[2] H. E. Wimperis, Nature (London, Eng.), vol. 71, 1904, p. 82.

Naturally the possibility of human beings and animals being struck by these falling bodies has been discussed, and several instances dating back to periods from 1511 to 1674 are mentioned in which persons were killed. It must be confessed that the absence of any recorded instances of this sort within more recent times, when the subject could be discussed more calmly, renders the occurrences open to question.

NUMBER OF FALLS AND WEIGHTS.

Upward of 650 falls and finds of meteorites have been reported, representatives of which have found their way into museums and private collections, and there preserved for study and investigation. These, however, constitute a very small fraction of those which actually fall and are never recovered, since it is estimated that upward of 20,000,000 strike the earth daily. These are for the most part very small, perhaps scarcely more than a grain in weight. It is interesting as well as singular that of all that have been seen to fall and have been recovered but nine are of iron. The largest known meteoric mass is that brought by Commander Peary from Cape York, Greenland. This weighed 73,000 pounds. The next largest lies in the plain near Bacubirito in Mexico, and has been estimated to weigh some 50,000 pounds, while the third is that of Willamette, Oregon, weighing 31,107 pounds. These are all iron meteorites. The largest known individual aerolite or meteoric stone is that of Knyahinya, Hungary, weighing some 550 pounds, now in the Vienna National Museum.[1]

It may be added, in conclusion, that all known meteorites are of an igneous nature and have yielded no traces of animal or vegetable life, although the peculiar radiating and grate-like structures of the chondrules were at one time mistaken for organic remains.[2]

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[1] The Estacado, Texas, stone is stated to have weighed nearly 640 pounds when found, but it has since been cut up.

[2] O. Hahn, Die Meteorite (Chondrite) und ihre Organismen, Tübingen, 1880.

PART II.

DESCRIPTIVE CATALOGUE.

A. MUSEUM COLLECTION.

INTRODUCTORY SERIES.

Series illustrative of three principal types of meteorites:
- Meteoric stone: Aerolite. Forest City, Iowa, Cat. No. 167.
- Meteoric stony-iron: Pallasite. Ilimae, Chile, South America, Cat. No. 383.
- Meteoric iron: Siderite. Toluca, Mexico, Cat. No. 347.

Series illustrating mineral composition and structure:
- Graphite, out of Canon Diablo siderite, Cat. No. 476.
- Schreibersite, out of Canon Diablo siderite, Cat. No. 475.
- Diamonds, out of Canon Diablo siderite, Cat. No. 473.
- Nodule of amorphous carbon in Canon Diablo siderite, Cat. No. 512.
- Troilite, in Toluca siderite, Cat. No. 347.
- One-half of nodule of troilite out of Canon Diablo siderite, Cat. No. 514.
- Widmanstätten figures, cube of Casas Grandes siderite, No. 369.
- Neumann lines, Scottsville, Allen County, Kentucky, siderite, No. 77.
- Chondrules, out of Allegan, Michigan, aerolite, Cat. No. 515.
- Crust, due to fusion by heat in passage through the atmosphere, Forest City, Iowa, Cat. No. 167.

ABERT IRON. (Loality uncertain, probably Toluca, Mexico.) No. 16.

Iron, Om. Section of mass weighing 150 grams. One face etched, showing coarse Widmanstätten figures. The original mass, weighing 466 grams, was found without label in the collection of the late Col. J. J. Abert. The structure and composition agree so completely with the Toluca irons that it seems best to so consider it, at least provisionally, rather than catalogue as an unknown as is usually done. At the time Colonel Abert was making his collection the Toluca irons were among the most common, and therefore most likely to find a place in mineral collections where a representative native iron was desired.

ADMIRE, LYON COUNTY, KANSAS. Nos. 248, 249, 257, 258, 364, 381.

Stony-iron, Pallasite (Röckiky group of Brezina). Mass weighing 3,220 grams (original weight 5,460 grams); mass weighing 2,048 grams, cut in halves and polished; two complete individuals weighing 1,450 and 1,550 grams, oxidized; polished section showing brecciated structure, weighing 203 grams; mass weighing 6,725 grams, now disintegrated and preserved in petroleum distillate. A mass is known which weighed upward of 7,000 grams, making the weight of all that has thus far been found about 24,436 grams, and it is a safe assumption that upward of 30,000 grams must have at one time been in existence. A considerable portion of these have fallen to pieces through the oxidation of the included lawrencite and become destroyed. The polished slices in this collection have been preserved by immersion in a petroleum distillate. Mineral composition: olivine with metallic iron, scheibersite, troilite, lawrencite, and chromite. The structure is that of a siliceous breccia with a metallic cement. (See pls. 8 and 9.)

Composition of the metallic portion, as shown by Wirt Tassin's analyses:

	Per cent.
Iron (Fe)	93.00
Nickel (Ni)	6.00
Cobalt (Co)	.02
Sulphur (S)	.03
Phosphorus (P)	.25
Copper (Cu)	Traces
	99.30

This corresponds to:

	Per cent.
Nickel-iron	98.273
Schreibersite	1.645
Troilite	.082
	100.00

The meteorite is the third of its class thus far known. Nothing is definitely known regarding its fall, the material having been discovered by a Mr. W. Davis while plowing, and attention called to it on account of its unusual appearance, which was wholly unlike any of the local rocks of the vicinity.

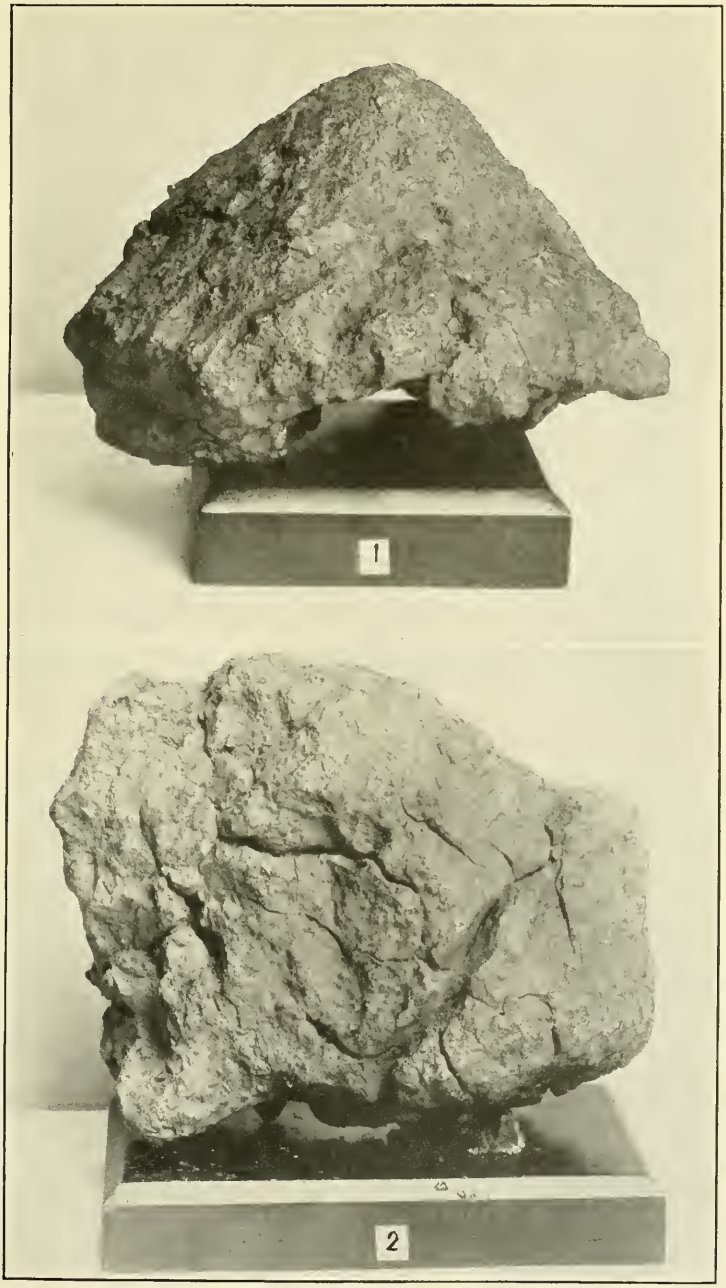
Reference.—G. P. Merrill, Proc. U. S. Nat. Mus., vol. 24, 1902, p. 907.

AGEN, LOT-ET-GARONNE, FRANCE. No. 231.

Stone, Cia. Three small fragments, weighing 38 grams, from a stone which fell September 5, 1814.

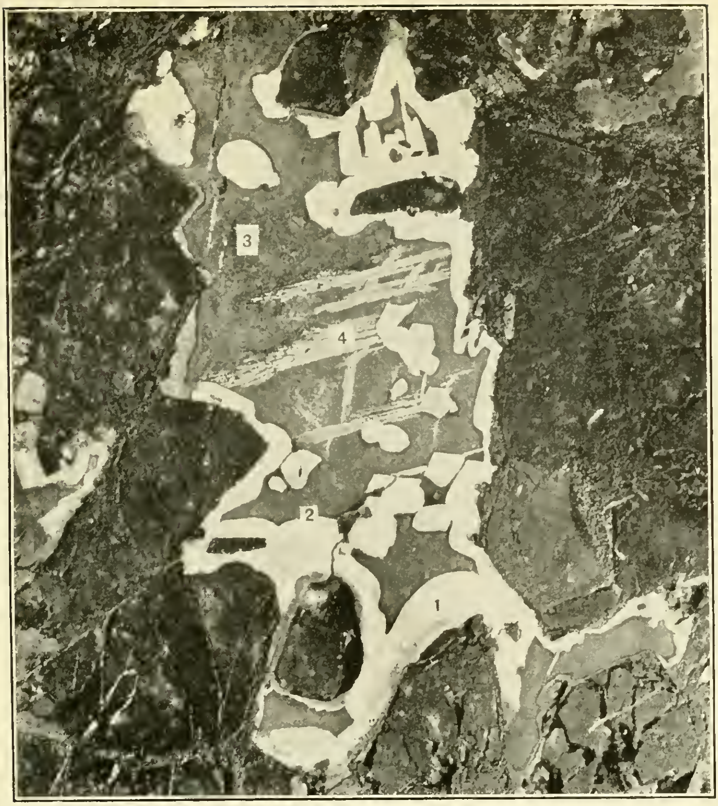
AHUMADA, CHIHUAHUA, MEXICO. No. 436.

Stony-iron, Pallasite. Irregular slice some 17 cm. by 10 cm. by 15 mm., weighing 840 grams. Consists of irregular masses of olivine,



TWO SPECIMENS OF ADMIRE PALLASITE, AS FOUND.

FOR DESCRIPTIONS SEE PAGE 30.

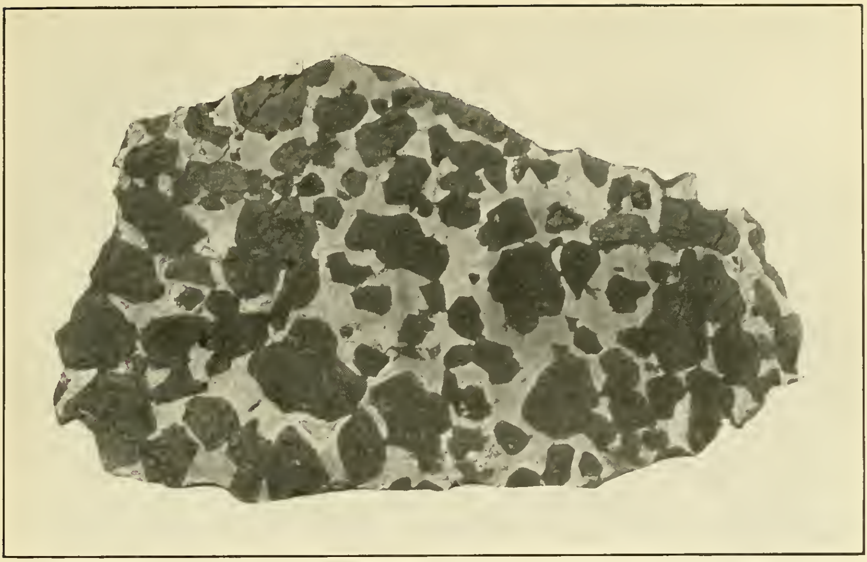


1

2

SECTION OF (1) METALLIC PORTION AND (2) POLISHED SLICE OF ADMIRE PALLASITE.

FOR DESCRIPTIONS SEE PAGE 30.



1

2

Polished Slices of (1) Ahumada Pallasite and (2) of Ainsworth Iron.

For descriptions see pages 30 and 31.

sometimes 2 cm. in diameter, in a coarse network of metal, with very little sulphide. Found in 1909. (Pl. 10, fig. 1.)

Reference.—O. C. Farrington, Field Mus. Nat. Hist., Publ. 178, Geol. Ser., vol. 5, No. 1, 1914, p. 1.

AINSWORTH, BROWN COUNTY, NEBRASKA. No. 375.

Iron, Ogg. Etched slab weighing 1,716 grams. A portion of a mass weighing 10.65 kilograms, or 23½ pounds. Remarkable for its coarse crystallization (see pl. 10). Found in 1907. Analysis by Wirt Tassin showed:

	Per cent.
Iron (Fe)	92.22
Nickel (Ni)	6.49
Cobalt (Co)	.42
Copper (Cu)	.01
Phosphorus (P)	.28
Sulphur (S)	.07
Chromium (Cr)	.01
Silicon (Si)	.049
Carbon (C)	.09
	99.639

Reference.—E. E. Howell, Amer. Journ. Sci., vol. 25, 1908, p. 105.

ALBUQUERQUE, NEW MEXICO. (See also Glorieta.) No. 115.

Iron, Om. Small section showing original and etched surface, weighing 56 grams; part of a mass found in 1884, and regarded by Kunz as probably a part of the Glorieta fall. Composition according to Eakins:

	Per cent.
Iron (Fe)	88.76
Nickel (Ni)	9.86
Cobalt (Co)	.51
Copper (Cu)	.034
Zinc (Zn)	.030
Chromium (Cr)	Trace.
Manganese (Mn)	Trace.
Carbon (C)	.41
Phosphorus (P)	.182
Sulphur (S)	.012
Silicon (Si)	.044
	99.842

References.—G. F. Kunz, Further notes on the meteoric iron from Glorieta Mountain, New Mexico. Amer. Journ. Sci., vol. 32, 1886, p. 311. L. G. Eakins, Meteoric iron from New Mexico. Proc. Colo. Sci. Soc., vol. 2, 1885, p. 14.

ALEPPO (HALEB), SYRIA. No. 287.

Stone, Cwb. Section of mass, with portion of crust, weighing 167 grams, from a stone weighing 3 kilograms, supposed to have fallen in 1873. An ash-gray groundmass flecked with rust and containing numerous metallic grains; traversed with slickensided veins.

ALFIANELLO, PROVINCE OF BRESCIA, ITALY. Nos. 71, 466, 497.

Stone, Ci. Three fragments weighing, respectively, 61.3, 134, and 17 grams, with and without crust. Showing ash-gray groundmass flecked with rust spots and carrying chondrules and metallic grains. Fell at 2.55 p. m. February 16, 1883, traveling in a south-southeast direction, but, through some unaccountable reason, burying itself obliquely in the soil to the depth of a meter in an opposite direction. The grass in the vicinity of the hole is stated to have been singed and the stone still warm when dug up. Orignal weight 260 kilograms.

The results of analyses as given by chemists are somewhat variable. In column I below are those of H. von Foullon, and in column II those of P. Maissen:

Constituents.	I.	II.
Silica (SiO_2)	39.14	37.63
Alumina (Al_2O_3)	.93	1.78
Ferrous oxide (FeO)	17.42	24.42
Magnesia (MgO)	25.01	23.43
Lime (CaO)	1.96	.89
Soda (Na_2O)	.75	1.09
Potash (K_2O)	.10	.24
Iron (Fe)	11.31	5.76
Nickel (Ni)	1.09	1.14
Cobalt (Co)	....	.08
Sulphur (S)	2.71	2.54
Phosphorus (P)	....	.15
Chromic oxide (Cr_2O_3)	....	.10
Manganous oxide (MnO)	....	.13
	100.42	[1] 99.38

[1] Record also CrO_3 0.629.

The mineral composition, as calculated from these analyses, is:

	Per cent.
Bronzite and feldspar (maskelynite)	41.37
Olivine	43.77
Nickel-iron	7.66
Pyrrhotite	7.45
	100.25

There are present also a phosphatic mineral and granules of chromic iron.

References.—H. von Foullon, Sitz. Akad. Wiss. Wien, vol. 88, 1883, p. 433. P. Maissen, Gazz. Chim. Ital., vol. 13, 1884, p. 369. George P. Merrill, Proc. Nat. Acad. Sci., vol 1, 1915, pp. 302–308.

ALGOMA POST OFFICE, KEWAUNEE COUNTY, WISCONSIN. No. 273.

Iron, Om. Two fragments weighing 4 and 12 grams, from a mass weighing a little more than 2 kilograms, found in 1887. The original iron was remarkable for its discoid shape, measuring 25 by 16½ cm. with a maximum thickness of 2½ cm. The chemical composition, as given by Hobbs, is as follows:

	Per cent.
Iron (Fe)	88.62
Nickel (Ni)	10.63
Cobalt (Co)	.84
Phosphorus (P)	.15
Silica (SiO_2)	.02
Sulphur (S)	Trace.
Copper (Cu)	None.
Carbon (C)	None.
	100.26

Reference.—W. H. Hobbs, Meteorite from Algoma, Wisconsin Bull. Geol. Soc. America, vol. 14, 1903, p. 97.

ALLEGAN, THOMAS HILL, ON THE SAUGATUCK ROAD, ALLEGAN COUNTY, MICHIGAN. No. 215.

Stone, Cco. Principal mass, covered, except where broken, with thick black crust (pl. 11), and many fragments. Total weight about 35.5 kilograms. Fell a little after 8 o'clock on the morning of July 10, 1899. Flight from the northeast toward the southwest. When first seen in the air (after explosion) it had the appearance of a black ball, the size of a man's hand when closed, followed by a bluish cloud apparently some six feet in length. The explosion was reported as cannon-like, and was followed by a hissing sound compared with that of an engine blowing off steam. But one mass was seen to fall, which buried itself in the sand only to the depth of 18 inches.

The chemical composition of the stone is as follows:

	Per cent.
Metallic part, 23.06 per cent:	
Iron (Fe)	21.09
Copper (Cu)	.01
Nickel (Ni)	1.81
Cobalt (Co)	.15
Stony part, 76.94 per cent:	
Silica (SiO_2)	34.95
Titanic oxide (TiO_2)	.08
Phosphoric acid (P_2O_5)	.27
Alumina (Al_2O_3)	2.55
Chromic oxide (Cr_2O_3)	.53
Ferrous oxide (FeO)	8.47
Ferrous sulphide (FeS)	5.05
Manganous oxide (MnO)	.18
Nickel oxide (NiO)	Trace.

Stony part, 76.94 per cent—Continued.	Per cent.
Lime (CaO)	1.73
Magnesia (MgO)	21.99
Potash (K_2O)	.23
Soda (Na_2O)	.66
Lithia (Li_2O)	Faint trace.
Ignition (H_2O) at 110°	.06
Ignition (H_2O) above 110°	.19
	100.00

Specific gravity at 27° C., 3.905.

The mineral composition of this stone is essentially olivine and enstatite in nearly equal proportions, with 23.06 per cent nickeliferous iron and 1.3 per cent chromite. Structurally, it is chondritic and tufaceous, the chondrules showing in some cases undoubted evidences of their fragmental nature before the stone consolidated in its present form. Extremely friable; color light ash gray.

Reference.—Geo. P. Merrill and H. N. Stokes, A new stony meteorite from Allegan, Michigan [and a new iron meteorite from Mart, Texas]. Proc. Washington Acad. Sci., vol. 2, 1900, pp. 41–56.

AMALIA FARM, NEAR GIBEON, GERMAN SOUTHWEST AFRICA. No. 433.

Iron, Off. Etched slice, 25 by 15 by 6 cm., weighing 6,538 grams and showing structure indicative of the welding of three distinct masses. (See also Mukerop.)

Gift of C. S. Bement.

ANDERSON, LITTLE MIAMI VALLEY, HAMILTON COUNTY, OHIO. No. 106.

Stony-iron, Pallasite. Weight 15 grams. Found in "Indian mound No. 3 of the Turner Group," in the Little Miami Valley of Ohio. (Supposed to be a part of Brenham, Kiowa County, Kans.)

Reference.—O. W. Huntington, Prehistoric and Kiowa County pallasites. Proc. Amer. Acad. Arts and Sci., vol. 26, 1891, pp. 1–12.

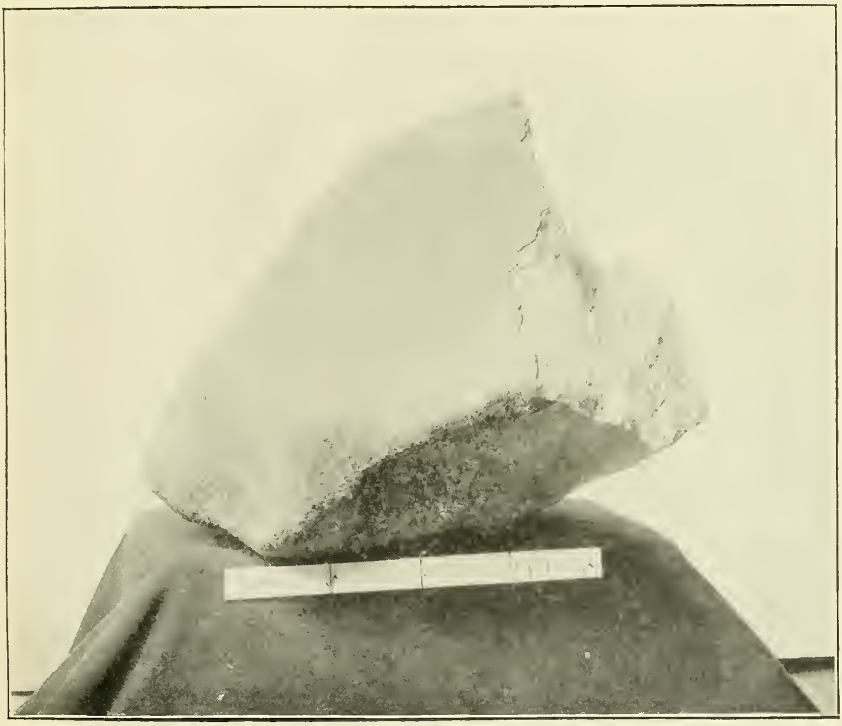
ANGRA DOS REIS, RIO DE JANEIRO, BRAZIL. No. 111.

Stone, A. Fragment weighing 8.5 grams, with shining black crust. The fragment is interesting as representing the rare group of angrites, or stones which are composed almost wholly of the mineral augite.

ARISPE, SONORA, MEXICO. Nos. 299, 325.

Iron, Ogg. Two samples; an etched slab 48 by 28 by 2 cm., weighing 9,695 grams, and a complete individual weighing 52,727 grams. Found in 1898 in northeastern Mexico. Nothing known regarding fall. The slice shows an interrupted line of troilite masses, which, together with the crystallization brought out by the etched figure, indicates that it is made up of two differently oriented masses welded together. A partial analysis by Whitfield yielded: iron, 92.268;

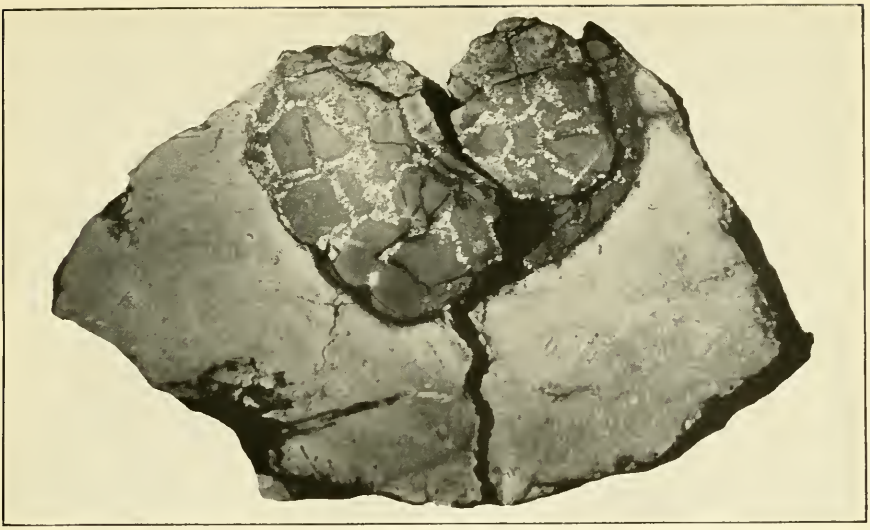
1



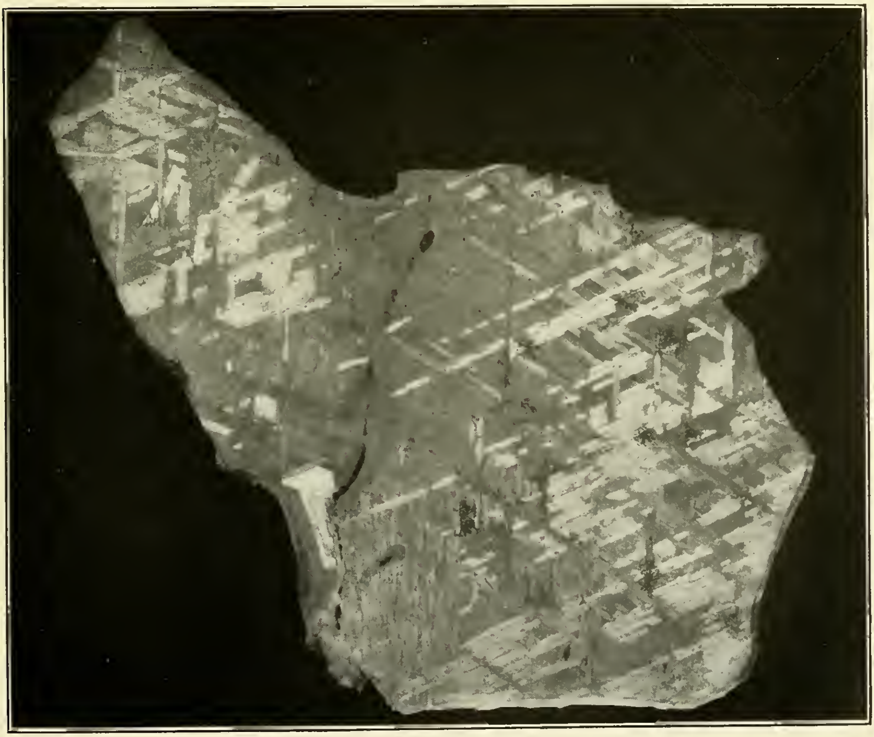
2

POLISHED SLICE OF (1) BRENHAM PALLASITE AND (2) THE ALLEGAN METEORIC STONE, AS FOUND.

FOR DESCRIPTIONS SEE PAGES 33 AND 49.



1



2

POLISHED SLICE OF (1) CANON DIABLO IRON AND (2) ETCHED SLICE OF ARISPE IRON.

FOR DESCRIPTIONS SEE PAGES 34 AND 51.

nickel, 7.040. Subsequently Dr. John M. Davison found traces of platinum. Specific gravity, 7.853. This iron is remarkable for the large masses of dendritic schreibersite it contains. (See pl. 12, fig. 2.)

Reference.—H. A. Ward, Proc. Rochester Acad. Sci., vol. 4, 1902, p. 79.

ARLINGTON, SIBLEY COUNTY, MINNESOTA. No. 492.

Iron, Om. A thin slice 60 by 20 mm. and weighing 24 grams, from a mass weighing 19¾ pounds, found in 1894. An analysis by F. F. Sharpless yielded:

	Per cent.
Iron (Fe)	90.781
Nickel (Ni)	8.605
Cobalt (Co)	1.023
Phosphorus (P)	.045
	100.454

No sulphur, silicon, or manganese, and but traces of chromium, copper, and carbon.

Reference.—N. H. Winchell, Amer. Geologist, vol. 18, 1896, p. 267.

AUBURN, LEE (FORMERLY MACON) COUNTY, ALABAMA. No. 35.

Iron, H. Weight 23 grams. Date of fall unknown, the mass being ploughed up in a field "many years" prior to 1869. The iron as found was described by C. U. Shepard as cracked up and subdivided by open veins as if it had been shattered by striking against a rock at the time of its fall. The cohesion was so imperfect that it could be broken into small pieces by means of a sledge hammer, and a very large portion of it has been lost. The chemical composition as given is:

	Per cent.
Iron (Fe)	94.58
Nickel (Ni)	3.015
Phosphorus (P)	.129
Insoluble	.523
Chromium (Cr), Magnesium (Mg), Calcium (Ca), Silicon? (Si), Loss	1.753
	100.00

Reference.—C. U. Shepard, Meteoric iron from Auburn. Macon County, Alabama. Amer. Journ. Sci., vol. 47, 1869, p. 230.

AUGUSTINOWKA, EKATERINOSLAW, RUSSIA. No. 224.

Iron, Of. Weight 70 grams. Rectangular slice, 9.5 by 2.5 cm., etched and showing Widmanstätten figures. Date of fall unknown. Found 1890, buried at the depth of a meter in the loess. Original weight 25 pfund (400 kilograms). Composition as given by Meunier: One gram yielded:

	Per cent.
Ferric oxide (Fe_2O_3)	0.88
Nickel oxide (NiO)	.132
Schreibersite	.038
Insoluble material	.021
	1.07

The iron as found was very badly oxidized, but is of interest as being probably of prediluvial age. Structure octahedral.

Reference.—S. Meunier, Compt. Rend., vol. 116, 1893, p. 1151.

BABB'S MILL, GREENE COUNTY, TENNESSEE. No. 98.

Iron, Db. Weight, 38.4 grams. Date of fall unknown; found in 1842 and described by Troost in 1845; later (in 1876) a larger mass was found which was described and figured by W. P. Blake in 1886. The second find was remarkable for its peculiar shape, being 36 inches long, 10 inches broad, and 6 inches in thickness, with a girth of 24 inches. (See Cast No. 291.) It belongs to the group of structureless irons, ataxites, and shows no figures on an etched surface. The chemical composition as given by Cohen and Weinschenk is:

	Per cent.
Iron (Fe)	86.30
Nickel (Ni)	12.58
Cobalt (Co)	1.66
	100.54

References.—G. Troost, Meteoric iron from Green Co., Tenn. Amer. Journ. Sci., vol. 49, 1845, pp. 342–344. W. P. Blake, Amer. Journ. Sci., vol. 31, 1886, pp. 41–46. Cohen and Weinschenk, Ann. k. k. Naturhist. Hofmus., vol. 6, 1891, p. 142.

BALLINOO, MURCHISON RIVER, WEST AUSTRALIA. No. 254.

Iron, Off. Weight, 1,266 grams; etched slab 19.5 by 9 cm., showing troilite nodules. Date of fall not known. Found in 1893. Weight of original mass, 42.9 kilograms (93 lbs.). Composition:

	Per cent.
Iron (Fe)	89.909
Nickel (Ni)	8.850
Cobalt (Co)	.740
Phosphorus (P)	.501
Carbon (C)	Traces.
Copper (Cu)	Traces.
Sulphur (S)	Traces.
Silicon (Si)	Traces.
	100.00
Specific gravity	7.8

Subsequent investigations have shown this iron to contain traces of palladium and ruthenium.

References.—H. A. Ward, Amer. Journn. Sci., vol. 5, 1898, p. 136. Geo. P. Merrill, Proc. U. S. Nat. Mus., vol. 43, 1912, p. 596.

BARBOTAN, LANDES, FRANCE. No. 305.

Stone, Cga. Weight, 273 grams. Irregular fragment without crust. Dark gray, rust spotted. Fell July 24, 1790. The fall was observed over an area of many miles, the meteor appearing as a blinding white ball followed by a dark red trail. Its fall was accompanied by an explosion, the thunder-like report of which continued for three or four minutes, the fragments burying themselves in the earth to a depth of from three to five feet. Wülfing gives the known weight as 5,911 grams, of which 858 grams are in the British Museum and 618 in the Vienna Museum.

Composition: Satisfactory chemical analyses seem never to have been made. A microscopic study by Tschermak showed it to have an indistinct chondritic structure and to consist of bronzite and olivine with nickel-iron and troilite. The stone is of more than usual interest, being one of the early well-authenticated falls.

Reference.—H. Pfahler, Min. pet. Mitth., vol. 13, 1893, p. 353.

BARRATTA STATION, 35 MILES NORTHWEST OF DENILIQUIN, NEW SOUTH WALES, No. 289.

Stone, Cgb. Weight, 451 grams; triangular fragment, with polished surface and original crust. Date of fall unknown. Three stones found, the first, weighing about 71 kilograms, in 1852, and the two others, weighing 21.77 kilograms and 14.3 kilograms, in 1889. Compact, dark gray, chondritic stones, the chondrules so large (1–5 mm.) and abundant as to give it, even to the unaided eye, a conglomerated appearance. Under the microscope a mass of more or less fragmental and distorted chondrules of olivine and enstatite, with interstitial iron and troilite. An analysis by Liversidge yielded:

	Per cent.
Silica (SiO_2)	40.280
Alumina (Al_2O_3)	1.843
Ferric oxide (Fe_2O_3)	3.930
Lime (CaO)	1.400
Magnesia (MgO)	23.733
Manganous oxide (MnO)	.734
Potash (K_2O)	1.024
Soda (Na_2O)	.997
Sulphur (S)	2.288
Iron (Fe)	14.966
Nickel (Ni)	4.219

	Per cent.
Cobalt (Co)	Traces.
Copper (Cu)	.182
Phosphorus (P)	.617
	96.213

with traces of chromium and carbon.

Reference.—A. Liversidge, Journ. Proc. Royal Soc. New South Wales, vol. 16, 1883, p. 31; vol. 36, 1902, p. 350.

BATH, BROWN COUNTY, SOUTH DAKOTA. Nos. 201, 276.

Stone, Ccb. Weights, 25 and 687 grams. Fragments with crust and polished surface. Crust dull black, papillated and somewhat blebby. Groundmass ash gray, flecked with rust and containing chondrules and metallic particles. Fine, granular, compact. Fell about 4 p. m. on August 29, 1892, the fall being witnessed by two men. Stone buried itself in the ground to a depth of 16 inches and was still warm when dug up. Apparently has never been analyzed. Original weight, 21.2 kilos, or 46¾ pounds.

Reference.—A. E. Foote, Amer. Journ. Sci., vol. 45, 1893, p. 64.

BATH FURNACE, KENTUCKY. No. 302.

Stone, Cia. Triangular fragment weighing 323 grams. Fragment of a stone which fell in the early evening of November 15, 1902. Three masses were found—one weighing 5.8 kilograms or 12 pounds, 12½ ounces, the second weighing 223 grams and the third 80.57 kilograms, or about 177 pounds. The last mentioned, now in the Field Museum at Chicago, is remarkable on account of the perfection of its strongly fluted surface. It has not been analyzed.

Reference.—H. A. Ward, Proc. Rochester Acad. Sci., vol. 4, 1905, p. 193.

BEAR CREEK, DENVER COUNTY, COLORADO. No. 60.

Iron, Of. Weight 25 grams. Thin slice 3.7 by 2.8 by 4 cm. Polished and etched showing Widmanstätten figures. Taenite plates very distinct. Date of fall unknown. Found and described in 1866. Composition as determined by J. L. Smith:

	Per cent.
Iron (Fe)	83.89
Nickel (Ni)	14.06
Cobalt (Co)	.83
Copper (Cu)	Trace
Phosphorus (P)	.21
	98.99

Smith also determined the presence of schreibersite and pyrrhotite, the latter of which yielded on analysis:

	Per cent.
Sulphur (S)	35.08
Iron (Fe)	61.82
Nickel (Ni)	.41
Insol. residue	1.81
	99.12

Reference.—J. L. Smith, Amer. Journ. Sci., vol. 44, 1867, p. 66.

BEAVER CREEK, WEST KOOTENAI DISTRICT, BRITISH COLUMBIA. Nos. 170, 342.

Stone, Cck. Two pieces weighing 330 and 369 grams. Fragments with dull black papillated crust; from a stone which fell between 3 and 4 o'clock on the afternoon of May 26, 1893; flight from the west toward the east; fall preceded by sharp report heard for a distance of 25 miles. Stone broke in two pieces, the largest of which, weighing 14,000 grams, buried itself in the earth for a distance of about 3 feet, the direction of the hole being at an angle of about 58° with the horizon. Chemical composition: The metallic portion yielded:

	Per cent.
Iron (Fe)	90.68
Nickel (Ni)	8.80
Cobalt (Co)	.49
Copper (Cu)	.03
	100.00

The silicates, divided into soluble and insoluble portions, as usual, yielded:

Constituents.	Soluble portion.	Insoluble portion.
Silica (SiO_2)	38.26	57.75
Titanic oxide (TiO_2)	....	.18
Alumina (Al_2O_3)	.56	4.89
Ferrous oxide (FeO)	19.52	8.02
Nickel oxide (NiO)	.09	Trace.
Manganous oxide (MnO)	.27	.35
Lime (CaO)	1.03	3.44
Magnesia (MgO)	38.73	23.19
Potash (K_2O)	.02	.25
Soda (Na_2O)	.13	1.87
Ignition (H_2O) above 100°	.70	.06
Phosphoric acid (P_2O_5)	.68	....
Chlorine (Cl)	Trace.	....
	99.99	100.00

From these results, aided by a microscopic study, the composition of the entire mass has been calculated as follows:

	Per cent.
Silica (SiO_2)	37.14
Alumina (Al_2O_3)	2.15
Titanic oxide (TiO_2)	.07
Ferrous oxide (FeO)	10.45
Nickel oxide (NiO)	.033
Manganous oxide (MnO)	.23
Lime (CaO)	1.76
Magnesia (MgO)	23.44
Potash (K_2O)	.097
Soda (Na_2O)	.79
Water (H_2O)	.28
Phosphoric acid (P_2O_5)	.25
Iron (Fe)	15.53
Nickel (Ni)	1.51
Cobalt (Co)	.09
Copper (Cu)	.006
Troilite	5.05
Chromite	.77
Magnetite	.16
	99.806

The mineral composition is olivine, enstatite, metallic iron, magnetite, troilite, and chromite, with a lime phosphate and plagioclase feldspar (?) in very small quantity. The proportional amounts of these constituents are: Iron, 17.30; troilite, 5.05; chromite, 0.77; magnetite, 0.16; soluble silicates (mainly olivine) and phosphates, 37.23; insoluble silicates (mainly enstatite), 39.66.

The structure is chondritic and compact; somewhat friable; color, gray.

The 330-gram piece is the gift of Mr. James Hislop.

Reference.—E. E. Howell, The Beaver Creek meteorite. (Chemical work by W. F. Hillebrand, microscopic work by Geo. P. Merrill.) Amer. Journ. Sci., vol. 47, 1894, p. 430.

BELLA ROCA, SIERRA DE SAN FRANCISCO, SANTIAGO, PAPASQUIARO, DURANGO, MEXICO. No. 142.

Iron, Of. Weight 152 grams. Irregular mass 5 by 6 cm., containing cavity left by oxidation of large troilite nodule; one surface etched, showing Widmanstätten figures and scattering troilites. Weight of original mass 33 kilograms. Date of fall unknown. Found in 1888. Described by Whitfield, who found the metallic portion to consist of:

	Per cent.
Iron (Fe)	91.48
Nickel (Ni)	7.92
Cobalt (Co)	.22
Phosphorus (P)	.21
Sulphur (S)	.21
Carbon (C)	.06
	100.10

The iron was deeply pitted exteriorly. From the bottom of one of these pits was obtained material which on examination proved to be troilite, from which it was assumed that the pits were formed by the weathering out of troilite nodules.

Gift of Messrs. Ward and Howell.

Reference.—J. E. Whitfield, Amer. Journ. Sci., vol. 37, 1889, p. 439.

BEMDEGO, PROVINCE OF BAHIA, BRAZIL. No. 351.

Iron, Og. Triangular slab 11.5 by 4.5 cm., weighing 140 grams, with one large troilite nodule. The original mass as found weighed 5,370 kilograms, or 11,814 pounds, being, therefore, the fourth largest mass known. Found about 1811. Date of fall unknown.

Reference.—Orville A. Derby, Archiv. Mus. Nac. Rio de Janeiro, vol. 9, 1896, p. 89.

BENARES (KRAKHUT), INDIA. No. 42.

Stone, Cc. A 1-gram fragment from a shower which fell at Benares on December 19, 1798.

BETHANY, GREAT NAMAQUALAND, SOUTH AFRICA. No. 489.

Iron, Om. An end slice showing portion of original surface, weighing 127 grams, from a mass known since 1860, weighing originally some 231.84 kilograms (510 pounds). An average of two analyses by Dr. J. Fahrenhorst yielded the results in columns I and II below, I being that of the mass as a whole and II that of the nickel-iron freed from other constituents.

Constituents.	I.	II.
Iron (Fe)	91.68	91.485
Nickel (Ni)	7.975	7.885
Cobalt (Co)	.60	.59
Copper (Cu)	.025	.03
Carbon (C)	.015	.01
Chromium (Cr)	.02	....
Chlorine (Cl)	.01	....
Sulphur (S)	.03	....
Phosphorus (P)	.06	....
	100.415	100.000

From these the mineral composition is calculated as:

Nickel-iron	99.51
Schreibersite	.39
Daubreelite	.05
Troilite	.04
Lawrencite	.01
	100.00

Gift of South African Museum.

Reference.—E. Cohen, Ann. South African Mus., vol. 2, 1900, p. 21.

BIALYSTOCK, RUSSIAN POLAND. No. 332.

Stone, Ho. A 21-gram fragment from a shower weighing altogether some 2 kilograms, which fell on October 5, 1827.

BILLINGS, CHRISTIAN COUNTY, MISSOURI. No. 444.

Iron, Om. Slice 70 by 175 mm., weighing 440 grams. Found in 1903. Date of fall unknown. Chemical analysis by H. W. Nichols yielded:

	Per cent.
Iron (Fe)	91.99
Nickel (Ni)	7.38
Cobalt (Co)	.42
Copper (Cu)	.01
Silicon (Si)	.08
Phosphorus (P)	.15
Sulphur (S)	.06
	100.09

Reference.—H. A. Ward, Amer. Journ. Sci., vol. 19, 1905, p. 240.

BISCHTUBE, PROVINCE OF TURGAI, RUSSIA. No. 229.

Iron, Og. Weight, 1,290 grams; slice 14 by 24 cm., showing coarse lamellæ with inclusions of troilite and schreibersite. Weight of three original masses, 48.75 kilograms. Date of fall unknown; found in 1888. Described by E. A. Kislakowsky as consisting of:

	Per cent.
Schreibersite	3.85
Olivine	9.88
Anorthite	8.06
Nickel-iron	78.25
	100.04

The nickel-iron contained:

	Per cent.
Iron (Fe)	93.10
Nickel (Ni)	4.82
Cobalt (Co)	2.08
	100.00

The percentage of cobalt is unusually high. Specific gravity as made on different samples from the mass, 6.36, 6.60, and 6.92. This iron was subsequently studied by Brezina, whose results differed greatly, so far as proportional amounts of the varying constituents are concerned. He found:

	Per cent.
Nickel-iron	96.97
Schreibersite	2.52
Carbon	.09
Chromite and silicate granules	.01
Undetermined residue	.41
	100.00

Omitting the undetermined residue and certain angular pieces separated in solution, he obtained for the iron:

	Per cent.
Iron (Fe)	91.52
Nickel (Ni)	7.12
Cobalt (Co)	.84
Phosphorus (P)	.39
Carbon (C)	.10
Copper (Cu)	.02
"Körner" (?)	.01
	100.00

References.—E. D. Kislakowsky, Ueber den Meteoriten von Turgaisk. Bull. Soc. Imp. Nat. Moscow, No. 2, 1890, p. 187. Abstract in Neues Jahrb., vol. 1, 1892, p. 51. E. Cohen, Meteoreisen Studien, 5, Ann. k. k. Naturhist. Hofmus., vol. 12, Heft 1, 1897, p. 52.

BISHOPVILLE, SUMTER COUNTY, SOUTH CAROLINA. No. 222.

Stone. Chla. Weight, 102 grams; two fragments from the interior. Fell March 25, 1843. Original weight, 13 pounds (6 kilograms). This is a very interesting and somewhat unique stone belonging to Tschermak's group of chladnites, of which but four representatives are at present known. The stone was first described by Shepard in 1846 as consisting in large part of a light gray material regarded by him as a persilicate of magnesia to which he proposed to give the name *chladnite*, in honor of the chemist, Chladni. Subsequent researches (in 1864) by J. Lawrence Smith showed the mineral to be identical with enstatite. In addition to this, Shepard thought to discover two other new minerals, the one blue and the other yellow, to which he proposed to give, respectively, the names *iodolite* and *apatoid.* These have since been shown to be oxidation products of the nickeliferous iron, or pyrrhotite. The stone was described in 1851 by W. Sartorious von Waltershausen, who thought to show that the siliceous portion of the stone was made up of 95.011 per cent chladnite and 4.985 per cent of labradorite. Rammelsberg, in 1863, declared, as a result of his examination, that the stone contained no feldspar. In 1883, the stone was studied by modern petrographic methods by M. E. Wadsworth, who agreed with Shepard in describing it as a grayish-white mass resembling albitic granite, with brown and black spots and with a structure essentially granitic. The mineral composition as given is as follows: Enstatite, augite, feldspar, olivine, pyrrhotite, and iron. No perfectly satisfactory chemical analysis of the stone as a whole has until recently been made, those of Shepard, Smith, Rose, and Rammelsberg being all on selected siliceous material. Recent results by J. E. Whitfield are as below:

	Per cent.
Silica (SiO_2)	57.034
Alumina (Al_2O_3)	1.706
Ferric oxide (Fe_2O_3)	1.406
Manganous oxide (MnO)	.189
Lime (CaO)	2.016
Magnesia (MgO)	33.506
Cobalt oxide (CoO)	Trace
Nickel oxide (NiO)	.538
Soda (Na_2O)	1.027
Potash (K_2O)	.089
Ignition (H_2O)	1.995
Iron (Fe)	.181
Nickel (Ni)	.039
Sulphur (S)	.297
	100.023
Less O for S	.147
	99.876

An amount of lime equivalent to 0.67 per cent calcium sulphide was liberated by boiling the finely pulverized stone for two hours in distilled water. Inspection of the stone in mass shows, in addition, occasional granules of an iron sulphide (troilite or pyrrhotite) which were evidently not included in the portion analyzed. No traces of barium, strontium, or zirconium could be detected. The amount of material utilized in the analysis was not as large as could have been desired.

References.—See Wülfing, p. 30. Also G. P. Merrill, Mem. Nat. Acad. Sci., vol. 14, 1916, p. 7.

BITBURG (ALBACHER MÜHLE), RHENISH PRUSSIA, GERMANY. Nos. 122, 445.

Stony-iron, Pallasite. Irregular slag-like mass, weighing 22 grams, and polished and etched slice, some 35 by 35 by 20 mm., showing original surface, weighing 86 grams. Found in 1802. Weight of original mass, over 1,600 kilograms. Analysis by Finkener yielded:

	Per cent.
Iron (Fe)	85.04
Nickel (Ni)	10.51
Cobalt (Co)	1.70
Copper (Cu)	.06
Carbonaceous matter	.09
Sulphur (S)	1.89
Phosphorus (P)	.20
	99.49

Reference.—See Wülfing, p. 31.

BJELAJA ZERKOW, UKRAINE, KIEW, RUSSIA. No. 183.

Stone, Ce or Cg. A 10-gram fragment from the interior of a mass which fell on January 16, 1796.

BJELOKRYNITCHIE, VOLHYNIA, RUSSIA. No. 219.

Stone, Cib. An 8-gram fragment from a stone which fell on January 1, 1887.

BJURBÖLE, NEAR BORGA, IN SOUTHERN FINLAND. No. 238.

Stone, Cca. Weight, 617 grams; fragment with crust. Fell on March 12, 1899, at about half past 10 p. m., local time. The fall was accompanied by the usual light and by thunder-like sounds. The light was seen over a large part of Finland; the direction of flight was from west to east, passing over the western part of the Finnish Sea at a height estimated as some 53 kilometers. The stone fell upon the frozen surface of a lake, the ice being some 40 mm. in thickness (a little more than an inch and a half), making a hole some 3.5 meters by 4.25 meters, with a very uneven outline. The water of the lake was 90 cm. (about 35½ inches) deep at this point, with a bottom consisting of mud composed largely of organic remains, and underlaid by clay, hard sand, and gravel, the stone burying itself in the clay, where it was found at a depth of 6 meters below the surface. The stone, when found, was broken in numerous pieces, large and small, estimated to weigh altogether 328 kilograms, of which the largest pieces weighed, respectively, 80.2, 21, 18, and 17 kilograms, the 80.2-kilogram piece being now in the museum of the Geological Survey of Finland. The stone is chondritic and very friable, of an ash gray color, with the usual crust. Composition:

	Per cent.
Magnetic material	5.84
Nonmagnetic material	94.16

The magnetic portion yielded:

	Per cent.		
Iron (Fe)	70.1	or	4.09[1]
Nickel (Ni)	8.0	or	.47[1]
Cobalt (Co)	.3	or	.018[1]
Phosphorus (P)	.1	or	.006[1]
Ferrous sulphide (FeS)	1.9	or	.110[1]
Silicates	19.2	or	1.121[1]
	99.6		5.815

The nonmagnetic portion yielded:

	Per cent.
Iron (Fe)	2.43
Nickel (Ni)	.27
Cobalt (Co)	.02
Sulphur (S)	2.06
Phosphorus (P)	.14
Silica (SiO_2)	43.05
Alumina (Al_2O_3)	2.68
Chromic oxide (Cr_2O_3)	.62
Ferrous oxide (FeO)	19.06
Nickel oxide (NiO) } Cobalt oxide (CoO) }	.08
Manganous oxide (MnO)	.13
Lime (CaO)	1.91
Magnesia (MgO)	27.01
Potash (K_2O)	.34
Soda (Na_2O)	1.34
	101.14
Less O for S	1.03
	100.11

From these figures the bulk composition of the entire mass was calculated as follows:

	Per cent.
Iron (Fe)	6.38
Nickel (Ni)	.72
Cobalt (Co)	.04
Phosphorus (P)	.14
Ferrous sulphide (FeS)	5.44
Silica (SiO_2)	41.06
Alumina (Al_2O_3)	2.55
Chromic oxide (Cr_2O_3)	.59
Ferrous oxide (FeO)	13.80
Nickel oxide (NiO)	.07
Manganous oxide (MnO)	.12
Lime (CaO)	1.82
Magnesia (MgO)	25.75
Potash (K_2O)	.32
Soda (Na_2O)	1.24
	100.04

[1] Of the entire mass.

From this the mineral composition was calculated as:

	Per cent.
Nickel-iron	7.14
Troilite	5.44
Phosphor-nickel-iron	.90
Chromite	.87
Silicates	85.47
	99.82

The silicate material yielded, on analysis, results as follows:

	Per cent.
Silica (SiO_2)	48.15
Alumina (Al_2O_3)	2.98
Ferrous oxide (FeO)	14.75
Manganous oxide (MnO)	.14
Lime (CaO)	2.13
Magnesia (MgO)	30.13
Potash (K_2O)	.37
Soda (Na_2O)	1.45
	100.10

the silicates being enstatite, augite, anorthite, olivine, maskelynite (?), and glass.

The structure is, as above noted, strongly chondritic, the chondrules being exceptionally variable in composition, the following forms being noted: (1) Anorthite chondrules; (2) olivine chondrules, both monosomatic and polysomatic; (3) glass chondrules with porphyritic olivine inclusion; (4) olivine-pyroxene chondrules; and (5) pyroxene chondrules. The structure, as a whole, is that of a fragmental rock, and it is so regarded by Messrs. W. Ramsay and L. H. Borgström, who have studied it.

Reference.—W. Ramsay and L. H. Borgström, Bull. Comm. geol. Finlande, No. 12, 1902.

BLUFF, FAYETTE COUNTY, TEXAS. Nos. 135, 240, 344.

Stone, Ckb. Three fragments of first find (1878), weighing 137 grams, 110 grams, and 6,363 grams, showing crust; one with black vein as figured in American Journal of Science (vol. 36, 1888, p. 118). One fragment found in 1901, weighing 3,136 grams, with one polished surface; other surfaces weathered. Date of fall unknown. Weight of mass found in 1878, 146,000 grams; chemical analyses by Whitfield yielded results as follows:

Constituents.	No. 1: Total mass.	No. 2: 5.67 per cent total metal.	No. 3: 33.3 per cent total insoluble in HCl.	No. 4: 60.62 per cent total soluble in HCl.
Silica (SiO_2)	37.70		49.64	33.59
Iron (Fe)	3.47	82.42		
Ferrous oxide (FeO)	23.82		15.56	31.12
Alumina (Al_2O_3)	2.17		4.12	1.34
Phosphoric acid (P_2O_5)	.25			.42
Lime (CaO)	2.20		4.93	1.00
Manganous oxide (MnO)	.45		.54	.43
Magnesia (MgO)	25.94		25.21	28.08
Nickel oxide (NiO)	1.59		Trace.	2.66
Nickel (Ni)	.65	15.44	Trace.	
Cobalt oxide (CoO)	.16		Trace.	.27
Cobalt (Co)	.09	2.14		
Sulphur (S)	1.30			2.18
	99.79	100.00	100.00	101.09
Less O for S	.65			1.09
	99.14			100.00
Specific gravity 3.510				

Mineral composition.—Mainly olivine and enstatite with 5.67 per cent metallic iron. Structure chondritic; compact; is traversed by narrow, irregular dark veins (see pl. 7, fig. 2), the origin of which is problematic. In mineral composition they do not differ essentially from the main mass of the stone. Color, dark greenish-gray on a fresh surface.

Reference.—J. E. Whitfield and G. P. Merrill, The Fayette County meteorite. Amer. Journ. Sci., vol. 36, 1888, pp. 113–119.

BOHUMILITZ, PRACHIN, BOHEMIA, AUSTRIA. No. 446.

Iron, Og. A slice 55 by 20 by 4 mm., weighing 103 grams, from a mass weighing some 57 kilograms, found in 1829. Several analyses have been made, but none can be considered satisfactory. Steinman gives iron, 94.06; nickel, 4.01; residue, 1.12; and sulphur, 0.81.

Reference.—Cohen and Weinschenk, Ann. k. k. Naturhist. Hofmus., vol. 6, 1891, p. 143.

BORKUT, MARMAROS, HUNGARY. No. 189.

Stone, Cc. Fragment from the interior, weighing 2 grams.

BRAHIN, MINSK, RUSSIA. No. 124.

Stony-iron, Pallasite. Fragment of the iron matrix from which all the stony matter has disappeared, weighing 14 grams; from a mass weighing some 100 kilograms, known as early as 1810.

BRAUNAU, BOHEMIA, AUSTRIA, Nos. 49, 491.

Iron, H. A fragment weighing 7.35 grams and a thin slice 25 by 30 by 2 mm., weighing 16 grams, from one of two masses weighing

17,082 grams and 23,628 grams, which fell July 14, 1847. This iron is of interest, being one of the very few which have been seen to fall, and, further, because of its hexahedral structure. The chemical analysis made by Fischer and Duflos is unsatisfactory.

Reference.—C. C. Beinert, Der Meteorit von Braunau, Breslau, 1848.

BREMERVÖRDE, GNARRENBURG, HANOVER, GERMANY. No. 144.

Stone, Ccb. Fragment weighing 2 grams, from a mass weighing 7¼ kilograms, which fell May 13, 1855.

BRENHAM, KIOWA COUNTY, KANSAS. Nos. 154, 161, 266, 271, 280, 337.

Stony-iron, Pallasite. Weights 261, 326, 463, and 551 grams; also slice 31 by 25 cm., weighing 4.37 kilograms, and one complete individual weighing 17.27 kilograms. Date of fall unknown: found in 1885 when the prairie was first plowed. Over 20 individuals were found, weighing in the aggregate upward of 2,000 pounds, or about 909 kilograms, the largest individual weighing 466 pounds, or 211.8 kilograms. The relative proportions of olivine and iron are quite variable. (See pl. 11, fig. 1.) A polished surface shows large rounded blebs of greenish olivine imbedded in a groundmass of metallic iron. Occasional rounded masses of a bronze-colored troilite are evident, and there is a peculiar black lustrous border about the olivines which, as shown by Eakin's analyses, was evidently an iron-rich variety of the same mineral.

The chemical composition of the two chief constituents, as shown by analyses, is as follows:

Constituents.	Eakins.	Dodge.
IRON.	*Per cent.*	*Per cent.*
Iron (Fe)	88.49	90.48
Nickel (Ni)	10.35	8.59
Cobalt (Co)	.57	.16
Copper (Cu)	.03	Trace.
Phosphorus (P)	.14	.27
Sulphur (S)	.08	.05
Carbon (C)	Trace.	Trace.
Silicon (Si)	Trace.	.24
	99.66	99.79
OLIVINE.		
Silica (SiO_2)	40.70	40.50
Alumina (Al_2O_3)	Trace.	....
Ferric oxide (Fe_2O_3)	.18	.77
Ferrous oxide (FeO)	10.79	10.51
Nickel oxide (NiO)	.02	....
Manganous oxide (MnO)	.14	....
Magnesia (MgO)	48.02	47.18
	99.85	98.96

Specific gravity of the iron at 23.4° C., 7.93; of the olivine at 23.2°, 3.376, according to Eakins. The proportional mineral composition of the meteorites as a whole, as given by Winchell and Dodge, is as follows:

	Per cent.
Nickel-iron	74. 42
Chromite	18. 31
Troilite	4. 76
Schreibersite	2. 13
	99. 62

Kunz thought to have detected scales of graphite, and speaks of the olivines leaving cavities highly polished, "showing even crystal face with a mirror-like luster." In the United States National Museum's specimens nothing of the kind exists, the cavities being smoothly rounded throughout.

No. 154, gift of George F. Kunz; No. 161, of Robert Hay.

References.—G. F. Kunz, On the group of meteorites recently discovered in Brenham Township, Kiowa County, Kansas. Amer. Journ. Sci., vol. 40, 1890, pp. 312–318. N. H. Winchell and J. A. Dodge, The Brenham, Kiowa County, Kansas, meteorites. Amer. Geologist, vols. 5 and 6, 1890, pp. 309 and 370.

BURLINGTON, OTSEGO COUNTY, NEW YORK. No. 32.

Iron, Om. Fragment weighing 76.87 grams; one surface etched. Weight of original mass not known, but reported to have been from 100 to 200 pounds (45 to 90 kilograms). Date of fall unknown; plowed up in field and put in hands of a country blacksmith, who cut it up and made from portions articles for farmers' use. Analysis by B. Silliman, jr., showed:

	Per cent.
Metallic iron	92. 291
Metallic nickel	8. 146
	100. 437

No other substances were detected. Specific gravity, 7.501.

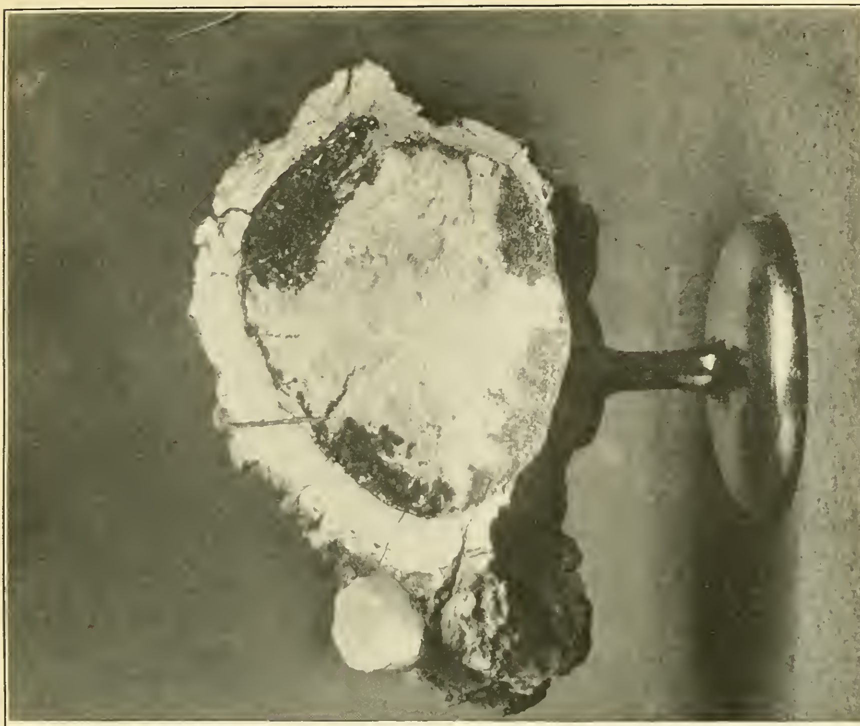
Reference.—B. Silliman, jr., Amer. Journ. Sci., vol. 46, 1843–44, p. 401.

BUTLER, BATES COUNTY, MISSOURI. No. 96.

Iron, Off. Section 7.5 by 5.5 by 1.1 cm. showing troilite nodules and weighing 270 grams. From a mass weighing 36 kilograms, first described in 1875. Analysis by J. L. Smith yielded:

	Per cent.
Iron (Fe)	89. 12
Nickel (Ni)	10. 02
Cobalt (Co)	. 26
Copper (Cu)	. 01
Phosphorus (P)	. 12
	99. 53

1



2

Oxidized Canon Diablo Iron (1) as Found, (2) Sliced to Show Metallic Nucleus.

ETCHED SLICE OF CANON DIABLO IRON.

FOR DESCRIPTION SEE PAGE 51.

Reference.—J. L. Smith, Amer. Journ. Sci., vol. 13, 1877, p. 214.

BUTSURA, GORUCKPUR, INDIA. No. 93.

Stone, Ci. Fragment with crust, weighing 11 grams, from a shower of five stones weighing 22 kilograms which fell May 12, 1861.

CABIN CREEK, JOHNSON COUNTY, ARKANSAS. No. 76.

Iron, Om. A fragment weighing 34 grams from a mass of iron weighing some 47 kilograms; fell March 27, 1886.

CAMBRIA, NEAR LOCKPORT, NIAGARA COUNTY, NEW YORK. No. 105.

Iron, Of. Weight 155 grams. Polished slice about 6 by 11 cm., showing Widmanstätten figures and troilite nodules. Found about 1818 and described in 1845. Weight of original, 16.33 kilograms, or about 36 pounds.

Chemical composition as shown by Silliman and Hunt:

	Per cent.
Iron	92.583
Nickel	5.708
Copper and arsenic	Traces.
Insoluble material	1.4
	99.691

References.—Silliman, Amer. Journ. Sci., vol. 48, 1845, p. 388. Silliman and Hunt, Amer. Journ. Sci., vol. 2, 1846, p. 370.

CANON DIABLO, COCONINO COUNTY, ARIZONA. Nos. 193–199, 210, 355, 373, 390, 394, 401, 402, 403, 420.

Iron, Og. Nearly 400 complete individuals, weighing from less than 5 grams to 435,374 grams and of an aggregate weight of approximately 2,200 pounds or 998 kilograms; also two etched slices, 34 by 22 cm. and 37 by 20 cm., showing large troilite nodules; a slice 18 by 12 cm., showing unusually large graphite nodules with veins of nickel iron; and an etched slice 26 by 13 cm., weighing altogether 20,894 grams. (See pls. 12, 13, 14, and 17.) Aggregate weight of all found not known, but nearly 5 tons, or 4,545 kilograms have been accounted for. Date of fall unknown, but first iron found in 1891. Structure coarsely octahedral. In addition to the nickel-iron constituent, O. A. Derby found this iron to contain schreibersite, troilite, graphite, cohenite, and rhabdite. Koenig and Huntington found microscopic diamonds. (See No. 473.) Moissan showed it also to contain carborundum, while Mallet found small and variable amounts of platinum, iridium, and probably rhodium. An analysis by J. E. Whitfield showed:

	Per cent.
Silicon (Si)	Trace.
Sulphur (S)	0.009
Phosphorus (P)	.261
Manganese (Mn)	None.
Copper (Cu)	.015
Nickel (Ni)	7.335
Cobalt (Co)	.510
Combined carbon	.105
Graphitic carbon	.028
Iron oxides	2.520
Iron protochloride	.097
Iron (Fe)	89.167
	100.047

This iron is of unusual interest on account of the large amount found. By some it is thought that the large crater in the near vicinity was formed by the impact of larger members of the same shower. (See Meteor Crater Exhibit.)

References.—A. E. Foote, Amer. Journ. Sci., vol. 42, 1891, p. 413. Henri Moissan, Compt. Rend., vol. 139, 1904, p. 773. O. A. Derby, Amer. Journ. Sci., vol. 49, 1895, p. 101. Geo. P. Merrill, Smithsonian Misc. Coll., vol. 50, pt. 4, 1908, p. 460; Amer. Journ. Sci., vol. 35, 1913, p. 513.

CANYON CITY, TRINITY COUNTY, CALIFORNIA. No. 468.

Iron, Og. Weight 275 grams. Nearly rectangular mass 5.5 by 5.5 mm., showing troilite nodules. Found in 1875 on the border of a little stream flowing into Trinity River. Date of fall unknown. Weight of original mass 18¾ pounds.

Chemical analysis by J. M. Davison yielded:

	Per cent.
Iron	91.25
Nickel	7.85
Cobalt	.17
Phosphorus	.10
	99.37

Specific gravity, 7.68.

This iron is singularly enough considered by Wülfing to be identical with that of Glorieta, New Mexico.

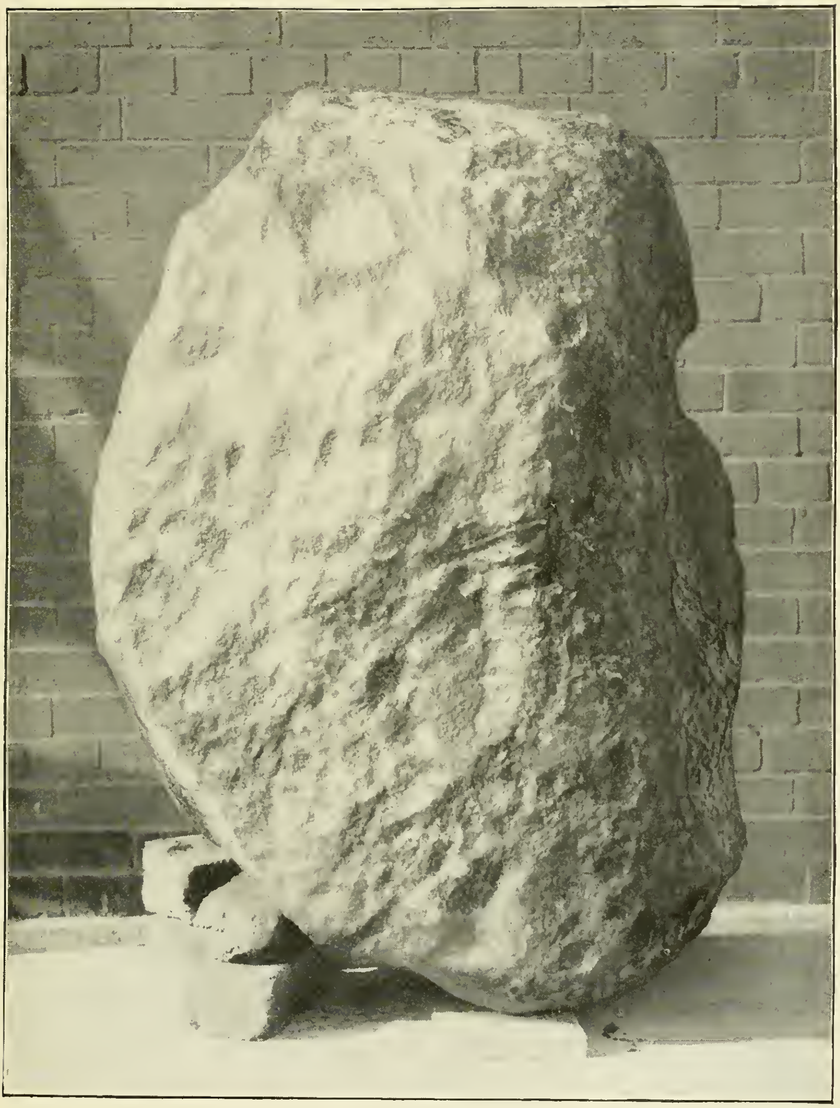
Reference.—H. A. Ward, Amer. Journ. Sci., vol. 17, 1904, p. 383.

CAPE GIRARDEAU, MISSOURI. No. 108.

Stone, Cc. A 4-gram fragment with crust, from one of three pieces which fell August 14, 1846.

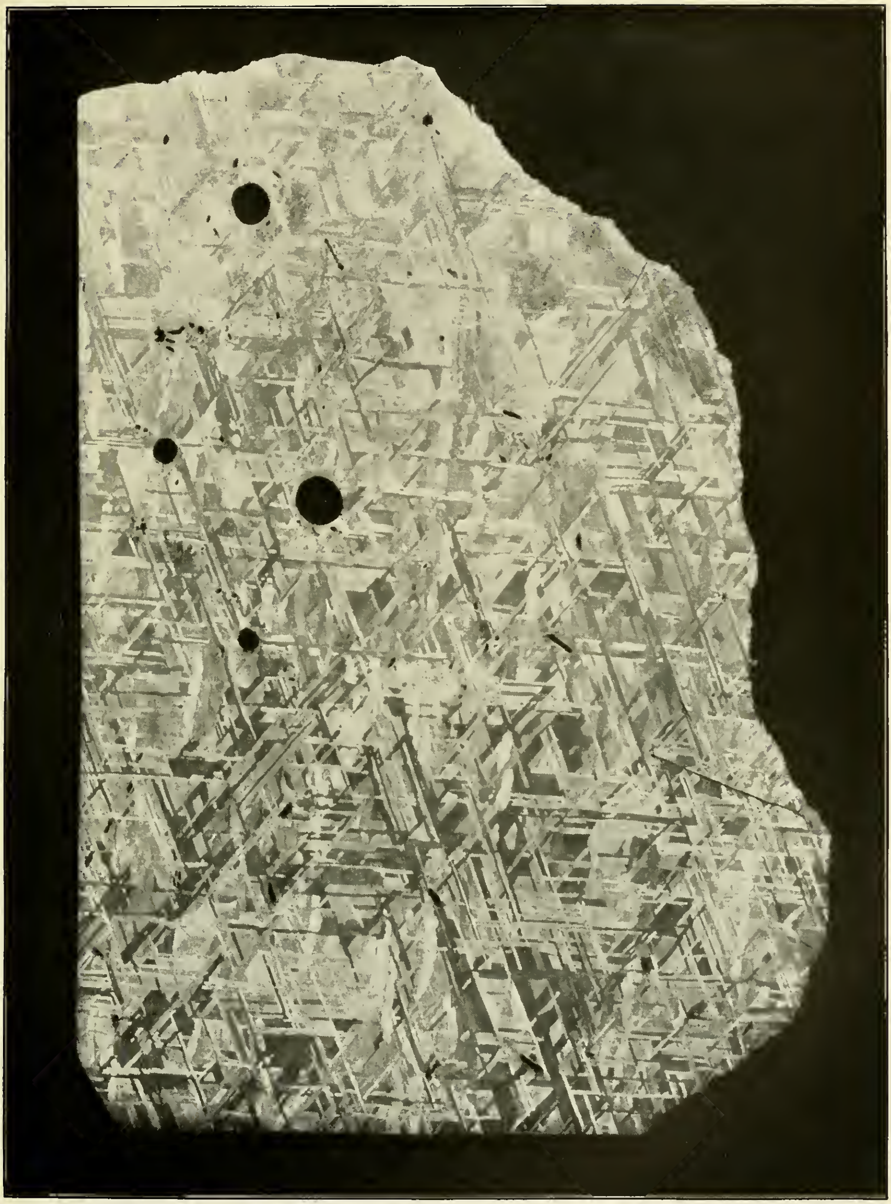
CAPE OF GOOD HOPE (CAPE IRON), CAPE COLONY, SOUTH AFRICA. No. 36.

Iron, Hca. Twenty-gram fragment from a mass weighing upward of 71 kilograms, found in 1793.



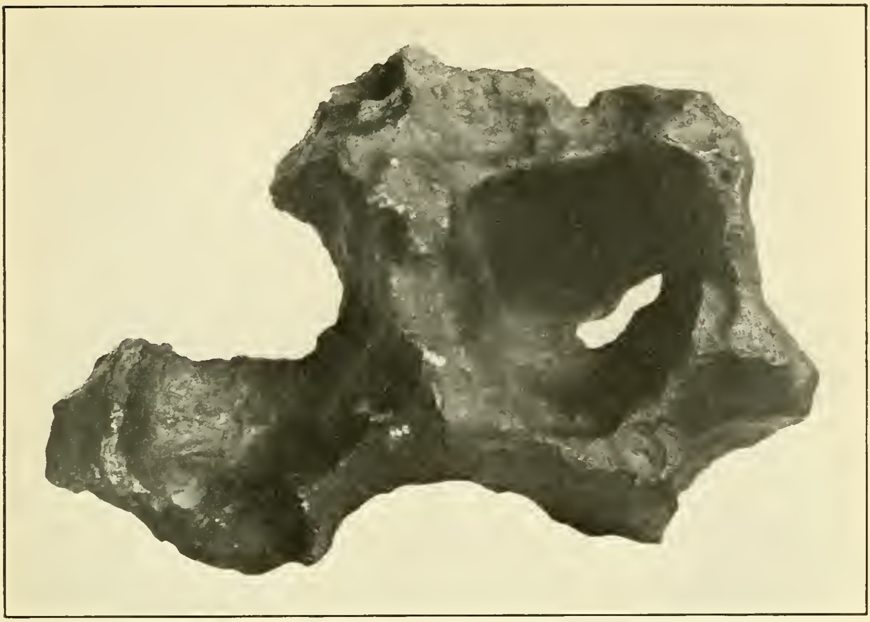
Casas Grandes Iron, Weight 3,407 Pounds.

For description see page 53.



ETCHED SLICE OF CASAS GRANDES IRON.

FOR DESCRIPTION SEE PAGE 53.



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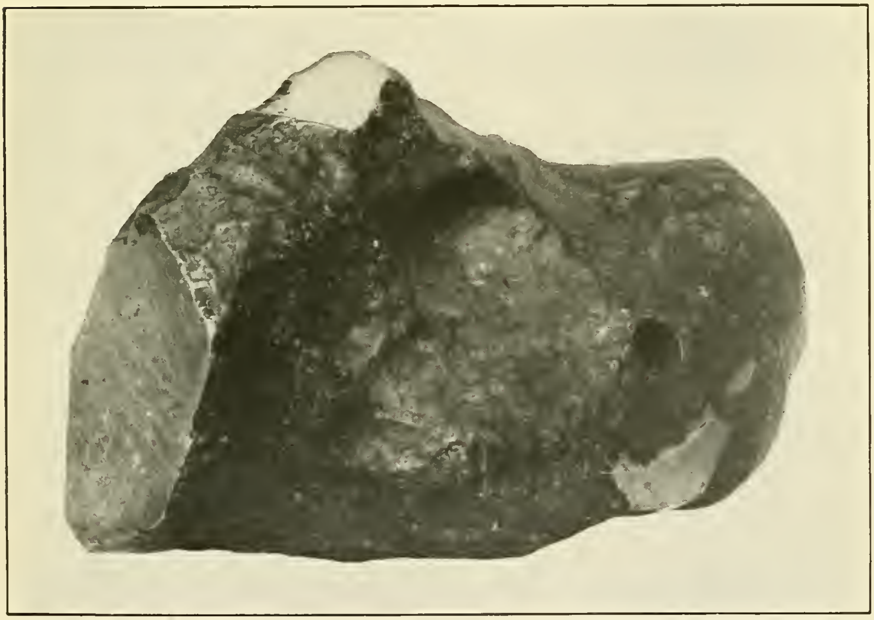


2

(1) CANON DIABLO IRON, AND (2) COUCH, COAHUILA OR SANCHEZ ESTATE IRON.

FOR DESCRIPTIONS SEE PAGES 51 AND 141.

CARLTON, HAMILTON COUNTY, TEXAS. No. 152.

Iron, Of. A 115-gram fragment from a mass weighing 81½ kilograms, found in 1887. (See also Tucson, p. 163.)

CARTHAGE, SMITH COUNTY, TENNESSEE. No. 97.

Iron, Om. A 65-gram slice from a mass weighing 127 kilograms, found in 1840.

CASAS GRANDES, CHIHUAHUA, MEXICO. No. 369.

Iron, Om. Large oval mass, 97 by 74 by 46 cm., weighing 1,317,920 grams, with cut surface 55 by 38 cm., showing Widmanstätten figures and troilite nodules; also three etched slices, 44 by 28 cm., 44 by 13 cm., and 42 by 25 cm., weighing altogether 17,573 grams; in introductory series, etched cube 5 cm. in diameter, weight 987 grams. (See pls. 15 and 16.) Found wrapped in coarse cloth and built into a brick tomb or altar. Original weight, 1,545,391 grams (3,407 pounds). No record of fall or early history. Composition as shown by J. E. Whitfield's analysis:

		Per cent.
Silicon (Si)		0.01
Iron (Fe)		90.470
Nickel (Ni)		7.742
Cobalt (Co)		.604
Copper (Cu)		.012
Carbon	combined	.145
	graphitic	.032
Phosphorus (P)		.166
Sulphur (S)		.029
Iron oxides		.794
		100.004

References.—W. Tassin, Proc. U. S. Nat. Mus., vol. 25, 1902, pp. 69–74. Geo. P. Merrill, Amer. Journ. Sci., vol. 35, 1913, p. 514. L. Fletcher, On the Mexican meteorites. Min. Mag., vol. 9, 1890.

CASTALIA, NASH COUNTY, NORTH CAROLINA. No. 101.

Stone, Cgb. Nineteen-gram fragment with black, papillated crust, from one of three fragments weighing 7,300 grams, which fell May 14, 1874.

CERESETO, NEAR OTTIGLIO, PIEDMONT, ITALY. No. 245.

Stone, Cgb. Weight, 65 grams. Fragment with crust and slickensided fracture surfaces. Fell on the morning of July 17, 1840, at about half past seven. Flight was from east toward the west. Fall preceded by a sharp detonation. Three pieces were seen to fall, of which but one was found. Original weight, according to

Buchner, 5,000 grams, of which 4,361 grams are accounted for by Wülfing.

Composition: Olivine, pyroxene, and a feldspar, with a little iron and pyrrhotite.

Structure: Chondritic, brecciated, with slickensided surfaces.

Color: Ash gray.

CHANDAKAPUR, BERAR, INDIA. No. 28.

Stone, Cib or Cgb. Four grams from a 5,076-gram mass which fell June 6, 1838.

CHANTONNAY, VENDÉE, FRANCE. No. 176.

Stone, Cgb. A 12-gram fragment of a black chondritic stone from a mass weighing some 10 kilograms, which fell on August 5, 1812.

CHARCAS, SAN LUIS POTOSI, MEXICO. No. 146.

Iron, Om. Pyramidal mass polished on four sides and weighing 67 grams, from a mass weighing originally some 778,069 grams, known as early as 1804, perhaps identical with Descubridora.

CHARSONVILLE, NEAR ORLEANS, LOIRET, FRANCE. No. 137.

Stone, Cga. Fragment with crust, weighing 54 grams, fell November 23, 1810.

CHATEAU-RENARD, MONTARGIS, LOIRET, FRANCE. No. 312.

Stone, Cia. Weight, 360 grams. Irregular fragment with crust on one side; shows faults and slickensides. Fell at 1.30 p. m. June 12, 1841. Original weight, some 20 kilos; according to Buchner, 30 to 40 kilos. The flight was from the southwest to northeast, the fall being accompanied by the usual explosion. On striking the ground, was broken into fragments, the largest of which weighed 15 kilos. According to an analysis by Dufrénoy (1841), the stone consists of:

	Per cent.
Silica (SiO_2)	38. 13
Ferrous oxide (FeO)	29. 44
Magnesia (MgO)	17. 67
Manganese (Mn)	Trace.
Alumina (Al_2O_3)	3. 82
Lime (CaO)	0. 14
Iron (Fe)	7. 70
Nickel (Ni)	1. 55
Sulphur (S)	. 39
Potash (K_2O)	. 27
Soda (Na_2O)	. 86
	99. 97

Fifty-one per cent soluble in hydrochloric acid. From this the mineral composition was calculated:

By Dufrénoy:	Per cent.	By Rammelsberg:	Per cent.
Nickel-iron	9.25	Nickel-iron	10.00
Troilite	.67	Troilite	
Olivine	51.62	Olivine	52.50
Albite	6.31	Augite	21.30
Hornblende	31.86	Labradorite	16.20
	99.71		100.00

Specific gravity, 3.56.

Structure compact, indistinctly chondritic.

References.—Dufrénoy, Compt. Rend., vol. 13, 1841, p. 47. Rammelsberg, Pogg. Ann., vol. 60, 1843, p. 136. O. Buchner, Die Meteoriten, 1863, p. 66.

CHEROKEE COUNTY, GEORGIA. Nos. 208, 349.

Iron, Om. Three pieces weighing 123, 189, and 423 grams. Cross sections and portion of end of mass showing Widmanstätten figures and grains of troilite. Date of fall unknown; found in 1894, 2½ miles east of Cherokee Mills and 5 miles southwest of Canton, in Cherokee County. Appearance of iron such as to lead to the supposition that it had lain in the soil for a long period. Analyses by H. N. Stokes yielded:

	Per cent.
Iron (Fe)	91.96
Nickel (Ni)	6.70
Cobalt (Co)	.50
Copper (Cu)	.03
Phosphorus (P)	.01
Sulphur (S)	.01
Silicon (Si)	Trace.
Carbon (C)	Trace.
	99.21

Structure coarsely octahedral with broad kamacite lamellæ.

This iron is regarded by Wülfing as identical with that of Losttown, Cherokee County, found in 1867, and described by Shepard in 1868. Howell does not agree to this.

Reference.—E. E. Howell, Amer. Journ. Sci., vol. 50, 1895, p. 252.

CHICO MOUNTAIN, BREWSTER COUNTY, TEXAS. No. 513.

Iron, H. A 212-gram fragment from a mass of unknown weight found on the south side of Chico Mountain.

CHULAFINNEE, CLEBURNE COUNTY, ALABAMA. No. 81.

Iron, Om. Weight, 8.5 grams. From a mass weighing 14,750 grams found in 1873.

CLEVELAND, EAST TENNESSEE. (Lea Iron.) No. 58.

Iron, Om. Weight, 221 grams. Slab, 11 by 5 mm., with one small troilite nodule. Found in 1860. Original weight, 150.5 kilograms. Composition, as given by F. A. Genth:

	Per cent.
Iron (Fe)	89.93
Nickel (Ni)	8.06
Copper (Cu)	.06
Cobalt (Co)	.56
Phosphorus (P)	.66
	99.27

Reference.—F. A. Genth, Proc. Acad. Nat. Sci. Phila., 1886, p. 366.

COAHUILA, MEXICO. (See also Sanchez Estate.) No. 64.

Iron, Hexahedrite. Weight, 3,510 grams. This practically complete mass is entered in previous catalogues as of unknown source, having been found in the collections without record. It is unquestionably the iron described by Prof. C. U. Shepard in the American Journal of Science[1] under the name of "A new meteoric iron of unknown locality in the Smithsonian Museum." Examination shows it to be a normal hexahedrite, and according to Shepard's analysis it has the following composition:

	Per cent.
Iron	92.923
Nickel	6.071
Cobalt	.539
Schreibersite	.562
	100.095

with traces of copper (and tin?).

Specific gravity, 7.589.

The physical and chemical characters all agree so closely with irons from Coahuila, Mexico, that it is thought to be unquestionably a member of that group, although the mass shows on the exterior surface numerous tendencies to exfoliate, which are lacking in others from this locality. It is, however, placed provisionally among the Coahuila irons.

COLD BOKKEVELD, CAPE COLONY, SOUTH AFRICA. Nos. 5, 182.

Stone, K. Three fragments weighing 7 grams; fell October 13, 1838.

[1] Vol. 22, 1881.

COLFAX, RUTHERFORD COUNTY, NORTH CAROLINA. No. 151.

Iron, O. Weight, 315 grams. One face etched. Original weight, 2,400 grams. Found, 1880. Nothing known regarding fall. Analysis by Eakins showed:

	Per cent.
Iron (Fe)	88.05
Nickel (Ni)	10.37
Cobalt (Co)	.68
Copper (Cu)	.04
Phosphorus (P)	.21
Sulphur (S)	.08
Silicon (Si)	.02
	99.45

Gift of S. W. Cramer.

Reference.—L. G. Eakins, Amer. Journ. Sci., vol. 39, 1890, p. 395.

COLLESCIPOLI, TERNI, ITALY. No. 493.

Stone, Cc. Two grams of fragments from a stone weighing originally 4 to 5 kilograms, which fell February 3, 1890. The first analysis, by Trottarelli, yielded somewhat anomalous results, which were not borne out by Whitfield's later analysis given below:

	Per cent.
Silica (SiO_2)	34.59
Alumina (Al_2O_3)	6.43
Ferrous oxide (FeO)	15.87
Magnesia (MgO)	21.17
Lime (CaO)	1.79
Potash (K_2O)	.26
Soda (Na_2O)	1.46
Iron (Fe)	17.04
Nickel (Ni)	1.49
Cobalt (Co)	.09
Manganese (Mn)	None.
Chromium (Cr)	None.
Sulphur (S)	None.
Ignition (H_2O)	None.
	100.19

References.—Trottarelli, Gazz. Chim. Ital., vol. 20, 1890, p. 611. G. P. Merrill, Mem. Nat. Acad. Sci., vol. 14, 1916, p 8.

COON BUTTE, ARIZONA. No. 168.

Stone, Cib. Complete cross section weighing 200 grams. Weight of original, 2,787 grams. Found 1905. Date of fall unknown. A gray, chondritic stone, presenting no unusual features. Analysis by J. W. Mallet of the metallic portion yielded:

	Per cent.
Iron (Fe)	88.81
Nickel (Ni)	10.72
Cobalt (Co)	.15
Tin (Sn)	.01
	99.69

with traces of copper, manganese, and carbon. The mineral composition as calculated by Mallet is:

	Per cent.
Enstatite	44.73
Olivine	33.48
Maskelynite	6.87
Nickel-iron	8.63
Iron rust	3.03
Schreibersite	.76
Pyrrhotite	2.14
Chromite	.08
	99.72

Gift of D. M. Barringer.

Reference.—J. W. Mallet, Amer. Journ. Sci., vol. 21, 1906, p. 347.

COOPERTOWN, ROBERTSON COUNTY, TENNESSEE. No. 30.

Iron, Om. Section of mass 16 by 10 cm., etched, weighing 633 grams; from a mass weighing nearly 17 kilograms (37 pounds) found in 1860. Is of interest from the perfection of the Widmanstätten figures (see pl. 20). An analysis by J. L. Smith yielded:

	Per cent.
Iron (Fe)	89.59
Nickel (Ni)	9.12
Cobalt (Co)	.35
Phosphorus (P)	.04
Copper (Cu)	Trace.
	99.10

Gift of D. Crockett.

Reference.—J. L. Smith, Amer. Journ. Sci., vol. 31, 1861, p. 266.

COSBY'S CREEK, COCKE COUNTY, TENNESSEE. Nos. 70, 495.

Iron, Og. Thirty-four grams of fragments from an iron found in 1837. Analysis by Dr. J. Fahrenhorst yielded:

	Per cent.
Iron (Fe)	91.49
Nickel (Ni)	6.36
Cobalt (Co)	.72
Copper (Cu)	.02
Phosphorus (P)	.40
Sulphur (S)	.81
Carbon (C)	.20
	100.00

The mineral composition is given as:

	Per cent.
Nickel-iron	94.95
Schreibersite	2.63
Troilite	2.22
Graphite, carbon, and silicates	.20
	100.00

References.—G. Troost, Amer. Journ. Sci., vol. 38, 1840, pp. 250–254, and (for analyses) E. Cohen, Meteoreisen Studien, 11 Ann. k. k. Naturhist. Hofmus., vol. 15, 1900, pp. 372–373.

COSTILLA PEAK, CIMARRON RANGE, TAOS, NEW MEXICO. No. 382.

Iron, Om. Etched slice weighing 1,619 grams. Found 1881. Nothing known regarding fall. Original weight of mass 35 kilograms (78 pounds). Analysis by Eakins yielded:

	Per cent.
Iron (Fe)	91.65
Nickel (Ni)	7.71
Cobalt (Co)	.44
Phosphorus (P)	.10
Sulphur (S)	.26
	100.16

Reference.—R. C. Hill, Proc. Colorado Sci. Soc., vol. 5, 1895, p. 121.

CRAB ORCHARD MOUNTAINS, POWDER MILL CREEK, ROCKWOOD, TENNESSEE. Nos. 119, 346, 376.

Stony-iron, Mesosiderite. Three fragments weighing 38, 943, and 1,010 grams. Found in 1887. Nothing known regarding fall. Weight of original three masses 43 kilograms. Shows metallic matrix containing grains of olivine and pyroxene. Structure quite irregular. Analysis by J. E. Whitfield yielded:

	Per cent.
Silica (SiO_2)	41.92
Alumina (Al_2O_3)	9.27
Ferrous oxide (FeO)	22.94
Lime (CaO)	9.09
Magnesia (MgO)	8.76
Iron (Fe)	3.75
Nickel (Ni)	1.74
Chlorine (Cl)	.18
Phosphorus (P)	.65
Sulphur (S)	1.58
	99.88

Reference.—J. E. Whitfield, Amer. Journ. Sci., vol. 34, 1887, p. 387.

CRANBOURNE, VICTORIA, AUSTRALIA. Nos. 89, 121.

Iron, Og. Two pieces weighing 15 and 71 grams, one with troilite nodules, from iron found in 1854.

CROSS ROADS, BOYETT, WILSON COUNTY, NORTH CAROLINA. Nos. 163, 409.

Stone, Cg. Twelve grams from a mass weighing 161 grams, which fell May 24, 1892.

CROSS TIMBERS, RED RIVER, TEXAS. No. 95.

Iron, Om. Thirteen grams from a mass, the principal part of which, weighing 740½ kilograms, is now in the museum of Yale University. Found about 1808.

This is historically one of the most interesting of American meteoric irons. It was first made known to a white man (Capt. Anthony Glass) in 1808, by Indians, who seem to have regarded it with veneration, though apparently without recognizing its origin. In 1810 it was taken across the Brazos to the Red River and transported thence by boat to New Orleans, whence it was shipped to New York, where it passed into the possession of Col. George Gibbs and was by him deposited in trust in the museum of the New York Lyceum. After the death of Colonel Gibbs the iron was given to the museum of Yale University, Connecticut, where it still remains. Analyses by Shepard show it to consist of 90.02 of iron and 9.67 of nickel.

References.—Bruce's Min. Journ., vol. 1, 1814, pp. 127 and 218. Shepard, Amer. Journ. Sci., vol. 16, 1829, p. 217. See also vol. 27, 1835, p. 382.

CUERNAVACA, MEXICO. No. 447.

Iron, Of. Irregular slice 100 by 120 by 10 mm., weighing 757 grams.

CULLISON, PRATT COUNTY, KANSAS. No. 430.

Stone, Cc. Slice weighing 277 grams; mass showing original surface, weighing 2,340 grams (pls. 18 and 19). Weight of original mass 10.10 kilograms. Found 1911. Nothing is known regarding fall. A very dense stone, nearly black, and the metallic points scarcely visible except on polished surface. Mineral composition, olivine, orthorhombic and monoclinic pyroxenes, and fragmentary plagioclase feldspars, together with metallic iron and iron sulphide. The slice shows a nodular mass some 10 by 17 mm., composed wholly of twinned pyroxenes with a few grains of troilite. The chemical and mineral composition, as determined by Whitfield, yielded results as below:

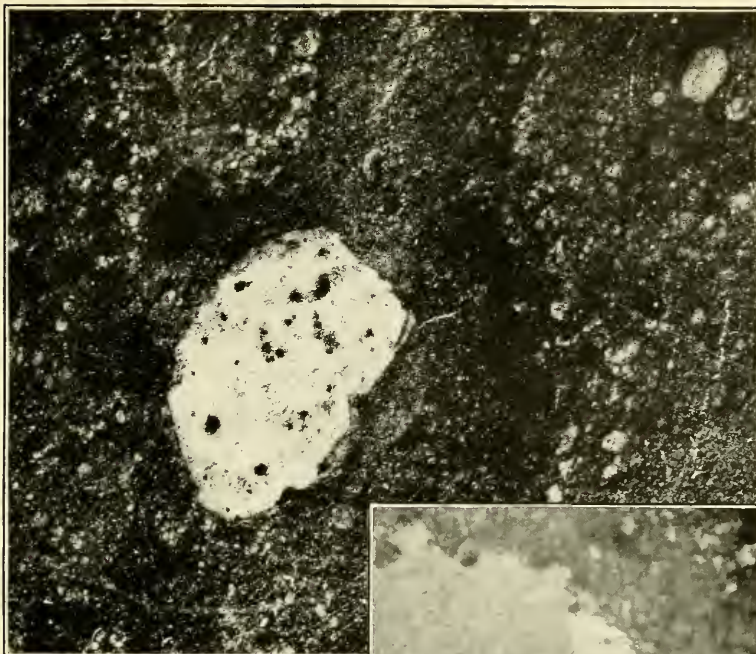
	Per cent.
Troilite (?)	6.00
Metallic iron	19.40
Silicate minerals	74.50
Schreibersite	.10
	100.00

1

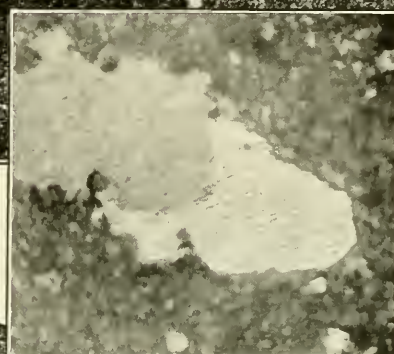
2

TWO VIEWS OF THE CULLISON STONE, AS FOUND.

FOR DESCRIPTIONS SEE PAGE 60.



1



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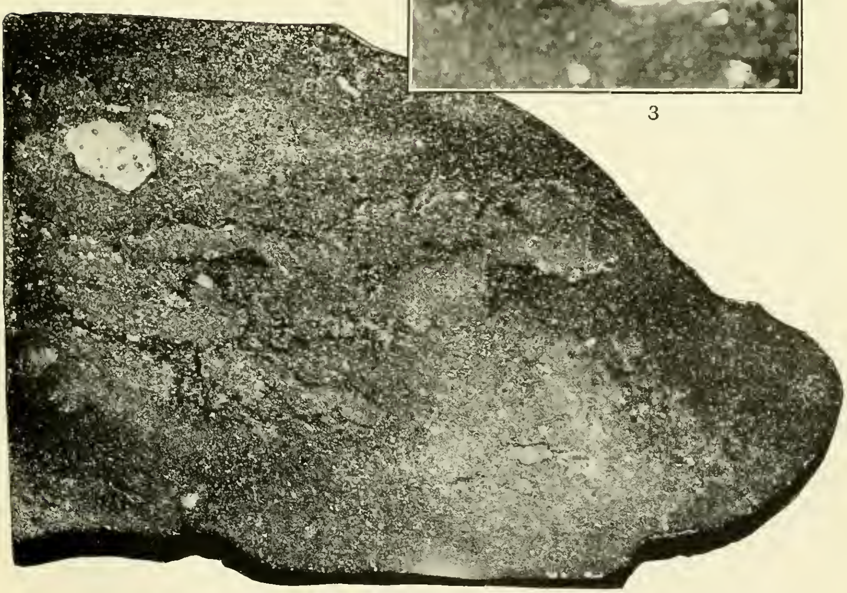
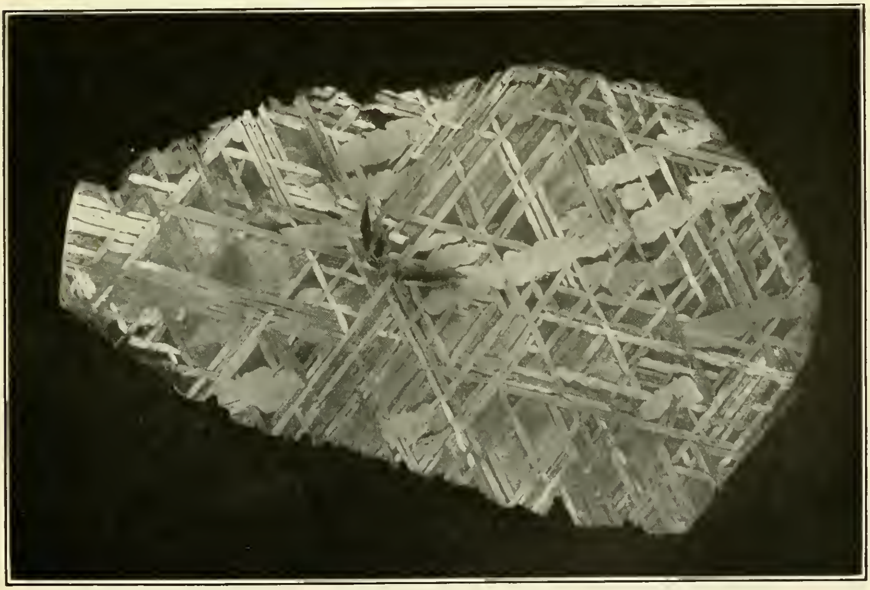


2

POLISHED SLICES OF THE CULLISON STONE.

FOR DESCRIPTION SEE PAGE 60.

1



2

ETCHED SLICES OF (1) KENDALL COUNTY IRON AND (2) OF COOPERTOWN IRON.

FOR DESCRIPTIONS SEE PAGES 58 AND 90.

The metallic portions yielded:

	Per cent.
Silicon (Si)	0.129
Sulphur (S)	Trace.
Phosphorus (P)	0.071
Nickel (Ni)	9.207
Cobalt (Co)	.507
Copper (Cu)	.040
Chromium (Cr)	.160
Carbon (C)	.088
Manganese (Mn)	.080
Iron (Fe)	89.700
	99.982

No traces found of molybdenum, tungsten, or vanadium.

The silicate portion yielded:

	Per cent.
Silica (SiO_2)	47.36
Alumina (Al_2O_3)	5.67
Ferric oxide (Fe_2O_3)	.10
Ferrous oxide (FeO)	11.25
Lime (CaO)	.84
Magnesia (MgO)	31.72
Manganese protoxide (MnO)	.36
Soda (Na_2O)	2.42
Potash (K_2O)	.23
Titanic oxide (TiO_2)	.00
	99.95

Combining the metallic and nonmetallic portions and recalculating, after making the very unsafe assumptions that the material called troilite is all the monosulphide, and that the schreibersite conforms to the formula $(FeNi)_3P$, the following figures are obtained, representing the composition of the stone in mass or bulk:

	Per cent.
Silica (SiO_2)	35.30
Alumina (Al_2O_3)	4.24
Ferric iron (Fe_2O_3)	.75
Ferrous iron (FeO)	8.38
Lime (CaO)	.62
Magnesia (MgO)	23.631
Manganous oxide (MnO)	.268
Soda (Na_2O)	1.804
Potash (K_2O)	.171
Sulphur (S)	2.184
Phosphorus (P)	.0138
Nickel (Ni)	1.80
Cobalt (Co)	.098
Copper (Cu)	.008
Chromium (Cr)	.029
Carbon (C)	.017
Manganese (Mn)	.015
Iron (Fe)	21.270
	100.5988

None of the rarer elements sometimes reported as occurring in meteorites were found, although very carefully looked for.

Reference.—G. P. Merrill, Publ. 1952, Proc. U. S. Nat. Mus., vol. 44, 1913, pp. 325–330.

DALTON, WHITFIELD COUNTY, GEORGIA. Nos. 519, 520.

Iron, Om. In Museum collection, two pieces weighing 35 and 80 grams from a 13-pound mass found in 1877. In Shepard collection 735.7 grams, and a larger, nearly complete individual weighing 50,340 grams (111 pounds) found in 1879. Nothing definite known of date of fall, and the two irons regarded as of doubtful identity.

An analysis of a slice from the 111-pound mass yielded J. E. Whitfield:

Iron (Fe)	81.853
Nickel (Ni)	7.434
Cobalt (Co)	.580
Copper (Cu)	.017
Platinum (Pt)	Trace.
Iridium (Ir)	.002
Silicon (Si)	.002
Manganese (Mn)	None.
Chromium (Cr)	None.
Sulphur (S)	.025
Phosphorus (P)	.081
Carbon (C)	.006
Schreibersite	10.00
	100.000

An analysis of the same mass by Shepard yielded:

	Per cent.
Iron (Fe)	94.66
Nickel (Ni)	4.80
Cobalt (Co)	.34
	99.80

References.—W. E. Hidden, Amer. Journ. Sci., vol. 21, 1881, p. 287. C. U. Shepard, Amer. Jorun. Sci., vol. 26, 1883, p. 336.

DANDAPUR, GORUCKPUR, INDIA. No. 408.

Stone, Cia. Two grams from a stone which fell September 5, 1878.

DEEP SPRINGS, ROCKINGHAM COUNTY, NORTH CAROLINA. No. 470.

Iron, Db. Irregular slice some 10 by 4.5 cm. and showing part of original surface. Weight, 342 grams. Weight of original mass, 11,500 grams. Is stated to have fallen in 1846 and to have buried itself 4 or 5 feet under the surface of the ground. Analysis by Venable yielded:

	Per cent.
Iron (Fe)	87.01
Nickel (Ni)	11.69
Cobalt (Co)	.79
Phosphorus (P)	.04
Silica (SiO_2)	.53
Chlorine (Cl)	.39
	100.45

Reference.—F. P. Venable, Amer. Journ. Sci., vol. 40, 1890, p. 161.

DELEGATE, NEW SOUTH WALES. No. 484.

Iron, Om. Etched slice 6 by 7 cm., weighing 200 grams. Not yet described. Gift of Department of Mines, Sydney, New South Wales.

DESCUBRIDORA, SAN LUIS POTOSI, MEXICO. Nos. 78, 469.

Iron, Om. Rectangular fragment weighing 57.4 grams, with 3 etched faces; one face marked "Porte de aerolito del Estodo de S. Luis Potosi caido en el anno de 1871"; another marked "A Ulisis S. Grant." Received by the museum with the relics of President Grant. Also a triangular slice 34 by 25 cm. weighing 2,822 grams. These are from a mass weighing 576 kilograms now in the National Museum of Mexico. It is regarded by Fletcher as identical with the mass described by J. L. Smith under the name of "Venajas." Date of fall unknown. Said to have been found in 1780–1783. Chemical composition as determined by P. Murphy:

	Per cent.
Iron (Fe)	89.51
Nickel (Ni)	8.05
Cobalt (Co)	1.94
Sulphur (S)	.45
Chromium (Cr)	Trace.
	99.95

References.—L. Fletcher, On the Mexican meteorites, Min. Mag., vol. 9, 1890, p. 66. M. Barcena, On certain Mexican meteorites, Proc. Acad. Nat. Sci. Phila., 1876, p. 123.

DHURMSALA, KANGRA, PUNJAUB, INDIA. Nos. 82, 498.

Stone, Ci. Fragments from interior weighing 32 and 43 grams. Fell July 14, 1860. Original weight approximately 145 kilograms, in form of several large masses. A gray, compact stone, to the naked eye indistinctly chondritic and showing no metallic points; faintly rust spotted. Composition, according to analysis by C. T. Jackson, as follows:

	Per cent.
Silica (SiO_2) with traces of tin oxide (SnO_2)	40.00
Magnesia (MgO)	26.60
Ferrous oxide (FeO)	27.70
Iron (Fe)	3.50
Nickel (Ni)	.80
Alumina (Al_2O_3)	.40
Chlorine (Cl)	.049
	99.049

This fall was remarkable from the fact that fragments picked up immediately after the fall were stated to have been so cold as to benumb the fingers, although but a moment before they had been glowing hot.

References.—C. T. Jackson, Proc. Boston Soc. Nat. Hist., vol. 8, 1861, p. 233; S. Haughton, Philos. Mag., vol. 32, 1866, p. 266.

DJATI-PENGILON, DISTRICT OF NGAWI, JAVA. No. 114.

Stone, Ck. Rectangular fragment with crust, weighing 469 grams. Weight of original mass, 166 kilograms. Fell March 19, 1884. Composition according to analysis of Verbeek and Retgers:

	Per cent.
Silica (SiO_2)	56.61
Alumina (Al_2O_3)	3.75
Ferrous oxide (FeO)	16.04
Manganous oxide (MnO)	Trace.
Lime (CaO)	3.00
Magnesia (MgO)	19.52
Potash (K_2O)	.07
Soda (Na_2O)	1.15
Chromate (?)	.24
	100.38

From this the mineral composition was calculated as:

	Per cent.
Nickel-iron	21.3
Iron sulphide	5.1
Olivine	33.4
Bronzite	39.0
Chromite	.1
	98.9

The nickel-iron consists of 88.68 iron, 10.78 nickel, and 0.54 cobalt; the iron sulphide consists of iron 63.64 and sulphur 36.36, which is the composition of troilite. This is claimed to be the first accurate determination of this form of the sulphide in a stony meteorite.

Gift of Government of Netherlands.

Reference.—Daubrée, Compt. Rend., vol. 105, 1887, p. 203. Abstract in Neues Jahrb. für Min., vol. 2, 1888, p. 35.

DORES DOS CAMPOS, FORMOSOS NEAR UBERABA, MINAS GERAES, BRAZIL. No. 487.

Stone, Cka. A fragment with crust, weighing 65 grams, from a fall aggregating 30 to 40 kilograms, which took place June 29, 1903. It is described by Hussak as a veined kugeln-chondrite consisting of bronzite, olivine, nickel-iron, troilite, and a little glass. Apparently has not been analyzed.

Reference.—E. Hussak, Ann. k. k. Naturhist. Hofmus., vol. 19, 1904, p. 85.

DORONINSK, DAURIA, IRKUTSK, SIBERIA. No. 181.

Stone, Cgb. Fragment of 7.7 grams; fell April 6, 1805.

DRAKE CREEK, NEAR NASHVILLE, DAVIDSON COUNTY, TENNESSEE.

Stone, Cwa. 28-gram fragment with dull black papillated crust. Fell May 9, 1827.

DURUMA, MOMBAS, WANIKALAND, EAST AFRICA. No. 216.

Stone, Cia. Fragment weighing 1.5 grams. Fell March 6, 1853.

EAGLE STATION, CARROLL COUNTY, KENTUCKY. Nos. 155, 275.

Stony-iron, Pallasite (Rockiky group of Brezina). Two slices of 36 and 189 grams, respectively. Found in 1880. Date of fall unknown. Original weight, 36.5 kilograms. This meteorite belongs to an interesting group, of which but 3 representatives are known. They consist of more or less fragmental, often sharply angular olivines bound together by metallic nickel-iron and schreibersite. The mineral and chemical composition as given by Kunz is:

	Per cent.
Iron (Fe)	71.73
Nickel (Ni)	14.37
Cobalt (Co)	.95
Phosphorus (P)	.05
Olivine	11.12
Chromite	.90
	99.12

The 36-gram slice the gift of George F. Kunz.

Reference.—G. F. Kunz, Amer. Journ. Sci., vol. 33, 1887, p. 228.

ELBOGEN, BOHEMIA, AUSTRIA. No. 309.

Iron, Om. Weight, 71 grams. Prismatic piece some 60 by 16 by 11 mm. Date of fall unknown, perhaps 1400; preserved at the Rathhaus in Elbogen for centuries; first mentioned in 1785 and described as a meteorite in 1812. Original weight, 107 kilograms. Analysis by Berzelius yielded: Iron, 88.23; nickel, 8.51; insoluble, 2.211; cobalt, 0.762.

Reference.—See Wülfing, p. 111.

EL CAPITAN, EL CAPITAN MOUNTAINS, NEW MEXICO. Nos. 169, 209, 345.

Iron, Om. Fragment showing cleavage, weighing 66 grams; slice 20 by 11 by 2 cm. weighing 753 grams, and end mass 20 by 10 by 5 cm. weighing 4 kilograms. Weight of original mass, 27,500 grams (about 61 pounds). Found in July, 1893, and supposed to have fallen in 1882. Structure is octahedral with broad bands of kamacite. Analysis by H. N. Stokes yielded:

	Per cent.
Iron (Fe)	90.51
Nickel (Ni)	8.40
Cobalt (Co)	.60
Copper (Cu)	.05
Silicon (Si)	Trace.
Phosphorus (P)	.24
Sulphur (S)	Trace.
	99.80

Sixty-six gram piece, gift of C. R. Biederman; 753-gram piece, gift of Edward E. Howell.

Reference.—E. E. Howell, Amer. Journ. Sci., vol. 50, 1895, p. 253.

ELM CREEK, LYON COUNTY, KANSAS. No. 371.

Stone, CcO. Fragment weighing 1,120 grams. Found May, 1906. Date of fall unknown. A dark gray, compact stone showing numerous small points of metal on polished surface, and indistinct chondrules. Consists of the silicates olivine, and orthorhombic and monoclinic pyroxenes, and nickel-iron. Analysis by Whitfield yielded:

Metallic portion, 6.82; silicate portion, 93.18.

The metal yielded: Iron, 87.13; nickel, 11.30; cobalt, 1.42; manganese, 0.15.

The silicate portion yielded: Silica, 36.76; alumina, 3.10; ferric oxide, 13.23; ferrous oxide, 14.22; chromic oxide, 0.35; lime, 1.62; magnesia, 25.66; water, 5.10.

Recalculated, the following results are obtained to show the bulk or mass composition of the stone:

	Per cent.
Silica (SiO_2)	34.25
Alumina (Al_2O_3)	2.89
Ferric oxide (Fe_2O_3)	12.32
Ferrous oxide (FeO)	13.25
Chromic oxide (Cr_2O_3)	.326
Lime (CaO)	1.509
Magnesia (MgO)	23.909
Iron (Fe)	5.94
Nickel (Ni)	.77
Cobalt (Co)	.09
Manganese (Mn)	.01
Volatile (H_2O) (?)	4.75
	100.014

References.—K. Howard, Amer. Journ. Sci., vol. 23, 1907, p. 379. George P. Merrill, Mem. Nat. Acad. Sci., vol. 14, 1916, p. 10.

EL NAKHLA EL BAHARIA, EGYPT. No. 426.

Stone, A. Fell June 28, 1911. Two stones, one a nearly complete individual, with black, shining crust, weighing 117 grams, and one fragment weighing 52 grams. About 40 stones fell, weighing collectively nearly 10 kilograms, scattered over an area of some 4½ kilometers in diameter. Of peculiar interest, as this is the first recorded Egyptian fall. The stone is further unique in mineral and chemical composition, consisting mainly of green diopside and olivine. (See pl. 3, fig. 1.) The chemical composition as given by Prior is:

	Per cent.
Silica (SiO_2)	48.96
Titanic oxide (TiO_2)	.38
Alumina (Al_2O_3)	1.74
Chromic oxide (Cr_2O_3)	.33
Ferric oxide (Fe_2O_3)	1.29
Ferrous oxide (FeO)	19.63
Manganous oxide (MnO)	.09
Lime (CaO)	15.17
Magnesia (MgO)	12.01
Soda (Na_2O)	.41
Potash (K_2O)	.14
Sulphur (S)	.06
Water at 110°	.07
	100.28

Specific gravity, 3.47.

No barium, strontium, or zirconium detected.

Gift of Geological Survey of Egypt.

Reference.—G. T. Prior, Min. Mag., vol. 16, 1912, p. 274.

EMMITSBURG, FREDERICK COUNTY, MARYLAND. Nos. 279, 414.

Iron, Om. Two pieces, weighing 7 and 14 grams from a mass the original weight of which is not known, and of which only 177 grams appear to be now in existence. Found in 1854.

ENSISHEIM, UPPER ALSACE, GERMANY. No. 506.

Stone, Ckb. A 200-gram fragment, with crust, from a stone which fell on November 16, 1492, and is believed to be the oldest known meteoric stone extant. Fletcher refers to it in his "Introduction to the study of meteorites" (edition of 1908, p. 19) as follows:

The oldest undoubted sky-stone still preserved is that which was long suspended by a chain from the vault of the choir of the parish church of Ensisheim in Elsass, and is now kept in the Rathhaus of that town. The following is a translated extract from a document which was preserved in the church:

On the 16th of November, 1492, a singular miracle happened, for between 11 and 12 in the forenoon, with a loud crash of thunder and a prolonged noise heard afar off, there fell in the town of Ensisheim a stone weighing 260 pounds. It was seen by a child to strike the ground in a field near the canton called Gisgaud, where it made a hole more than five feet deep. It was taken to the church as being a miraculous object. The noise was heard so distinctly at Lucerne, Villing, and many other places that in each of them it was thought that some houses had fallen. King Maximilian, who was then at Ensisheim, had the stone carried to the castle. After breaking off two pieces, one for the Duke Sigismund of Austria and the other for himself, he forbade further damage, and ordered the stone to be suspended in the parish church.

The stone is stated to have remained in the church until the French Revolution. Since then it has been frequently broken, and according to F. Crook, writing in 1868, but 40 or 50 kilograms remained. The fragments have been widely distributed and only a little over 70 kilograms are accounted for by Wülfing.

According to Crook's determinations, the stone consists of:

	Per cent.
Iron monosulphide	5. 642
Metal	9. 243
Chromite	. 600
Silicates	84. 079
	99. 564

The mass or bulk composition as recalculated by Farrington from this analysis is:

	Per cent.
Silica (SiO_2)	36. 65
Alumina (Al_2O_3)	2. 31
Ferrous oxide (FeO)	34. 19
Magnesia (MgO)	13. 13
Lime (CaO)	1. 78
Soda (Na_2O)	. 38
Potash (K_2O)	. 22
Iron (Fe)	8. 00
Nickel (Ni)	1. 23
Sulphur (S)	2. 05
Phosphorus (P)	1. 01
Chromic oxide (Cr_2O_3)	. 41
Manganous oxide (MnO)	. 21
	101. 57

Reference.—F. Crook, On the chemical constitution of the Ensisheim, Mauerkirchen, Shergotty, and Muddoor meteoric stones, Inaugural Dissertation, Göttingen, 1868, p. 21.

ERGHEO, SOMALILAND, AFRICA. No. 320.

Stone, Ckb. Fragment weighing 416 grams. Fell July, 1889. Total weight of fall, 20.375 kilograms. A compact, dark gray stone composed principally of olivine and a rhombic pyroxene with minor quantities of troilite, nickel-iron, magnetite glass, and maskelynite. Chemical composition (analysis recalculated in part):

	Per cent.
Iron (Fe)	0.57
Nickel and cobalt (Ni and Co)	.17
Ferrous sulphide (FeS)	9.48
Silica (SiO_2)	42.55
Ferrous oxide (FeO)	17.13
Alumina (Al_2O_3)	2.23
Lime (CaO)	1.01
Magnesia (MgO)	26.14
Potash and soda (K_2O and Na_2O)	.12
	99.40

Reference.—E. Artini and G. Melzi, Esplorazione Commerciale, December, 1898.

ESTACADO, CROSBY COUNTY, TEXAS. Nos. 372, 462.

Stone, Cka. Polished slab 26 by 38 cm., weighing 5.45 kilograms, or 12 pounds, and slab weighing 476 grams. Weight of original mass, about 290 kilograms, or 638 pounds, and hence exceeding in size any known stony meteorites. Found in 1883 and supposed to have fallen the year previous. Composition as shown by Davison's analysis:

	Per cent.
Iron (Fe)	14.68
Nickel (Ni)	1.60
Cobalt (Co)	.08
Copper (Cu)	Trace.
Carbon (C) found, but not determined.	
Sulphur (S)	1.37
Phosphorus (P)	.15
Silica (SiO_2)	35.82
Ferrous oxide (FeO)	15.53
Magnesia (MgO)	22.74
Lime (CaO)	2.99
Alumina (Al_2O_3)	3.60
Soda (Na_2O)	2.07
Potash (K_2O)	.32
Titanic oxide (TiO_2) found, but not determined.	
Chromic oxide (Cr_2O_3) found, but not determined.	
Manganous oxide (MnO) found, but not determined.	
	100.95
Less O for S	.68
	100.27

The mineral composition was found to be: Metallic, 16.41; silicates, 83.59, being mainly olivine and enstatite. Chromite and pyrrhotite are also present in small quantities.

The 12-pound piece gift of Mrs. Coonley-Ward.

Reference.—Howard and Davison, Amer. Journ. Sci., vol. 22, 1906, p. 55.

ESTHERVILLE, EMMET COUNTY, IOWA. Nos. 12–15, 38, 425.

Stony-iron, M. Forty-five nodular pieces weighing all together 478 grams; one of these, No. 13, weighing 82 grams, the original specimen examined by Dr. J. L. Smith. Total weight of known material, 337 kilograms. Fall occurred about 5 p. m. on May 10, 1879, under a clear sky. In some places the meteorite was plainly visible, looking like a ball of fire, with a long train of vapor or cloud of fire behind it. One observer saw it at a distance of 100 miles from where it fell. The sounds produced were described as terrible and "indescribable," as scaring cattle, and terrifying people over an area many miles in diameter. At first these sounds were louder than that of the largest artillery. These were followed by a rumbling noise, as of a train of cars crossing a bridge. The concussion, when it struck the ground, was sensible to many persons, and it is reported that the soil was thrown into the air at the edge of a ravine where the largest masses struck. There were distinctly two explosions—the first at a considerable height, whereby several large fragments were projected to different points over an area of 4 square miles. The second explosion occurred just before reaching the ground and accounts for the numerous small fragments. The largest fragment, weighing 437 pounds, embedded itself 8 feet in a stiff blue clay. In all 744 pounds, or 337 kilograms. The irregular structure of this meteorite makes any attempt at mass analyses unsatisfactory. J. L. Smith found its mineral composition to be olivine, pyroxene, nickel-iron, troilite and chromite, and an undetermined silicate.

Nos. 12 to 15 gift of Mr. Charles P. Birge; No. 425 from the G. F. Barker estate.

Reference.—J. L. Smith, Amer. Journ. Sci., vol. 19, 1880, p. 459.

FARMINGTON, WASHINGTON COUNTY, KANSAS. No. 352.

Stone, Csa. Fragment, with crust on one side. Weight, 204 grams. A dark gray compact stone which fell June 25, 1890; two stones weighing, respectively, 4 and 80 kilograms, the larger of which penetrated the hard shaly earth to a depth of nearly 4 feet. An analysis by L. G. Eakins shows the stone to consist of:

	Per cent.
Nickel-iron	7.7
Troilite	5.0
Silicates soluble in HCl (olivine)	46.0
Silicates insoluble in HCl (mostly pyroxene)	41.5
	100.2

Reference.—Kunz and Weinschenk, Amer. Journ. Sci., vol. 43, 1892, p. 65.

1

2

(1) Felix Stone; (2) the Third Largest Stone of the Fisher Fall.

For descriptions see pages 71 and 72.

FELIX, PERRY COUNTY, ALABAMA. No. 235.

Stone, Cc. Weight, 1,708 grams. Principal mass with thin black crust on all sides but one. (See plate 21.) Fell about 11.30 a. m. on May 15, 1900. Weight of original mass, so far as known, 2,049 grams. Flight was from east toward the west. First explosion a "very loud report, followed by two lesser ones, the appearance being compared to that of a big pan of red-hot iron being struck with a hammer, causing many sparks to fly in all directions." While in the air the stone broke into three pieces, of which but one, the largest, was found. Composition:

	Per cent.	
Iron (Fe)	2.59	Metallic portion.
Nickel (Ni)	.36	
Cobalt (Co)	.08	
Copper (Cu)	.01	
Silica (SiO_2)	33.57	Stony portion.
Alumina (Al_2O_3)	3.24	
Chromic oxide (Cr_2O_3)	.80	
Ferrous oxide (FeO)	26.22	
Ferrous sulphide (FeS)	4.76	
Manganous oxide (MnO)	.68	
Nickel and cobalt oxides (NiO and CoO)	1.01	
Lime (CaO)	5.45	
Magnesia (MgO)	19.74	
Potash (K_2O)	.14	
Soda (Na_2O)	.62	
Carbon (C) (graphite)	.36	
Ignition (H_2O) at 110°	.16	
	99.79	

Mineral composition:

	Per cent.
Metal	3.04
Troilite	4.76
Chromite	1.17
Graphite	.36
Soluble silicate (olivine in part)	72.60
Insoluble silicate (enstatite and augite in part)	18.07
	100.00

Specific gravity, 3.78.

Structure chondritic, tufaceous; color, dark, smoky gray.

Reference.—George P. Merrill, On a new stony meteorite which fell near Felix, Perry County, Alabama, May 15, 1900. Proc. U. S. Nat. Mus., vol. 24, 1901, pp. 193–198.

FINMARKEN, NORWAY. No. 329.

Stony-iron, Pallasite. Slice 10 by 17 cm., weighing 595 grams. Found in 1902. Date of fall unknown. Weight of original mass, 77.5 kilograms, or 170½ pounds.

Reference.—E. Cohen, Mitth. naturwiss. Ver. Neu-Vorpommern u. Rügen, vol. 35, 1903.

FISHER, POLK COUNTY, MINNESOTA. No. 212.

Stone, Cia. Nearly complete individual weighing 1.30 kilograms. Fell April 9, 1894 (pl. 21, fig. 2). Four stones known to have fallen, the largest being broken up and scattered. The second largest weighed 9½ pounds and is in the museum of the University of Minnesota. A compact, light gray stone, thickly spotted with metallic points and light gray and white chondrules. Chemical analysis by J. E. Whitfield, yielded:

	Per cent.
Metallic constituents	11.44
Silicate constituents	88.56

The silicate portion yielded:

	Per cent.
Silica (SiO_2)	43.70
Alumina (Al_2O_3)	4.96
Ferrous oxide (FeO)	18.27
Manganous oxide (MnO)	.38
Nickel oxide (NiO)	.23
Lime (CaO)	2.19
Magnesia (MgO)	29.38
Chromite ($FeOCr_2O_3$)	.80
	99.91

The chromium present is tabulated as chromite, as it occurs as such in the stone.

The metallic portion freed from the last trace of siliceous matter contained:

	Per cent.
Iron (Fe)	85.00
Nickel (Ni)	14.15
Cobalt (Co)	.74
Copper (Cu)	Trace.
	99.89

On recalculating, these figures give the bulk or mass composition of the stone as follows:

	Per cent.
Silica (SiO_2)	38.699
Alumina (Al_2O_3)	4.240
Ferrous oxide (FeO)	16.179
Manganous oxide (MnO)	.336
Nickel oxide (NiO)	.200
Lime (CaO)	1.939
Magnesia (MgO)	26.018
Chromite ($FeOCr_2O_3$)	.708
Iron (Fe)	9.724
Nickel (Ni)	1.608
Cobalt (Co)	.084
	99.735

with traces of sulphur and soda but none of barium, strontium, zirconium, or potassium.

Reference.—George P. Merrill, Proc. U. S. Nat. Mus., vol. 48, 1915, pp. 503–506.

FLOYD MOUNTAIN, INDIAN VALLEY, VIRGINIA. No. 323.

Iron, Hb. Etched slice 15 by 9 cm. Weight 569 grams. Found 1887. Date of fall unknown. Weight of original mass 14.2 kilograms, or 31¼ pounds. A coarsely granular, brecciated hexahedrite, of which but 8 representatives have thus far been described. Composition as determined by L. C. Eakins:

	Per cent.
Iron (Fe)	93.59
Nickel (Ni)	5.56
Cobalt (Co)	.53
Copper (Cu)	Trace.
Phosphorus (P)	.27
Sulphur (S)	.01
Silicon (Si)	Trace.
	99.96

Reference.—Kunz and Weinschenk, Amer. Journ. Sci., vol. 43, 1892, p. 424.

FOREST CITY, WINNEBAGO COUNTY, IOWA. Nos. 157, 158, 166, 167, 333.

Stone, Ccb. Nine fragments and more or less complete individuals weighing 35, 42, 45, 83, 150, 248, 257, 297, and 1,074 grams. Fell May 2, 1890. The shower comprised five large stones weighing, respectively, 4, 4, 10, 66, and 80 pounds, and over 500 small stones weighing from a fraction of 1 to 20 ounces. Total weight, so far as known, 122 kilograms, 37 grams. Chemical analysis by L. C. Eakins yielded:

	Per cent.
Iron (Fe)	18.076
Nickel (Ni)	1.192
Cobalt (Co)	.127
Ferrous sulphide (FeS)	6.189
Silica (SiO_2)	35.622
Alumina (Al_2O_3)	2.082
Chromic oxide (Cr_2O_3)	.096
Ferrous oxide (FeO)	10.248
Lime (CaO)	1.415
Magnesia (MgO)	23.938
Potash (K_2O)	.056
Soda (Na_2O)	.812
	99.853

The 45-gram piece, gift of J. P. Dolliver; the 83-gram, of George F. Kunz.

Reference.—G. F. Kunz, Amer. Journ. Sci., vol. 40, 1890, pp. 312-323.

FORT DUNCAN, MAVERICK COUNTY, TEXAS. No. 448.

Iron, H. A 258-gram fragment, some 65 by 100 by 18 mm., by some supposed to be identical with the Coahuila.

FRANCEVILLE, EL PASO COUNTY, COLORADO. No. 328.

Iron, Om. Etched slab, 18 by 10 cm., weighing 300 grams. Found in 1890. Date of fall unknown. Weight of original mass, 18.3 kilograms, or 41 pounds, 6½ ounces. Partial analysis by Davison yielded:

Kamacite, Taenite } Fe, 91.92; Ni, 8.13.
Schreibersite, 0.837.
Platinum, traces.

Reference.—H. L. Preston, Journ. Geol., vol. 10, 1902, p. 852.

FUKUTOMI, KINEJIMA, HIZEN, JAPAN. No. 113.

Stone, Cga. Weight, 9.7 grams. Fell on March 19, 1882, at 1 p. m. Original weight, 7,680 grams. Gift of Educational Museum of Tokyo, Japan.

GARGANTILLO (TOMATLAN) JALISCO, MEXICO. No. 40.

Stone, Cc. Fragment weighing 4 grams, from the interior. Exact date of fall not known—either August or September, 1879.

GIBEON (MUKEROP), GREAT NAMAQUALAND, SOUTHWEST AFRICA. No. 330.

Iron, Off. Etched slab 25 by 70 cm., weighing 14.32 kilograms, or 31.5 pounds (see pl. 22). From a mass weighing 178 kilograms, found in 1899. The cross section, as etched, shows three zones of crystallization, as though three differently oriented masses had been welded together. A chemical analysis by O. Hillebrand yielded:

	Per cent.
Iron (Fe)	90.96
Nickel (Ni)	8.19
Cobalt (Co)	.46
Copper (Cu)	.04
Carbon (C)	.02
Chromium (Cr)	.02
Chlorine (Cl)	.01
Sulphur (S)	Trace.
Phosphorus (P)	0.18
Residue	.01
	99.89

Reference.—A. Brezina and E. Cohen, Jahr. Ver. Vaterl. Naturk. in Württemberg, vol. 58, 1902, p. 292.

ETCHED SLICE OF GIBEON (MUKEROP) IRON.

FOR DESCRIPTION SEE PAGE 74.

GILGOIN STATION NO. 1, NEAR BREWARRINA, NEW SOUTH WALES. No. 288.

Stone, Ck. Weight, 290 grams. Fragment with polished surface and crust. Date of fall unknown. Found 1889. Weight of original mass about 30½ kilograms, or 67½ pounds. A compact chondritic stone composed essentially of olivines and enstatites with metallic iron and iron sulphide. The most striking feature is the abundance of small, wavy, nearly parallel fracture lines, which may have been produced by impact with the earth, or by shearing stresses in the mass itself. Analysis by A. Liversidge yielded:

Magnetic portion:	Per cent.
Insoluble in HCl	1.5074
Iron, metallic	82.4551
Nickel, Cobalt	8.3451
Sulphur	Trace.
Phosphorus	None.
Oxygen and undetermined	7.6924
	100.00

Nonmagnetic portion (dried at 105° = 0.349 per cent of moisture):

	Per cent.
Silica (SiO_2)	42.690
Ferrous oxide (FeO)	12.665
Ferric oxide (Fe_2O_3)	6.698
Alumina (Al_2O_3)	4.980
Nickel (Ni)	.280
Cobalt (Co)	None.
Manganese (Mn)	Traces.
Lime (CaO)	17.530
Magnesia (MgO)	12.661
Soda (Na_2O)	.744
Potash (K_2O)	.104
Sulphur (S)	2.535
Chlorine (Cl)	None.
Phosphorus (P)	.135
	101.022
Less oxygen equivalent to sulphur and phosphorus	1.267
	99.755

Reference.—A. Liversidge, Journ. Proc. Roy. Soc. N. S. Wales, vol. 36, 1903, p. 352.

GILGOIN STATION NO. 2, NEAR BREWARRINA, NEW SOUTH WALES. No. 465.

Stone, Ck. Mass with three surfaces sawn and one broken. Weight, 1,299 grams. Found February 8, 1893, about 2 miles south of Gilgoin No. 1, and regarded as part of the same fall. Weight of original mass 33¾ kilograms, or 74¼ pounds.

Reference.—A. Liversidge, Journ. Proc. Roy. Soc. N. S. Wales, vol. 36, 1903, p. 354.

GILGOIN STATION NO. 7, NEAR BREWARRINA, NEW SOUTH WALES. No. 509.

Stone, Ck. Rough, oxidized fragment. Weight, 155 grams. Gift of J. C. H. Mingaye.

GIRGENTI, SICILY. No. 378.

Stone, Cwa. Fragment with crust, weighing 99 grams. Fell February 10, 1853. Weight of original mass some 3 or 4 kilograms. History very incomplete. Analysis yielded:

	Per cent.
Silica (SiO_2)	39.81
Alumina (Al_2O_3)	1.44
Ferrous oxide (FeO)	16.47
Magnesia (MgO)	24.61
Lime (CaO)	1.696
Soda (Na_2O)	1.375
Iron (Fe)	10.381
Nickel (Ni)	1.054
Sulphur (S)	2.054
	98.89
Chromite	1.10
	99.99

Reference.—G. Vom Rath, Pogg. Ann., vol. 138, 1869, p. 541.

GLORIETA MOUNTAIN, SANTA FE COUNTY, NEW MEXICO. No. 47.

Iron, Om. Weight, 380 grams. Polished slab 13.3 by 6.6 cm. Date of fall unknown. Found August 9, 1884. The original find consisted of three masses weighing, respectively, 67.35 kilograms (148½ pounds), 52.38 kilograms (115 pounds), and 24.263 kilograms (53½ pounds). Later four smaller pieces were found, of which one has disappeared. The three remaining weighed 337 kilograms (744 pounds). The fragments were regarded by Kunz as originally portions of one mass, which, however, was disrupted on striking and not in mid-air. The composition of the iron, as a whole, as determined by Eakins, is as follows:

	Per cent.
Iron (Fe)	88.76
Nickel (Ni)	9.86
Cobalt (Co)	.51
Copper (Cu)	.034
Zinc (Zn)	.030
Chromium (Cr)	Trace
Manganese (Mn)	Trace
Carbon (C)	0.410
Phosphorus (P)	.182
Sulphur (S)	.012
Silicon (Si)	.044
	99.842

Subsequent determinations by Whitfield failed to show any traces of zinc.

Cohen and Weinschenk examined this iron and found it to consist of:

	Per cent.
Nickel-iron	83.30
Taenite	4.35
Schreibersite	7.87
Kamacite	4.22
"Rost"	.18
Carbonaceous matter	.08
	100.00

References.—George F. Kunz, The meteorites from Glorieta Mountain, Santa Fe County, New Mexico. Ann. New York Acad. Sci., vol. 3, 1885, pp. 329-334. E. Cohen and E. Weinschenk, Meteoreisen Studien, 13, Ann. k. k. Naturhist. Hofmus., vol. 6, 1891, p. 155.

GRAND RAPIDS (WALKER TOWNSHIP), KENT COUNTY, MICHIGAN. No. 31.

Iron, Of. Etched slice 16 by 11 cm., weighing 1,205 grams, and one 13 by 11 cm., weighing 966 grams. Found in 1883. Nothing known regarding fall. Analysis by R. B. Riggs yielded:

	Per cent.
Iron (Fe)	88.71
Nickel (Ni)	10.69
Copper (Cu)	.07
Magnesium (Mg)	.02
Phosphorus (P)	.26
Sulphur (S)	.03
Carbon (C) (combined)	.06
Graphite	.07
	99.91

Gift of J. G. Pulcher.

References.—R. B. Riggs, Amer. Journ. Sci., vol. 30, 1885, p. 312; Bull. U. S. Geol. Surv. 42, 1887, p. 94.

GREENBRIER COUNTY, 3 MILES NORTH OF WHITE SULPHUR SPRINGS, WEST VIRGINIA. No. 118.

Iron, Og. Eleven grams from a mass weighing some 11 pounds, found in 1880.

GROSNAJA (MIKENSKOI), RIVER TEREK, CAUCASUS, RUSSIA. No. 138.

Stone, Cs. Weight, 4½ grams. Fell June 28, 1861.

GROSSLIEBENTHAL, NEAR ODESSA, CHERSON, RUSSIA. No. 511.

Stone, Cwa. Fragment from interior weighing 10 grams, from a mass weighing 8,048 grams which fell on the 19th of November, 1881. The composition is given as follows:

	Per cent.
Hygroscopic water	.10
Silica (SiO_2)	39.57
Magnesia (MgO)	22.97
Lime (CaO)	2.28
Ferrous oxide (FeO)	13.44
Manganous oxide (MnO)	.53
Alumina (Al_2O_3)	2.45
Soda (Na_2O)	1.30
Potash (K_2O)	.45
Iron sulphide (Fe_7S_8)	6.73
Nickel-iron ($Fe_{11}Ni_2$)	8.16
Chrome iron ($FeCr_2O_4$)	1.30
Phosphorus (P)	.02
Phosphoric acid (P_2O_5)	.21
Chlorine (Cl)	.04
Chromium (Cr)	Traces.
	99.35

Reference.—P. Melikoff and C. Schwalbe, Ber. Deut. Chem. Ges., vol. 26, 1893, p. 234.

HACHIMAN, MINO PROVINCE, JAPAN. No. 440.

Stone. Three fragments weighing 21 grams.

HAINHOLZ, MINDEN, WESTPHALIA, GERMANY. Nos. 136, 507.

Stony-iron, Mesosiderite. Two fragments weighing 8 and 17 grams, from a mass weighing 16½ kilograms, found in 1856.

HAMMOND TOWNSHIP, ST. CROIX COUNTY, WISCONSIN. No. 471.

Iron, Or. Weight, 298 grams. Irregular slice 17.5 by 6.5 cm. Etched and showing large troilite nodule, with gash-like veins of schreibersite. Weight of original mass, 24 kilograms, or about 53 pounds. Found in 1884. Chemical analysis yielded:

	Per cent.
Iron (Fe)	89.78
Nickel (Ni)	7.65
Cobalt (Co)	1.33
Phosphorus (P)	.51
Silica (SiO_2)	.56
Carbon (C), copper (Cu), and tin (Sn)	Traces.
	99.83

Reference.—Davenport Fisher, Amer. Journ. Sci., vol. 34, 1887, p. 381.

Two Views of Hendersonville Stone, as Found.

For description see page 79.

MICROSTRUCTURE OF THE HENDERSONVILLE STONE.

FOR DESCRIPTION SEE PAGE 79.

HARRISON COUNTY, INDIANA. No. 56.

Stone, Cho. Eleven grams from a shower which fell March 28, 1859. Gift of J. Berrien Lindsley.

HARTFORD (MARION), LINN COUNTY, IOWA. Nos. 129, 185.

Stone, Cwa. Two pieces with crust, weighing 23.7 and 41 grams. Fell February 25, 1847. Weight of original mass, 21 kilograms, or 46 pounds. Other masses reported as found, but the disposition of which is unknown. Analysis by Rammelsberg showed:

	Per cent.
Silica (SiO_2)	38.95
Alumina (Al_2O_3)	2.04
Ferrous oxide (FeO)	14.518
Magnesia (MgO)	26.05
Lime (CaO)	1.175
Soda (Na_2O)	.384
Iron (Fe)	9.46
Nickel (Ni)	1.08
Ferrous sulphide (FeS)	6.37
	100.027

Reference.—See Wülfing, p. 139.

HENDERSONVILLE, HENDERSON COUNTY, NORTH CAROLINA. No. 326.

Stone, Cc. Nearly complete individual, weighing 3.545 kilograms. Weight of original mass, 11 pounds 6 ounces, or 5.17 kilograms. A compact dark gray stone thickly spotted with small points of metallic iron. (See pls. 23 and 24.) Found in 1901, though supposed to have fallen in 1876. Chemical analysis yielded as follows:

	Per cent.
Iron (Fe)	2.37
Nickel (Ni)	.21
Cobalt (Co)	.01
Sulphur (S)	1.61
Phosphorus (P)	.012
Silica (SiO_2)	46.06
Ferrous oxide (FeO)	14.33
Alumina (Al_2O_3)	2.20
Chromic oxide (Cr_2O_3)	.23
Lime (CaO)	2.13
Magnesia (MgO)	28.62
Potash (K_2O)	.10
Soda (Na_2O)	.96
Residue (chromite)	.51
	99.352

Approximation of the relative quantities of the different constituents:

	Per cent.
Nickel-iron	2.59
Troilite	4.43
Schreibersite	.08
Chromite	.80
Olivine	40.48
Pyroxenes	51.62
	100.00

Reference.—G. P. Merrill, Proc. U. S. Nat. Mus., vol. 32, 1907, p. 79.

HESSLE, NEAR UPSALA, SWEDEN. Nos. 27, 482.

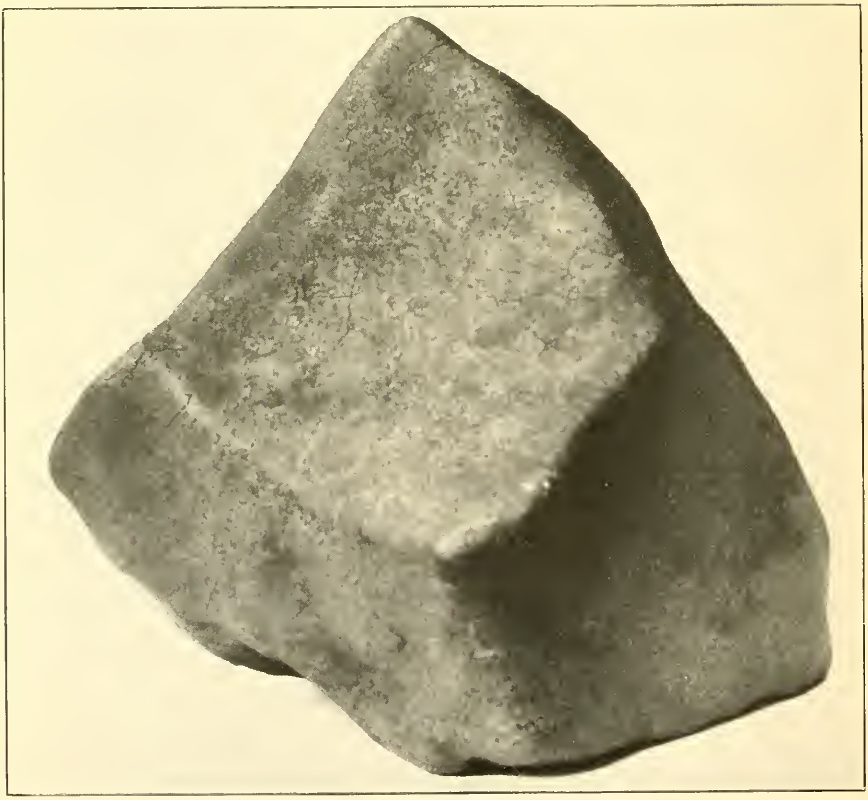
Stone, Cc. Two pieces, one a fragment showing crust and weighing 40 grams, and the second a small completely incrusted individual weighing 11 grams, from a shower comprising many individuals varying in weight from a fraction of a gram to a kilogram, which fell on January 1, 1869. The fall is of interest, being the first recorded fall in Sweden, and, further, (1) from the low velocity with which they struck the earth, Nordenskiöld stating that though the stones were so friable as to be readily broken if thrown against a hard surface, they were not broken or even scarred by the impact of the fall; and (2) from an associated carbonaceous matter which seemed to partake of the nature of a hydrocarbon.

Chemical analyses by the various workers are somewhat variable. In column I below are given results obtained by Nordenskiöld and in column II those of Linström.

Constituents.	I.	II.
	Per cent.	*Per cent.*
Silica (SiO_2)	36.91	36.83
Alumina (Al_2O_3)	1.55	2.38
Ferrous oxide (FeO)	13.43	10.85
Magnesia (MgO)	25.06	23.21
Lime (CaO)	2.08	1.80
Manganous oxide (MnO)	....	.42
Soda (Na_2O)	1.57	.94
Iron (Fe)	16.36	20.08
Nickel (Ni)	2.16	2.15
Cobalt (Co)	Trace.	.02
Sulphur (S)	.18	1.88
Phosphorus (P)	Trace.	.15
Copper and tin (Cu and Sn)	.02	.02
Chromic oxide (Cr_2O_3)	....	.07
	99.32	100.80

The mineral composition presents, aside from the hydrocarbon compound, no apparent departure from the ordinary olivine-pyroxene type.

1



2

COMPLETE INDIVIDUALS OF (1) HOLBROOK AND (2) MODOC STONES.

FOR DESCRIPTIONS SEE PAGES 81 AND 108.

Reference.—A. E. Nordenskiöld, Kongl. Sven. Vet.-Akad. Handl., vol. 8, No. 9, 1870.

HEX RIVER, CAPE COLONY, SOUTH AFRICA. No. 311.

Iron. H. Weight 332 grams. A nearly rectangular slab some 80 by 90 by 6 mm.; etched. Date of fall unknown; found in 1882 and described in 1885. Original weight unknown; 37,704 grams are now in the museum at Vienna and some 7,960 grams are distributed in other collections, making a total weight of 45,644 grams. Analyses, as given by Cohen and Weinschenk.[1] showed: Iron, 93.33; nickel, 5.58; cobalt, 0.84; schreibersite, 0.94.

Reference.—See Wülfing, p. 143.

HOLBROOK, NAVAJO COUNTY, ARIZONA. Nos. 437, 442.

Stone, Cck. Four nearly complete individuals, weighing 1,035, 895, 447, and 1,120 grams. (Pl. 25, fig. 1.) Fell Friday, July 19, 1912, 7.15 p. m. Several hundred individuals found weighing upward of 218 kilograms, or about 481 pounds. Compact, light gray chondritic stone showing very little metal, but comparatively numerous nodules of troilite. Mineral composition, olivine with monoclinic and orthorhombic pyroxenes and a small amount of glassy material which may be maskelynite. Chemical analysis gave results as below:

	Per cent.
Schreibersite	0. 11
Troilite	7. 56
Metal	4. 85
Silicates	87. 48
	100. 00

The metallic portion yielded:

Nickel (Ni)	8. 68
Cobalt (Co)	. 64
Copper (Cu)	. 29
Iron (Fe)	90. 50
	100. 11

The silicate portion yielded:

Silica (SiO_2)	41. 93
Alumina (Al_2O_3)	4. 30
Ferrous oxide (FeO)	21. 85
Lime (CaO)	2. 40
Magnesia (MgO)	29. 11
Soda (Na_2O)	Trace.
Manganous oxide (MnO)	0. 25
Nickel oxide (NiO)	. 08
	99. 92

[1] Ann. k. k. Naturhist. Hofmus., vol. 6, 1891, p. 143.

Recalculated, these results give the following, showing the composition of the stone as a whole:

	Per cent.
Silica (SiO_2)	36.68
Alumina (Al_2O_3)	3.76
Ferrous oxide (FeO)	19.11
Lime (CaO)	2.10
Magnesia (MgO)	25.46
Manganous oxide (MnO)	.22
Nickel oxide (NiO)	.07
Nickel (Ni)	.42
Cobalt (Co)	.03
Copper (Cu)	.01
Iron (Fe)	4.39
Ferrous sulphide (FeS)	7.56
	99.81

The sulphide separated mechanically yielded:

	Per cent.
Iron	63.62
Sulphur	36.50
	100.12

Specific gravity, 4.61.

These results show the mineral to be troilite and not pyrrhotite.

Gifts of F. C. Chekal and C. S. Bement.

References.—G. P. Merrill, Smithsonian Misc. Coll., vol. 60, No. 9, 1912. W. M. Foote, Amer. Journ. Sci., vol. 34, 1912, pp. 437–456.

HOLLAND'S STORE, CHATTOOGA COUNTY, GEORGIA. Nos. 127, 304.

Iron Hb. Weight, 142 grams. Thin triangular slice, etched, and showing granular structure, weight, 122 grams, and fragment weighing 20 grams. Found 1887; date of fall unknown. Weight of original mass 12.5 kilos (27 pounds). Analysis by Whitfield showed:

	Per cent.
Iron (Fe)	94.60
Nickel (Ni)	4.97
Cobalt (Co)	.21
Phosphorus (P)	.21
	99.99

Chlorine and sulphur present, but not determined. Specific gravity, 7.801. This iron belongs to the hexahedrite group of Brezina, and shows the fine markings due to twinning, known as Neumann lines.

Reference.—G. F. Kunz, Amer. Journ. Sci., vol. 34, 1887, p. 471.

HOMESTEAD, IOWA COUNTY, IOWA. Nos. 11, 21, 423.

Stone, Cgb. Complete individual with dull black, somewhat blebby crust, weighing 322 grams; fragments, weighing 79 and 230 grams. Fell on the evening of February 12, 1875, at about half past 10 o'clock. Flight was from the south toward the north, about 18° east, and was witnessed over a region at least 400 miles in length, from southwest to northeast, and 250 miles in breadth. The velocity with which it moved has been estimated at a maximum of 10 miles a second. It was described as exploding like a rocket, and detonations followed "so violent as to shake the earth and to jar the windows like the shock of an earthquake." Over 100 irregularly shaped stones were found, the largest of which weighed 74 pounds and the aggregate of which was upward of 500 pounds.[1]

The composition of the stone as determined by J. L. Smith is as follows:

	Per cent.
Stony matter	81.64
Troilite	5.82
Nickel-iron	12.54

Of this stony part there was:

Soluble in acid	54.15
Insoluble in acid	45.85

Analyses of these portions gave:

Constituents.	Soluble.	Insoluble.
Silica (SiO_2)	35.61	55.02
Ferrous oxide (FeO)	27.20	27.41
Magnesia (MgO)	33.45	13.12
Alkalies (mostly Na_2O)	1.45	2.01
Alumina (Al_2O_3)	.71	.84
	98.42	98.40

These analyses show the stony portion to be a mixture of an iron-rich olivine and enstatite. The composition of the metallic portion was found to be:

Iron	89.04
Nickel	10.34
Cobalt	.58

with traces of phosphorus, sulphur, and copper.

This stone has been described by Gümbel, Lasaulx, and Wadsworth. The first named described it as entirely crystalline and fragmental in character. Lasaulx states that it shows an evident brecciated structure, with olivine grains and rounded enstatite masses in a fine-grained groundmass containing grains and fragments of crystals. Wadsworth found no evidence of a fragmental structure, but regarded

[1] Wülfing says some 700 pounds, the largest of which weighed 120 pounds. I can find no authority for this.

it as the result of rapid cooling of a liquid magma. It was from work upon fragments of this stone that A. W. Wright was enabled to make the important generalizations on gases in stony meteorites mentioned on p. 8.

References.—C. W. Gümbel, Sitz k. bayr. Akad. München, 1875, pp. 313–330. A. Lasaulx, Sitz. Niederrh. Ges., 1882, pp. 102–105. M. E. Wadsworth, Lithological Studies, 1884, p. 86.

HONOLULU, HAWAIIAN ISLANDS. No. 278.

Stone, Cwa. Fragment weighing 13.5 grams, showing a portion of the crust. Fell September 27, 1825.

HOPPER, HENRY COUNTY, VIRGINIA. No. 159.

Iron. Twenty-seven grams from a mass weighing 1.7 kilograms, found in 1889. Gift of H. B. Battle.

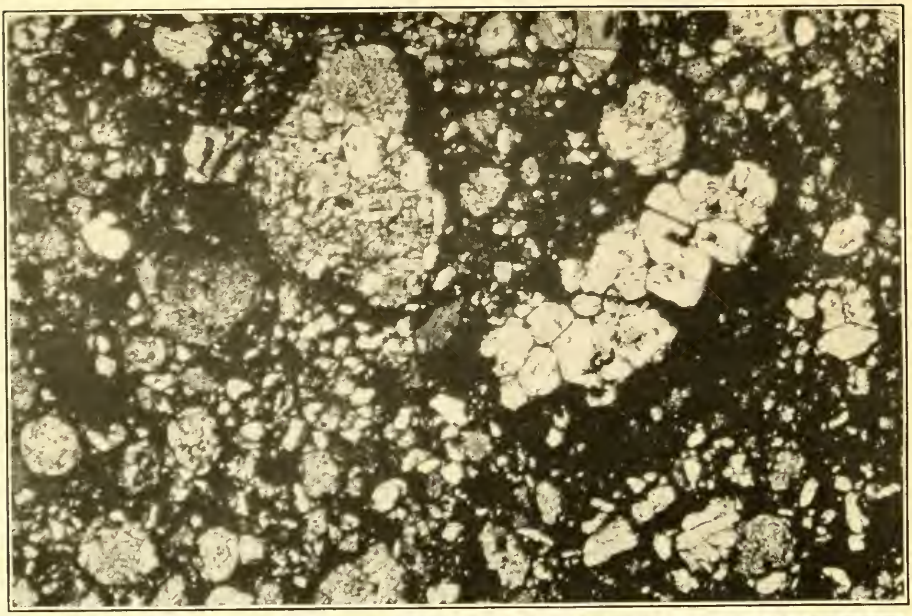
HVITTIS, ÅBO LAN, FINLAND. No. 400.

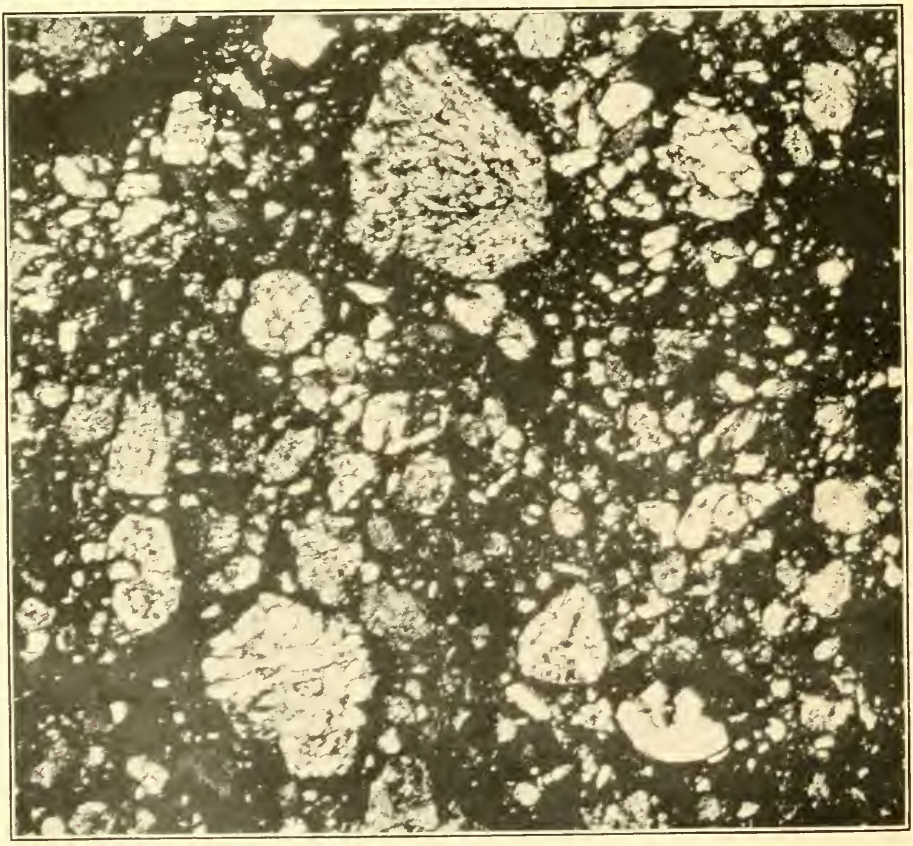
Stone, Cck. Triangular fragment with crust, weighing 70 grams. Fell at midday October 21, 1901. Weight of original mass 14.04 kilograms. This fall was made the subject of an exhaustive study by L. H. Borgström, who from chemical and microscopic studies made the following calculation of its mineral composition:

	Per cent.
Oldhamite	0.86
Daubreelite	.57
Troilite	7.31
Phosphor-nickel-iron	.50
Nickel-iron	21.50
Enstatite	59.01
Orthoclase	9.86
Chromite	.32
	99.93

The chemical composition was found to be as follows:

	Per cent.
Silica (SiO_2)	41.53
Iron (Fe)	24.66
Ferrous oxide (FeO)	.34
Nickel (Ni)	1.96
Cobalt (Co)	.07
Alumina (Al_2O_3)	1.55
Chromic oxide (Cr_2O_3)	.57
Lime (CaO)	1.41
Magnesia (MgO)	23.23
Potash (K_2O)	.32
Soda (Na_2O)	1.26
Sulphur (S)	3.30
Phosphorus (P)	.08
	100.28





MICROSTRUCTURE OF THE INDARCH STONE.

FOR DESCRIPTION SEE PAGE 85.

Reference.—L. H. Borgström, Die Meteoriten von Hvittis und Marjalahti. Bull Comm. geol. Finlande, No. 14, 1903.

ILIMAE, DESERT OF ATACAMA, CHILE. No. 383.

Stony-iron, Pallasite. Fragment weighing 155 grams. From a mass weighing 51.7 kilograms found in 1870. Gift of George P. Merrill.

Reference.—L. Fletcher, Min. Mag., vol. 8, No. 40, 1889, p. 223.

IMILAC, ATACAMA, CHILE. Nos. 6, 7, 8.

Stony-iron, Pallasite. Three pieces weighing, respectively, 34, 60, and 194 grams. Found early in the nineteenth century, but nothing known regarding fall.

Reference.—L. Fletcher, Min. Mag., vol. 8, No. 40, 1889, p. 223.

INDARCH, NEAR GINDORCHA, RUSSIA. Nos. 334, 449.

Stone, Kc. Two fragments weighing, respectively, 33 and 261 grams. Fell April 7, 1891. (Pl. 26.) Total weight of fall, 27 kilograms, or 59.4 pounds. One of the carbonaceous chondrites, and of interest in that it carries the rare calcium sulphide oldhamite. The chemical composition, as determined by J. E. Whitfield, is as follows:

	Per cent.
Silica (SiO_2)	35. 699
Alumina (Al_2O_3)	1. 969
Ferrous oxide (FeO)	14. 350
Manganous oxide (MnO)	. 130
Nickel oxide (NiO)	. 549
Cobalt oxide (CoO)	. 049
Lime (CaO)	1. 160
Magnesia (MgO)	16. 920
Carbonic acid (CO_2)	. 271
Phosphoric acid (P_2O_5)	. 520
Water (H_2O)	2. 799
Iron (Fe)	10. 400
Nickel (Ni)	. 949
Cobalt (Co)	. 020
Phosphorus (P)	. 092
Manganese (Mn)	. 119
Carbon (graphite) (C)	. 310
Iron and calcium sulphide (FeS and CaS)	14. 000
	100. 306

No barium, strontium, or zirconium detected.

The mineral composition is:

	Per cent.
Silicate (enstatite)	74. 42
Metal	11. 50
Troilite and oldhamite	14. 00
Graphite	. 31
	100. 23

Reference.—G. P. Merrill, Proc. U. S. Nat. Mus., vol. 49, 1915, p. 109.

IREDELL, BOSQUE COUNTY, TEXAS. No. 261.

Iron, H. Weight, 98 grams; rough fragment with small surface etched showing granular structure and fine Neumann lines. Date of fall unknown; found 1898. The mass has been broken up and distributed, the total weight of known fragments being but 500 grams. Iron soft and takes a high polish. Composition, according to Whitfield:

	Per cent.
Iron (Fe)	93.75
Nickel (Ni)	5.51
Cobalt (Co)	.52
Phosphorus (P)	.20
Sulphur (S)	.06
	100.04

Reference.—W. M. Foote, Am. Journ. Sci., vol. 8, 1898, pp. 415, 416.

ITAPICURU-MIRIM, MARANHÃO, BRAZIL. No. 110.

Stone, Cc. Weight, 9.7 grams. Fell in March, 1879.

IVANPAH, SAN BERNARDINO COUNTY, CALIFORNIA. No. 73.

Iron, Om. Seventy grams of turnings from a mass found in 1880.

JAMESTOWN, STUTSMAN COUNTY, NORTH DAKOTA. No. 350.

Iron, Of. Slice 11 by 2 cm. by 5 mm., weighing 83 grams. Portion of a mass, weighing 4,015 grams, found in 1885. Date of fall unknown. Analysis by Huntington yielded:

	Per cent.
Iron (Fe)	90.24
Nickel (Ni)	9.75
Phosphorus (P)	.05
Copper (Cu)	trace
	100.04

Reference.—O. W. Huntington, Proc. Amer. Acad. Arts and Sci., vol. 25, 1890, p. 229.

JELICA, SERBIA. No. 315.

Stone, Am. Weight, 16 grams; fragments with crust; shows a gray, brecciated interior with chondrules. Fell at 2 p. m., December 1, 1889; a shower of stones over an area some 8 kilometers long by 5 kilometers broad. Twenty-six stones were found, weighing altogether 33.83 kilograms. Twenty-five of these, weighing 30.83 kilograms, are still in the museum at Belgrade. This stone belongs to the group of amphoterites of which but three representatives are known. Chemical analysis by S. M. Losanitsch yielded:

	Per cent.
Iron (Fe)	1. 61
Nickel (Ni)	. 83
Cobalt (Co)	. 05
Copper (Cu)	Trace.
Iron-sulphide (FeS?)	7. 09
Chromite ($FeOCr_2O_3$)	. 73
Silica (SiO_2)	39. 72
Alumina (Al_2O_3)	1. 88
Magnesia (MgO)	25. 34
Lime (CaO)	1. 23
Ferrous oxide (FeO)	21. 29
Manganese oxide (Mn_2O_3)	. 21
Alkalies and organic matter	. 12
	100. 10

From these results the mineralogical composition was calculated as:

	Per cent.
Metal	2. 49
Troilite	7. 09
Chromite	. 73
Soluble silicates (mainly olivine)	54. 00
Insoluble silicates (mainly pyroxene)	36. 25
	100. 56

Reference.—S. M. Losanitsch, Ber. Deut. Chem. Ges., vol. 25, No. 128, 1892, p. 876.

JENNY'S CREEK, WAYNE COUNTY, WEST VIRGINIA. No. 46.

Iron, Ogb. Twenty-two grams in fragments from one of three masses weighing 23 pounds, found in 1883.

JEROME, GOVE COUNTY, KANSAS. No. 218.

Stone Ckb. Weight 110 grams. Section of mass, one surface polished, shows fine granular compact mass, with numerous small grains of nickel-iron and many olivine and bronzite chondrules. Found April 10, 1894. Date of fall unknown. Total weight found 65¾ pounds, or about 30 kilograms. The chemical composition as determined by H. S. Washington is:

	Per cent.
Silica (SiO_2)	33.11
Titanic oxide (TiO_2)	Traces.
Chromic oxide (Cr_2O_3)	.58
Alumina (Al_2O_3)	1.77
Ferrous oxide (FeO)	27.97
Iron (Fe)	3.81
Nickel oxide (NiO)	1.77
Nickel (Ni)	.43
Cobalt oxide (CoO)	Trace.
Cobalt (Co)	0.01
Manganous oxide (MnO)	Trace.
Magnesia (MgO)	21.59
Lime (CaO)	1.31
Soda (Na_2O)	.65
Potash (K_2O)	.28
Ignition (H_2O)	3.03
Phosphoric acid (P_2O_5)	.37
Sulphur (S)	1.88
Extra (O)	1.76
	100.32
Less O for S	.92
	99.40

From this and the study of thin sections the mineral composition was calculated as below:

	Per cent.
Nickel-iron	4.3
Troilite	5.2
Chromite	.9
Schreibersite (?)	.8
Olivine	30.2
Bronzite	23.6
Pyroxene	5.0
Oligoclase	6.6
Orthoclase	1.6
Limonite	20.2
Nickel oxide	1.6
	100.0

Reference.—H. S. Washington, Amer. Journ. Sci., vol. 5, 1898, p. 447.

JEWELL HILL, MADISON COUNTY, NORTH CAROLINA. No. 52.

Iron, Og. One gram.

JHUNG, PUNJAUB, INDIA. No. 72.

Stone, Ce. 1.22 grams. Fell in June, 1873.

JIGALOWKA, CHARKOW, RUSSIA. No. 172.

Stone, Cwa. 26.2 grams from a mass weighing 1,300 grams which fell on October 13, 1787.

JOE WRIGHT MOUNTAIN, INDEPENDENCE COUNTY, ARKANSAS. Nos. 139, 354.

Iron, Om. Two pieces weighing 309 grams and 115 grams. Found 1884; date of fall unknown. Weight of original mass 42.5 kilograms or 94 pounds. Incomplete analysis shows the approximate composition to be:

	Per cent.
Iron	91.22
Phosphorus	.16
Nickel and cobalt (by difference)	8.62
	100.00

Reference.—W. E. Hidden, Amer. Journ. Sci., vol. 31, 1886, p. 460.

JUVINAS, DEPARTMENT L'ARDECHE, FRANCE. No. 439.

Stone, Eu. Weight 100 grams. Fell June 15, 1821. Weight of original mass 91 kilograms, or 200 lbs. Analysis I by J. E. Whitfield, and II by C. Rammelsberg yielded:

Constituents.	I.	II.
	Per cent.	*Per cent.*
Silica (SiO_2)	47.99	49.23
Titanic oxide (TiO_2)	.57	.10
Alumina (Al_2O_3)	13.50	12.55
Ferric oxide (Fe_2O_3)	.22	1.21
Iron (Fe)	Trace.	.16
Nickel oxide (NiO)	0.11	....
Cobalt oxide (CoO)	Trace.	....
Ferrous oxide (FeO)	18.63	20.33
Lime (CaO)	10.60	10.23
Magnesia (MgO)	7.20	6.44
Barium oxide (BaO)	None.	....
Strontium oxide (SrO)	None.	....
Zirconium oxide (ZrO_2)	None.	....
Potash (K_2O)	None.	.12
Soda (Na_2O)	0.55	.63
Chromic oxide (Cr_2O_3)	Trace.	.24
Phosphoric acid (P_2O_5)	None.	.28
Sulphur (S)	0.054	.09
Sulphuric anhydride (SO_3)	.02	....
	99.444	101.61

References.—C. Rammelsberg, Ann. Phys. Chem., vol. 73, 1848, p. 585. G. P. Merrill, Mem. Nat. Acad. Sci., vol. 14, 1916, p 14.

KARAKOL, KIRGHIS STEPPES, RUSSIA. No. 175.

Stone, Cw. Fragment with crust, weighing 5 grams, from a stone weighing 3 kilograms, which fell May 9, 1840.

KENDALL COUNTY, TEXAS. Nos. 255, 343.

Iron, Hb. Two pieces, one of 767 grams and one of 1,165 grams. Ends of mass with original and etched surfaces, showing brecciated structure, and schreibersite and troilite (pl 20, fig. 1). From a mass weighing 20.883 kilograms, or nearly 46 pounds, found in 1887. Nothing known regarding fall. Analysis by Scherer yielded:

	Per cent.
Iron (Fe)	92. 65
Nickel (Ni)	5. 64
Cobalt (Co)	. 78
Copper (Cu)	. 03
Chromium (Cr)	. 01
Carbon (C)	1. 62
Phosphorus (P)	. 34
Sulphur (S)	. 03
Chlorine (Cl)	. 01
	101. 11

From this the mineral composition is calculated as:

	Per cent.
Nickel-iron	96. 11
Schreibersite	2. 19
Carbon	1. 60
Daubreelite	. 03
Troilite	. 05
Lawrencite	. 02
	100. 00

Reference.—E. Cohen, Ann. k. k. Naturhist. Hofmus., vol. 15, 1900, p. 382.

KENTON COUNTY, KENTUCKY. No. 206.

Iron, Om. Slice 4 by 4 cm., weighing 146 grams. Shows faint Widmanstätten figures and grains of troilite. From a mass weighing 163 kilograms, or 368½ pounds. Found in 1889. Date of fall uncertain; thought possibly to be July 7, 1873. Analysis by Davison yielded:

	Per cent.
Iron (Fe)	91. 59
Nickel (Ni)	7. 65
Cobalt (Co)	. 84
Carbon (C)	. 12
	100. 20

with traces of copper, phosphorus, and sulphur.

Reference.—H. L. Preston, Amer. Journ. Sci., vol. 44, 1892, p. 163.

KERNOUVÉ, MORBIHAN, BRITTANY FRANCE. No. 359.

Stone, Ck. Fragment weighing 567 grams, from a stone weighing 80 kilograms, or 176 pounds, which fell on May 22, 1869. An analysis by M. F. Pisani yielded:

	Per cent.
Iron (Fe)	22.25
Nickel (Ni)	1.55
Sulphur (S)	2.15
Copper (Cu)	Traces.
Chrome-iron (Cr_2O_3+FeO)	Traces.
Silica (SiO_2)	32.95
Alumina (Al_2O_3)	3.19
Iron protoxide (FeO)	11.70
Magnesia (MgO)	23.68
Lime (CaO)	1.89
Soda (Na_2O) (traces of potash (K_2O))	1.41
	100.77

Reference.—F. Pisani, Compt. Rend., vol. 68, 1869, p. 1489.

KESEN, IWATE, JAPAN. Nos. 200, 418.

Stone, Ccb. Fragments weighing 208 grams and 318 grams, with dull black crust. Surface blebby and indented with broad, shallow pits. Polished surface ash gray, granular, and compact, traversed by black veins. Fell June 13, 1850. Known weight, 7,088 grams. Several fragments were found buried in the ground. Analysis by Kondo yielded:

	Per cent.
Silica (SiO_2)	35.98
Alumina (Al_2O_3), Ferrous oxide (FeO)	16.51
Magnesia (MgO)	22.63
Lime (CaO)	2.20
Soda (Na_2O)	.36
Potash (K_2O)	.60
Iron (Fe)	12.79
Nickel and cobalt (Ni and Co)	2.32
Phosphorus (P)	.31
Manganese (Mn)	.21
Ferrous sulphide (FeS)	5.75
	99.66

Reference.—Kotora Jimbo, Beitr. Min. Japan, No. 2, February, 1906, p. 37.

KNYAHINYA, HUNGARY. Nos. 102, 341, 464.

Stone, Cg. Fragments and complete individuals with crust, weighing 27.8, 205, 211, and 405.8 grams. Fell June 9, 1866. Groundmass ash gray, granular, compact. Structure chondritic. Original fall over 1,000 stones, weighing upward of 500 kilograms, or 1,100 pounds. This is one of the most interesting of stony meteorites owing to the very full data compiled by Haidinger regarding its fall, as well as on account of the number of stones. It was studied in thin sections by Kenngott in 1869, who recognized the presence of enstatite, olivine, troilite, and native iron. These results have since been confirmed by Wadsworth. Analysis (recalculated from Baumhauer) yielded:

	Per cent.
Silica (SiO_2)	44.30
Alumina (Al_2O_3)	3.057
Ferrous oxide (FeO)	16.379
Lime (CaO)	2.727
Magnesia (MgO)	22.16
Soda (Na_2O)	1.00
Potash (K_2O)	.658
Chromic oxide and ferrous oxide (Cr_2O_3 and FeO)	.80
Ferrous sulphide (FeS) (recalculated)	2.22
Iron and nickel (Fe and Ni) (recalculated)	5.00
	98.301

It was in this meteorite that Dr. Otto Hahn thought to have discovered fossil remains of sponges, corals, and crinoids. The fall is of further interest from the fact that it included one of the largest stone meteorites known, a mass weighing 294 kilograms (647 pounds), which is now preserved in the Vienna Museum.

References.—W. Haidinger, Sitz. Akad. Wiss. Wien, vol. 54, pt. 2, 1866, pp. 200, 475–522. E. H. v. Baumhauer, Archiv. Néerl., vol. 7, 1872, p. 146. Wadsworth, Lithological Studies, 1884, p. 88.

KODAIKANAL, PALNI HILLS, MADRAS, INDIA. No. 317.

Iron, Obk. Thin slab weighing 90 grams.

KRASNOJARSK, JENISEISK, SIBERIA. No. 331.

Stony-iron, Pallasite. Rough fragment, a coarse mesh of iron with included olivines, weighing 287 grams. The fragment represents historically one of the most interesting meteorites. It was found by a Cossack in 1749 on the surface of the highest point of a lofty mountain between Krasnojarsk and Abakansk in Siberia, where it was regarded by the natives as a holy thing fallen from heaven. It was first made known to the scientific world by the explorer Pallas in 1772. The original mass weighed about 1,500 pounds, the largest portion of which is in the museum at St. Petersburg. It has been the subject of numerous investigations. The olivine presents a perfection of crystal outlines quite unusual, some 19 faces having been detected. Chemical analysis of the mineral by Baumhauer yielded:

	Per cent.
Silica (SiO_2)	40.87
Magnesia (MgO)	46.96
Iron (Fe)	12.11
	99.94

which is almost the theoretical composition of this species. Rumler thought to have detected the presence of arsenic, but this has not been borne out by subsequent investigation. The metallic portion was analyzed by J. E. Whitfield, who reported:

	Per cent.
Iron (Fe)	89.90
Nickel (Ni)	9.52
Cobalt (Co)	.60
Phosphorus (P)	.085
	100.105

but no tin, though the last named had been reported by Reichenbach.

Reference.—See Wülfing, p. 187.

KRASNOJ-UGOL, RASAN, RUSSIA. No. 184.

Stone, Cc. Six grams from the interior. Fell September 9, 1829.

KULESCHOWKA, POLTAWA, RUSSIA. No. 173.

Stone, Cwa. Two fragments weighing 5.5 grams. Fell March 12, 1811.

LA BÉCASSE, INDRE, FRANCE. No. 370.

Stone, Cw. Weight 76 grams. Fragment from a stone weighing 2.8 kilograms, or 6 pounds, which fell January 31, 1879.

LA GRANGE, OLDHAM COUNTY, KENTUCKY. No. 55.

Iron, Of. Weight 172 grams. From a mass weighing 51 kilograms, or 112 pounds, found in 1860. Analysis by J. L. Smith showed it to contain:

	Per cent.
Iron (Fe)	91.21
Nickel (Ni)	7.81
Cobalt (Co)	.25
Copper (Cu)	Minute quantity, not estimated.
Phosphorus (P)	.05
	99.32

Gift of J. Berrien Lindsley.

Reference.—J. L. Smith, Amer. Journ. Sci., vol. 31, 1861, p. 264.

L'AIGLE, ORNE, FRANCE. Nos. 50 and 485.

Stone, Cib. Two fragments, weighing 56 and 27 grams, with brownish-black crust, stained by iron oxides. Groundmass ash-gray, also stained, compact, granular, chondritic. Fell about 1 p. m. April 26, 1803, the course being from the southeast to the northwest. Fall accompanied by the usual phenomena. Between 2,000 and 3,000 stones fell over an ellipsoidal area some 2½ French miles in greatest diameter, the aggregate weight being not less than 36,843 grams. Analysis by E. H. v. Baumhauer showed the stone to consist of:

	Per cent.
Nickel-iron	8.0
Pyrrhotite	1.8
Chromite	.6
Olivine	45.3
Pyroxene	44.3
	100.0

with a trace of calcium sulphate.

Specific gravity on different samples varied from 3.279 to 3.626.

This fall is of interest since it took place at a time when there was still great doubt in the minds of even scientific men as to whether or no stones did actually fall from the skies. As Chladni himself wrote:

> Kam der fall von L'Aigle gerade zur rechten Zeit, um so Manchen zum glauben an das Neiderfallen Meteorischen Massen zu nothigen.

Fletcher writes:

> Whilst the minds of the scientific men of France were in this unsettled condition there came a report that still another shower of stones had fallen, this time in their own country, and within easy reach of Paris. To settle the matter finally, if possible, the physicist Biot, member of the French Academy, was directed by the minister of the interior to inquire into the event upon the spot. After a careful examination of the stones and a comparison of the statements of the villagers, Biot was convinced that—
>
> 1. On Tuesday, April 26, 1803, about 1 p. m., there was a violent explosion in the neighborhood of L'Aigle, in the department of Orne, lasting for five or six minutes. This was heard for a distance of 75 miles around.
>
> 2. Some minutes before the explosion at L'Aigle a fireball in quick motion was seen from several of the adjoining towns, though not from L'Aigle itself.
>
> 3. There was absolutely no doubt that on the same day many stones fell in the neighborhood of L'Aigle.
>
> Biot estimated the number of the stones at 2,000 or 3,000. They fell within an ellipse of which the larger axis was 6.2 miles and the smaller 2.5 miles, and this inequality might indicate not a single explosion but a series of them. With the exception of a few little clouds of ordinary character the sky was quite clear.[1]

The exhaustive report of Biot and its conclusive nature compelled the whole of the scientific world to recognize the fall of stones on the earth from outer space as an undoubted fact.

Reference.—H. Pfahler, Ueber den Meteoriten von L'Aigle, 26 April, 1803. Min. pet. Mitth., vol. 13, 1893, p. 362.

[1] Memoires de l'Institut National de France, vol. 7, pt. 1, 1806, p. 224.

LANCÉ, LOIR-ET-CHER, FRANCE. No. 380.

Stone, Cc. Fragment weighing 93 grams, from a shower of six stones weighing in the aggregate 51.75 kilograms, or 114 pounds, which fell on July 23, 1872. Analysis showed it to consist of:

	Per cent.
Nickel-iron	7.81
Iron and other metals combined with sulphur	9.09
Sulphur combined as above	5.19
Silica	17.20
Iron protoxide	11.33
Manganese	.05
Magnesia	13.86
Sodium chloride	.12
Insoluble constituents	33.44
Hygrometric water	1.24
	99.33

The above is interesting on account of the reported occurrence of sodium chloride. There is a doubt, however, as to the correctness of this.

Reference.—W. Flight, History of Meteorites, 1887, p. 54.

LANÇON, BOUCHES-DU-RHONE, FRANCE. No. 269.

Stone, Cia. Fragment from interior weighing 72 grams. One face polished, showing chondrules and metallic grains. Fell on June 20, 1897. An analysis by Meunier showed:

	Per cent.
Nickel-iron	8.80
Pyrrhotite	6.35
Chromite	.54
Enstatite (with plagioclase)	52.21
Olivine (by difference)	32.10
	100.00

Reference.—S. Meunier, Compt. Rend., vol. 131, 1900, pp. 969–972.

LENARTO, GALICIA, AUSTRIA. No. 450.

Iron, Om. Slice, 50 by 65 by 5 mm., weighing 132 grams. From a mass weighing 1,086 kilograms reported to have fallen in 1814. This, however, considered doubtful. Chemical analysis by W. S. Clark showed:

	Per cent.
Iron (Fe)	90.153
Nickel (Ni)	6.553
Cobalt (Co)	.502
Manganese (Mn)	.145
Copper (Cu)	.08
Tin (Sn)	.082
Sulphur (S)	.482
Iron phosphide	1.226
	99.223

This iron was investigated by Thomas Graham and found to yield 2.85 times its volume of gas, of which 85.68 was hydrogen, 4.46 carbon monoxide, and 9.86 nitrogen.

References.—W. S. Clark, Dissertation on Meteorites, 1852, p. 39. T. Graham, Compt. Rend., vol. 64, 1867, p. 1067.

LEXINGTON COUNTY, SOUTH CAROLINA. No. 10.

Iron, Og. Weight, 45 grams. Fragment showing octahedral structure. Date of fall unknown; found 1880. Weight of original mass, 4,750 grams.

Analysis yielded, for the iron:

	Per cent.
Iron (Fe), with traces of manganese (Mn)	92. 416
Nickel (Ni)	6. 077
Cobalt (Co)	. 927
Insoluble matter	. 264
	99. 684

Specific gravity, 7; of the iron freed from troilite and schreibersite, 7.405.

Reference.—C. U. Shepard, Meteoric iron from South Carolina. Amer. Journ. Sci., vol. 21, 1881, p. 117.

LICK CREEK, DAVIDSON COUNTY, NORTH CAROLINA. No. 413.

Iron, H. Irregular mass, 35 by 18 by 12 mm., weighing 18 grams, from a mass weighing 1.24 kilograms, found in 1879.

LIME CREEK, NEAR CLAIBORNE, MONROE COUNTY, ALABAMA. No. 379.

Iron, H. A slice, 8 by 5 by 2 cm., weighing 523 grams, from a mass weighing 40.888 kilograms. Found about 1833 or 1834, and nothing known regarding fall. The iron is of historical interest, being the first in which iron protochloride was discovered, which was later named lawrencite.

References.—C. T. Jackson, Amer. Journ. Sci., vol. 34, 1838, p. 332; also vol. 48, 1845, p. 145.

LIMERICK, ADARE, IRELAND. No. 246.

Stone, Cga. Weight, 24 grams. Fragment from interior, showing black veins and slickensided surfaces. Fell September 10, 1813, about 6 o'clock in the morning. Original weight, 106 pounds, according to Wülfing. The composition, as made out by Apjohn, is:

	Per cent.
Iron and nickel	23. 07
Pyrrhotite	4. 38
Chromite	3. 34
Earthy matrix	68. 47
Alkalies and loss	. 74
	100. 00

Specific gravity, 3.621 to 4.23. The "earthy matrix," as indicated by the analysis, is composed mainly of olivine and pyroxene. Color, gray.

Reference.—James Apjohn, Trans. Royal Irish Acad., vol. 18, 1837, pp. 17–30.

LION RIVER, GREAT NAMAQUALAND, SOUTH AFRICA. No. 59.

Iron, Of. Weight, 34.87 grams. Date of fall unknown. Brought to London in 1852 and thence transferred to the Shepard collection at Amherst, Massachusetts. Original weight, 80.5 kilograms (178 pounds). Shepard's analysis yielded:

	Per cent.
Nickel	6.70
Iron with traces of phosphorus, sulphur, tin, and potassium	93.30
	100.00

Other analyses made at intervals, by von Baumhauer and van der Boon Mesch (1866) and by Sjöström, as given by Cohen (Meteorisen Studien, 1897, p. 43), show a considerable variation. The latest, by Sjöström, gave results as follows:

	Per cent.
Iron (Fe)	92.06
Nickel (Ni)	7.79
Cobalt (Co)	.69
Phosphorus (P)	.05
	100.59

References.—C. U. Shepard, Amer. Journ. Sci., vol. 15, 1853, p. 1; E. Cohen, Ann. k. k. Naturhist. Hofmus., vol. 12, 1897, p. 43.

LISSA, BUNZLAU, BOHEMIA, AUSTRIA. No. 228.

Stone, Cwa, sometimes Cwb. Weight, 47 grams. Fell September 3, 1808, the fall being accompanied by the usual reports, but no light observed. Four or five stones fell, weighing altogether 10,366 grams. Analysis by Klaproth, as quoted by Buchner (Die Meteoriten in Sammlungen, 1863, p. 27), yielded:

	Per cent.
Silica (SiO_2)	43.00
Alumina (Al_2O_3)	1.25
Magnesia (MgO)	22.00
Lime (CaO)	.50
Iron (Fe)	29.00
Nickel (Ni)	.50
Manganous oxide (MnO)	.25
Sulphur (S) and loss	3.50
	100.00

A fine-grained, light gray, chondritic stone with pyrrhotite and metallic particles visible to the unaided eye. Stone traversed by fine dark veins.

References.—K. von Schreiberg, Gilbert's Ann. Phys., vol. 30, 1808. O. Buchner, Die Meteoriten in Sammlungen, 1863, p. 26.

LLANO DEL INCA, 35 LEAGUES SOUTHEAST OF TOLTAL, ATACAMA, CHILE. No. 156.

Stony-iron, M. Weight, 66 grams, from a mass weighing 3,145 grams found in 1888.

LODHRAN, PUNJAUB, EAST INDIA. No. 481.

Stone, Lo. Fragments from interior weighing 17.52 grams. Fell October 1, 1868. Is of interest on account of its granular and friable nature and the unusual crystallographic development of the olivine and bronzite. The mineral composition, as determined by Tschermak, is:

	Per cent.
Nickel-iron	32.5
Olivine	28.9
Bronzite with some chromite and anorthite	31.2
Pyrrhotite	7.4
	100.00

Reference.—G. Tschermak, Sitz. Akad. Wiss. Wien, vol. 61, 1870, p. 465.

LONG ISLAND, PHILLIPS COUNTY, KANSAS. No. 211.

Stone, Cia. Weight, 1,893 grams; in three pieces, (A) weighing 493 grams, having a slickensided surface, later smoothed to a smooth brown crust; (B) weighing 159 grams; and (C) weighing 1,241 grams. All have surfaces much oxidized and in places encrusted with calcium carbonate. Date of fall unknown; found in 1891. Original weight some 936 kilograms, of which the larger portion, in many pieces, is in the collections of the Field Columbian Museum. Described by Weinschenk as a dark green stone showing metallic iron, with crystalline structure (rarely chondritic) plainly evident to the unaided eye. The mineral composition is given as olivine and bronzite, sometimes the one and sometimes the other prevailing, rarely a monoclinic pyroxene (diallage), pyrrhotite, chromite, and metallic iron. Analysis by H. W. Nichols yielded:

	Per cent.
Silica (SiO_2)	35.65
Alumina (Al_2O_3)	3.08
Ferrous oxide (FeO)	22.85
Magnesia (MgO)	22.74
Lime (CaO)	1.40
Soda (Na_2O)	.25
Potash (K_2O)	.03
Iron (Fe)	2.60
Nickel (Ni)	.67
Cobalt (Co)	.04
Sulphur (S)	1.90
Phosphorus (P)	.06
	91.27

References.—E. Weinschenk, Min. pet. Mitth., vol. 14, 1895, p. 471. O. C. Farrington, Field Col. Mus. Publ., Geol. Ser., vol. 1, 1902, p. 297.

LOSTTOWN, CHEROKEE COUNTY, GEORGIA. Nos. 33, 411.

Iron, Om. Thirteen grams from a mass weighing 300 grams, found in 1867.

LUIS LOPEZ, SOCORRO COUNTY, NEW MEXICO. Nos. 217, 451.

Iron, Om. Fragment 2 by 5 cm., weighing 22 grams, and an irregular slice 35 by 75 mm., weighing 118 grams, from a mass weighing 6,903 grams found in 1896. Chemical analysis by Mariner and Hoskins yielded:

	Per cent.
Iron (Fe)	91.312
Nickel (Ni)	8.170
Cobalt (Co)	.160
Silicon (Si)	Trace.
Phosphorus (P)	.333
Sulphur (S)	.013
Carbon (C)	.012
	100.000

Reference.—H. L. Preston, Amer. Journ. Sci., vol. 9, 1900, p. 283.

LUMPKIN, STEWART COUNTY, GEORGIA. No. 265.

Stone, Cck. Weight, 29 grams. Fragment with crust; compact, fine gray ground with darker chondrules; metallic portion evident only in small glittering points. Fell on the morning of October 6, 1869; original weight, 357 grams (12¾ oz.). Analyses by J. Lawrence Smith showed: Metallic portion, 7 per cent. This yielded:

Iron, 86.92; nickel, 12.01; cobalt, 0.75. Analyses of the silicate portion yielded:

Constituents.	Soluble in HCl 58.05.	Insoluble in HCl 41.95.
	Per cent.	*Per cent.*
Silica (SiO_2)	41.08	56.03
Alumina (Al_2O_3)	.32	5.89
Ferrous oxide (FeO)	18.45	15.21
Magnesia (MgO)	41.06	21.00
Lime (CaO)	....	.10
Soda (Na_2O) with a little potash (K_2O)	....	2.97
	100.91	101.20

From these results was calculated the mineral composition as below:

	Per cent.
Nickeliferous iron	7.00
Magnetic pyrites	6.10
Bronzite, Olivine, Albite or oligoclase, Chrome iron	86.90
	100.00

Reference.—J. L. Smith, Amer. Journ. Sci., vol. 50, 1870, pp. 339–341.

LUTSCHAUNIG (LAMPA), ATACAMA DESERT, CHILE. No. 419.

Stone, Cg. 70-gram fragment from a mass found in 1860.

MACAO, RIO GRANDE DO NORTE, BRAZIL. No. 134.

Stone, Cia or Ci. Weight, 68.5 grams. Fell November 11, 1836, at 5 o'clock in the morning, with the usual detonations and brilliant light. The stones were first stated to fall over an area of some ten leagues radius. Very many stones fell, weighing from one-half to 40 kilograms each. Total weight not known. Wülfing accounts for but 2,902 grams. No analysis seems to have been made, nor a satisfactory mineralogical determination.

Reference.—O. A. Derby, Meteoritos Brasileiros, Revista do Observatorio, 1888, p. 7.

McKINNEY, COLLIN COUNTY, TEXAS. Nos. 188, 340.

Stone, Cs (?). Two pieces, weighing 66 and 1,168 grams. From a mass weighing about 100 kilograms, thought to have fallen in 1870. Fragment with reddish brown, much oxidized crust. Ground green-black, fine, and compact. Susceptible of a polish. Chondrules abundant and of all sizes up to 7 mm. Whitfield found the stone to consist of:

	Per cent.
Troilite	6.26
Schreibersite	.58
Metal	5.70
Chromite	.11
Silicate minerals	87.35
	100.00

The silicate portion yielded:

Silica (SiO_2)	43.30
Alumina (Al_2O_3)	15.18
Ferrous oxide (FeO)	8.45
Lime (CaO)	1.88
Magnesia (MgO)	30.48
Manganous oxide (MnO)	.25
Nickel oxide (NiO)	.51
	100.05

The metallic portion yielded:

Iron (by difference)	85.84
Cobalt (Co)	.92
Copper (Cu)	.08
Nickel (Ni)	13.16
	100.00

Recalculated these analyses give the composition of the stone as a whole, as follows:

	Per cent.
Silica (SiO_2)	37.90
Alumina (Al_2O_3)	13.29
Ferrous oxide (FeO)	7.40
Lime (CaO)	1.65
Magnesia (MgO)	26.69
Manganous oxide (MnO)	.21
Nickel oxide (NiO)	.44
Iron (Fe)	5.07
Cobalt (Co)	.05
Copper (Cu)	.004
Nickel (Ni)	.92
Phosphorus (P)	.05
Ferrous sulphide (FeS)	6.26
Chromite	.11
	100.044

Reference.—G. P. Merrill, Amer. Journ. Sci., vol. 35, 1913, p. 520.

MAEME, HISLUGARI, SATSUMA, JAPAN. Nos. 112, 407.

Stone, Cwa. Weight, 40.2 grams. Two fragments with crust. Fell November 10, 1886, at 3 p. m. Total original weight, 328 grams. The stone does not seem to have been analyzed or otherwise studied.

Reference.—Kotora Jimbo, Beitr. Min. Japan, No. 2, 1906, p. 30.

MAGURA (ARVA), SZLANICZA, HUNGARY. Nos. 22, 310.

Iron, Og. Two slices, weighing 98 and 102 grams, respectively. Etched showing Widmanstätten figures. Found in 1840; date of fall unknown. Original weight perhaps 30 zentners (3,000 pounds?), of which the greater part was smelted, only some two zentners (200 pounds?) being saved. Composition: Analysis by Patera (I) and Löwe (II) yielded:

Constituents.	I.	II.
	Per cent.	*Per cent.*
Iron (Fe)	92.22	90.92
Nickel (Ni)	6.76	7.32
Residue (Si and C)	1.41	1.17
	100.39	99.41

It was the nickel-iron phosphide found in this iron to which Haidinger and Patera first gave the name schreibersite.

Reference.—See Wülfing, p. 211.

MANBHOOM, BENGAL, EAST INDIA. Nos. 147, 480.

Stone, Am. Fragments weighing 12 grams, from a shower of three stones weighing collectively 1.5 kilograms, which fell December 22, 1863. The stone is breccia-form in structure and consists of olivine, bronzite, feldspar, chromite, metallic iron, and troilite. A chemical analysis by H. B. von Foullon yielded:

	Per cent.
Silica (SiO_2)	40.12
Ferric oxide (Fe_2O_3)	.83
Chromic oxide (Cr_2O_3)	.55
Alumina (Al_2O_3)	1.80
Ferrous oxide (FeO)	20.53
Manganous oxide (MnO)	.07
Magnesia (MgO)	27.30
Lime (CaO)	1.93
Soda (Na_2O)	.44
Potash (K_2O)	.20
Iron (Fe)	4.24
Nickel (Ni)	.91
Sulphur (S)	1.70
Phosphorus (P)	.20
	100.82

References.—W. Haidinger, Der Meteorstein von Manbhoom. Sitz. Akad. Wiss. Wien, vol. 50, 1864, p. 241. H. B. von Foullon, Ann. k. k. Naturhist. Hofmus., vol. 3, 1888, p. 203.

MARION (9 MILES FROM), LINN COUNTY, IOWA. No. 461.

Stone, Cwa. Fragment about 70 by 75 mm., with crust, weighing 45 grams. Fell February 25, 1847. (See Hartford, Linn County, Iowa.)

MARJALAHTI, FINLAND. No. 319.

Stony-iron, Pallasite. Fragment weighing 346 grams, from a mass weighing 44.8 kilograms, which fell on June 1, 1902. It has been the object of detailed investigation by L. H. Borgström, who reports it to consist of some 80 per cent by weight of nickel-iron and 20 per cent olivine. The iron yielded:

	Per cent.
Iron (Fe)	92.28
Nickel (Ni)	7.13
Cobalt (Co)	.42
Chromium and phosphorus (Cr and P)	None
	99.83

The olivine yielded:

	Per cent.
Silica (SiO_2)	40.26
Ferrous oxide (FeO)	11.86
Magnesia (MgO)	47.26
Chromic oxide (Cr_2O_3)	.12
Potash (K_2O)	.05
Soda (Na_2O)	.04
	99.59

Analyses were also given of the fused crust and the kamacite-taenite-plessite compound.

Reference.—L. H. Borgström, Die Meteoriten von Hvittis und Marjalahti. Bull. Comm. geol. Finlande, No. 14, 1903, p. 45.

MART, McLENNAN COUNTY, TEXAS. No. 221.

Iron, Of. Weight, 456 grams. Slice etched, showing typical Widmanstätten figures: small nodules and veins of troilite and schreibersite. Weight of original mass, 7,149 grams. Date of fall unknown. Found in 1898. Chemical composition, as determined by H. N. Stokes:

	Per cent.
Iron (Fe)	89.68
Nickel (Ni)	9.20
Cobalt (Co)	.33
Copper (Cu)	.037
Phosphorus (P)	.158
Sulphur (S)	.017
Chromite ($FeOCr_2O_3$)	Trace
Ferric oxide (Fe_2O_3)	Trace
	99.422

The mineral composition as calculated from analyses is:

	Per cent.
Nickel-iron	98.317
Schreibersite	1.06
Troilite	.05
Chromite	Trace
Secondary iron oxide (Fe_2O_3)	Trace
	99.427

The structure is octahedral, with fine plates of taenite. In composition and structure it so closely resembles the Carlton-Hamilton iron as to lead to the suggestion by Merrill that it may belong to the same fall.

Gift of O. C. Charlton.

Reference.—George P. Merrill and H. N. Stokes, A new iron meteorite from Mart, Texas. Proc. Washington Acad. Sci., vol. 2, 1900, p. 41.

MATATIELA, EAST GRIQUALAND, SOUTH AFRICA. No. 488.

Iron, Om. A 70-gram end slice, triangular in outline, showing portion of original surface, from a mass weighing 298 kilograms (657 pounds) found about 1885. Analyses by Dr. J. Fahrenhorst yielded the results given below, No. I being the total composition and II that of the metal minus the schreibersite, troilite, and lawrencite:

Constituents.	I.	II.
	Per cent.	*Per cent.*
Iron (Fe)	92.20	92.21
Nickel (Ni)	7.30	7.03
Cobalt (Co)	.67	.65
Copper (Cu)	.03	.03
Chromium (Cr)	None.	None.
Carbon (C)	0.08	0.08
Chlorine (Cl)	.03	
Phosphorus (P)	.19	
Sulphur (S)	.03	
	100.53	100.00

The mineral composition as calculated is:

	Per cent.
Nickel-iron	98.64
Iron-nickel-phosphide	1.23
Troilite	.08
Lawrencite	.05
	100.00

Specific gravity, 7.808.

Gift of South African Museum.

Reference.—E. Cohen, Ann. S. African Mus., vol. 2, 1900, p. 9.

MERCEDITAS, VALPARAISO, CHILE; also known as El Chanaralino. No. 313.

Iron, Om. Weight, 206 grams. Slice about 11 by 9 cm. by 5 mm. Etched and showing Widmanstätten figures. Date of fall unknown; found in 1884 and described in 1890. Original weight, 43.4 kilograms.

Reference.—E. E. Howell, Proc. Rochester Acad. Sci., vol. 1, 1890, p. 99.

MINAS GERAES, BRAZIL. No. 109.

Stone, Cwa. Fragment weighing 11 grams.

MINCY, TANEY COUNTY, MISSOURI. Nos. 128, 207, 353.

Stony-iron, Mesosiderite. Weight, 268 grams. In three pieces, weighing 34 grams, 108 grams, and 126 grams. Shows the reticulated metallic portion holding the siliceous material consisting of olivine, bronzite, augite, and plagioclase. Date of fall uncertain. First described in 1860. Original mass weighed 89.342 kilograms (197 pounds. Analysis by Whitfield yielded:

Metallic portion:	Per cent.
Iron (Fe)	89.41
Nickel (Ni)	10.41
Cobalt (Co)	.29
Phosphorus (P)	.16
	100.27

Stony portion:	
Silica (SiO_2)	45.88
Alumina (Al_2O_3)	7.89
Ferrous oxide (FeO)	19.73
Lime (CaO)	6.02
Magnesia (MgO)	17.96
Nickel sulphide (NiS)	1.67
Ferrous sulphide (FeS)	.54
	99.69

The silicate portion yielded:

Constituents.	Insoluble portion.	Soluble portion.
	Per cent.	*Per cent.*
Silica (SiO_2)	26.95	52.39
Alumina (Al_2O_3)	17.69	7.11
Ferrous oxide (FeO)	35.98	14.68
Lime (CaO)	15.98	4.49
Magnesia (MgO)	3.40	21.33
	100.00	100.00

Recalculations of these analyses give the following figures to show the composition of the entire meteorite:

	Per cent.
Silica (SiO_2)	20.64
Alumina (Al_2O_3)	3.55
Ferrous oxide (FeO)	8.88
Magnesia (MgO)	8.08
Lime (CaO)	2.71
Iron (Fe)	49.18
Nickel (Ni)	5.73
Cobalt (Co)	.16
Phosphorus (P)	.08
Iron sulphide (FeS)	.99
	100.00

Specific gravity of mass, 4.484.

This stone is doubtless identical with that of Newton County, Arkansas, described by J. Lawrence Smith in 1865. The 34-gram piece the gift of George F. Kunz.

Reference.—G. F. Kunz, Amer. Journ. Sci., vol. 34, 1887, p. 467. It should be noted that on page 469 of this paper Mr. Kunz made a very obvious error in tabulating the soluble silicate portion as *insoluble*, and vice versa.

MISSHOF, COURLAND, RUSSIA. Nos. 236, 247.

Stone, Cc. Two pieces with crust, weighing, respectively, 45 grams and 109 grams. Weight of original mass, 5,800 grams. Fell on the afternoon of April 10, 1890, at about 4 o'clock. The stone is described by Bruno Doss as an aggregate of chondrules and isolated fragments of olivine and enstatite imbedded in an ash-gray ground of a tufaceous nature. Pyrrhotite and native iron occur in small quantities. There are also present other silicate minerals, as a triclinic feldspar and a monoclinic pyroxene. The rhombic pyroxene is polysynthetically twinned. Chromite occurs in the usual small granular form. A chemical analysis by E. Johanson yielded:

	Per cent.
Silica (SiO_2)	34.96
Alumina (Al_2O_3)	.29
Chromic oxide (Cr_2O_3)	1.368
Tin oxide (SnO_2)	.156
Iron (Fe)	14.806
Nickel (Ni)	1.35
Copper (Cu)	.19
Manganese (Mn)	.276
Ferrous oxide (FeO)	11.85
Manganous oxide (MnO)	4.372
Magnesia (MgO)	19.33
Potash (K_2O)	1.13
Soda (Na_2O)	3.94
Troilite (FeS)	5.75
Pyrrhotite (Fe_7S_8)	.54
Chlorine (Cl)	.007
	100.315

The mineral composition as given is:

	Per cent.
Nickel-iron	17.95
Pyrrhotite	5.82
Silicate soluble in HCl (37 per cent olivine)	46.52
Silicate insoluble in HCl (mainly bronzite)	29.26
Chrome iron	.45
Soluble in water	.12
	100.12

Reference.—B. Doss and E. Johanson, Der Meteorit von Misshof. Arbeiten des Naturforscher-Vereins zu Riga, Heft. 7, 1891.

MISTECA, OAXACA, MEXICO. No. 459.

Iron, Om. Slice 16 by 17 cm., weighing 1,280 grams. From a mass weighing 421 kilograms, or 927 pounds, found about 1804 and first described in 1843. An incomplete analysis by C. Bergemann yielded:

	Per cent.
Iron (Fe)	86.857
Nickel (Ni)	9.917
Cobalt (Co)	.745
Phosphorus (P)	.070
Sulphur (S)	.553
Insol. residue	.975
	99.117

The insoluble residue consisted of carbon, iron, phosphorus, and nickel.

Reference.—C. Bergemann, Pogg. Ann., vol. 100, 1857, p. 246.

MOCS, TRANSYLVANIA, HUNGARY. Nos. 18, 467.

Stone, Cwa. Thirty-six nearly complete individuals weighing from 7 to 86 grams. One fragment with crust, weighing 325 grams, and 19 smaller fragments, weighing 430 grams. Aggregate weight, 1,607 grams. Fell February 3, 1882, at 4 o'clock in the afternoon. This fall was one of the most remarkable on record, the number of fragments being estimated as upward of 3,000, the aggregate weight of which was from 174,113 grams to 300,000 grams, the largest known mass weighing 70,000 grams. The stones were distributed over an area of some 3 by .6 miles, according to Fletcher, or an area of 60 square kilometers, according to Koch. The chemical composition of the stone, according to Koch, is as follows:

	Per cent.	
Iron (Fe)	7.93	9.88
Manganese (Mn)	.57	
Nickel (Ni)	1.38	
Cobalt (Co)	Trace.	
Silica (SiO_2)	42.74	89.63
Alumina (Al_2O_3)	Trace.	
Ferrous oxide (FeO)	20.86	
Manganous oxide (MnO)	1.12	
Magnesia (MgO)	15.95	
Lime (CaO)	2.78	
Soda (Na_2O)	1.20	
Potash (K_2O)	.21	
Lithia (Li_2O)	Trace.	
Sulphur (S)	2.61	
Phosphorus (P)	.41	
Carbon (C) (?)	.19	
Chromite	1.56	
		99.51

Subtracting the sulphur and phosphorus as belonging to troilite and schreibersite, 99.51−1.39=98.12: Soluble in hydrochloric acid, 52.30; insoluble in hydrochloric acid, 47.70.

According to Tschermak's description, the stone is chondritic, of a gray color, flecked with rust spots, and traversed by fine black veins. The mineral composition is olivine, enstatite, diallage, a plagioclase feldspar, chromite, pyrrhotite, metallic iron, and an amorphous black undetermined substance.

References.—A. Koch, Min. pet. Mitth., vol. 5, 1883, p. 234. G. Tschermak, Sitz. Akad. Wiss. Wien., vol. 85, 1882, p. 195.

MODOC, SCOTT COUNTY, KANSAS. Nos. 360, 386.

Stone, Cwa. Two complete individuals, weighing, respectively, 1,170 grams and 2,268 grams, representing the second and fourth largest stones out of a shower of 15 stones having an aggregate weight of 16 kilograms (about 35 pounds), which fell on the night of September 2, 1905, at about 10 p. m. (pl. 25, fig. 2). The fall was observed and described by Mr. J. K. Freed, to whom the United States National Museum is indebted for the two samples here recorded, and from whose account the following has been taken:

The first explosion of the meteorite is said to have occurred when it was about 6 miles due west of Scott City, and to have occasioned a terrific roar plainly heard for a distance of 25 miles, awakening those who had already gone to sleep and frightening people for miles around. Its appearance at the time of the explosion was variously described as like the "headlight of a locomotive," and as a "white light as big as a haystack afire." Eighteen miles south of Scott City it is stated to have occasioned light enough to enable one to pick up a pin. Following the explosion there was a noise compared with the discharge of a heavy battery of artillery or of a heavy wagon running rapidly over the frozen ground, the noise gradually dying away like rolling thunder in the distance. Some claim to have heard the whistling of rocks through the air like bullets or heavy hail, while Mr. Freed himself compared the sound to that of "a mighty swish-h-h, resembling the sound of a sky rocket."

A search extending over a period of several months resulted in the finding of some 15 specimens, as noted above, scattered over an area of 2 by 7 miles in the vicinity of Modoc, a small town on the Missouri Pacific Railroad. These were mostly complete individuals, the largest of which weighed 4,640 grams. They were nearly all covered with dull brown-black crust, as shown in the specimens, showing no appreciable traces of flow structure or perceptible thickening in any part, and the surfaces as a whole are remarkably free from pittings. A broken fracture shows a gray, distinctly chondritic stone with small black veins. The mineral composition is essentially olivine and enstatite, together with metallic iron and troilite. Chondrites inconspicuous on broken surface. Chemical analyses by Wirt Tassin yielded the following results:

	Per cent.
Metallic portion:	
Iron (Fe)	6.56
Nickel (Ni)	.68
Cobalt (Co)	.034
	7.274
Soluble silicate portion:	
Silica (SiO_2)	17.38
Ferrous oxide (FeO)	10.95
Alumina Al_2O_3)	.20
Lime (CaO)	.14
Magnesia (MgO)	17.73
	46.40
Insoluble silicate portion:	
Silica (SiO_2)	26.75
Ferrous oxide (FeO)	4.42
Manganous oxide (MnO)	.10(?)
Alumina (Al_2O_3)	2.27
Lime (CaO)	1.60
Magnesia (MgO)	8.72
Potash (K_2O)	Present, but not determinable.
Soda (Na_2O)	.44
	44.30

The mass composition, as derived from the combination of the several determinations, is:

	Per cent.
Iron (Fe)	6.56
Nickel (Ni)	.68
Cobalt (Co)	.034
Sulphur (S)	1.38
Phosphorus (P)	.051
Silica (SiO_2)	44.13
Ferrous oxide (FeO)	15.37
Manganous oxide (MnO)	.10(?)
Lime (CaO)	1.74
Magnesia (MgO)	26.45
Alumina (Al_2O_3)	2.47
Potash (K_2O)	Trace.
Soda (Na_2O)	.44
	99.40

The mineralogical composition, as calculated from the above summation, is as follows:

	Per cent.
Nickel-iron	4.59
Troilite	3.79
Schreibersite	.34
Olivine	46.40
Enstatite	29.94
Other insoluble silicates	14.36
	99.42

References.—George P. Merrill, Amer. Journ. Sci., vol. 21, 1906, p. 356. O. C. Farrington, Field Col. Mus. Pub. No. 122, Geol Ser., vol. 3, No. 6, 1907, p. 121.

MOLONG, NEW SOUTH WALES, AUSTRALIA. No. 516.

Stony-iron, Pallasite. Roughly broken oxidized fragments weighing 510 grams from a recently found mass as yet undescribed.

Gift of Department of Mines, Sydney, New South Wales.

MONROE (CABARRUS COUNTY), NORTH CAROLINA. No. 268.

Stone, Cga. Fragment with small area of crust, weighing 49 grams, from a mass weighing originally about 8.8 kilograms, or 19½ pounds, which fell on October 31, 1849. The mineral and chemical composition as given by Merrill is as follows:

Silica (SiO_2)	36.71	Silicates 82.60
Alumina (Al_2O_3)	3.59	
Chromic oxide (Cr_2O_3)	Trace.	
Ferrous oxide (FeO)	14.80	
Manganous oxide (MnO)	.23	
Nickel and cobalt oxides (NiOCoO)	.46	
Lime (CaO)	2.27	
Magnesia (MgO)	24.54	

Iron (Fe)	12.58	Metal	13.54
Nickel (Ni)	.87		
Cobalt (Co)	.09		
Iron (Fe)	2.39	Troilite	3.80
Sulphur (S)	1.41		
			99.94

No traces of barium, strontium, lithium, soda, potash, zirconium, or copper could be discovered.

The early analysis by Shepard can scarcely be considered as satisfactory.

References.—C. U. Shepard, Account of three new American meteorites, with observations upon the geographical distribution of such bodies. Proc. Amer. Assoc. Adv. Sci., vol. 3, 1850, p. 147. George P. Merrill, Mem. Nat. Acad. Sci., vol 14, 1916, p. 15.

MOORANOPPIN, 160 MILES EAST OF YORK, WEST AUSTRALIA. No. 415.

Iron, Ogg. Thin slice 5 by 3 cm. by 7 mm. thick; weight 73 grams.

MOORESFORT (TIPPERARY), IRELAND. No. 306.

Stone, Cga or Ccb. Weight, 112 grams; fragment with crust on two sides. Fell in August, 1810. A single mass weighing 3.54 kilograms ($7\frac{3}{4}$ pounds). No satisfactory analysis seems to have been made.

Reference.—William Higgins, Philos. Mag., vol. 38, 1811, p. 262.

MORDVINOVKA, PAVLOGRAD, EKATERINOSLAV, RUSSIA. Nos. 117, 125.

Stone, Cw. Two fragments weighing 5 and 18 grams, respectively. Fell May 19, 1826.

MORRISTOWN, HAMBLEN COUNTY, TENNESSEE. No. 164.

Stony-iron, Grahamite. One piece weighing 1,621 grams. Found in 1887; date of fall unknown. Several fragments were found, weighing altogether some 16,363 grams. Structure peculiar, an uneven network of metallic iron inclosing the silicate minerals. Chemical composition, as shown by Eakins's analyses:

Nickeliferous iron:	Per cent.
Iron (Fe)	90.92
Nickel (Ni)	7.71
Cobalt (Co)	.80
Copper (Cu)	Trace.
Phosphorus (P)	.19
Sulphur (S)	.04
	99.66

Stony portion.

Constituents.	Soluble in HCl.			Insoluble in HCl.		
	Analysis.	Calculated to 100 per cent.	Molecular ratios.	Analysis.	Calculated to 100 per cent.	Molecular ratios.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Silica (SiO_2)	16.79	45.61	0.760	31.47	50.67	0.844
Alumina (Al_2O_3)	8.33	22.62	.222	9.25	14.89	.146
Chromic oxide (Cr_2O_3)				.82	1.32	.009
Ferrous oxide (FeO)	4.88	11.73	.163	6.55	10.55	.147
Nickel oxide (NiO)	.39	1.06	.014			
Manganous oxide (MnO)				.47	.76	.010
Lime (CaO)	5.19	14.09	.252	2.24	3.61	.064
Magnesia (MgO)	1.34	3.64	.091	11.16	17.98	.449
Potash (K_2O)				.02	.03	
Soda (Na_2O)				.12	.19	.003
Phosphoric acid (P_2O_5)	.46	1.25	.009			
Sulphur (S)	.25					
	37.63	100.00		62.10	100.00	

Mineral composition: Nickeliferous iron, enstatite, diallage, anorthite, olivine, oldhamite, lawrencite, troilite, schreibersite. Structure crystalline, sometimes cataclastic; variable. Color dark gray.

Gift of Prof. J. M. Safford.

References.—L. G. Eakins, A new meteorite from Hamblen County, Tennessee. Amer. Journ. Sci., vol. 46, 1893, p. 283. Geo. P. Merrill, On the composition and structure of the Hamblen County, Tennessee, meteorite. Amer. Journ. Sci., vol. 4, 1896, p. 149.

MOTECKA-NUGLA, BHURTPUR, RAJPUTANA, INDIA. No. 92.

Stone, Ck. Thin slice, weighing 3 grams, from a stone which fell December 22, 1868. Original weight not known.

MOUNT BROWNE, NEW SOUTH WALES. No. 478.

Stone, Cc. Irregular piece some 70 by 50 by 50 mm., with crust on two sides. Broken surface gray, faintly rust-spotted. Weight 408 grams. Fell about 9.30 a. m. July 17, 1902. Original weight 25¼ pounds. A fairly firm stone, but breaking easily under the hammer. Metallic grains not very evident. Silicate minerals chiefly enstatite and olivine with perhaps a little feldspar. Analyses of the soluble and insoluble portions yielded as follows:

Portions soluble in warm 5 per cent hydrochloric acid:

	Per cent.
Silica (SiO_2)	28.81
Ferric oxide (Fe_2O_3)	1.03
Ferrous oxide (FeO)	17.09
Ferrous sulphide (FeS)	14.40
Lime (CaO)	.76
Magnesia (MgO)	37.12
Alumina (Al_2O_3) and undetermined	.79
	100.00

Portion insoluble in acid:

Silica (SiO_2)	54.38
Ferric oxide (Fe_2O_3)	Absent.
Ferrous oxide (FeO)	8.73
Alumina (Al_2O_3)	6.58
Chromic oxide (Cr_2O_3)	.50
Lime (CaO)	3.70
Magnesia (MgO)	24.16
Soda (Na_2O)	1.97
Potash (K_2O)	.26
	100.28

Bulk analysis as follows:

Silica (SiO_2)	34.81
Alumina (Al_2O_3)	2.27
Iron (Fe)	28.84
Nickel (Ni)	1.78
Cobalt (Co)	.26
Copper (Cu)	Mere trace.
Tin (Sn)	Absent.
Antimony (Sb)	Absent.
Magnesia (MgO)	23.35
Lime (CaO)	2.24
Soda (Na_2O)	1.17
Potash (K_2O)	.24
Lithia (Li_2O)	Absent.
Manganous oxide (MnO)	Mere trace.
Chromic oxide (Cr_2O_3)	.02
Vanadium oxide (V_2O_3)	Mere trace.
Titanic oxide (TiO_2)	Mere trace.
Barium oxide (BaO)	Absent.
Strontium oxide (SrO)	Absent.
Zirconium oxide (ZrO_2)	Absent.
Chlorine (Cl)	Absent.
Phosphorus (P)	.11
Sulphur (S)	2.02
Carbon (C)	.11
Oxygen (O) by difference	2.78
	100.00

Reference.—Harold P. White, Notes and analysis of the Mt. Browne meteorite. Rec. Geol. Surv. New South Wales, vol. 7, 1900–1904, p. 312.

MOUNT DYRRING, SINGLETON DISTRICT, NEW SOUTH WALES. No. 479.

Stony-iron, Pallasite. Oxidized piece some 70 by 60 by 20 mm., polished on one side. Shows no metallic iron. Weight, 190 grams. Found in 1903 by an aboriginal at Mount Dyrring, 8 miles north of Bridgman. Original weight, 25 pounds. Mineral composition, as determined by George W. Card:

	Per cent.
Olivine	72.00
Nickel-iron	25.00
Schreibersite and troilite	1.00
Al_2O_3 Na_2O_3, etc	2.00
	100.00

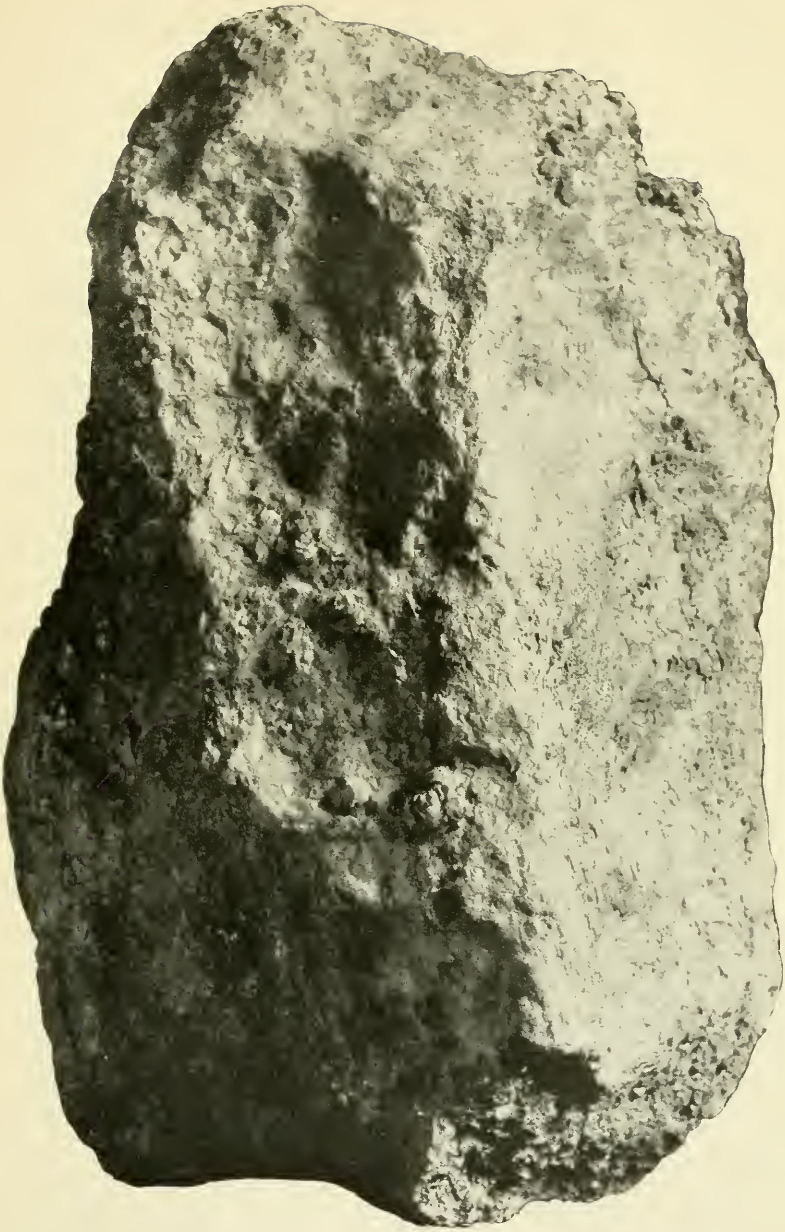
Bulk analysis by John C. H. Mingaye yielded:

	Per cent.
Moisture at 100° C	.82
Water about 100° C	3.89
Silica (SiO_2)	25.64
Alumina (Al_2O_3)	1.32
Ferric oxide (Fe_2O_3)	29.90
Ferrous oxide (FeO)	7.65
Manganous oxide (MnO)	[1] Trace.
Lime (CaO)	.01
Magnesia (MgO)	27.90
Soda (Na_2O)	.14
Potash (K_2O)	[1] Trace.
Nickel protoxide (NiO)	2.11
Cobalt protoxide (CoO)	[1] Trace.
Chromium sesquioxide (Cr_2O_3)	.11
Titanic oxide (TiO_2)	[1] Trace.
Sulphur trioxide (SO_3)	.15
Carbon dioxide (CO_2)	.13
Vanadium oxide (V_2O_3)	Absent.
Copper oxide (CuO)	[2] Trace.
Phosphoric anhydride (P_2O_5)	.51
Chlorine (Cl)	.01
	100.29

No tin detected. Traces of gold, platinum, iridium, and palladium.

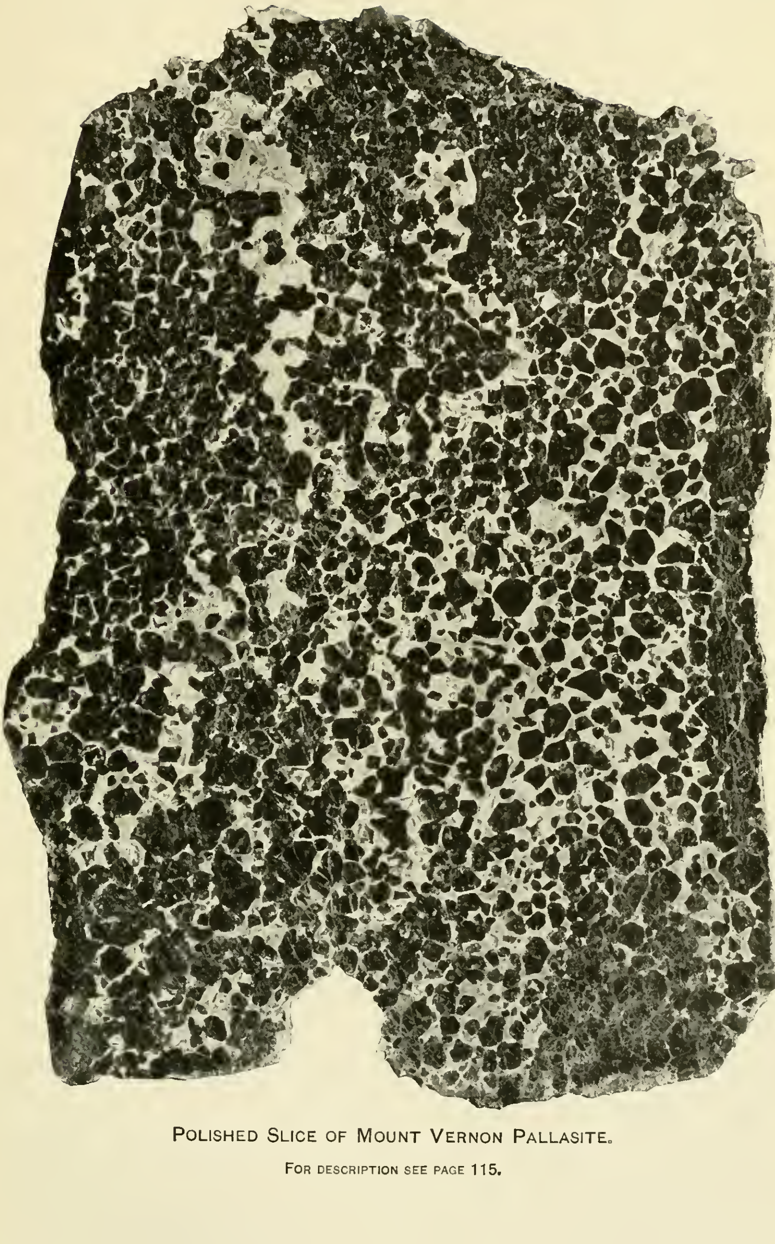
Reference.—J. C. H. Mingaye, Rec. Geol. Surv. New South Wales, vol. 7, 1900–1904, p. 305.

[1] Less than 0.1 per cent. [2] Copper, 0.005.



MOUNT VERNON PALLASITE, AS FOUND.

FOR DESCRIPTION SEE PAGE 115.



POLISHED SLICE OF MOUNT VERNON PALLASITE.

FOR DESCRIPTION SEE PAGE 115.

MOUNT JOY, ADAMS COUNTY, PENNSYLVANIA. Nos. 160, 213, 356.

Iron, Hb. Several pieces weighing 135, 1,330, and 1,765 grams, from a mass weighing 383.5 kilograms, found in 1887. No record of fall. The iron contains so much lawrencite (iron protochloride) that it decomposes rapidly on exposure. An analysis by W. Tassin yielded:

	Per cent.
Iron (Fe)	93. 80
Nickel (Ni)	4. 81
Cobalt (Co)	. 51
Copper (Cu)	. 005
Phosphorus (P)	. 19
Sulphur (S)	. 01
	99.325

Gifts of Edward E. Howell and Jacob Snyder.

Reference.—E. E. Howell, Amer. Journ. Sci., vol. 44, 1892, p. 415.

MOUNT VERNON, CHRISTIAN COUNTY, KENTUCKY. No. 300.

Stony-iron, Pallasite. Nearly complete individual, polished on one face, weighing 288 pounds, or 130.6 kilograms (pls. 27 and 28). Found many years ago but its meteoric origin not recognized until 1902. Complete analyses not available owing to the coarse nature of crystallization. Mineral composition has been estimated as follows:

	Per cent.
Olivine	63. 15
Nickel-iron	33. 12
Schreibersite	1. 95
Troilite	. 69
Chromite	1. 00
Carbon	. 09
Chlorine, abundant traces; not determined.	
	100. 00

The nickel-iron alloy approximates one-third of the mass. Etching shows it to be made up of a dark colored alloy in which are fine lines of a tin-white color (see pls. 27 and 28), which are in part oriented with and in part penetrate the mass in zigzag shapes. Bounding this is a band of bright, white iron, which varies in width from a line to a millimeter.

Examined under the glass the mass of the iron appears to be made up of minute octahedrons arranged in fine lamellæ, and considered as a unit may be defined as a granular octahedrite containing more or less troilite and schreibersite areas.

Two portions of this constituent, each weighing 10 grams, were taken for analysis, with the following results:

	Per cent.
Iron (Fe)	82.520
Nickel (Ni)	14.044
Cobalt (Co)	.949
Copper (Cu)	.104
Sulphur (S)	.288
Silica (SiO_2)	.808
Aluminum (Al)	.410
Carbon (C)	.465
Phosphorus (P)	.390
Chlorine (Cl)	Trace.
	99.978

The tænite occurs in very thin, brittle, tin-white lamellæ, with a specific gravity of 7 at 20.1° C., and has the following composition:

	Per cent.
Iron (Fe)	63.99
Nickel (Ni)	35.98
Cobalt (Co)	.10
Copper (Cu)	Trace.
Phosphorus (P)	.04
	100.11

The material is strongly magnetic, but does not possess polarity.

Schreibersite occurs fairly abundantly, approximating 1.35 per cent of the mass by measurement and 1.95 per cent by analysis. It occurs bounding the olivine areas and occasionally penetrating or contained in them. The more common occurrence is, however, as blebs, veins, or filaments in the nickel-iron constituent. The mineral has a brilliant tin-white color, is strongly magnetic, possessing polarity, and in one instance was undoubtedly crystallized, but, unfortunately, the specimen was so brittle that it fell to pieces on attempting to measure it.

An analysis gave the following:

	Per cent.
Iron	64.990
Nickel	18.905
Cobalt	.105
Phosphorus	15.700
Copper	Trace.
	99.700

Troilite occurs commonly associated with the black specular material lining the cavities containing the olivine in the nickel-iron constituent. It varies in its dimensions from a coating a line in thickness to masses 2 or more millimeters thick by 10 millimeters in length. Grains and flakes of troilite are occasionally contained in masses of the nickel-iron alloy and may then be associated with schreibersite areas. Further, it may occur as isolated grains or flakes and filling cracks in the olivine areas.

The material analyzed was obtained by treating the metallic portion with mercury bichloride, and after its solution separating the troilite and schreibersite from carbon, silicates, etc., with the magnet and from each other by lixiviation. The material thus obtained had a specific gravity of 4.759 at 18° C. and the following composition:

	Per cent.
Iron	62.99
Nickel, Cobalt	.79
Phosphorus	Trace.
Sulphur	36.35
	100.13

The specular material lining the olivine cavities is essentially a graphitic iron containing sulphur and chlorine. The material analyzed was far from being homogeneous, as it was separated mechanically with the aid of a glass. The composition was as follows:

	Per cent.
Iron	84.900
Nickel, Cobalt	5.039
Silica	2.990
Carbon	2.810
Sulphur	1.750
Phosphorus	1.470
Chlorine	.100
Alumina	.940
	99.999

Chromite occurs quite abundantly, varying in size from microscopic grains to a crystal 1 millimeter in diameter. The crystals are more or less perfect octahedrons, rarely modified by other forms, and then only by ∞ 0 (110), as noted in one instance. They are brilliant black in color, with a metallic luster; nonmagnetic; have a specific gravity of 4.49 at 18° C., with the following composition:

	Per cent.
Chromic oxide (Cr_2O_3)	64.91
Alumina (Al_2O_3)	9.85
Magnesia (MgO)	4.96
Ferrous oxide (FeO)	17.97
Silica (SiO_2)	1.38
	99.07

Olivine occurs in more or less rounded masses which, when carefully extracted, show well-marked facets. These are probably not to be referred to any crystal forms, since no zonal relations could be established after repeated measurements. The mineral is commonly brownish in color and only occasionally honey yellow. The blebs are more or less cracked and the cracks filled with foreign material, as graphitic iron, limonite, chromite, etc. Some of the clearest grains, which under the glass were quite free from impurities, were selected for analysis, with the following results:

	Per cent.
Silica (SiO_2)	35.70
Magnesia (MgO)	42.02
Ferrous oxide (FeO)	20.79
Ferric oxide (Fe_2O_3)	.18
Alumina (Al_2O_3)	.42
Manganese (Mn)	.14
Nickel oxide (NiO)	.21
Phosphorus (P)	Trace.
	99.46

Reference.—W. Tassin, Proc. U. S. Nat. Mus., vol. 28, 1905, p. 213.

MUONIONALUSTA, NORTHERN SWEDEN. No. 424.

Iron, Og. Slice weighing 107 grams, from a mass weighing 7.53 kilograms found in 1906. Analysis by R. Mauzelius yielded:

	Per cent.
Iron (Fe)	91.10
Nickel (Ni)	8.02
Cobalt (Co)	.69
Copper (Cu)	.01
Chromium (Cr)	.01
Phosphorus (P)	.05
Carbon (C) and sulphur (S)	Not determined.
	99.88

Nickel-iron was estimated to form 99 per cent of the mass, and troilite and daubreelite 0.2 per cent.

Gift of Geological Museum of Upsala, Sweden.

Reference.—A. G. Högbom, Bull. Geol. Inst. Univ. Upsala, vol. 9, 1908–9, p. 229.

MURFREESBORO, RUTHERFORD COUNTY, TENNESSEE. No. 99.

Iron, Om. Slice, 3.2 by 2 cm. Weight, 57.5 grams. From a mass weighing 8.5 kilograms or 18.7 pounds. Described in 1848. An imperfect analysis by G. Troost yielded:

	Per cent.
Iron	96.00
Nickel	2.40
Insoluble residue	1.60
	100.00

The nickel percentage is low and perhaps due to error in analysis.

Reference.—G. Troost, Amer. Journ. Sci., vol. 5, 1848, p. 351.

NAGAYA, NEAR CONCEPCION, ENTRE RIOS, ARGENTINA. No. 143.

Stone, C. Three and one-half grams, from a stone which fell July 1, 1879.

NANJEMOY, CHARLES COUNTY, MARYLAND. No. 277.

Stone, Cc. Thirteen-gram fragment from the interior of a stone stated to have weighed 16.7 ounces, which fell on February 10, 1825.

NEJED (WADEE BANEE KHALED), CENTRAL ARABIA. No. 241.

Iron, Om. Slice, 9 by 6 cm., weighing 309 grams, from a mass, weighing 59.4 kilograms, found in 1887 and believed to have been seen to fall in 1863. Analysis yielded:

	Per cent.
Iron (Fe)	91.04
Nickel (Ni)	7.40
Cobalt (Co)	.66
Phosphorus (P)	.10
Sulphur (S) and copper (Cu)	Trace.
Residue	.59
	99.79

The residue consisted of carbon and chromite.

Reference.—L. Fletcher, Min. Mag., vol. 7, 1887, p. 179.

NELSON COUNTY, KENTUCKY. No. 54.

Iron, Ogg. Two pieces weighing 215 grams and 370 grams, from a mass weighing 73 kilograms, or 161 pounds, found in 1856. The composition, as determined by J. Lawrence Smith, is:

	Per cent.
Iron (Fe)	93.10
Nickel (Ni)	6.11
Cobalt (Co)	.41
Phosphorus (P)	.05
Copper (Cu)	Trace.
	99.67

Gift of J. Berrien Lindsley.

Reference.—J. L. Smith, Original Researches in Mineralogy and Chemistry, 1884, p. 409. Originally published in Amer. Journ. Sci., vol. 30, 1860, p. 240.

NESS COUNTY, KANSAS. Nos. 226, 227, 250, 259, 260.

Stone, Cib. Twelve nearly complete individuals weighing respectively, 29, 48, 63, 70, 99, 103, 108, 138, 191, 206, 264, 833 grams. From a fall of unknown date, the first example of which was found in 1898.

The total weight of all the known material is nearly 10 kilograms. Analysis by J. E. Whitfield yielded:

	Per cent.
Silica (SiO_2)	38.340
Ferric oxide (Fe_2O_3)	8.551
Alumina (Al_2O_3)	8.259
Chromic oxide (Cr_2O_3)	.587
Lime (CaO)	1.180
Magnesia (MgO)	24.040
Loss on ignition	3.500
Iron (Fe)	13.860
Nickel (Ni)	1.050
Cobalt (Co)	.030
Copper (Cu)	.050
	99.447

References.—G. P. Merrill, Amer. Journ. Sci., vol. 35, 1913, p. 517. H. A. Ward, Amer. Journ. Sci., vol. 7, 1899, p. 233.

NETSHAËVO, GOVERNMENT OF TULA, RUSSIA. No. 494.

Stony-iron, Mesosiderite. A fragment, weighing 13 grams, from a 250-kilogram mass found in 1846. This fragment represents the silicate portion of a mass composed largely of metal, and classed by Brezina as an octahedral iron with crystalline chondrites. It may best be described as an iron with included fragments of silicate minerals in pieces up to a walnut in size. Auerbach's analyses showed it to consist of 72.98 olivine, 16.70 metal, 10.21 plagioclase and augite, 0.11 chromite, and traces of iron sulphide.

Reference.—H. Laspeyres, Zeitschr. Kryst. Min., vol. 24, 1895, p. 495.

NEW CONCORD, MUSKINGUM COUNTY, AND GUERNSEY COUNTY, OHIO. Nos. 2, 62, 324, 339, 367.

Stone, Cia. Three broken masses and two complete individuals, weighing 21, 196, 554, 1,720, and 2,841 grams. From a fall on May 1, 1860, comprising over 30 stones, the largest of which weighed 209 kilograms (460¾ pounds), and the aggregate weight of which was 350 kilograms (770 pounds).

This is one of the most remarkable and interesting of American falls, not merely on account of the size and number of the stones, but because of the large number of witnesses and consequently the amount of reliable data concerning it. It is well to note that though some of the stones were gathered up immediately they were not warmer than though they had been lying in the sun, and a 51-pound mass buried itself in the ground to a depth of but about 2 feet. As determined by J. Lawrence Smith, the mineral composition is:

	Per cent.
Nickel-iron	10.690
Schreibersite	.005
Magnetic pyrites	.005
Olivine	56.884
Pyroxene	32.416
	100.000

The chemical composition as determined by the same authority is:

	Per cent.
Silica (SiO_2)	41.73
Alumina (Al_2O_3)	.28
Ferrous oxide (FeO)	24.72
Magnesia (MgO)	21.64
Lime (CaO)	.02
Soda (Na_2O), Potash (K_2O)	.92
Iron (Fe)	9.23
Nickel (Ni)	1.31
Cobalt (Co)	.04
Sulphur (S)	.11
Manganese (Mn)	Trace
	100.00

In part, gifts of E. B. Andrews (No. 2), Jas. Greer (No. 324), and J. B. Lindsley (No. 62).

Reference.—J. L. Smith, Amer. Journ. Sci., vol. 31, 1861, p. 87.

NOWO-UREI, KRASNOSLOBODSK, PENSA, RUSSIA. No. 307.

Stone, Cu. Weight, 83 grams. Fragment with crust; fell September 22, 1886. Three stones fell, one of which was not recovered, having fallen in a marsh; a second passed into the hands of a countryman, and its weight not determined. The third, which passed into the possession of the mineral cabinet of the Institute of Forestry, St. Petersburg, weighed 1.9 kilos. The stone contains carbon in both the amorphous form and that of microscopic diamond, and is therefore of unusual interest.

A bulk or mass analysis yielded:

	Per cent.
Iron (Fe)	5.25
Nickel (Ni)	.20
Ferrous oxide (FeO)	13.35
Manganous oxide (MnO)	.43
Alumina (Al_2O_3)	.60
Chromic oxide (Cr_2O_3)	.95
Magnesia (MgO)	35.80
Lime (CaO)	1.40
Sulphur (S)	.15
Phosphorus (P)	.02
Silica (SiO_2)	39.51
Carbon (C) amorphous	1.26
Carbon (C) as diamond	1.00
	99.92

The chemical composition of the individual constituents is given as follows:

Constituents.	Olivine.	Augite.	Total.
	Per cent.	*Per cent.*	*Per cent.*
Magnesia (MgO)	28. 35	7. 42	35. 77
Lime (CaO)	. 86	. 55	1. 41
Ferrous iron (FeO)	11. 38	1. 70	13. 08
Manganous oxide (MnO)	. 34	. 09	. 43
Alumina (Al_2O_3)	....	. 60	. 60
Silica (SiO_2)	26. 43	13. 21	39. 67
Total silicate portion	67. 36	23. 57	90. 96
Nickel-iron (NiO, 20%)			5. 47
Iron sulphide			. 43
Chromic iron			65
Amorphous carbon			1. 26
Diamonds			1. 00
			99. 77

Reference.—M. Jerofeieff and P. Latschinoff. Der Meteorit von Nowo-Urei. Verh. russ.-kais. Min. Ges., vol. 24, 1888, p. 263.

OAKLEY, LOGAN COUNTY, KANSAS. No. 243.

Stone, Cka. Weight 320 grams; date of fall unknown; found in 1895 at a depth of about 1 meter below the surface. Original weight 61 pounds 10 ounces (28 kilograms). Mechanical analysis showed it to consist of:

	Per cent.
Iron (Fe)	12. 76
Nickel (Ni) and Cobalt (Co)	1. 68
Silicates	85. 56
	100. 00

J. M. Davison found the metallic portion to consist of:

	Per cent.
Iron (Fe)	89. 16
Nickel (Ni)	10. 84
	100. 00

The structure is described as chondritic, closely resembling that of Pipe Creek, Bandera County, Texas. The mineral composition is olivine, enstatite, pyrrhotite, and metallic iron, with possibly a lime-soda feldspar.

Reference.—H. L. Preston, On a new meteorite from Oakley, Logan County, Kansas, with notes on microscopic structure by G. P. Merrill. Amer. Journ. Sci., vol. 9, 1900, p. 410.

OBERNKIRCHEN, SCHAUMBURG-LIPPE, GERMANY. No. 87.

Iron, Of. Slice, weighing 152 grams, from a mass weighing 41 kilograms found in 1863. Date of fall unknown. Chemical analysis by Fahrenhorst yielded:

	Per cent.
Iron (Fe)	92.45
Nickel (Ni)	7.55
Cobalt (Co)	.83
Copper (Cu)	.02
Chromium (Cr)	.01
Sulphur (S)	.01
Phosphorus (P)	.12
Chlorine (Cl)	.02
	101.01

The mineral composition, as calculated from the analysis, is:

	Per cent.
Nickel-iron	99.16
Schreibersite	.77
Lawrencite	.05
Troilite	.02
	100.00

Reference.—E. Cohen, Meteoritenkunde, pt. 3, 1905, p. 363.

OCHANSK (TABORG), PERM, RUSSIA. No. 116.

Stone, Ccb. Two fragments, weighing 19 and 142 grams, from a shower which fell on August 30, 1887. Aggregate weight of fall uncertain. Known weight, 169,203 grams. The stone has not been analyzed as a whole, but is of interest in that it has been stated to carry the iron sulphide in the form of crystallized pyrite. The correctness of this identification has, however, been questioned.

Reference.—Julian v. Siemaschko, Tschermak's Min pet. Mitth., vol. 11, 1890, p. 87.

OESEL, LIVONIA, RUSSIA. No. 178.

Stone, Cw. Fragment with crust, weighing 13 grams, from a shower comprising some 6 kilograms which fell on May 11, 1855.

ORANGE RIVER, SOUTH AFRICA. No. 79.

Iron, Om. Irregular fragment 4 by 5 by 1 cm., weighing 99 grams, from a mass weighing 148½ kilograms, first known in 1855; described in 1856.

ORGUEIL, MONTAUBAN, TARN-ET-GARONNE, FRANCE. Nos. 234, 388.

Stone, K. Weights, 61 and 98 grams. Fragment with crust and nearly complete individual. Fell on the evening of May 14, 1864, a few minutes after 8 o'clock, the fall being accompanied by the usual phenomena. Over 20 stones fell, weighing in the aggregate some 11,523 grams.

This is one of the most interesting of carbonaceous meteorites, but perfectly satisfactory analyses are lacking. The stone is described as a black, porous, friable mass, falling to pieces in water. Cloez found it to contain 21.33 per cent water and organic matter. The mineral composition as calculated from his analysis would be, exclusive of the organic matter: Nickel-iron, 17.58; pyrrhotite, 11.62; chromite 0.35; and mixed silicates, 41.91. In detail his results are as follows on material dried at 110° C, the loss under this treatment being 5.975:

	Per cent.
Silica (SiO_2)	26.031
Sulphuric acid (SO_3)	2.3345
Sulphur (S)	4.6466
Chlorine (Cl)	.0776
Phosphorus (P)	Traces.
Alumina (Al_2O_3)	1.2498
Chromic oxide (Cr_2O_3)	.2392
Ferric oxide (Fe_2O_3)	14.2360
Ferrous oxide (FeO)	19.0630
Nickel oxide (NiO)	2.6057
Cobalt oxide (CoO)	.0904
Manganous oxide (MnO)	1.9302
Lime (CaO)	2.322
Magnesia (MgO)	8.6711
Soda (Na_2O)	1.323
Potash (K_2O)	.3265
Ammonia (NH_4OH)	.1042
Humic substance	6.41
Combined water	7.812
	99.4728

M. Pisani gives results as follows (the material likewise dried at 110° C.):

	Per cent.
Silica (SiO_2)	26.08
Magnesia (MgO)	17.00
Protoxide of iron (FeO)	7.78
Lime (CaO)	1.85
Soda (Na_2O)	2.26
Potash (K_2O)	.19
Oxide of manganese	.36
Alumina (Al_2O_3)	.90
Chrome-iron	.49
Magnetite	15.77
Sulphide of iron	13.43
Water and supposed organic matter	13.89
	100.00

According to Des Cloizeaux the stone contains small crystals of a carbonate of magnesia and iron corresponding to the formula (Mg Fe) CO_3, which is that of the mineral breunnerite. The exact character of the carbonaceous material is still in doubt. Cloez regarded it as a humus compound. This J. Lawrence Smith was disposed to doubt, but thought it more nearly allied to the so-called hydrated carbon obtained by Schutzenbergen and Bourgeois from white cast iron.

References.—M. Cloez, Compt. Rend., vol. 58, 1864, pp. 986–988, and vol. 59, 1864, p. 37. M. Pisani, Compt. Rend., vol. 59, 1864, p. 132. J. L. Smith, Original Researches in Mineralogy and Chemistry, 1884, p. 506.

ORVINIO, UMBRIA, ITALY. No. 308.

Stone, Co. Fragment weighing 53 grams. Fell about 5.15 on the morning of August 31, 1872. Six stones found, weighing respectively 4.75, 92, 432, 622, 1,003, and 1,242.5 grams—a total of 3,396 grams. The stone is remarkable in consisting of rounded pebble-like masses embedded in a dense paste or ground of essentially the same composition, as shown by the analyses given below, column I being that of the pebbles and column II that of the groundmass:

Constituents.	I.	II.
	Per cent.	*Per cent.*
Silica (SiO_2)	38.01	36.82
Alumina (Al_2O_3)	2.22	2.31
Iron oxide (FeO)	6.55	9.41
Magnesia (MgO)	24.11	21.69
Lime (CaO)	2.33	2.31
Soda (Na_2O)	1.46	.96
Potash (K_2O)	.31	.26
Sulphur (S)	1.94	2.04
Iron (Fe)	22.34	22.11
Nickel (Ni)	2.15	3.04
	101.42	100.95

Specific gravity of pebbles 3.675 and of groundmass 3.60. The mineral composition as determined from these analyses by L. Sipöcz is as below:

Constituents.	I.	II.
	Per cent.	*Per cent.*
Metallic iron	18.54	18.94
Metallic nickel	3.04	2.15
Metallic cobalt	Trace.	Trace.
Iron sulphide	5.61	5.34
Silicate	77.76	74.99
Chromite	Trace.	Trace.
	104.95	101.42

Reference.—G. Tschermak, Sitz. Akad. Wiss. Wien, vol. 70, 1874, p. 459.

OSCURO MOUNTAIN, NEW MEXICO. No. 214.

Iron. Og. Weight, 243.7 grams; in two pieces, weighing 140.2 grams and 103.5 grams, respectively, with original and etched surfaces. Date of fall unknown. Found December, 1895. Originally three pieces, weighing 3½, 3¼, and 1½ pounds, or, altogether, 8¼ pounds (3.7 kilograms). Composition as given by R. C. Hills:

	Per cent.
Iron (Fe)	90.79
Nickel (Ni)	7.66
Cobalt (Co)	.57
Phosphorus (P)	.27
Carbon (C) (graphite)	.07
	99.36

Reference.—R. C. Hills, Proc. Colo. Sci. Soc., vol. 6, 1897, pp. 30–33.

PACULA, JACALA, HIDALGO, MEXICO. No. 242.

Stone, Cwb. Weight, 23 grams. Fell July 18, 1881. Three pieces found, weighing in the aggregate 3,361 grams. Light ash-gray groundmass, flecked with rust spots. Indistinctly veined.

PARNALLEE, NEAR MADURA, MADRAS, INDIA. No. 3.

Stone, Cga. Fragment with crust, weighing 87 grams, from one of two stones weighing together 74 kilograms (163 pounds), which fell February 28, 1858, 12 m. This meteorite has been widely distributed and made the subject of much research, though the chemical analysis given below can not be considered exhaustive. Meunier has recognized in it fragments thought to represent seven different types of meteoric stones. Chemical analysis by E. von Pfeiffer yielded:

	Per cent.
Silica (SiO_2)	39.48
Alumina (Al_2O_3)	2.58
Ferrous oxide (FeO)	15.28
Magnesia (MgO)	22.82
Lime (CaO)	.56
Soda (Na_2O)	1.91
Potash (K_2O)	.55
Iron (Fe)	9.83
Nickel (Ni)	.90
Cobalt (Co)	.06
Sulphur (S)	2.71
Phosphorus (P)	.10
Manganous oxide (MnO)	.54
Nickel oxide (NiO)	.72
Cobalt oxide (CoO)	.06
	98.10

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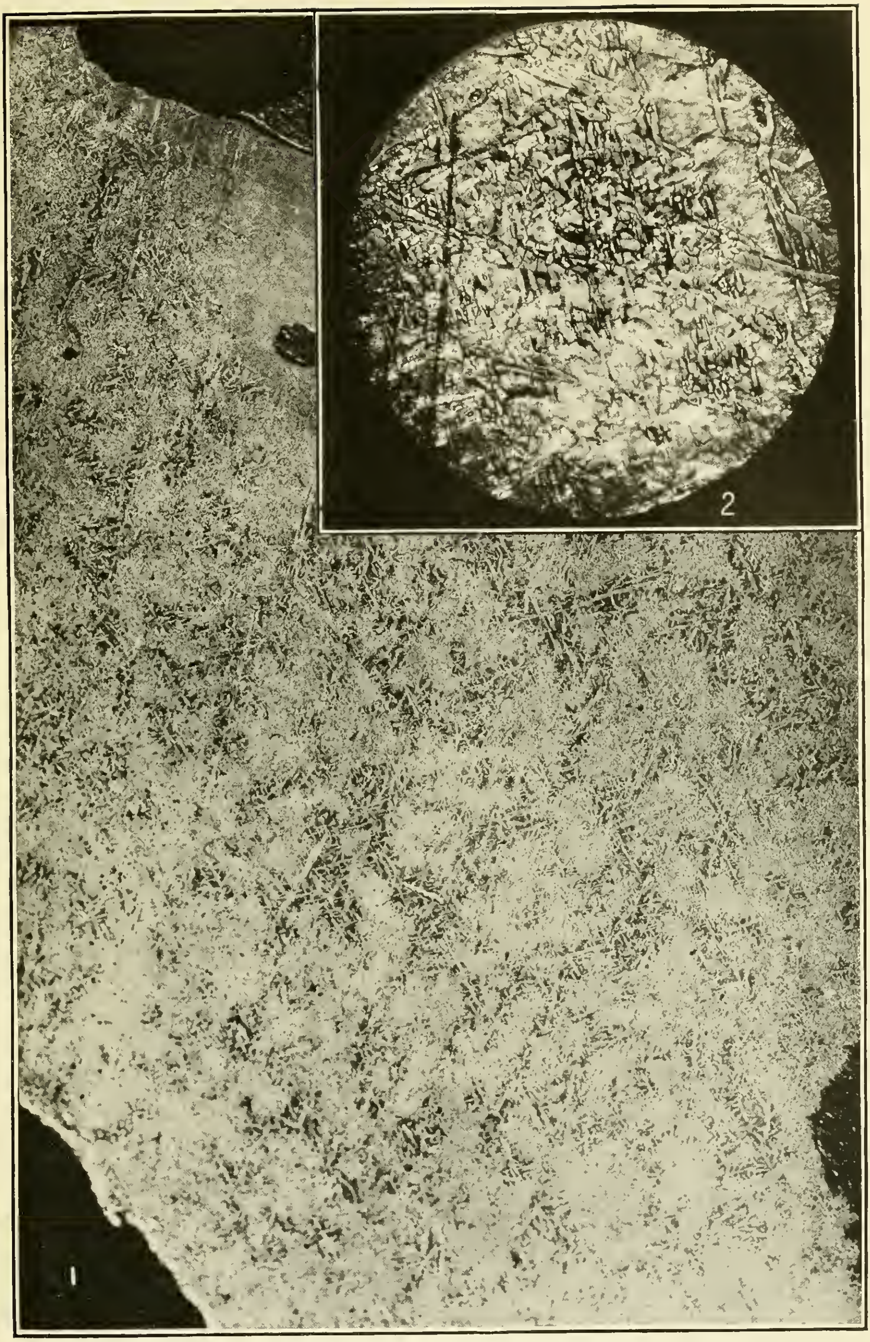
FRONT AND REVERSE OF PERRYVILLE IRON, AS FOUND.

FOR DESCRIPTION SEE PAGE 127.



ETCHED SURFACES OF PERRYVILLE IRON.

FOR DESCRIPTION SEE PAGE 127.

Gift of C. A. Young.

Reference.—E. von Pfeiffer, Sitz. Akad. Wiss. Wien, vol. 47, 1863, p. 460.

PERRYVILLE, PERRY COUNTY, MISSOURI. No. 428.

Iron, Off. Nearly complete individual weighing when received 17.386 kilograms, or about 38¼ pounds. (Pls. 29 and 30.) Two surfaces etched. Original weight estimated to have been 17.5 kilograms. Found August, 1906. Date of fall unknown. The iron is noted for its extreme, fine crystallization. Analysis by Whitfield yielded results as below:

	Per cent.
Iron (Fe)	89.015
Nickel (Ni)	9.660
Cobalt (Co)	.545
Copper (Cu)	.025
Manganese (Mn)	None.
Phosphorus (P)	.365
Sulphur (S)	.002
Silicon (Si)	.003
Carbon (C)	.015
Ferric oxide (Fe_2O_3)	.370
Iridium	Traces.
Palladium	
Platinum	
Ruthenium	
	100.00

Specific gravity, 7.61.

This iron is of interest on account of the careful search made for the rarer elements, of which iridium, palladium, platinum, and ruthenium were found in traces, the last named being reported for the first time. The schreibersite separated out in process of analysis yielded:

	Per cent.
Phosphorus (P)	14.00
Iron (Fe)	51.10
Nickel (Ni)	34.13
Cobalt (Co)	.30
	99.53

Reference.—G. P. Merrill, Proc. U. S. Nat. Mus., vol. 43, 1912, pp. 595–597.

PERSIMMON CREEK, CHEROKEE COUNTY, NORTH CAROLINA. No. 318.

Iron, Offb. Nearly complete mass, one surface polished, weighing 8 pounds 3 ounces. Original weight as found in 1893, 11 pounds 3 ounces, or a trifle over 5 kilograms (pl. 31). Nothing known as to date of fall. A brecciated mass of variously oriented fragments of octahedral iron and iron phosphide, cemented by iron sulphide, with interstitial carbon and silicates.

References.—W. Tassin, Proc. U. S. Nat. Mus., vol. 27, 1904, p. 955. C. Klein, Sitz. preuss. Akad. Wiss., vol. 16, 1904, p. 572.

PETERSBURG, LINCOLN COUNTY, TENNESSEE. No. 438.

Stone, Ho. A ten-gram fragment with crust, from a stone weighing 1,764 grams which fell August 5, 1855.

PIPE CREEK, BANDERA COUNTY, TEXAS. No. 205.

Stone, Cka. Weight, 168 grams. A polished section showing brown-black compact groundmass indistinctly chondritic; date of fall unknown; found December, 1887. Weight of original mass 13.5 kilograms. Partial analyses by Ledoux yielded:

	Per cent.
Metallic portion	30.89
Silicate portion	69.11
	100.00

The metallic portion yielded:

	Per cent.
Iron (Fe)	90.94
Nickel (Ni)	9.00
	99.94

The mineral composition, so far as determined, is olivine, enstatite, pyrrhotite, and iron.

Reference.—A. R. Ledoux, Trans. New York Acad. Sci., vol. 8, 1888–89, p. 186.

PLYMOUTH, MARSHALL COUNTY, INDIANA. No. 203.

Iron, Om. Weight, 182 grams. Polished slab 5.5 by 5.5 by. 0.7 cm. Date of fall unknown. Found 1893 (1883?). Original weight not given. Size, 12½ inches long by 7 inches thick. A larger mass found in same locality in 1872 was buried and has not since been found. Analysis by J. M. Davison yielded:

	Per cent.
Iron (Fe)	88.67
Nickel (Ni)	8.55
Cobalt (Co)	.66
Copper (Cu)	.24
Phosphorus (P)	1.25
Graphite (C)	.11
Sulphur (S)	.07
	99.55

Reference.—H. A. Ward, Amer. Journ. Sci., vol. 49, 1895, p. 53.

PRICETOWN, HIGHLAND COUNTY, OHIO. No. 192.

Stone, Cw. Two and one-half gram fragment with dull, papillated, and blebby crust, found February 13, 1893. Gift of F. W. Clarke.

PULTUSK (BETWEEN PULTUSK AND OSTROLENKA), ON THE NAREW, POLAND, RUSSIA. Nos. 17, 463.

Stone, Cg. Four complete individuals, weighing 12, 25, 43, and 158 grams, with dull black papillated and somewhat pitted crust, and over 100 smaller forms broken and showing portion of interior, weighing, in the aggregate, upward of 1,000 grams. Fell January 30, 1868, at 7 p. m. The fall is one of the most remarkable on record, on account of the extraordinary number of stones, estimated as some 100,000, varying in weight from 7 kilograms to 1 gram. Of this material, some 200,932 grams are represented in the various collections of the world. Chemical analyses by vom Rath are not all that could be desired, owing to incomplete separations of the metallic and silicate portions. The results given are as follows:

Constituents.	Nickel iron.	Constituents.	Nonmagnetic portion.
	Per cent.		*Per cent.*
Sulphur (S)	0.20	Chromite (Cr_2O_3, FeO)	0.34
Phosphorus (P)	Trace.	Sulphur (S)	2.14
Iron (Fe)	86.84	Iron (Fe)	3.29
Nickel (Ni)	6.44	Silica (SiO_2)	46.17
Magnesia (MgO)	1.61	Alumina (Al_2O_3)	1.20
Insoluble	3.40	Magnesia (MgO)	29.53
		Lime (CaO)	.31
		Ferrous oxide (FeO)	15.25
		Manganese (Mn)	.54
		Soda (Na_2O)	1.46
	98.49		100.23

The silicate analyses yielded:

Constituents.	47.16 % soluble.	52.84 % insoluble.
	Per cent.	*Per cent.*
Silica (SiO_2)	32.5	60.01
Alumina (Al_2O_3)	.6	1.7
Lime (CaO)	.0	.6
Magnesia (MgO)	35.8	24.8
Iron and manganese oxides	22.8	10.00
Soda (Na_2O)	....	2.8
Sulphur (S)	3.1	....
Iron (Fe)	4.8	....
	99.6	99.91

Wadsworth describes the stone as consisting of a light-gray chondritic mass containing grains of iron and pyrrhotite in a groundmass composed of olivine, enstatite, and some diallage.

References.—G. vom Rath, Festschrift d. Niederrhein. Ges. Nat.-u. Heilkunde zum 50 jähr. Jubiläum der Univers. Bonn, 1868. Review Neues Jahrb. Min., Geol. Pal., 1869, p. 80. M. E. Wadsworth, Lithological Studies, 1884, p. 94.

PUQUIOS, CHILE. No. 153.

Iron, Om. Two slices, weighing 10.3 and 17.7 grams, respectively, from a mass weighing 6½ kilograms, found in 1885. Gift of Ward and Howell.

PUTNAM COUNTY, GEORGIA. Nos. 51, 264.

Iron, Of. Found in 1839; date of fall unknown. Two pieces; one of 328 grams, somewhat oxidized, but showing cleavage plates separated by taenite, and one 10 cm. by 19 cm. by 25 cm., weighing 2,455 grams, with one face etched, showing small troilite nodule and a cleavage octahedron on one side (pl. 31). Composition, as shown by analyses of R. Knauer and O. Bürger, as follows:

	Per cent.
Iron (Fe)	90.28
Nickel (Ni)	7.89
Cobalt (Co)	.79
Copper (Cu)	.07
Chromium (Cr)	.17
Sulphur (S)	.25
Phosphorus (P)	.11
	99.56

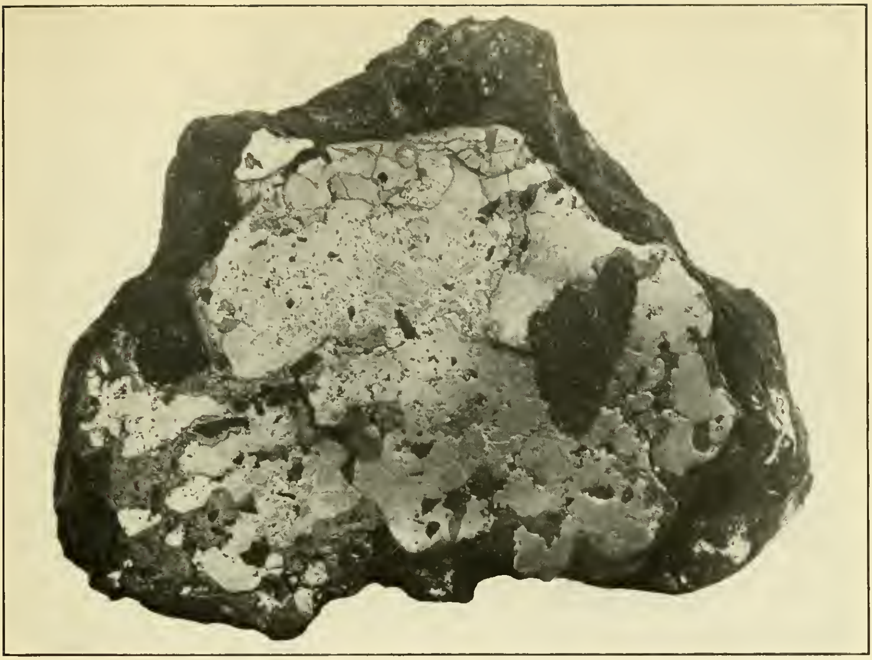
Considering the chromium as a constituent of the mineral daubreelite, the following is given as the probable mineral composition of the mass: Nickel-iron, 98.69; schreibersite, 0.73; daubreelite, 0.47; troilite, 0.11.

References.—J. E. Willet, Amer. Journ. Sci., vol. 17, 1854, p. 331. E. Cohen, Meteoritenkunde, pt. 3, 1905, p. 345.

QUENGGOUK, BASSEIN DISTRICT, PEGU, BRITISH BURMA. No. 452.

Stone, Cc. Fragments, weighing 17 grams, from one of three fragments which fell December 27, 1857. This fall is of interest in that the stone broke so low in the atmosphere that the fractured surfaces were not all re-fused, and the three pieces could be fitted together, proving their common origin.

Reference.—M. W. Haidinger, Das Meteor von Quenggouk, etc., Sitz. Akad. Wiss. Wien, vol. 44, 1861, p. 637.



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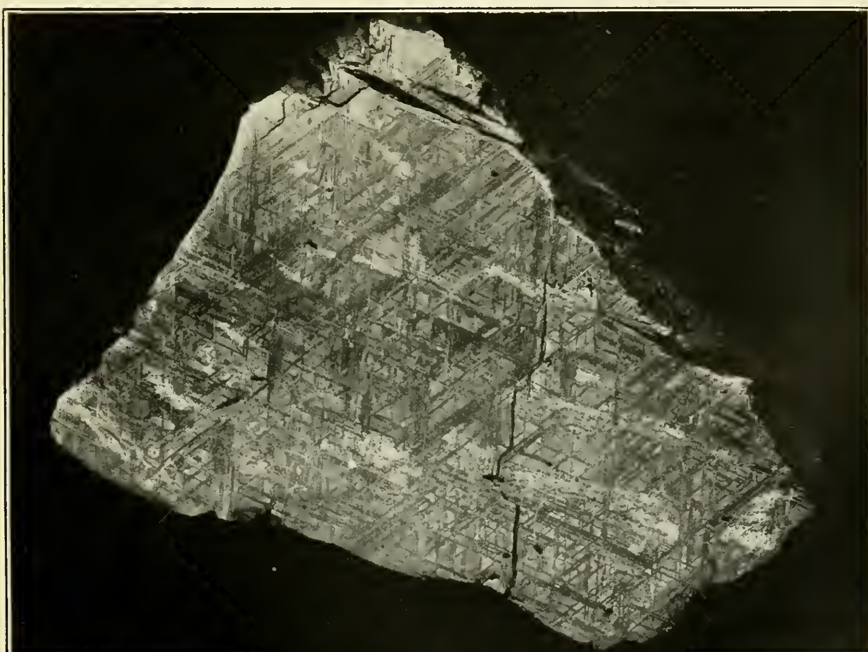
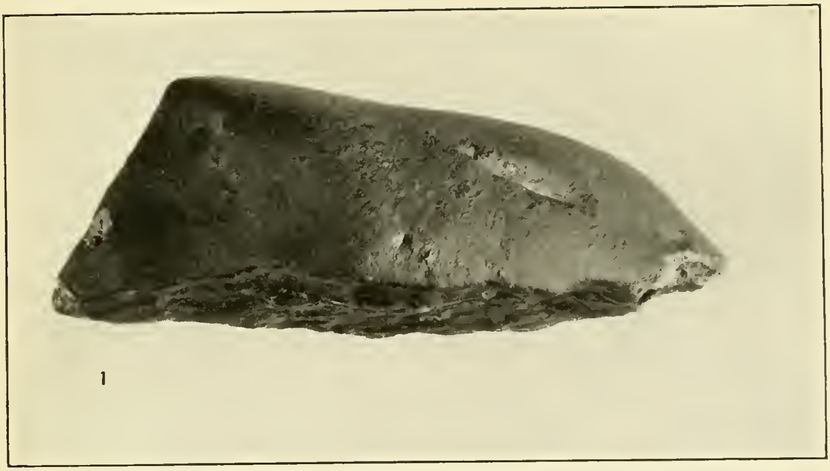


2

POLISHED SURFACE OF (1) PERSIMMON CREEK AND (2) OF PUTNAM COUNTY IRONS.

FOR DESCRIPTIONS SEE PAGES 127 AND 130.



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2

TWO VIEWS OF THE RICH MOUNTAIN STONE.

FOR DESCRIPTION SEE PAGE 132.

RAFRUTI IN THE EMMENTHAL, CANTON BERN, SWITZERLAND. No. 251.

Iron, Dn. Weight, 23 grams. Thin slice, 3 cm. by 3 cm., etched. Fell in 1856, according to researches of Dr. E. von Fellenberg. Weight of original mass, 18.2 kilograms.

Reference.—E. v. Fellenberg, Centr. Min. Geol. Pal., No. 5, 1900, pp. 152–158.

RANCHITO, NEAR BACUBIRITO, SINALOA, MEXICO. Nos. 162, 392.

Iron, Off. Two rough pieces with polished surfaces; weight, 177 and 619 grams; fragment with original and etched surfaces, weighing 14 grams. Date of fall unknown; found in 1871. Weight of the original mass not accurately known. It was stated by Barcena [1] to be not less than 12 feet in length. Castillo, as quoted by Fletcher,[2] gives its dimensions as 3.65 by 2.0 by 1.5 meters, which would indicate that it would weigh not far from 50,000 kilograms. Ward gives the extreme dimensions as 13 feet 1 inch by 6 feet 2 inches by 5 feet 4 inches, and estimates its weight as 50 tons (!). (See cast No. 435.) Analyses by Cohen and Hildebrand yielded:

	Per cent.
Iron (Fe)	89.54
Nickel (Ni)	9.40
Cobalt (Co)	.98
Copper (Cu)	.02
Chromium (Cr)	.02
Phosphorus (P)	.12
Sulphur (S)	.02
Carbon (C)	.01
Chlorine (Cl)	.02
	100.13

The mass still lies where it fell in western Mexico, but has been protected from vandalism by the building over it of a stone house with doors of iron grating, through which the occasional visitor may view the monster.

References.—H. A. Ward, Proc. Rochester Acad. Sci., vol. 4, 1902, p. 67. E. Cohen, Mitt. nat. Ver. Neu-Vorpommern u. Rügen, vol. 35, 1903.

RASGATA (TOCAVITA), PROVINCE OF BOYACA, COLOMBIA, SOUTH AMERICA. No. 457.

Iron, Ds. Irregular slice some 155 by 80 by 8 mm., with elongated cone of troilite. Weight, 645 grams. From a mass obtained by H. A. Ward from Museum at Bogota, Colombia, in 1906.

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[1] Proc. Acad. Nat. Sci. Phila., 1876, p. 122.
[2] Min. Mag., vol. 9, 1900, p. 151.

REED CITY, OSCEOLA COUNTY, MICHIGAN. No. 316.

Iron, Om. Triangular piece, some 18 by 18 cm., weighing 263 grams. From a mass weighing 19.8 kilograms, or 43 pounds 11 ounces, found in 1895. A chemical analysis by J. E. Whitfield yielded: Iron, 89.386; nickel, 8.180.

Reference.—H. L. Preston, Proc. Rochester Acad. Sci., vol. 4, 1903, p. 89.

RHINE VILLA (RHINE VALLEY?), SOUTH AUSTRALIA. No. 272.

Iron, Om. Section weighing 118 grams, found in 1901.

RICH MOUNTAIN, JACKSON COUNTY, NORTH CAROLINA. No. 362.

Stone, Cia. Weight, 179 grams. End of mass, showing one surface smooth sawn, one fractured surface with thin crust, and old surface with thicker crust (pl. 32). Weight of entire mass, so far as found, 668 grams. This, however, was plainly a fragment from a larger stone. Supposed to have been a portion of a fall which took place about June 20, 1903. Mineral composition, olivine, monoclinic and orthorhombic pyroxenes, and maskelynite, with the usual metallic and sulphide grains. Composition, as determined by W. Tassin, is as follows:

	Per cent.
Iron	7.070
Nickel	.730
Cobalt	.031
Troilite	3.890
Schreibersite	.200
Olivine	46.990
Insoluble silicates	40.670
Magnetite	.150
Graphite	.015
	99.746

Reference.—G. P. Merrill, Proc. U. S. Nat. Mus., vol. 32, 1907, p. 241.

ROCHESTER, FULTON COUNTY, INDIANA. No. 44.

Stone, Cc. Weight, 2 grams. Fragment with crust. Fell a little before 9 p. m. December 21, 1876, passing eastward over the states of Kansas, Missouri, Illinois, Indiana, and Ohio, the length of its observed track being from 1,000 to 1,100 miles. In various parts of its track it threw off fragments accompanied with the usual rumbling noise and commotion in the atmosphere common to the flight of these bodies. When crossing Indiana the main body was followed by a train of smaller bodies, many of them of the apparent size of Venus or Jupiter. Its velocity in reference to the earth's surface appeared to be from 8 to 12 miles a second. The pyrotechnic display is said to have been transcendently beautiful, hardly equaled or surpassed by any previous occurrence of the kind. But one fragment fell to the ground, so far as known. This did not weigh over 400 grams. Analyses by J. Lawrence Smith yielded:

Constituents.	Soluble in HCl.	Insoluble in HCl.
	Per cent.	*Per cent.*
Silica (SiO_2)	34.55	57.81
Iron protoxide (FeO)	27.75	11.04
Alumina (Al_2O_3)	Trace.	.23
Lime (CaO)	Trace.	5.31
Magnesia (MgO)	36.38	24.97
Chromic oxide (Cr_2O_3)	....	.10
Soda (Na_2O)	.46	.84
	99.14	100.30

The metallic portion yielded:

	Per cent.
Iron (Fe)	94.49
Nickel (Ni)	4.12
Cobalt (Co)	.51
	99.12

From the results were calculated the mineral proportions as follows:

	Per cent.
Bronzite and pyroxenic minerals	46.00
Olivine	41.00
Nickel-iron	10.00
Troilite	3.00
Chromite	.15
	100.15

Reference.—J. L. Smith, Amer. Journ. Sci., vol. 14, 1877, p. 219.

RODEO, DURANGO, MEXICO. No. 357.

Iron, Om. Etched slab about 20 by 17 cm., weighing 1,782 grams. From a mass weighing 44.1 kilograms. Found about 1852 and now in the Field Museum, Chicago. Analysis by H. W. Nichols yielded:

	Per cent.
Iron (Fe)	89.84
Nickel (Ni)	8.79
Cobalt (Co)	.28
Copper (Cu)	.07
Phosphorus (P)	.80
Sulphur (S)	.02
Carbon (C)	.09
	99.89

Reference.—O. C. Farrington, Field Col. Mus. Publ. 101, Geol. Ser., vol. 3, No. 1, 1905.

ROEBOURNE (about 200 miles southeast of), NORTHWEST AUSTRALIA. Nos. 453, 490.

Iron, Om. Slice 50 by 50 mm., weighing 237 grams, and slice 60 by 80 mm., weighing 145 grams, gift of F. Hess. From a mass weighing 191.5 pounds, or 86.8 kilograms, found in 1894. The chemical composition as determined by Mariner and Haskins is:

	Per cent.
Iron (Fe)	90.914
Nickel (Ni)	8.330
Cobalt (Co)	.590
Phosphorus (P)	.156
Sulphur (S)	Trace.
Manganese (Mn)	?Trace.
Silicon (Si)	.01
Carbon (C)	Trace.
	100.00

Specific gravity, 7.78.

Reference.—H. A. Ward, Amer. Journ. Sci., vol. 5, 1898, p. 135.

ROWTON, WELLINGTON, ENGLAND. No. 86.

Iron, Om. Slice 4.2 by 1.2 cm. weighing 19.5 grams, from a mass weighing 3.5 kilograms or 7¾ pounds, which fell on April 20, 1876. Composition as shown by analysis:

	Per cent.
Iron (Fe)	91.250
Nickel (Ni)	8.582
Cobalt (Co)	.371
Copper (Cu)	Trace.
	100.203

The iron sulphide was also analyzed and found to be troilite. Gas was determined to the amount of 6.38 times the bulk of the iron, having the following composition:

	Per cent.
Carbonic acid (CO_2)	5.155
Hydrogen (H)	77.778
Carbon monoxide (CO)	7.345
Nitrogen (N)	9.722
	100.000

The great interest in this iron lies in the fact that it is one of the nine irons which have been seen to fall.

Reference.—W. Flight, History of Meteorites, 1887, p. 194.

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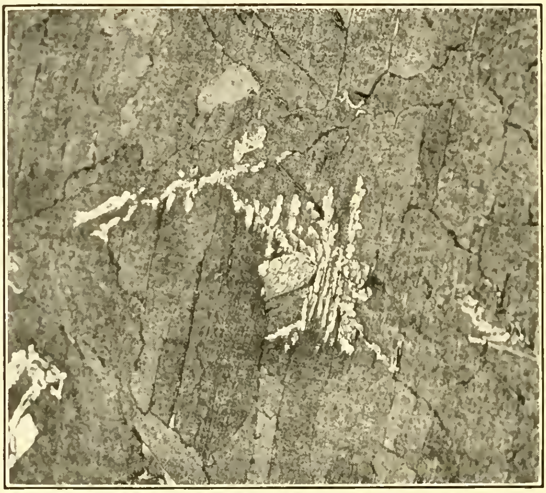

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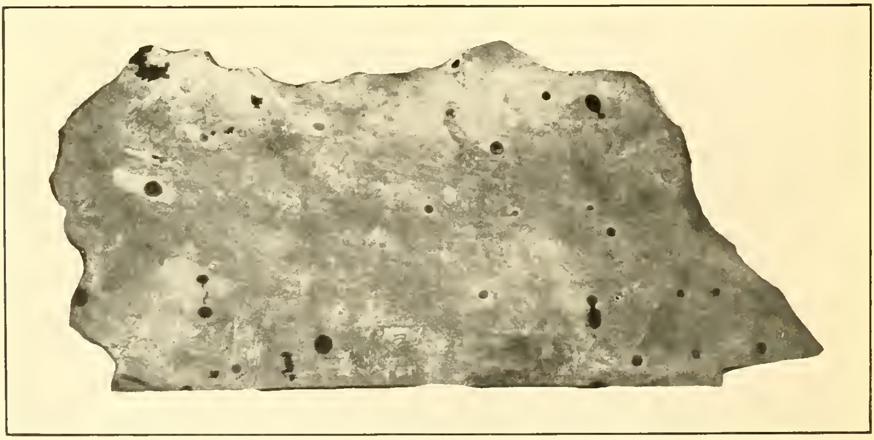

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(1) Etched Slice of Sacramento Iron; (2) Dendritic Schreibersite in Arispe Iron; (3) Etched Slice of Santa Rosa Iron.

For descriptions see pages 12, 135, and 143.

RUFF'S MOUNTAIN, LEXINGTON COUNTY, SOUTH CAROLINA. No. 34.

Iron, Om. Weight, 7 grams. Small slice with Widmanstätten figures. Weight of original mass, 53 kilograms (117 pounds). Date of fall unknown; found in 1844. Analysis by Shepard yielded:

	Per cent.
Iron (Fe)	96.00
Nickel (Ni)	3.121
Chromium (Cr)	Trace.
Sulphur (S)	Trace.
Cobalt (Co)	Trace.
Magnesium (Mg)	Trace.
	99.121

References.—C. U. Shepard, Amer. Journ. Sci., vol. 10, 1850, p. 128; Proc. Amer. Assoc. Adv. Sci., vol. 3, 1850, p. 152.

RUSSELL GULCH, GILPIN COUNTY, COLORADO. No. 186.

Iron, Of. Rectangular section, 4.5 by 1.7 by 1.2 cm., weighing 76 grams. One original surface. From a mass weighing 13 kilograms (29 pounds), found in 1863. Analysis by J. Lawrence Smith yielded:

	Per cent.
Iron (Fe)	90.61
Nickel (Ni)	7.84
Cobalt (Co)	.78
Phosphorus (P)	.02
Copper (Cu)	Minute trace
	99.25

Reference.—J. L. Smith, Amer. Journ. Sci., vol. 43, 1867, p. 66.

SACRAMENTO MOUNTAINS, EDDY COUNTY, NEW MEXICO. No. 230.

Iron, Om. Weight, 4,420 grams. Slab 60 by 16 cm., with etched surface showing Widmanstätten figures (pl 33). Weight of original mass, 237 kilograms. Date of fall uncertain—perhaps 1876. Analysis by J. E. Whitfield yielded:

	Per cent.
Iron (Fe)	91.39
Nickel (Ni)	7.86
Cobalt (Co)	.52
	99.77

Reference.—W. M. Foote, Amer. Journ. Sci., vol. 3, 1897, p. 65.

SAINT FRANCOIS COUNTY, MISSOURI. Nos. 130, 427.

Iron, Og. Weight, 276 grams; in two pieces—one a slice etched weighing 245 grams, one a fragment weighing 31 grams. In 1863 Shumard found a meteoric iron weighing 340 grams in the collections of the St. Louis Academy of Sciences and labeled as from southeast

Missouri. This was described by Shepard as an octahedral iron rich in schreibersite. Specific gravity, 7.015 to 7.112. The analysis yielded:

	Per cent.
Iron (Fe)	92.10
Nickel (Ni)	2.60
Schreibersite	5.00
	99.70

Later a larger mass (weight not given) was found in St. Francois County, which is regarded as identical with that described above. This, according to Dr. J. Fahrenhorst's analyses, consists of:

	Per cent.
Iron (Fe)	92.68
Nickel (Ni)	6.97
Cobalt (Co)	.52
Copper (Cu)	.02
Chromium (Cr)	.00
Chlorine (Cl)	.03
Sulphur (S)	.01
Phosphorus (P)	.34
Silicate granules	.01
	100.58

From this he calculates the mineral composition as follows:

	Per cent.
Nickel-iron	97.71
Schreibersite	2.20
Troilite	.03
Lawrencite	.05
Silicates	.01
	100.00

Specific gravity of mass, 7.746 at 16° C.; specific gravity of nickel-iron, 7.7728.

References.—C. U. Shepard, Amer. Journ. Sci., vol. 47, 1869, p. 230. E. Cohen, Ann. k. k. Naturhist. Hofmus., vol 15, 1900, p 369.

SAINTE GENEVIEVE COUNTY, MISSOURI. No. 454.

Iron, Of. Triangular slice 55 by 35 by 15 mm., weighing 129 grams, from a mass weighing 539 pounds (244 kilograms), found in 1888. Chemical analysis by J. E. Whitfield yielded:

	Per cent.
Iron (Fe)	91.58
Nickel (Ni)	7.98
Cobalt (Co)	.29
Silicon (Si)	.023
Phosphorus (P)	.200
Sulphur (S)	Trace.
Carbon (C)	None.
	100.073

Reference.—Henry A. Ward, Proc. Rochester Acad. Sci., vol. 4, 1901, p. 65.

SAINT MARK'S MISSION STATION, CAPE COLONY, SOUTH AFRICA. No. 486.

Stone, Cc. A 250-gram fragment from a stone weighing 13.783 kilograms, which fell on January 3, 1903, burying itself to a depth of 2 feet in cultivated land. An unusually firm and hard, dark gray chondritic stone, consisting mainly of olivine, enstatite, nickel-iron, and troilite. An analysis yielded:

	Per cent.
Silica (SiO_2)	38.29
Alumina (Al_2O_3)	.64
Ferrous oxide (FeO)	6.50
Manganous oxide (MnO)	.33
Magnesia (MgO)	18.23
Lime (CaO)	1.08
Iron (Fe)	26.44
Nickel (Ni)	1.84
Cobalt (Co)	.21
Manganese (Mn)	.29
Calcium (Ca)	.28
Sulphur (S)	5.26
Phosphorus (P)	.05
Chlorine (Cl)	.27
Carbon (C)	.36
Potash (K_2O)	.23
Soda (Na_2O)	.85
	101.15

The percentage mineral composition as calculated from this analysis is: Enstatite, 45.96; other silicates (mainly olivine), 19.45; nickel-iron, 19.27; troilite, 14.05; schreibersite, 0.32; oldhamite, 0.18; calcium chloride, 0.41; carbonaceous matter, 0.36.

References.—E. Cohen, Ann. S. African Mus., vol. 5, 1906, pp. 1–16. Also Neues Jahrb. Min. Geol. Pal., vol. 1, 1907, p. 370.

SAINT MESMIN, NEAR TROYES, DEPARTMENT OF AUBE, FRANCE. No. 262.

Stone, Cib or Cgb. Weight, 69 grams; fragment with crust. Dark gray with light areas; chrondritic. Fell May 30, 1866, at about 3.45 a. m. Original weight, 8.27 kilograms (according to Daubree, three stones weighing, respectively, 4.2, 2.21, and 1.86 kilograms). Analyses by M. Pisani, as follows:

Constituents.	Bulk.	Soluble in HC1, 59.4 per cent.	Insoluble in 40.6 per cent.
	Per cent.	*Per cent.*	*Per cent.*
Silica (SiO_2)	38.10	17.00	21.10
Alumina (Al_2O_3)	3.00	....	3.00
Magnesia (MgO)	25.64	19.54	6.10
Ferrous oxide (FeO)	17.21	11.84	5.37
Manganous oxide (MnO)	Traces.	....	....
Alkalies	3.13	1.92	1.21
Lime (CaO)	1.09	....	1.09
Iron (Fe)	4.94	4.94	....
Nickel (Ni)	.72	.72	....
Troilite	2.99	2.99	....
Chromite	2.18	....	2.18
	99.00	58.95	40.05

References.—Daubree, Compt. Rend., vol. 62, 1866, pp. 1305–1310. M. Pisani, Compt. Rend., vol. 62, 1866, p. 1326.

SAINT MICHEL, FINLAND. No. 443.

Stone, Ro(?). Irregular fragment, with no crust, approximately 85 by 60 by 20 mm. and weighing 625 grams, from a mass weighing some 7 kilograms which fell July 12, 1910, at 7.25 p.m. An analysis by L. H. Borgström showed:

	Per cent.
Iron (Fe)	11.71
Nickel (Ni)	1.16
Cobalt (Co)	.13
Copper (Cu)	.01
Silica (SiO_2)	39.52
Titanic oxide (TiO_2)	.02
Alumina (Al_2O_3)	3.31
Chromic oxide (Cr_2O_3)	.56
Ferrous oxide (FeO)	13.44
Manganous oxide (MnO)	.41
Lime (CaO)	1.64
Magnesia (MgO)	24.60
Potash (K_2O)	.13
Soda (Na_2O)	1.32
Phosphorus (P)	.08
Sulphur (S)	2.22
	100.26

The component minerals were also analyzed and the mineral composition calculated as:

	Per cent.
Nickel-iron	8.71
Schreibersite	.51
Troilite	6.11
Chromite	.82
Olivine	43.22
Bronzite	26.25
Plagioclase	14.25
	100.25

Reference.—L. H. Borgström, Bull. Comm. geol. Finlande, No. 34, 1912.

SALINE TOWNSHIP, KANSAS. No. 301.

Stone, Cck. Irregular mass, with crust on one side, weighing 589 grams. From a stone weighing upward of 20 kilograms found in 1898. Nothing known of fall. Analysis by H. W. Nichols yielded:

	Per cent.
Silica (SiO_2)	37.08
Alumina (Al_2O_3)	1.83
Ferrous oxide (FeO)	18.04
Magnesia (MgO)	23.34
Lime (CaO)	2.03
Soda (Na_2O)	.26
Potash (K_2O)	.08
Iron (Fe)	7.89
Nickel (Ni)	.95
Cobalt (Co)	.04
Sulphur (S)	1.65
Phosphorus (P)	.05
Ferric oxide (Fe_2O_3)	4.45
Chromic oxide (Cr_2O_3)	1.25
Nickel oxide (NiO)	.74
Cobalt oxide (CoO)	.07
Water (H_2O)	1.23
	100.98

References.—O. C. Farrington, Science, vol. 16, 1902, p. 67; Field Columbian Mus. Publ. 122, Geol. Ser., vol. 3, No. 6, 1907; Publ. 151, vol. 3, No. 9, 1911.

SALLES, NEAR VILLEFRANCHE, RHONE, FRANCE. No. 263.

Stone, Cia. Weight, 41 grams; fragment, with crust. Shows well the pseudofragmental structure. Fell about 6 p. m. on the afternoon of March 12 (according to some authorities, the 8th), 1798, the flight being from the east toward the west. In falling buried itself for some 18 inches in the soft soil. Original weight, 10 kilograms.

Vauquelin's analysis, the only thus far made, is of historical interest only. It is as follows:

	Per cent.
Silica (SiO_2)	46
Iron oxide (Fe_2O_3)	38
Magnesia (MgO)	15
Nickel (Ni)	2
Lime (CaO)	2
	103

The presence of sulphur was also recognized.

Reference.—M. De Dree, Tilloch's Philosophical Magazine, London, vol. 16, 1803, p. 217.

SALT LAKE CITY, UTAH. No. 107.

Stone, Cgb. Three grams from a stone weighing 175 grams which was found in 1869.

SAMS VALLEY, JACKSON COUNTY, OREGON. No. 510.

Iron, Om. Rhomboidal fragment weighing 22 grams. Two faces at angles of 45° to one another, etched. This is the fragment shown in figure 3 of Foote's paper cited below. From a mass weighing 6,900 grams (15¼ pounds), found in 1894. Analysis by J. E. Whitfield yielded:

	Per cent.
Silicon (Si)	0.009
Sulphur (S)	.056
Nickel (Ni)	9.160
Cobalt (Co)	.640
Copper (Cu)	.016
Carbon (C)	.100
Iron (Fe)	83.800
	93.781
Schreibersite	6.194
	99.975

Analysis of the schreibersite yielded: Iron, 65.13; nickel, 20.93; phosphorus, 13.94.

Reference.—W. M. Foote, Amer. Journ. Sci., vol. 39, 1915, p. 81.

SAN ANGELO, TOM GREEN COUNTY, TEXAS. NO. 256.

Iron, Om. Weight, 607 grams. Slab 7 by 25 cm., etched to show structure. Date of fall unknown; found July, 1897. Weight of original mass, 88 kilograms (194 pounds). Composition:

	Per cent.
Iron (Fe)	91.958
Nickel (Ni)	7.860
Cobalt (Co)	Trace.
Copper (Cu)	.040
Phosphorus (P)	.099
Sulphur (S)	.032
Manganese (Mn)	Trace.
Silicon (Si)	0.011
Carbon (C)	Trace.
	100.00

Specific gravity, 7.7.

Reference.—H. L. Preston, Amer. Journ. Sci., vol. 5, 1898, p. 269.

SANCHEZ ESTATE, COAHUILA, MEXICO. No. 389.

Iron, H. Original weight, 114,300 grams. Weight of main mass now in Museum, 104,773 grams (see pl. 17, fig. 2). This is one of several masses of meteoric iron found in Coahuila, Mexico, and which are commonly regarded as belonging to one and the same fall. These irons are known as the Bonanza masses (14), the Butcher masses (8), the Santa Rosa mass (1), and the Sanchez, Couch, or Smithsonian mass (1). Concerning the date of fall, it can only be said that in the autumn of 1835 a brilliant meteorite was seen to pass over the town of Santa Rosa, in the State of Coahuila, passing in a northwesterly direction and disappearing in the mountains. Immediately after its disappearance a series of explosions were heard, and shortly after a 12-pound piece of iron was brought into Santa Rosa, which was a fragment of one of the eight masses noted above. These were subsequently brought into the United States from the region some 90 miles northwest of the town by Dr. H. B. Butcher. This particular mass (the Sanchez Estate) was secured in 1854 by Lieut. D. N. Couch[1] and presented to the Smithsonian Institution. While its composition and structure, as well as its source, are indicative of its being a part of the fall noted above, there is no absolute proof of the same. The composition of the iron, as given by J. Lawrence Smith, is as below:

	Per cent.
Iron (Fe)	95.82
Cobalt (Co)	.35
Nickel (Ni)	3.18
Phosphorus (P)	.24
Copper (Cu)	Trace
	99.59

[1] Erroneously spelled *Cauch* and *Gouch* by various writers.

This would correspond to:

	Per cent.
Nickeliferous iron	98.45
Schreibersite	1.55
	100.00

According to Brezina, the iron belongs to the group of Hexahedrites, showing on etched surface a hexahedral structure and cleavage.

References.—L. Fletcher, On the Mexican meteorites. Min. Mag. and Journ., vol. 9, 1890, pp. 91–175; also bibliography given by Wülfing.

SAN EMIGDIO, SAN BERNARDINO COUNTY, CALIFORNIA. Nos. 133, 237.

Stone, Cc. Weight, 527 grams, in small fragments, the material having been put through an ore crusher for assaying before its true nature was known. Original mass said to have weighed 80 pounds (36,280 grams). Found by a prospector in the San Emigdio Mountains and nothing known regarding its fall and the main mass now lost. All fragments badly oxidized. Chemical composition:

	Per cent.
Metallic portion	6.21
Soluble in HCl	52.19
Insoluble in HCl	41.60
	100.00

Specific gravity, 3.57.

The metallic portion yielded 88.25 iron, 11.27 nickel, 0.48 cobalt.

Mineral composition: Olivine, enstatite, pyrrhotite, and iron.

Structure: Chondritic, tufaceous.

Gifts of Thomas Price and George P. Merrill.

Reference.—Geo. P. Merrill, On the San Emigdio metorite. Proc. U. S. Nat. Mus., vol. 11, 1888, pp. 161–167.

SAN LUIS POTOSI, MEXICO. No. 78.

Iron. (See Descubridora.)

SANTA CATHARINA, RIO SAN FRANCISCO DO SUL, BRAZIL. No. 104.

Iron, Dn (or Df). Weight, 82.4 grams. Mass but slightly altered, polished surface having a good metallic luster.

Large masses of this iron, of which some 137,453 grams are accounted for by Wülfing, were found in 1873 scattered over a triangular area of about 10,200 square meters. There is no positive evidence for or against its meteoric nature. The probabilities, however, seem to favor a meteoric origin, though anomalous from its high content in nickel.

The composition of the iron as given by E. Guignet and G. Ozorio de Almeida is: Iron, 64; nickel, 36. Damour gave the following results: Iron, 63.90; nickel, 33.97; cobalt, 1.48; sulphur, 0.16; phosphorus, 0.05; carbon, 0.20; silicon, 0.01. Specific gravity, 7.75. The iron is of more than ordinary hardness. Some 25,000 kilograms were sent to England to be smelted for nickel.

References.—E. Guignet and G. Ozorio de Almeida, Compt. Rend., vol. 83, 1876, pp. 917–919. A. Damour, Compt. Rend., vol. 84, 1877, p. 478. Amer. Journ. Sci., vol. 36, 1888, p. 157 (abstract as to occurrence).

SANTA ROSA, COAHUILA, MEXICO. No. 29.

Iron, H. Fragment, weighing 19.3 grams, from a mass brought by N. T. Lupton from near Santa Rosa, State of Coahuila, Mexico. It was stated to have been found in 1837, in the desert between Santa Rosa and the city of Chihuahua, and to have been brought into Santa Rosa by a Mexican named Juan Garca. The original mass was irregular in outline, the dimensions being about 33 by 28 by 21 cm., and the estimated weight 8.73 kilograms. An analysis by Lupton yielded:

	Per cent.
Iron (Fe)	91.86
Nickel (Ni)	7.42
Cobalt (Co)	.50
Phosphorus (P)	.27
	100.05

Reference.—N. T. Lupton, Amer. Journ. Sci., vol. 29, 1885, p. 232.

SANTA ROSA, PROVINCE OF BOYACA, COLOMBIA, SOUTH AMERICA. Nos. 361, 460.

Iron, Obz. Two slices—one weighing 442 grams and one, 400 by 180 by 10 mm., weighing 3,837 grams (pl. 33). The last named from a mass secured by H. A. Ward in 1906. Etched, showing brecciated structure and numerous troilite nodules. An analysis by O. Sjöström yielded:

	Per cent.
Iron (Fe)	92.30
Nickel (Ni)	6.52
Cobalt (Co)	.78
Copper (Cu)	.02
Chromium (Cr)	trace
Carbon (C)	.18
Phosphorus (P)	.36
Sulphur (S)	.04
	100.20

Reference.—E. Cohen, Meteoreisen Studien 8, Ann. k. k. Naturhist. Hofmus., vol. 13, 1899.

SAO JULIAO DE MOREIRA, NEAR PONTE DE LIMA, MINHO, PORTUGAL. Nos. 267, 314.

Iron, Ogg. Two slices, one irregularly 60 by 60 by 5 mm., weighing 164 grams, and one 14 by 7.5 cm. by 8 mm., weighing 671 grams.

Etched and showing peculiar schreibersite markings. Date of fall unknown. First came to notice in 1883, and described in 1888. Weight of original mass some 162 kilograms. Composition according to analyses by C. von Bonhorst: Iron, 89.39; nickel and cobalt, 8.27; phosphorus, 0.26, with a trace of copper.

Reference.—See Wülfing, p. 308.

SAREPTA, SARATOV, RUSSIA. No. 455.

Iron, Og. Slice about 35 by 40 mm., weighing 124 grams, from a mass weighing 14,325 grams, found in 1854. Auerbach's analysis yielded:

	Per cent.
Iron (Fe)	95.927
Nickel (Ni)	2.657
Silicon (Si)	.020
Tin (Sn)	.017
Schreibersite	1.315
	99.936

Reference.—W. Haidinger, Sitz. Akad. Wiss. Wien, vol. 46, 1862, p. 286; 49, 1864, p. 497.

SCHÖNENBERG, PFAFFENHAUSEN, SCHWABEN, BAVARIA. No. 220.

Stone, Cwa. Weight, 8 grams. Fragment with small area of crust. Mass dark gray with light and dark chondrules and metallic grains, traversed by dark veins. Fell December 25, 1846, at 2 p. m. Was traveling in, at first, a northeast and finally southeast direction. The fall was accompanied by the usual cannon-like report, and the stone, weighing 8 kilograms, 15 grams, buried itself in the soil to a depth of 2 feet. Analyses by Gümbel yielded:

Constituents.	Bulk analysis.	55.18 per cent soluble in HCl.	44.82 per cent insoluble in HCl.
Silica (SiO_2)	40.13	24.47	57.85
Alumina (Al_2O_3)	5.57	9.45	6.75
Iron (Fe)	13.77	30.56	....
Nickel (Ni)	1.47	1.48	1.44
Sulphur (S)	1.93	3.52	....
Phosphorus (P)	0.36	.33	.27
Chromite	.60	....	1.35
Iron protoxide (FeO)	17.12	10.41	15.37
Lime (CaO)	2.31	3.72	.56
Magnesia (MgO)	13.81	11.55	16.63
Potash (K_2O)	.73	1.33	Trace.
Soda (Na_2O)	2.20	3.18	1.02
	100.00	100.00	101.24

From these results Gümbel calculated the mineral composition to be:

	Per cent.
Olivine	10.00
Feldspathic and scapolite-like mineral	18.50
Augitic mineral	40.00
Nickel-iron	14.50
Pyrrhotite	5.00
Schreibersite	2.00
Chromite	1.00
	100.00

The stone is described as chondritic, finely granular, and so friable as to be readily crushed between the thumb and fingers.

Reference.—Gümbel, Sitz. k. bayr. Akad. Munchen, vol. 1, 1878, p. 40.

SCOTT CITY, KANSAS. No. 429.

Stone, Cc. Weight, 175 grams. Weight of main mass, 1,900 grams. Found in November, 1911. A very dense chondritic stone consisting of the usual olivine and pyroxenes, and of which no analysis has been made.

Reference.—G. P. Merrill, Proc. U. S. Nat. Mus., vol. 42, 1912, pp. 295–296.

SCOTTSVILLE, ALLEN COUNTY, KENTUCKY. No. 77.

Iron, H. Weight, 99.8 grams. In two pieces; a section, weighing 66.5 grams, contains troilite nodules, and one, weighing 33.5 grams, etched, shows also troilite nodules and presents a granular or stippled surface overlaid with a network of fine lines. Date of fall unknown; found in June, 1867. Original weight about 10 kilograms; dimensions, 14 by 18 by 16 cm.

The markings on an etched surface are exceedingly fine and require the aid of a lens to distinguish them. There appear to be two sets of figures—one of long, very fine lines, representing octahedral cleavage, and the other series being smaller, more crowded, and barely perceptible. (Whitfield).

Analysis by Whitfield yielded:

	Per cent.
Iron (Fe)	94.32
Nickel (Ni)	5.01
Cobalt (Co)	Trace
Sulphur (S)	0.34
Phosphorus (P)	.16
Carbon (C)	.12
	99.95

Specific gravity, 7.848.

Reference.—J. E. Whitfield, Amer. Journ. Sci., vol. 33, 1887, p. 500.

SCRIBA, OSWEGO COUNTY, NEW YORK No. 48

Iron, Dn (or Df). Weight, 9.15 grams. A fragment with etched surface but having a granular or stippled appearance and no Widmanstätten figures. Date of fall unknown; found in 1835. Original weight, 3.6 kilograms (8 pounds). Analysis by Shepard yielded:

	Per cent.
Iron (Fe)	99.66
Silicon (Si)	.20
Calcium (Ca)	.09
Aluminum (Al)	Traces.
	99.95

The iron was found in a forest near charcoal pits. It gives no Widmanstätten figures on etched surfaces nor does it contain nickel or cobalt. Its meteoric nature is commonly considered as doubtful.

References.—C. U. Shepard, Amer. Journ. Sci., vol. 40, 1841, p. 366; vol. 4, 1847, p. 75.

SEARSMONT, WALDO COUNTY, MAINE. Nos. 4, 190.

Stone, Cc. Two fragments from interior, weighing 12 and 20 grams. Fell at 8.15 a. m. on May 21, 1871. The fall was accompanied by the usual report and a hissing sound compared to the escape of steam from a boiler. The passage was from the north toward the south. On striking the ground, it buried itself to a depth of 2 feet and was broken into several pieces, the largest of which weighed 2 pounds. The structure is chondritic. Analyses by J. Lawrence Smith yielded:

	Per cent.
Nickeliferous iron	14.63
Pyrrhotite	3.06
Olivine	43.04
Bronzite, etc. (including chromite)	39.27
	100.00

The metallic portion yielded:

Iron (Fe)	90.02
Nickel (Ni)	9.05
Cobalt (Co)	.43
	99.50

The silicate portion yielded:

Constituents.	Soluble in HCl. 52.30.	Insoluble in HCl. 47.70.
	Per cent.	*Per cent.*
Silica (SiO_2)	40.61	56.25
Protoxide of iron (FeO)	19.21	13.02
Magnesia (MgO)	36.34	24.14
Sulphide of iron (FeS)	3.06	....
Alumina (Al_2O_3)	....	2.01
Alkalies	....	2.10
	99.22	97.52

Gifts of A. C. Hamlin and L. T. Chamberlain.

References.—C. U. Shepard, Amer. Journ. Sci., vol. 2, 1871, p. 133. J. L. Smith, Amer. Journ. Sci., vol. 2, 1871, p. 200.

SEELÄSGEN, BRANDENBURG, PRUSSIA. No. 80.

Iron, Ogg. Weight, 105 grams. Etched section showing irregular plates. Date of fall unknown. Found in 1847. Original weight, 102 kilograms. Composition as given by Duflos:

	Per cent.
Iron (Fe)	90.000
Nickel (Ni)	5.308
Cobalt (Co)	.434
Manganese (Mn)	.912
Copper (Cu)	.104
Silica (SiO_2)	1.157
Residue	.834
	98.749

As given by Rammelsberg:

	Per cent.
Iron (Fe)	92.33
Nickel (Ni)	6.23
Cobalt (Co)	.67
Silicon (Si)	.02
Carbon (C)	.52
Residue	.18
	99.95

Specific gravity, 7.63–7.71.

Reference.—A. Duflos, Pogg. Ann., ser. 3, vol. 74, 1848, p. 61.

SELMA, DALLAS COUNTY, ALABAMA. No. 366.

Stone, Cc. Weight, 120 grams. Irregular fragment, portion of a complete individual weighing some 140.6 kilograms (310 pounds), being therefore one of the largest of the stony meteorites. Found in 1907. Nothing definitely known regarding its fall. A dense, dark gray stone, sufficiently compact to receive a polish. Chondrules abundant. Metallic portion inconspicuous to the unaided eye. Mineral composition: Olivine and orthorhombic and monoclinic pyroxenes, with some isotropic matter, metallic iron, and iron sulphide (pl. 34).

Chemical analysis by Whitfield yielded as follows:

	Per cent.
Silica (SiO_2)	31.06
Alumina (Al_2O_3)	4.30
Phosphoric acid (P_2O_5)	.25
Chromic oxide (Cr_2O_3)	.41
Ferric oxide (Fe_2O_3)	18.15
Ferrous oxide (FeO)	13.07
Manganous oxide (MnO)	.26
Nickel oxide (NiO)	1.45
Cobalt oxide (CoO)	.15
Lime (CaO)	2.13
Magnesia (MgO)	21.21
Soda (Na_2O)	3.96
Potash (K_2O)	.07
Vanadium oxide (V_2O_5)	Trace.
Water (H_2O)	3.07
Troilite (S)	.19
Troilite (Fe)	.32
	100.05

Considering the metallic portion alone, the results were as follows, in totals:

	Per cent.
Iron	25.866
Chromium	.127
Nickel	1.470
Cobalt	.090
Manganese	.210
Vanadium	Trace.
	27.763

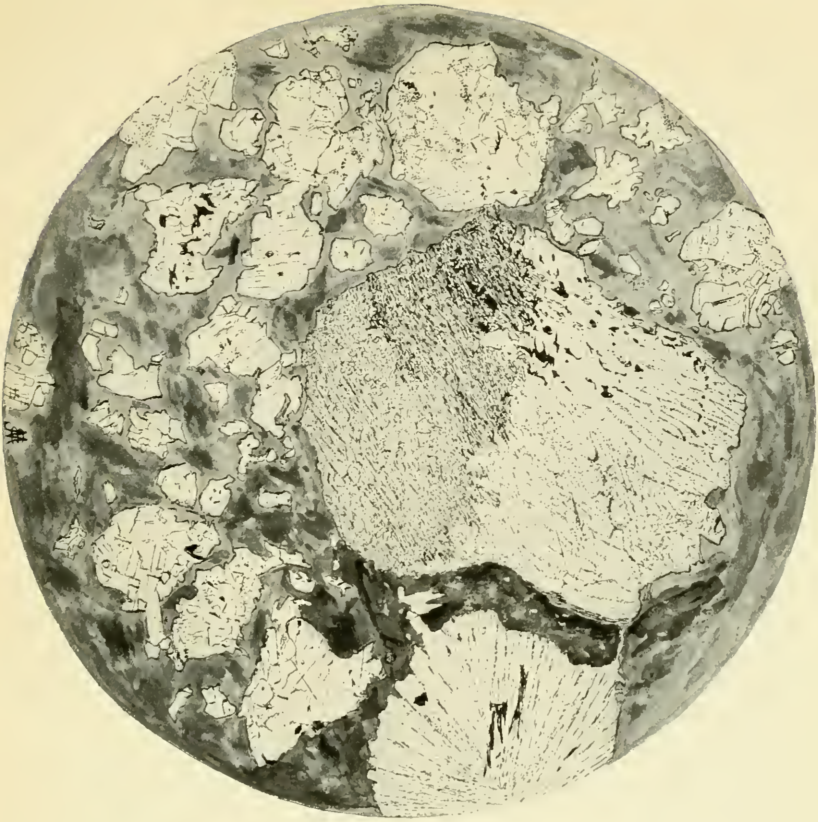
Gift of the American Museum of Natural History.

References.—Geo. P. Merrill, Proc. U. S. Nat. Mus., vol. 32, 1907, pp. 59–61; Mem. Nat. Acad. Sci., vol. 14, 1916, p. 16.

SENHADJA, AUMALE, CONSTANTINE, ALGERIA. No. 150.

Stone, Cwa. Weight, 18 grams. Fragment with light brown crust. Fell between 11 a. m. and 12 m. on August 25, 1865. Fall accompanied by usual report. Two stones fell at points some 4,800 meters apart. Original weight of both masses, 50 kilograms. Seems never to have been analyzed or subjected to microscopic examination; nickel, iron, phyrrhotite, chromite, in ash-gray silicate groundmass.

Reference.—Daubree, Compt. Rend., vol. 62, 1866, p. 72.



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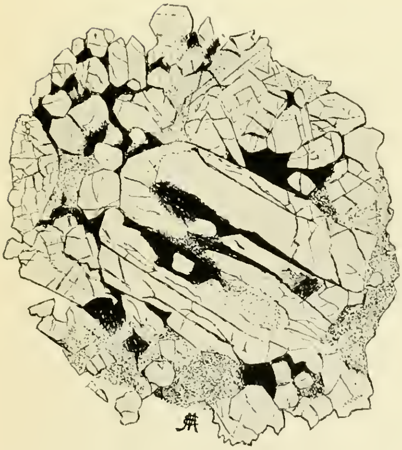


2

3

MICROSTRUCTURE OF THE SELMA STONE.

FOR DESCRIPTION SEE PAGE 147.

SHALKA, NEAR BISSEMPORE IN BANCOORAH, BENGAL, INDIA. No. 244.

Stone, Chl. Weight, 53 grams. Fragment with crust. Fell three hours before sunrise on the morning of November 30, 1850. The weight of the original mass is not known, some 3,626 grams only being accounted for in Wülfing's catalogue.

Composition, according to H. B. von Foullon: SiO_2, 52.51; Cr_2O_3, 1.25; FeO, 16.81; Al_2O_3, 0.66; CaO, 0.89; MgO, 28.35; NaO, 0.22; S, 0.14; Fe, 0.25; P, trace. The mineral composition as given is bronzite, with inclosures of chromite, dark and light brown glass, picotite (?), and a little pyrrhotite. No native iron. The structure is remarkably coarsely granular; color light ash gray.

Reference.—H. B. von Foullon, Ann. k. k. Naturhist, Hofmus., vol. 3, 1885, p. 195. This gives a full review of all previous work.

SHELBURNE, GREY COUNTY, ONTARIO, CANADA. No. 358.

Stone, Cga. Fragment weighing 578 grams from one of two stones which fell on the evening of August 13, 1904. The stones weighed, respectively, 12.6 kilograms and 6 kilograms, or together 40¾ pounds. Though the stones fell with such force as to penetrate the ground to a depth of 2 feet, the heat was so slight that a green burdock leaf carried by it into the ground was still green and uncharred when disinterred. An analysis as given by L. H. Borgström yielded:

	Per cent.
Silica (SiO_2)	39.19
Iron (Fe)	10.70
Nickel (Ni)	.78
Cobalt (Co)	.04
Ferrous oxide (FeO)	15.16
Manganous oxide (MnO)	.12
Alumina (Al_2O_3)	2.15
Chromic oxide (Cr_2O_3)	.62
Lime (CaO)	1.75
Magnesia (MgO)	26.24
Potash (K_2O)	.22
Soda (Na_2O)	.73
Sulphur (S)	1.61
Phosphorus (P)	.06
	99.37

From the analysis and microscopic examination it was possible to calculate the mineral composition, as follows:

	Per cent.
Nickel-iron	8.50
Troilite	4.50
Chromite	.80
Schreibersite	.40
Olivine	45.00
Enstatite	27.80
Maskelynite (?)	13.00
	100.00

Reference.—L. H. Borgström, Trans. Roy. Astr. Soc. Canada, 1904, p. 69.

SHERGOTTY, BEHAR, BENGAL, INDIA. No. 321.

Stone, She. Fragment with crust, weighing 286 grams, from a mass weighing 4.5 kilograms, or 10 pounds 6 ounces, which fell on August 25, 1865. This stone belongs to a rare group, consisting essentially of pyroxene and maskelynite, with accessory magnetite. The chemical composition as given by Tschermak is as follows:

	Per cent.
Silica (SiO_2)	50.21
Alumina (Al_2O_3)	5.90
Ferrous oxide (FeO)	17.59
Magnesia (MgO)	10.00
Lime (CaO)	10.41
Soda (Na_2O)	1.28
Potash (K_2O)	.57
Magnetite (FeO, Fe_2O_3)	4.57
	100.53

Reference.—G. Tschermak, Min. Mitth., vol. 2, 1872, p. 87.

SHINGLE SPRINGS, ELDORADO COUNTY, CALIFORNIA. No. 103.

Iron, Dsh. Weight, 32.4 grams. Date of fall unknown; found 1869–70. Original weight, 38.5 kilograms (85 pounds). This iron has been described and analyzed, with somewhat variable results, by C. U. Shepard, C. T. Jackson, and B. Silliman. Silliman's analysis follows:

	Per cent.
Iron (Fe)	81.48
Nickel (Ni)	17.173
Cobalt (Co)	.604
Aluminum (Al)	.088
Chromium (Cr)	.020
Magnesium (Mg)	.010
Calcium (Ca)	.163
Carbon (C)	.071
Silicon (Si)	.032
Phosphorus (P)	.308
Sulphur (S)	.012
Potassium (K)	.026
	99.987

Specific gravity, 7.875.

References.—C. U. Shepard, Amer. Journ. Sci., vol. 3, 1872, p. 438. C. T. Jackson, Amer. Journ. Sci., vol. 4, 1872, p. 495. B. Silliman, Amer. Journ. Sci., vol. 6, 1873, p. 18.

SHREWSBURY, YORK COUNTY, PENNSYLVANIA. No. 422.

Iron, Om. Irregular slice some 12 by 7 cm., weighing 425 grams, from a mass weighing some 27 pounds (12.2 kilograms), found in 1909. An analysis by Dickman and Mackenzie, as given by Farrington, is as follows:

	Per cent.
Iron (Fe)	90.84
Nickel (Ni)	8.80
Cobalt (Co)	Trace.
Sulphur (S)	.01
Phosphurus (P)	.29
	99.94

Reference.—O. C. Farrington, Amer. Journ. Sci., vol. 29, 1910. p. 350.

SITATHALI, NEAR NURRAH, RAIPUR, RAJPUTANA, INDIA. No. 91.

Stone, Cho. Weight, 13.5 grams. Fragment with crust. Fell March 4, 1875. Two pieces found at distance of three-fourths mile from one another; total weight, 1,413 grams. The stone seems never to have been analyzed or otherwise described.

SLOBODKA, JUCHNOW, SMOLENSK, RUSSIA. No. 171.

Stone, Cc. Three and one-half grams from a stone weighing 2.75 kilograms, which fell August 10, 1818.

Gift of R. de Kroustchoff.

SMITH'S MOUNTAIN, ROCKINGHAM COUNTY, NORTH CAROLINA. No. 94.

Iron, Of. A slab weighing 58.8 grams from a mass weighing 5 kilograms, found about 1863.

SMITHVILLE, DEKALB COUNTY, TENNESSEE. No. 202.

Iron, Og. Weight, 214 grams. Section with original and polished surface, showing large troilite nodule. Three of these irons were found, weighing, respectively, about 7, 15, and 65 pounds each. They were plowed up in a field in 1840 and date of fall is unknown. The largest mass, as described by Huntington, was remarkable for its silver-white color and in carrying a nodule of fine-grained, compact graphite, nearly 2 inches in diameter. In addition, the iron carries schreibersite and cliftonite, the latter containing minute glassy grains of a hardness above that of the ruby and believed by Huntington to be diamonds. Chemical composition as given is:

	Per cent.
Iron (Fe)	91.50
Nickel (Ni)	7.02
Cobalt (Co)	0.62
Copper (Cu)	Trace.
Phosphorus (P)	0.18
	99.32

Reference.—O. W. Huntington, The Smithville meteoric iron. Proc. Amer. Acad. Arts and Sci., vol. 29, 1893–94, p. 251.

SOKO-BANJA (SARBANOVAC), NEAR BELGRADE, SERBIA. Nos. 41, 303.

Stone, Cc. Weight, 220 grams; fragments with crust; a gray stone of uneven texture and evident fragmental structure. Fell October 13, 1877, at about 2 p. m., with the usual detonations and light effects. A shower of many stones, estimated to weigh from 48 to 80 kilograms, the largest of which weighed 23 *oka* (1,250 grams ?). Some 40,329 grams from this fall are now represented in 52 collections, public and private, three stones, weighing, respectively, 16,285 grams, 9,695 grams, and 254 grams, being in the museums of Belgrade. An analysis by Losanitch yielded:

	Per cent.
Silica (SiO_2)	40.14
Ferrous oxide (FeO)	25.54
Magnesia (MgO)	25.78
Manganous oxide (MnO)	0.012
Soda (Na_2O)	0.26
Potash (K_2O)	0.06
Iron (Fe)	5.82
Nickel (Ni)	0.92
Cobalt (Co)	0.07
Sulphur (S)	1.46
Chromite	0.04
	100.102

The stone is described by Döll and Meunier as clastic and consisting of olivine, some enstatite, pyrrhotite, and nickel-iron.

References.—E. Döll, Verh. k. k. geol. Reichsanst., 1877, p. 283. S. Meunier, Compt. Rend., vol. 92, 1881, p. 331.

STANNERN, NEAR IGLAU, MORAVIA, AUSTRIA. Nos. 84, 141.

Stone, Eu. Weight, 47 grams. In two pieces; fragment with crust, weighing 14 grams, and a nearly complete individual, weighing 33 grams. Crust shining black, showing lines of flow. Fell

May 22, 1808, at 6 a. m. Some 200 to 300 individuals fell, strewed over an area some 8 by 3 miles, and estimated to weigh 52 kilograms. Chemical analyses by Rammelsberg yielded:

Constituents.	A. 34.98 per cent soluble in HCl.	B. 65.02 per cent insoluble.
	Per cent.	*Per cent.*
Silica (SiO_2)	46.19	49.44
Alumina (Al_2O_3)	31.26	2.64
Iron oxide	2.93	28.31
Manganese oxide	....	1.25
Lime (CaO)	16.98	8.20
Magnesia (MgO)	1.12	9.97
Soda (Na_2O)	1.14	.35
Potash (K_2O)	.50	.10
Chromite	....	.83
	100.12	101.09

Later analysis by J. E. Whitfield, made with especial reference to the possible occurrence of barium, strontium, and zirconium, yielded:

	Per cent.
Silica (SiO_2)	47.94
Alumina (Al_2O_3)	11.19
Titanium oxide	.41
Zirconium oxide (ZrO_2)	None.
Phosphoric acid (P_2O_5)	.14
Chromic oxide (Cr_2O_3)	.35
Ferric oxide (Fe_2O_3)	1.20
Ferrous oxide (FeO)	18.97
Barium oxide (BaO)	None.
Strontium oxide (SrO)	None.
Nickel oxide (NiO)	.25
Cobalt oxide (CoO)	Trace.
Ferrous sulphide (FeS)	.86
Lime (CaO)	10.36
Magnesia (MgO)	7.14
Soda (Na_2O)	.75
Potash (K_2O)	.13
Water (above 104° C.) (H_2O)	.30
	99.99

The mineral nature and structure of the stone has been described by Tschermak, who found it a somewhat variable admixture of fragmentary matter, consisting mainly of the silicates anorthite and augite, with small, colorless, weakly refracting particles of an undetermined nature; in addition, nickel-iron, pyrrhotite and chromite.

References.—C. Rammelsberg, Pogg. Ann., vol. 83, 1851, p. 592. G. Tschermak, Min. pet. Mitth., 1872, p. 83. G. P. Merrill, Mem. Nat. Acad. Sci., vol. 14, 1916, p. 17.

STAUNTON, AUGUSTA COUNTY, VIRGINIA. Nos. 68, 69.

Iron, Om. Weight, 145 grams. From a mass found in 1858 and described by Mallet in 1871; a rectangular slab, etched, and showing coarse Widmanstätten figures, with scattering grains of troilite; also small mass weighing 9.86 grams found in 1887 and described by G. F. Kunz in 1887. Date of fall unknown. Five masses of this iron, with an aggregate weight of 113,964 grams, were found between 1858 and 1887. Analyses of these masses as made (Nos. I, II, III, and V) by Mallet, and (No. IV) by Santos, yielded the results given below:

Constituents.	I	II	III	IV	V
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron (Fe)	88.706	88.365	89.007	91.439	90.293
Nickel (Ni)	10.163	10.242	9.964	7.559	8.848
Cobalt (Co)	.396	.428	.387	.608	.486
Copper (Cu)	.003	.004	.003	.021	.016
Tin (Sn)	.002	.002	.003	Trace.	.005
Phosphorus (P)	.341	.362	.375	.068	.243
Sulphur (S)	.019	.008	.026	.018	.012
Chlorine (Cl)	.003	.002	.004	Trace.	Trace.
Carbon (C)	.172	.185	.122	.142	.177
Silica (SiO_2)	.067	.061	.056	.108	.092
	99.872	99.659	99.947	99.963	100.172

Specific gravity at 15° 7.853, 7.855, 7.839, respectively.

Mallet also determined the amount and character of the gases yielded by these irons and found the following:

	Per cent.
Hydrogen	35.83
Carbonic oxide	38.33
Carbonic anhydride	9.75
Nitrogen	16.09
	100.00

References.—J. W. Mallet, Amer. Journ. Sci., vol. 2, 1871, p. 10; Proc. Royal Soc. London, vol. 20, 1872, p. 365.

STAVROPOL, CAUCASUS, RUSSIA. No. 179.

Stone, Ck. Weight, 52.4 grams; fragment with crust; ground ash-gray and finely granular. Fell March 24, 1857. Original weight, 1,632 grams. Analyses by Abich yielded:

Constituents.	54.10 per cent soluble in HCl.	Constituents.	45.89 per cent insoluble in HCl.
Silica (SiO_2)	31.32	Silica (SiO_2)	47.44
Magnesia (MgO)	34.43	Alumina (Al_2O_3)	9.97
Ferrous oxide (FeO)	27.95	Ferrous oxide (FeO)	10.72
Iron (Fe)	4.37	Magnesia (MgO)	21.33
Nickel (NiO)	.35	Lime (CaO)	5.10
Alkalies (K_2O+Na_2O)	.50	Soda (Na_2O)	2.18
Sulphur (S)	1.64	Potash (K_2O)	.97
Tin oxide (SnO_2)	Traces.	Nickel oxide (NiO)	1.21
		Loss	1.08
	100.56		100.00

Bulk analyses yielded:

	Per cent.
Silica (SiO_2)	33.16
Alumina (Al_2O_3)	4.22
Magnesia (MgO)	29.24
Lime (CaO)	1.20
Ferrous oxide (FeO)	18.59
Nickel oxide (NiO)	3.81
Tin oxide (SnO_2)	1.10
Iron (Fe)	4.32
Soda (Na_2O)	1.40
Sulphur (S)	1.60
Potash (K_2O)	0.60
Chlorine (Cl) and loss	0.76
	100.00

The mineral nature, as calculated from the above, is given as:

	Per cent.
Hyalosiderite	45.65
Olivine	23.04
Labradorite	18.13
Pyrrhotite	2.95
Nickeli-ron	10.25
	100.02

Gift of R. de Kroutschoff.

Reference.—H. Abich, Bull. Acad. Imp. Sci. St. Petersb., vol. 2, 1860, p. 403.

STEINBACH (BREITENBACH, RITTERSGRÜN) SAXONY, GERMANY. Nos. 9, 90, 140, 496.

Stony-iron, Siderophyre. Four pieces, weight, 124.7 grams. (1) Rittersgrün, found in 1847; section with crust, weighing 38 grams, and irregular slice weighing 31 grams. The stony portion exceeds the metallic, which consists of nickel-iron and one small mass of troilite. (2) Fragment weighing 2 grams, from Steinbach.

(3) One from Breitenbach, weighing 53.7 grams. The three localities mentioned are but about 1 mile apart, and the stones regarded as part of one and the same fall. Date of fall unknown—perhaps 1540. The Steinbach sample found previous to 1751; that of Rittersgrün in 1847; and that of Breitenbach in 1861.

The chemical and mineralogical composition of the Rittersgrün material has been investigated by Weisbach and by Winkler. According to the latter, the mineral composition and its relative proportions are as follows:

		Per cent.
Metallic portion, 51.031 per cent	Nickel iron (Fe_2Ni)	50.406
	Phosphor-nickel-iron ($FeNi_4P$)	.149
	Phosphide of iron (Fe_2P)	.274
	Silicide of iron (Fe_2Si)	.169
	Sulphide of iron (FeS)	.015
	Carbide of iron	Trace.
	Copper	.018
Nonmetallic portion, 48.969 per cent	Troilite	7.211
	Asmanite	8.527
	Bronzite	32.908
	Chromite	.323

Analyses of the troilite, asmanite, nickel-iron, and the bronzite are also given. It was in this meteorite that the English mineralogist Maskelyne found the rhombic form of silica to which he gave the name *Asmanite*.

References.—N. Story-Maskelyne, Proc. Royal Soc. London, vol. 17, 1869, p. 370; vol. 19, 1871, p. 266; Philos. Trans., vol. 161, 1871, pp. 161 and 212. A. Weisbach, Verl. k. Berg-akad.; Verh. naturh. Ver. Bonn, vol. 33, 1876, p. 92. C. Winkler, Nova Acta k. Leop. Karol. Akad., vol. 40, 1878, p. 333.

TADJERA, SETIF, CONSTANTINE, ALGERIA. No. 286.

Stone, Ct. Fragment from interior, weighing 75 grams, from one of two masses, weighing 8,843 grams, which fell on June 9, 1867. Meunier described the stone as consisting of:

	Per cent.
Soluble silicates (mainly olivine)	50.40
Insoluble silicates (mainly pyroxene)	33.08
Chrome-iron	.20
Troilite	8.04
Nickel-iron	8.32
	100.04

Reference.—Daubree, Compt. Rend., vol. 66, 1868, p. 513.

TAZEWELL, CLAIBORNE COUNTY, TENNESSEE. No. 53.

Iron, Off. Weight, 152 grams. Date of fall unknown: found in 1853. Weight of original mass, 25 kilograms (55 pounds), according

1

2

View of (1) Thomson Stone and (2) Etched Slice of Toluca Iron.

For descriptions see pages 157 and 159.

to J. Lawrence Smith. Smith's examination showed this meteorite to consist mainly of nickel-iron with troilite, schreibersite, a few scattered grains of olivine, and lawrencite (iron chloride). Duplicate analyses yielded:

	Per cent.	Per cent.
Iron (Fe)	82.39	83.02
Nickel (Ni)	15.02	14.62
Cobalt (Co)	.43	.50
Copper (Cu)	.09	.06
Phosphorus (P)	.16	.19
Chlorine (Cl)	-----	.02
Sulphur (S)	-----	.08
Silica (SiO_2)	.46	.84
Magnesia (MgO)	-----	.24
	98.55	99.57

Analyses are given also of the schreibersite.

Reference.—J. L. Smith, Amer. Journ. Sci., vol. 19, 1855, p. 121.

TENNASILM, ESTHLAND, RUSSIA. Nos. 83, 483.

Stone, Cca. Two pieces weighing 48 and 990 grams, with papillated, somewhat blebby crust. Groundmass dark ash-gray and coarsely granular. Fell June 28, 1872, at midday. Originally seven pieces, weighing 28.5 kilograms. Analysis by Schilling showed:

	Per cent.
Soluble in dilute hydrochloric acid	42.317
Insoluble in dilute hydrochloric acid	57.683

Bulk or mass composition:

Silica (SiO_2)	38.91
Magnesia (MgO)	22.261
Lime (CaO)	1.374
Iron protoxide (FeO)	17.531
Nickel (Ni)	1.675
Iron (Fe)	11.767
Phosphorus (P)	.073
Alumina (Al_2O_3)	2.551
Chromic oxide (Cr_2O_3)	.920
Alkalies (K_2O, Na_2O)	2.236
Sulphur (S)	.625
	99.923

The mineral composition was found to be olivine, bronzite, labradorite, nickel-iron, and troilite.

Reference.—G. Baron Schilling, Archiv. Naturk. Liv.-Ehst.- u. Kurlands, vol. 9, Heft 2, 1882, p. 95.

THOMSON, McDUFFIE COUNTY, GEORGIA. No. 395.

Stone, Cca. Weight, 218 grams. Nearly complete individual, constituting so far as known the entire fall (pl. 35). Found in 1888.

Nothing known regarding fall. A compact, distinctly chondritic stone belonging to class of veined chondrites. Mineral composition, olivine and pyroxenes with small areas of maskelynite and the usual metallic and sulphide particles. No chemical analyses have been made.

Reference.—G. P. Merrill, Smithsonian Misc. Coll., vol. 52, 1909, p. 473.

THUNDA, WINDORAH, QUEENSLAND, AUSTRALIA. No. 456.

Iron, Om. Slice about 45 by 45 mm., weighing 118 grams, from a mass weighing about 9,287 grams, found in 1886. Cohen gives the composition as follows:

	Per cent.
Iron (Fe)	91.54
Nickel (Ni)	8.49
Cobalt (Co)	.56
Copper (Cu)	.02
Sulphur (S)	.02
Phosphorus (P)	.17
Chromite	.01
	100.81

From this he calculated the mineral composition to be as follows:

	Per cent.
Nickel-iron	98.85
Schreibersite	1.09
Troilite	.05
Chromite	.01
	100.00

Reference.—E. Cohen, Meteoreisen-Studien 11, Ann. k. k. Naturhist. Hofmus., vol. 15, 1900, p. 381.

TIMOSCHIN, JUCHNOW, SMOLENSK, RUSSIA. No. 174.

Stone, Cc. Weight, 6.8 gr.; fragment from interior. Fell March 25, 1807. Weight of original mass 40 kilograms. Fall accompanied by the usual thunder-like detonations. Groundmass light ash-gray with rust spots, and showing dark green to brown kugels. Metallic constituents scarcely visible to the unaided eye. Analyses (I) by Scheerer and (II) by Klaproth yielded:

Constituents.	I.	II.
	Per cent.	*Per cent.*
Silica (SiO_2)	39.00	38.00
Ferric oxide (Fe_2O_3)	17.5	25.00
Alumina (Al_2O_3)	....	1.00
Magnesia (MgO)	20.00	14.25
Iron (Fe)	17.75	17.60
Nickel (Ni)	1.25	.40
Lime (CaO)	....	.75
Manganous oxide (MnO)		
Sulphur (S)	4.5	3.00
Chromium (Cr)		
Loss		
	100.00	100.00

Gift of R. de Kroutschoff.

Reference.—O. Buchner, Die Meteoriten, 1863, p. 21.

TOLUCA (XIQUIPILCO), MEXICO. Nos. 75, 204, 357, 396.

Iron, Om. Weight 33,610 grams. (1) Etched slice some 16 by 20 cm., weighing 840 grams, showing distinct Widmanstätten figures and irregular nodules of troilite (pl. 35); (2) two complete individuals weighing 530 and 735 grams, showing oxidized and pitted surfaces; (3) end of mass weighing 1,050 grams and showing two large troilite nodules; and (4) nearly complete individual weighing 28,458 grams, with slab cut from same weighing 1,997 grams. Date of fall unknown. Known as early as 1776. Numerous masses of meteoric iron, varying in weight from 300 pounds to minute specimens, have been found in the Toluca Valley, and it is highly probable that they all came from the vicinity of Xiquipilco, in the State of Mexico. Many of these masses were used by the native blacksmiths as anvils and for making agricultural implements.[1] The iron is described by Cohen and Weinschenk as consisting of:

	Per cent.
Nickel-iron	95.05
Taenite	2.45
Schreibersite and rhabdite	1.17
Kamacite (?)	.98
Nonmagnetic residue	.35
	100.00

The nonmagnetic residue contained siliceous particles, among which orthoclase, plagioclase, feldspar, quartz, zircon, and pyroxene have been determined, with possibly garnet and cordierite. Chromite, apatite, and graphite were also found. This is the first meteoric iron in which the presence of quartz crystals and apatite were proven.[2]

[1] Eastman, The Mexican meteorite, Bull. Philos. Soc. Washington, vol. 12, March, 1892.

[2] It may be added that there is doubt concerning the occurrence of the quartz as an original constituent.

References.—For full bibliography, which includes a large number of titles, see Wülfing, pp. 357–360. Especial references, Cohen and Weinschenk, Ann. k. k. Naturhist. Hofmus., vol. 6, 1891, pp. 135–142. H. Laspeyres and E. Kaiser, Zeitschr. für Kryst. u. Min., vol. 24, 1895, pp. 485–493; vol. 27, 1896–97, p. 586.

TOMBIGBEE RIVER, CHOCTAW COUNTY, ALABAMA. No. 252.

Iron, Ha. Weight 2,954 grams. Slice some 11 by 18 by 4 cm., showing original and polished surface, the latter etched, showing a granular structure and large schreibersite inclosures (see pl. 36). Described in 1899. Originally six masses, weighing all together 53,795 grams. The slice in this collection is from mass No. 3 described by Foote, the original weight of which was 9,125 grams. This was found in 1886 on a hill in the southwest quarter of section 4, range 2 west, township 14, Choctaw County. Analysis by Whitfield on sample No. 5 yielded:

	Per cent.
Iron (Fe)	95.02
Nickel (Ni)	4.11
Cobalt (Co)	.40
Phosphorus (P)	.324
Carbon (C)	.161
Sulphur (S)	Trace.
	100.015

Reference.—W. M. Foote, Amer. Journ. Sci., vol. 8, 1899, pp. 153–156.

TOMHANNOCK CREEK, RENSSELAER COUNTY, NEW YORK. No. 23.

Stone, Cgb. Twenty-two grams from a mass weighing about 1.5 kilograms found in 1863.

TONGANOXIE, LEAVENWORTH COUNTY, KANSAS. No. 253.

Iron, Om. Weight 195 grams. Polished slab 13.5 by 8 cm. with etched surface showing Widmanstätten figures. Date of fall unknown. Found in 1886. Original weight 11.8 kilograms (26 pounds). It has the following composition:

	Per cent.
Iron (Fe)	91.18
Nickel (Ni)	7.93
Cobalt (Co)	.39
Phosphorus (P)	.10
Copper (Cu)	Trace.
	99.60

Specific gravity, 7.45.

Reference.—E. H. S. Bailey, Amer. Journ. Sci., vol. 42, 1891, p. 385.

TOYAH, REEVES COUNTY, TEXAS. No. 441.

Iron. Weight 28 grams. Locality uncertain. Undescribed.

TRAVIS COUNTY, TEXAS. No. 145.

Stone, Ckb. Weight 2,650 grams. Nearly complete mass with surface much oxidized. Interior nearly black and stained by iron rust. Found 1889; date of fall unknown. Composition as shown by L. G. Eakins's analysis:

	Per cent.
Silica (SiO_2)	44.75
Alumina (Al_2O_3)	2.72
Chromic oxide (Cr_2O_3)	.52
Copper (Cu)	Trace.
Ferrous oxide (FeO)	16.04
Iron (Fe)	1.83
Nickel oxide (NiO)	.52
Nickel (Ni)	.22
Cobalt (Co)	.01
Manganous oxide (MnO)	Trace.
Lime (CaO)	2.23
Magnesia (MgO)	27.93
Potash (K_2O)	.13
Soda (Na_2O)	1.13
Phosphoric acid (P_2O_5)	.41
Sulphur (S)	1.83
Ignition (H_2O)	.84
	101.11
Less O for S	.92
	100.19

The soluble and insoluble silicate analyses yielded:

Constituents.	Soluble in HCl (troilite deducted).			Insoluble in HCl.		
	Analysis.	Calculated to 100 per cent.	Molecular ratios.	Analysis.	Calculated to 100 per cent.	Molecular ratios.
Silica (SiO_2)	15.67	38.13	0.636	30.36	56.14	0.936
Alumina (Al_2O_3)	1.06	2.58	.025	2.02	3.73	.036
Chromic oxide (Cr_2O_3)				.54	1.00	.007
Ferrous oxide (FeO)	8.12	19.76	.274	4.95	9.15	.127
Nickel oxide (NiO)	.49	1.19	.016			
Lime (CaO)	.42	1.02	.018	1.94	3.59	.064
Magnesia (MgO)	15.34	37.32	.933	13.22	24.44	.611
Potash (K_2O)	Undet.			.10	.19	.002
Soda (Na_2O)	Undet.			.95	1.76	.028
	41.10	100.00		54.08	100.00	

The strictly metallic portion yielded:

	Per cent.
Iron (Fe)	88.74
Nickel (Ni)	10.68
Cobalt (Co)	.58
	100.00

From these analyses the proportional mineral composition is calculated as:

	Per cent.
Nickeliferous iron	2.23
Troilite	5.03
Sol. in HCl (mainly olivine)	39.84
Insol. in HCl (mainly enstatite with a little chromite and feldspar)	52.42
	99.52

Structure indistinctly chondritic, firm, and compact; iron scarcely visible to the naked eye. Wülfing suggests that this may belong to the same fall as the Bluff, Fayette County, stone. The general appearance, color, relative portion of the constituents, and chemical composition are, however, all against this.

Gift of R. T. Hill.

Reference.—L. G. Eakins, A new stone meteorite. Amer. Journ. Sci., vol. 39, 1890, pp. 59–61.

TRENTON, WASHINGTON COUNTY, WISCONSIN. No. 65.

Iron, Om. Weight 327 grams. Section 8.3 by 7 by 1.5 cm. etched and showing Widmanstätten figures and large troilite nodule. Date of fall unknown; found in 1858. Originally six masses weighing 65 kilograms, four being found in 1858, one in 1869, and one in 1871. Chemical composition as given by J. Lawrence Smith:

	Per cent.
Iron (Fe)	91.03
Nickel (Ni)	7.20
Cobalt (Co)	.53
Phosphorus (P)	.14
Copper (Cu)	Trace.
Insol. residue	.45
	99.35

The iron is octahedral in structure, but shows on an etched surface peculiar rectangular markings to which Smith proposed to give the name *Laphamite*.

References.—J. L. Smith, Amer. Journ. Sci., vol. 47, 1869, p. 271; I. A. Lapham, Amer. Journ. Sci., vol. 3, 1872, p. 69.

TRENZANO, LOMBARDY, ITALY. No. 327.

Stone, Cca. Fragment weighing 163 grams, from one of two stones weighing 882,459 grams, which fell on November 12, 1856. The mineral composition as quoted by Buchner is:

	Per cent.
Nickel-iron	22. 78
Troilite	4. 96
Iron magnesian silicates	71. 88
	99. 62

Reference.—O. Buchner, Die Meteoriten in Sammlungen, 1863, p. 90.

TUCSON, ARIZONA: THE SIGNET, IRWIN, OR RING METEORITE. No. 368.

Iron, Dm. Weight of main mass 621,531 grams. Original mass stated to have weighed 637,224 grams. In form of a complete ring. Height, 97 centimeters; greatest width, 124 centimeters; width of opening, 68 centimeters; greatest thickness of ring, 49 centimeters; least thickness, 4.5 centimeters. (See pl. 1.) Date of fall unknown. First called to public attention by Dr. John L. LeConte in 1851,[1] and brought to the Smithsonian Institution in 1863, through the influence of Dr. B. J. D. Irwin, U. S. A. The original source is believed to have been the Pass of Los Muchachos, in the Sierra de la Madera, whence it was brought by Spanish soldiers to the old Presidio, where it remained until the withdrawal of the Spanish garrison. It was then taken to Tucson and set up as a kind of "public anvil for the use of the inhabitants." The mass was sent in 1860 from Tucson to Hermosillo, and later to Guaymas. In 1863 it was taken to San Francisco and thence to Washington by way of the Isthmus of Panama.

The results of chemical analyses obtained by various investigators are somewhat variable, as might be anticipated from material not absolutely homogeneous. The following are the results obtained by J. L. Smith, F. A. Genth, and G. J. Brush:

Constituents.	Smith.	Genth.		Brush.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Iron (Fe)	85. 54	83. 47	83. 64	81. 65
Nickel (Ni)	8. 55	9. 44	9. 85	9. 17
Cobalt (Co)	. 61	. 42	....	. 44
Copper (Cu)	. 03	. 008	(2)	. 08
Phosphorus (P)	. 12	. 10	. 15	. 49
Alumina (Al_2O_3)	Trace.	Trace.	Trace.	Trace.
Lime (CaO)	....	. 46	(2)	1. 16
Magnesia (MgO)	2. 04	2. 59	2. 15	2. 43
Soda (Na_2O)	....	(2)	. 174	....
Potash (K_2O)	....	(2)	. 098	....
Chromic oxide (Cr_2O_3)	. 21	(2)	. 50	....
Silica (SiO_2)	3. 02	2. 87	....	3. 63
Labradorite (?)	....	1. 05	4. 17	....
	100. 12	100. 408	100. 732	99. 05

[1] Proc. Amer. Assoc. Adv. Sci., Albany meeting, 1851, p. 188.
[2] Not estimated.

The composition of the strictly metallic portion is given as:

	Per cent.
Iron (Fe)	89.89
Nickel (Ni)	9.58
Cobalt (Co)	.49
Copper (Cu)	.04
	100.00

The mineralogical composition as given by the authorities quoted is:

Constituents.	Smith.	Genth.	Brush.
	Per cent.	*Per cent.*	*Per cent.*
Nickel-iron	90.64	90.03	86.24
Olivine	8.29	8.60	10.05
Schreibersite	.77	.64	3.18
Chromite	.30	.73	.53
	100.00	100.00	100.00

Subsequent[1] investigations by Cohen yielded results as below:

	Per cent.
Iron (Fe)	84.60
Nickel (Ni)	9.24
Cobalt (Co)	.95
Copper (Cu)	.02
Chromium (Cr)	.02
Carbon (C)	.04
Sulphur (S)	.01
(Ce)[2]	.04
Phosphorus (P)	.17
Silica (SiO_2)	1.76
Magnesia (MgO)	.51
Olivine residue	3.39
	100.75

The olivine yielded:

Silica (SiO_2)	44.91
Ferrous oxide (FeO)	2.08
Lime (CaO)	1.33
Magnesia (MgO)	51.44
	99.76

Specific gravity, according to Shepard, 6.66; to Smith, 6.52, 6.91, and 7.13; Brush, 7.29.

The mass is not a homogeneous iron, as it appears on casual inspection, but contains many minute, sometimes microscopic inclosures of olivine, as indicated in the analyses given above. No Widmanstätten figures are brought out by etching, as is common in

[1] Festschrift zu der 50 jährigen Doctor-Jubelfeier d. Herrn H. Limpricht, Greifswald, 1900, pp. 27–73. Abstract in Neues Jahrbuch, 1901, No. 2, p. 37.

[2] Probably a typographical error and should be Cl.

meteoric irons, the surface becoming covered only with "an irregular net work of yellow metallic lines resembling troilite or schreibersite," and round each inclosure, large or small, may be seen a linear margin of the same material. This is shown somewhat indistinctly on the polished surface on the inner part of the ring, and in the small sample (No. 40) in the Shepard collection.

Through misunderstandings a controversy arose as to whom was entitled the credit of securing this unusually interesting relic for the national collections. The matter seems to have been settled in Doctor Irwin's favor in the publication mentioned below.

References.—L. Fletcher, The meteoric iron of Tucson, Min. Mag., vol. 9, 1890, p. 16. B. J. D. Irwin, History of the Great Tucson Meteorite, etc., 1865 (privately printed).

UBERABA, MINAS GERAES, BRAZIL. No. 363.

Stone, Cka. Forty-gram fragment from a shower aggregating some 30–40 kilograms which fell on June 29, 1903.

Reference.—E. Hussak, Ann. k. k. Naturhist. Hofmus., 1904.

UTRECHT, HOLLAND. No. 85.

Stone, Cca or Cc. Weight, 28.7 grams, of which 25.9 grams are in form of coarse powder. Fell June 2, 1843, at 8 p. m. Two stones fell; the first, weighing 7 kilograms, buried itself to a depth of 1 meter (39 inches) in the earth. It was quite cold when removed a quarter of an hour later. The second, weighing 2.7 kilograms, was not found until three days later. The stone is described as clear gray, nearly white with iron granules, and yellow and black, sometimes purple red points.

Analysis recalculated by Baumhauer yielded: Magnetic portion, 10.91; nonmagnetic, 89.09; specific gravity, 3.65.

The magnetic portion consists of nickel-iron. The nonmagnetic portion was calculated by Baumhauer to consists of pyrrhotite, olivine, albite, and augite. A bulk analysis (recalculated) yielded:

	Per cent.
Silica (SiO_2)	39.30
Alumina (Al_2O_3)	2.25
Iron (Fe)	11.07
Ferrous oxide (FeO)	15.29
Lime (CaO)	1.48
Magnesia (MgO)	24.37
Soda (Na_2O)	1.39
Potash (K_2O)	.15
Chromic oxide and ferrous oxide (Cr_2O_3+FeO)	.65
Nickel (Ni) and cobalt (Co)	1.24
Sulphur (S)	1.90
Phosphorus (P)	.005
Copper (Cu) and tin (Sn)	.025
	99.120

Reference.—E. H. von. Baumhauer, Pogg. Ann., vol. 66, 1845, p. 465.

VACA MUERTA (SIERRA DE CHACO), ATACAMA, CHILE. No. 1.

Stony-iron, Grahamite. Weight, 432 grams; roughly cubical mass with portion of original surface. Date of fall unknown; found prior to 1862. The Museum sample was received from the University of Santiago, labeled as found in 1862, and is probably from the sample described by Professor Domeyko.[1] The composition of the metallic and silicate portions of this, as given by Domeyko, is:

		Per cent.
Metallic:		
Iron (Fe)		88.6
Nickel (Ni)		11.4
		100.00
Silicate:		
Silica (SiO_2)		43.22
Alumina (Al_2O_3)		7.60
Ferrous oxide (FeO)		26.52
Magnesia (MgO)		6.60
Lime (CaO)		4.27
Soda (Na_2O)		.40
Sulphur (S)	4.34	11.84
Iron (Fe)	7.50	
		100.45

The mineral composition of the Sierra de Chaco stone, which is considered the same, is given as nickel-iron, pyrrhotite, olivine, enstatite, augite, and plagioclase. For the Mejillones iron Domeyko gives the following composition:

	Per cent.
Iron	95.4
Nickel	3.8
Cobalt	.1
Schreibersite	.9
	100.2

Gift of the University of Santiago, Chile.

References.—Domeyko, Compt. Rend., vol. 58, 1864, p. 551, and vol. 81, 1875, p. 599. L. Fletcher, Min. Mag., vol. 8, 1889, p. 223.

VERAMIN (KARAND), TEHERAN, PERSIA. Nos. 225, 410.

Stony-iron, Mesosiderite. Two pieces, weighing about 10 grams, from a mass weighing some 45 kilograms which fell in February, 1880.

Reference.—H. A. Ward, A trip after meteorites. The Mineral Collector, vol. 6, June, 1899, p. 59.

[1] Comptes Rendus, vol. 58, 1864, p. 551.

VICTORIA (SASKATCHEWAN RIVER), BRITISH COLUMBIA. No. 417.

Iron, Om. Rectangular piece, 30 by 14 by 3 mm., weighing 13 grams, from a mass weighing 175 kilograms, found in 1871.

VIGARANO PARISH, NEAR FERRARA, ITALY. No. 477.

Stone, Cc. A roughly cubical mass some 60 by 50 by 40 mm. with oxidized crust on two surfaces; dark gray with white spots. Weight, 297 grams, from a stone weighing 11.5 kilograms, or 25 pounds, which fell January 22, 1910. It is described by A. Rosati as a carbonaceous chrondrite. It consists of olivine, rhombic pyroxene and iron, with iron sulphide, chromite, plagioclase, augite, glass, and carbonaceous matter.

Reference.—A. Rosati, Neues Jahrb. Min. Geol. Pal., vol. 1, 1912, p. 44 (abstract).

VOUILLE, NEAR POITIERS, FRANCE. No. 404.

Stone, Cia. 11 grams from a mass weighing some 20 kilograms, which fell May 13, 1831.

WACONDA, MITCHELL COUNTY, KANSAS. Nos. 61, 502.

Stone, Ccb. Fragment from interior weighing 112 grams, and two smaller weighing together 8 grams, one showing crust. Date of fall unknown; found in 1874, and about one-half carried away in fragments and lost; portion remaining weighing 58 pounds (26 kilograms). Analyses by Smith yielded:

	Per cent.
Stony matter	90.81
Nickel-iron	5.34
Troilite	3.85
	100.00

The nickel-iron yielded:

	Per cent.
Iron (Fe)	86.18
Nickel (Ni)	12.02
Cobalt (Co)	.91
Copper (Cu)	.04
	99.15

The stony portion yielded:

Constituents.	Soluble, 69 per cent.	Insoluble, 41 per cent.
Silica (SiO_2)	34.52	54.02
Ferrous oxide (FeO)	30.01	18.10
Magnesia (MgO)	32.50	23.45
Alumina (Al_2O_3)	.43	2.30
Manganese (Mn)	.61	.36
Alkalies	.89	1.58
Copper oxide (CuO)	....	Trace.
	98.96	99.81

The mineral composition as calculated from these analyses would then be: Nickel-iron, 5.34; troilite, 3.85; olivine and enstatite.

References.—C. U. Shepard, Amer. Journ. Sci., vol. 11, 1876, pp. 473–474. J. L. Smith, Amer. Journ. Sci., vol. 13, 1877, pp. 211–214; Original Researches, 1884, p. 523.

WALKER COUNTY, ALABAMA. No. 120.

Iron, H. A thin slice some 2 by 3 cm. in diameter, weighing 15 grams, from a mass weighing about 165 pounds, or 74.5 kilograms, found in 1832 in the northeast corner of Walker County. Excepting that this iron is hexahedral in crystallization, there is no apparent reason for including it in the Lime Creek, Claiborne find, several hundred miles to the southwest.

WARRENTON, WARREN COUNTY, MISSOURI. No. 43.

Stone, Cco. Weight, 11 grams; fragment from interior. A fine, somewhat loosely aggregated mass of a smoky blue-gray color. Fell January 3, 1877, at 7 a. m. No report nor luminous phenomena accompanied the fall, the only sound being that caused by its passage through the air, which was compared to the whistle of a distant locomotive or the passage of a cannon ball. Struck a tree in falling and portions of wood fibers adhered, which, however, were not in the least charred, indicating that the temperature was not high, though it was reported that the snow was melted immediately around the spot where it fell. Original weight estimated at 100 pounds (45.5 kilograms), but only some 10 or 15 pounds (4 to 7 kilograms) preserved. Passage of stone in its flight from northwest to southeast. Analyses by Smith yielded:

	Per cent.
Nickel-iron	2.01
Troilite	3.51
Silicates (including chromite)	94.48
	100.00

The metallic portion yielded:

	Per cent.
Iron (Fe)	88.51
Nickel (Ni)	10.21
Cobalt (Co)	.60
	99.32

The silicate portion yielded:

Constituents.	Soluble, 80.40 per cent.	Insoluble, 19.60 per cent.
Silica (SiO_2)	33.02	56.90
Ferrous oxide (FeO)	37.57	10.20
Alumina (Al_2O_3)	.12	.20
Lime (CaO)	Trace.	7.62
Magnesia (MgO)	28.41	22.41
Soda (Na_2O)	.07	1.00
Nickel oxide (NiO)	1.54	....
Cobalt oxide (CoO)	.31	....
Chromic oxide (Cr_2O_3)	....	.33
	101.04	98.66

The mineral composition as calculated from these analyses was:

	Per cent.
Olivine	76.00
Bronzite and pyroxene minerals	18.00
Nickel-iron	2.00
Troilite	3.50
Chromite	.50
	100.00

Reference.—J. L. Smith, Amer. Journ. Sci., vol. 14, 1877, pp. 219–299; Original Researches, 1884, p. 532.

WELLAND, ONTARIO, CANADA. No. 416.

Iron, Om. Fragment some 40 by 20 by 20 mm., weighing 38 grams, from a mass weighing 8 kilograms found in 1888. The chemical composition, as determined by J. M. Davison, is as follows: Iron, 91.17; nickel, 8.54; cobalt, 0.06; sulphur, 0.07.

Reference.—E. E. Howell, Proc. Rochester Acad. Sci., vol. 1, 1890, p. 86.

WESTON, FAIRFIELD COUNTY, CONNECTICUT. Nos. 126, 270, 406.

Stone, Ccb. Four fragments weighing 4, 6, 6, and 17 grams. All from the interior. Fell December 14, 1807, at 6.30 a. m. The fall was accompanied by the usual flash of light and detonations compared to the sound produced by cannon balls rolling over a floor. The meteor passed from the north toward the west and was in sight some 30 seconds. Six or seven masses were known to fall within a distance of some 9 or 10 miles along the line taken by the meteor, the aggregate weight of which has been estimated at about 330 pounds, or 150 kilograms. The largest individual is estimated to have weighed some 10 kilograms. The stone is chondritic, of ash-gray color, with metallic iron and pyrrhotite visible to the unaided eye. Analyses made by Professor Silliman are, owing to the condition of analytical science at that time, of only historical value. The stone is of interest in being the first recorded and described meteoric stone to fall in America.

Reference.—B. Silliman and J. L. Kingsley, Trans. Amer. Philos. Soc., vol. 6, 1809, p. 323.

WICHITA COUNTY (BRAZOS RIVER), TEXAS. Nos. 20, 348.

Iron, Og. Two slices, one 4 by 1 by 0.7 cm., weighing 20.8 grams, and one, 5 by 5 cm., weighing 143 grams. Date of fall uncertain; first known in 1836. Original weight unknown, but not far from 160 kilograms, as given by Mallet. Analysis by this authority yielded:

	Per cent.
Iron (Fe)	90.769
Nickel (Ni)	8.342
Cobalt (Co)	.265
Manganese (Mn)	Trace.
Copper (Cu)	.018
Tin (Sn)	.004
Phosphorus (P)	.141
Sulphur (S)	.016
Graphitic carbon (C)	.190
Silica (SiO_2) } Magnetic iron oxide }	.132
	99.877

Specific gravity at 24° C., 7.841.

It has been suggested that this iron may have been a part of the same fall as the Red River or Cross Timbers mass found about 1808.

References.—B. F. Shumard, Trans. St. Louis Acad. Sci., vol. 1, 1856–60, p. 622. J. W. Mallet, Amer. Journ. Sci., vol. 28, 1884, p. 285.

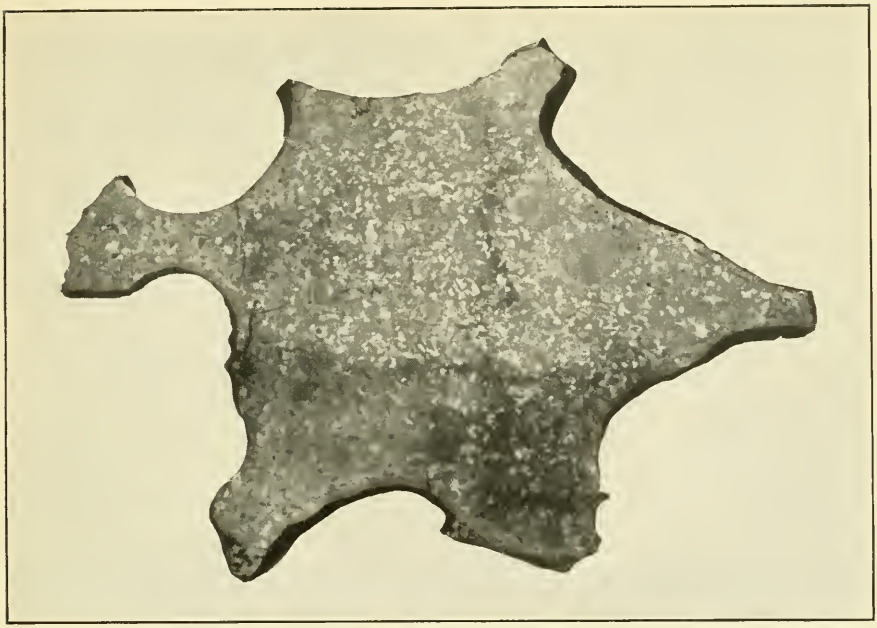
WILLAMETTE, CLACKAMAS COUNTY, OREGON. No. 500.

Iron, Om. An irregular slice 23 by 30 cm. in greatest diameter, weighing 1,954 grams, from the gigantic mass weighing 31,107 pounds, found in the autumn of 1902, and now in the American Museum of Natural History in New York. It is the third largest mass known. Its chemical composition as shown by Davison's analysis is:

	Per cent.
Iron (Fe)	91.65
Nickel (Ni)	7.88
Cobalt (Co)	.21
Phosphorus (P)	.09
	99.83

Gift of C. S. Bement. (Pl. 36, fig. 1.)

References.—H. L. Ward, Proc. Rochester Acad. Sci., vol. 4, 1904, p. 137. E. O. Hovey, Amer. Mus. Journ., vol. 6, No. 3, July, 1906, p. 105.



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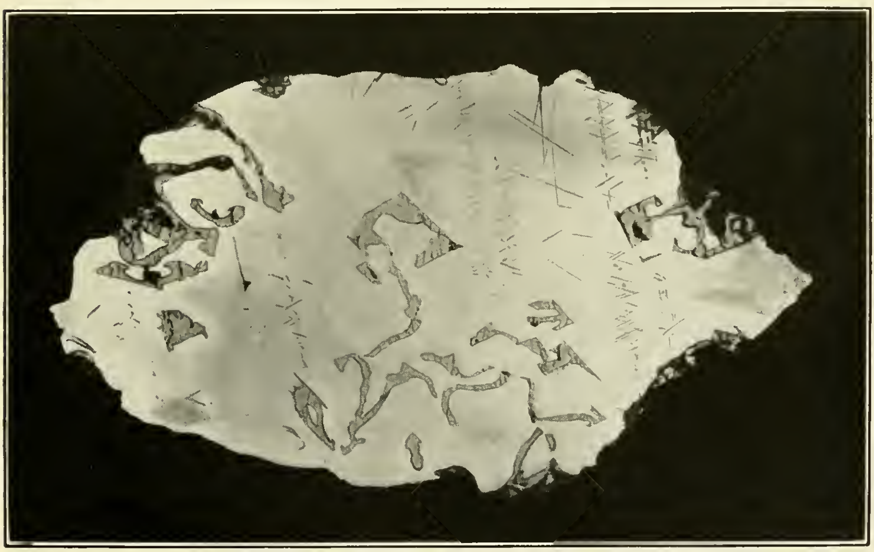


2

ETCHED SLICE OF (1) WILLAMETTE IRON AND (2) OF TOMBIGBEE RIVER IRON.

FOR DESCRIPTIONS SEE PAGES 160 AND 170.

WILLIAMSTOWN, KENTUCKY. Nos. 374, 377.

Iron, Om. Portion of end of mass, weighing 731 grams, and a slice 30 by 6 cm., weighing 555 grams. From a mass weighing 68 pounds, or 31 kilograms, found in April, 1892. The composition as shown by analysis by W. Tassin is:

	Per cent.
Iron (Fe)	91.54
Nickel (Ni)	7.26
Cobalt (Co)	.52
Copper (Cu)	.03
Chromium (Cr)	.05
Phosphorus (P)	.12
Sulphur (S)	.17
Carbon (C)	.004
Silicon (Si)	Trace.
	99.694

Reference.—E. E. Howell, Amer. Journ. Sci., vol. 25, Jan., 1908, p. 49.

YOUNDEGIN, 70 MILES EAST OF YORK, WEST AUSTRALIA. No. 458.

Iron, Og. Slice 6 by 6 cm., weighing 410 grams, from one of 4 masses weighing 73¼ pounds, found in 1884. The composition as given by L. Fletcher is:

	Per cent.
Iron (Fe)	92.67
Nickel (Ni)	6.46
Cobalt (Co)	.55
Copper (Cu)	Trace.
Magnesium (Mg)	.42
Phosphorus (P)	.24
Sulphur (S)	None.
Insoluble cubes (Cliftonite)	.04
	100.38

The chief interest of this iron lies in the presence of crystals of a cubic form of carbon about 0.25 mm. in diameter, to which Dr. L. Fletcher gave the name *cliftonite*, in honor of Prof. R. B. Clifton, of Oxford University.

Reference.—L. Fletcher, Min. Mag., vol. 7, 1887, p. 121.

ZABORZIKA, VOLHYNIA, RUSSIA. No. 180.

Stone, Cw. Weight, 4.1 grams; fragment from the interior. Light gray ground, fine, granular, and friable. Fell April 10, 1818. Original weight, 4 kilograms. A light gray stone with small rust spots and pyrrhotite and metallic iron scarcely visible to the unaided eye. Indistinctly chondritic. Laugier's analysis, published in 1823, sums up 109.4 and is obviously erroneous. He gives:

	Per cent.
Silica (SiO_2)	41.00
Ferric oxide (Fe_2O_3)	45.00
Alumina (Al_2O_3)	.75
Magnesia (MgO)	14.9
Lime (CaO)	2.00
Nickel (Ni)	1.00
Chromium (Cr)	.75
Sulphur (S)	4.00
	109.40

Gift of R. de Kroutschoff.

Reference.—Laugier, Gilbert's Annalen, vol. 75, 1823, p. 264.

ZACATECAS, MEXICO. No. 57.

Iron, Obz. Weight, 14.8 grams. Date of fall unknown; found in 1792. Original weight some 1,000 kilograms. According to Bergmann, as quoted by Buchner (p. 145), this iron consists of 93.77 nickel-iron, 2.27 pyrrhotite, 1.48 chromite, 1.65 schreibersite, and 0.49 carbon.

Gift of J. Berrien Lindsley.

ZAVID, BOSNIA, AUSTRIA. No. 232.

Stone, Cia (?). Weight, 31 grams. Irregular fragment from the interior. Fell August 1, 1897, about 11.30 a. m. Four stones were reported. The largest, which was broken, was estimated to have weighed 90 kilos; the others weighed 2.542 kilograms, 220 grams, and 48 grams, respectively, a total of 92,810 grams. General direction of flight southeast to northwest. A moderately firm, indistinctly chondritic stone, of a light gray color, in which the metallic particles are so small as to be scarcely distinguishable by the unaided eye.

The mineral composition, according to Berwerth, is olivine, bronzite, a monoclinic pyroxene, a little plagioclase, chromite, pyrrhotite, and nickel-iron. Analyses by Carl Hödlmoser yielded:

	Per cent.
Ignition (H_2O)	0.39
Silica (SiO_2)	41.90
Alumina (Al_2O_3)	1.92
Iron (Fe)	.15
Ferrous oxide (FeO)	27.40
Cobalt (Co)	Trace.
Nickel (Ni)	Trace.
Manganese (Mn)	Trace.
Lime (CaO)	4.60
Magnesia (MgO)	22.79
Soda (Na_2O)	1.05
Potash (K_2O)	.41
Sulphur (S)	1.01
	101.62
Less O for S	.51
	101.11

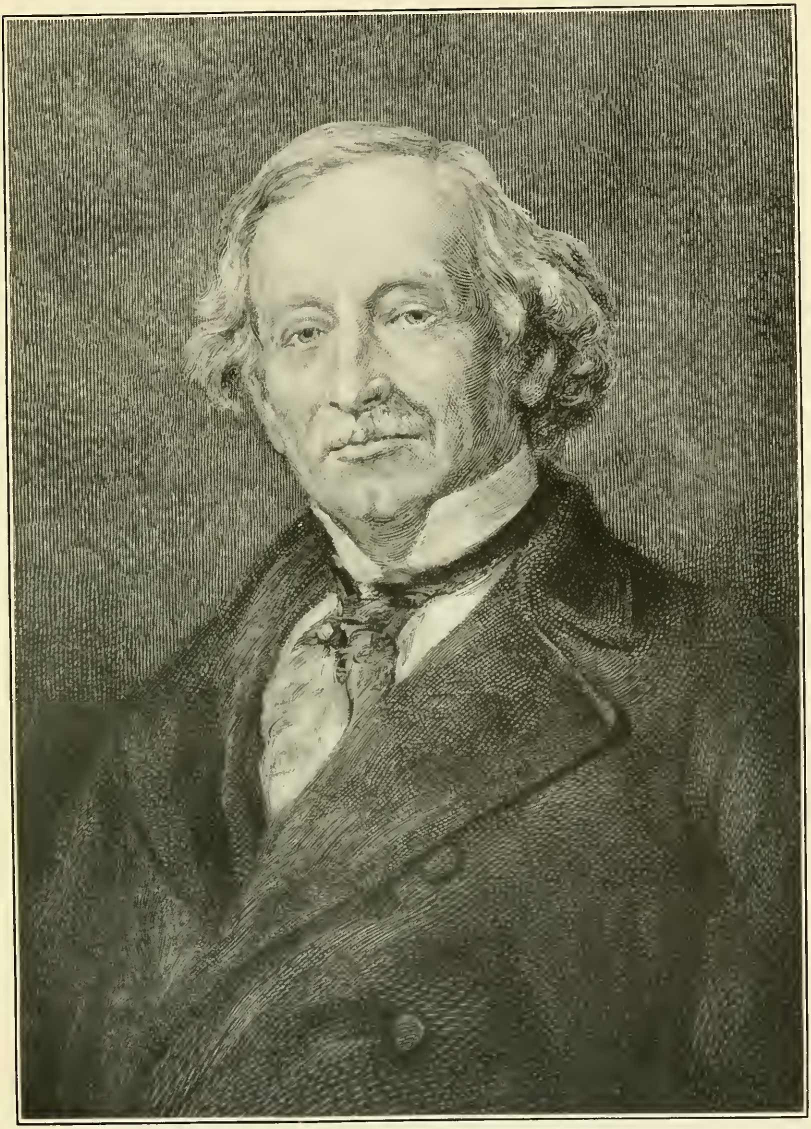
Berwerth regards the stone as a tufaceous rock somewhat metamorphosed by heat.

References.—C. Hödlmoser, Min. pet. Mitth., vol. 18, 1899, p. 513. F. Berwerth, Wiss. Mitth. Bosnien u. der Hercegovina, vol. 8, 1901, pp. 1–17; Centralblatt für Min., No. 21, 1901, pp. 641–647.

CASTS OF METEORITES.

The collections contain casts in plaster of the meteorites listed below. The asterisk indicates also a mold from which additional casts may be made, for exchange purposes, if desired.

Algoma, Kewaunee County, Wisconsin.
Babb's Mill, Greene County, Tennessee.
Bacubirito (Ranchito), Sinaloa, Mexico.
Bath Furnace, Bath County, Kentucky.
Beaver Creek, West Kootenai District, British Columbia.
Braunau, Hauptmannsdorf, Bohemia.
Cabin Creek, Johnson County, Arkansas.
Cape York, Greenland. (3 casts.)
Cross Roads, Boyett, Wilson County, North Carolina.
*Cullison, Pratt County, Kansas.
Davidson County, North Carolina.
El Capitan, New Mexico.
Glorieta Mountain, Santa Fe County, New Mexico.
Grand Rapids, Kent County, Michigan.
*Hendersonville, Henderson County, North Carolina.
Kendall County, Texas.
Kokstadt, Griqualand, South Africa.
*Mart, McLennan County, Texas.
Mazapil, Mexico.
**Modoc, Kansas. (Casts of 2 largest stones.)
Mount Joy, Adams County, Pennsylvania.
Nedagolla, Madras, India.
*Perryville, Perry County, Missouri.
Plymouth, Marshall County, Indiana.
*Rich Mountain, Jackson County, North Carolina.
Rowton, Shropshire, England.
*Santa Rosa, Coahuila, Mexico.
Sarepta, Saratov, Russia.
Scottsville, Allen County, Kentucky.
Steinbach, Saxony, Germany.
*Thomson, McDuffie County, Georgia.
Wold Cottage, Yorkshire, England.



PROFESSOR CHARLES UPHAM SHEPARD.

Born, 1804; died, 1886.

SHEPARD COLLECTION OF METEORITES IN THE U. S. NATIONAL MUSEUM.

FOR DESCRIPTION SEE PAGE 175.

B. THE SHEPARD COLLECTION.

Prof. C. U. Shepard, one of the earliest American mineralogists, was born June 29, 1804, and died May 1, 1886. For several years he served as an assistant to Prof. Benj. Silliman, sr., in Yale College, New Haven, Connecticut, and was professor of chemistry in the Medical College of the State of South Carolina, at Charleston, South Carolina, from 1833 to 1870, except during the period of the Civil War. For some years also he was professor of chemistry and natural history at Amherst College, in Massachusetts. He was one of the most enthusiastic American students of meteorites, wrote many papers relating to them, and made extensive collections. This collection is exhibited through the courtesy of his son, Dr. C. U. Shepard, of Summerville, South Carolina.[1]

ABERT IRON. No. 20.

Iron, Om. Fragment weighing 11.3 grams. Source unknown.

ALAIS, GARD, FRANCE. No. 133.

Stone, K. A dark brown powder and some friable fragments weighing 0.60 grams; carbonaceous. Fell March 15, 1806, 5 p. m.

ALBARETO, NEAR MODENA, ITALY. No. 124.

Stone, Cc. Fragment from interior weighing 1 gram. Groundmass light gray. Fell July, 1766.

ALEXANDER COUNTY, NORTH CAROLINA. No. 82.

Iron. Etched fragment weighing 12.3 grams. Found in 1860.

ALFIANELLO, PROVINCE OF BRESCIA, ITALY. No. 237.

Stone, Ci. Two fragments from interior weighing 29.54 grams. Fell February 16, 1883, 3 p. m.

ALLEGAN, MICHIGAN. No. 247.

Stone, Cco. Fragments from interior weighing 125 grams.

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[1] Dr. Shepard died on July 5, 1915, since the manuscript of this Bulletin went to the printer. By his will the collection has been left to the United States National Museum as a memorial of his father's labors.

ANGERS, MAINE-ET-LOIRE, FRANCE. No. 147.

Stone, Cwa. Fragments from interior weighing 0.72 gram. Fell June 3, 1882.

ASSAM, INDIA. No. 168.

Stone, Cgb. Dark ash gray fragment with crust, weighing 7 grams; gray chondrules. Found 1846.

ASSISI, NEAR PERUGIA, ITALY. No. 239.

Stone, Cc. Fragment with crust, weighing 29 grams; groundmass ash-gray, containing chondrules and metallic grains. Fell May 24, 1886.

AUBURN, LEE (FORMERLY MACON) COUNTY, ALABAMA. No. 76.

Iron, H. Eight fragments weighing 228.15 grams. Found in 1867.

AUGUSTINOWKA, EKATERINOSLAW, RUSSIA. No. 245.

Iron, Of. Three fragments: Two oxidized, weighing 50 grams and 24 grams, respectively, and one unoxidized, weighing 7 grams. Found in 1890.

AUMIERS, CANTON, MASSEGROS, LOZÉRE, FRANCE. No. 165.

Stone, Cwa. Fragment weighing 0.45 gram. Fell June 3, 1842.

AUSSEN (CLARAC), MONTRÉJEAU, HAUTE-GARONNE, FRANCE. No. 185.

Stone, Cc. Two fragments, one showing crust, weighing 20.1 grams. Groundmass ash gray flecked with rust and containing light and dark chondrules and metallic grains. Fell December 9, 1858.

BABB'S MILL, GREENE COUNTY, TENNESSEE, No. 34.

Iron, Db. (1) Small fragment; (2) vial of filings; (3) vial of turnings; total weight, 20.63 grams. Known in 1842.

BACHMUT (ALEXEJEWKA), EKATERINOSLAW, RUSSIA. No. 142.

Stone, Civ. Fragment with crust and polished surface, weighing 8.6 grams. Groundmass greenish gray with numerous metallic grains and chondrules. The metallic portion is more or less oxidized. Fell February 15, 1814.

BAIRD'S PLANTATION, ASHEVILLE, BUNCOMBE COUNTY, NORTH CAROLINA. No. 29.

Iron, Om. Three fragments, weighing 2.95 grams. Found in 1839.

BALLINOO (10 MILES SOUTH OF), MURCHISON RIVER, WEST AUSTRALIA. No. 104.

Iron, Off. Weight 122 grams. Etched surface has a stippled appearance, overlaid with a network of fine lines. Found in 1892.

BANDONG, JAVA. No. 212.

Stone, Cw. Fragment with pitted dull black crust, weighing 50.87 grams. Groundmass ash gray, containing chondrules; grains of nickel iron and troilite, some of them quite large. Fell December 10, 1871, 1.30 p. m.

BARBOTAN, ROQUEFORT, LANDES, FRANCE. No. 126.

Stone, Cga. Section showing crust; weight 28.7 grams. Groundmass light gray, and containing chondrules and numerous metallic grains. Fell July 24, 1790, 9 p. m.

BEAR CREEK, DENVER COUNTY, COLORADO. No. 75.

Iron, Of. (1) Section of mass showing troilite nodules, weighing 117.20 grams; (2) section with well-marked Widmanstätten figures and distinct plates of taenite, weighing 62.05 grams; (3) two vials of fragments showing octahedral cleavage. Found in 1866.

BEMDEGO, MONTE SANTO, BAHIA, BRAZIL. No. 8.

Iron, Og. Thin slab weighing 102 grams. Found in 1784.

BENARES (KRAKHUT), INDIA. No. 131.

Stone, Cc. Fragment with crust, weighing 7.32 grams. Polished surface shows chondrules and scattered metallic grains. Fell December 19, 1798.

BISHOPVILLE, SUMTER COUNTY, SOUTH CAROLINA. No. 166.

Stone, Chla. Weight, 1,090.4 grams. Mass with grayish vitreous crust; one vial of fragments. Fell March 25, 1843.

BITBURG, PRUSSIA, GERMANY. No. 14.

Stony-iron, Pallasite. Fragment weighing 19 grams. Found in 1807.

BOHUMILITZ, BOHEMIA, AUSTRIA. No. 21.

Iron, Og. Fragment with original surface, weighing 0.95 gram. One side etched to show Widmanstätten figures. Found in 1829.

BONANZA, BOLSON DE MAPIMI, MEXICO. No. 27.

Iron, H. Two etched fragments, weighing 238.6 grams. Found in 1837.

BRAHIN, MINSK, RUSSIA. No. 118

Stony-iron, Pallasite. Fragment of iron matrix from which the stony matter has disappeared, weighing 5.13 grams. Found in 1810.

BRAUNAU, HAUPTMANNSDORF, BOHEMIA. No. 45.

Iron, H. Rectangular section containing troilite nodule; weight, 14.5 grams. Etched surface shows a network of fine lines. Fell July 14, 1847, 3.45 a. m.

BRENHAM, KIOWA COUNTY, KANSAS. No. 120.

Stony-iron, Pallasite. Weight, 430 grams. Polished slice showing a sponge-like metallic matrix, with olivine filling the cavities. Found in 1890.

BURLINGTON, OTSEGO COUNTY, NEW YORK. No. 19.

Iron, Om. Two pieces: Larger one, weighing 1,503.3 grams, shows original surface, one face etched; smaller one, weighing 25 grams, contains drill hole and is etched on three faces. Known prior to 1819.

BUSTEE, INDIA. No. 176.

Stone, Bu. Fragment, weighing 0.2 gram. Fell December 2, 1852.

BUTLER, BATES COUNTY, MISSOURI. No. 86.

Iron, Off. Weight, 391 grams. Section showing original surface. Etched face shows comb-like markings made up of fine lines; Widmanstätten figures very distinct. Minute nodules of troilite are scattered over the surfaces. Found in 1874.

BUTSURA, GORUCKPUR, INDIA. No. 190.

Stone, Ci. Fragment with crust and polished surface, weighing 7.83 grams. Metallic grains present in large amount; olivine chondrules 1 mm. in diameter. Fell May 12, 1861.

CABEZA DE MAYO, MURCIA, SPAIN. No. 210.

Stone, Civ. Fragment from interior, weighing 13.7 grams. Fell August 18, 1870.

CAMBRIA (LOCKPORT), NIAGARA COUNTY, NEW YORK. No. 37.

Iron, Of. Weight 33.2 grams. Etched slab containing large nodule of troilite; etch figures coarse and approximately square. Found in 1818 (?).

CAMPO DEL PUCARA, ARGENTINA, SOUTH AMERICA. No. 112.

Stony-iron, Pallasite. Fragment weighing 0.192 gram. Found in 1879.

CAPE IRON, CAPE COLONY, SOUTH AFRICA. No. 10.

Iron, Hca. Section, weighing 182.5 grams, showing portion of original surface and containing troilite nodule. Found in 1793.

CARTHAGE, SMITH COUNTY, TENNESSEE. No. 36.

Iron, Om. Section, weighing 43.1 grams, showing Widmanstätten figures, also delicate lines of taenite. Found in 1840.

CASEY COUNTY, KENTUCKY. No. 89.

Iron, Og. Fragment weighing 3.30 grams. Found in 1877.

CASTINE, HANCOCK COUNTY, MAINE. No. 171.

Stone, Cwa. Minute fragment with crust. Fell May 20, 1848.

CHANDAKAPUR, BERAR, INDIA. No. 159.

Stone, Cib or Cgb. Powder and angular fragments, weighing 1.05 grams. Fell June 6, 1838, 12 noon.

CHANTONNAY, VENDÉE, FRANCE. No. 141.

Stone, Cgb. Two fragments weighing 45.1 grams. Fell August 5, 1812, 2 a. m.

CHARLOTTE, DICKSON COUNTY, TENNESSEE. No. 25.

Iron, Of. Triangularly shaped section, weighing 2.70 grams. Fell in July or August, 1835.

CHARSONVILLE, NEAR ORLEANS, LOIRET, FRANCE. (1) No. 138, (2) No. 150.

Stone, Cga. (1) Fragment from interior, weighing 3.77 grams; (2) ("Bois de Fontaine") fragments and powder from interior, weighing 3.27 grams. Fell November 23, 1810, 1.30 p. m.

CHATEAU-RENARD, MONTARGIS, LOIRET, FRANCE. No. 162.

Stone, Cia. Fragment from interior, weighing 3.74 grams. Groundmass ash gray, compact, and containing numerous metallic grains. Fell June 12, 1841.

CHEMNITZ, SAXONY. No. 107.

Iron. Part of a mass, perhaps Bitburg, weighing 75.27 grams. The iron has apparently been heated in a forge. Found in 1853.

CHESTERVILLE, CHESTER COUNTY, SOUTH CAROLINA. (1) No. 42, (2) No. 43.

Iron, Hch. (1) An irregularly shaped section weighing 36.4 grams; etched surface shows a network of fine lines. (2) A rectangular section weighing 54.6 grams; etched surface as above. Found in 1847.

CHILE, No. 74.

Fragment consisting entirely of nickel-iron; weight, 4.76 grams.

CHULAFINNEE, CLEBURNE COUNTY, ALABAMA. No. 84.

Iron, Om. Thin slab, etched, weighing 54 grams. Widmanstätten figures broad and well outlined. Found in 1873.

CLAIBORNE (LIME CREEK), MONROE COUNTY, ALABAMA. No. 24.

Iron, H. Fragment weighing 3.7 grams. Found in 1834.

CLAYWATER (VERNON COUNTY), WISCONSIN. No. 198.

Stone, Cka. Polished slice, weighing 9.35 grams, made up of coarse, transparent, nonmetallic grains, with scattering grains of nickel-iron and chondrules, the whole resembling sandstone. Fell March 25, 1865.

CLEVELAND (LEA IRON), EAST TENNESSEE. No. 99.

Iron, Om. Weight 260 grams. Found in 1860.

COAHUILA (SMITHSONIAN IRON), MEXICO. No. 94.

Iron, H. Part of mass, weighing 88.3 grams. Etched surface shows cubic structure. Known in 1852.

COLD BOKKEVELD, CAPE COLONY, SOUTH AFRICA. No. 160.

Stone, K. Fragment of a dull black color flecked with white, weighing 9.27 grams. Fell October 13, 1838, 9 a. m.

COOPERTOWN, ROBERTSON COUNTY, TENNESSEE. No. 67.

Iron, Om. Weight, 327.83 grams. Two slices etched, showing Widmanstätten figures made up of broad plates 5 to 7 mm. in width. Known in 1860.

COSBY'S CREEK, COCKE COUNTY, TENNESSEE. No. 32.

Iron, Og. One lot of fragments, weighing 69.16 grams, some of which show octahedral cleavage. Found in 1837.

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2

(1) THE DALTON IRON AND (2) NEW CONCORD STONE.

FOR DESCRIPTIONS SEE PAGES 181 AND 190.

CRANBERRY PLAINS, POPLAR HILL, VIRGINIA. No. 50.

Iron, O. Fragment weighing 7.92 grams. Found in 1852.

CRANBOURNE, VICTORIA, AUSTRALIA. (1) No. 59, (2) No. 59*a*.

Iron, Og. (1) Fragment, weighing 10.6 grams, much oxidized and somewhat decomposed from occluded lawrencite; found in 1854. (2) Oxidized fragment, weighing 21 grams (Yarra Yarra River), found in 1858.

CRONSTADT, ORANGE RIVER, ORANGE FREE STATE, SOUTH AFRICA. No. 225.

Stone, Cga. Fragment with crust and polished surface, weighing 12.5 grams. Crust dull black, somewhat pitted and in swellings. Groundmass ash gray, with abundant metallic grains. Chondrules gray and white. Fell November 19, 1877.

CROSS TIMBERS, RED RIVER, TEXAS. No. 18.

Iron, Om. Two pieces, one weighing 62.85 grams, the other a cleavage crystal, weighing 0.85 gram. Known in 1808.

CYNTHIANA, HARRISON COUNTY, KENTUCKY. No. 223.

Stone, Cg. Fragment with crust, weighing 1.77 grams. Fell January 23, 1877.

DALTON, WHITFIELD COUNTY, GEORGIA. (1) No. 90, (2) No. 248.

Iron, Om. (1) Two pieces weighing 735.71 grams. Etched face shows broad Widmanstätten figures with scattering plates of taenite; surface more or less decomposed from presence of lawrencite. Found in 1879. (2) Nearly complete individual—weighing 50,340 grams, or 111 pounds. This is the mass described and figured by Shepard[1] but from which possibly 2 kilograms has been cut from the apex (pl. 39).

DANIELS KULL, GRIQUALAND, SOUTH AFRICA. No. 204.

Stone, Ck. Fragment from interior, weighing 4.6 grams. Ground mass ash gray flecked with rust. Fell March 20, 1868.

DEAL, MONMOUTH COUNTY, NEW JERSEY. No. 157.

Stone, Ci. Fragment with crust, weighing 4.19 grams. Groundmass ash gray, fine granular and compact with delicate veins ap-

[1] Amer. Journ. Sci., vol. 26, 1883, p. 336.

parently filled with nickel-iron somewhat oxidized. Structure chondritic with numerous metallic grains. Fell August 14, 1829.

DENTON COUNTY, TEXAS. No. 63.

Iron, Om. Etched fragment showing coarse Widmanstätten figures; weight, 7.97 grams. Found in 1856.

DESCUBRIDORA, SAN LUIS POTOSI, MEXICO. No 3.

Iron, Om. Oblong slabs, etched, weighing 24.8 grams. Known in 1780.

DHURMSALA, KANGRA, INDIA. No. 189.

Stone, Ci. Weight, 259.2 grams. Fell July 14, 1860, 2.30 p. m. (1) Fragment with faint, shining and much pitted crust. Groundmass ash gray, compact, with finer grained bluish gray nodules and oxidized metallic grains distributed through it. (2) Fragment from interior, one surface polished. Two faces show fragmentary slickensides.

DONA INEZ, ATACAMA, CHILE. No. 117.

Stony-iron, Pallasite. Portion of mass, weighing 59.5 grams and showing original and polished surfaces. The metallic and stony parts are about equal in amount, the latter being distributed through the mass in reticulated shapes. The specimen exhibits in a slight degree the characteristic cracked surface. Found in 1888.

DRAKE CREEK, NEAR NASHVILLE, DAVIDSON COUNTY, TENNESSEE. No. 154.

Stone, Cwa. Fragment with crust, weighing 4.18 grams. Fell May 9, 1827.

DURANGO, MEXICO. No. 13.

Iron, Om. Etched fragment showing Widmanstätten figures; weight, 45.43 grams. One surface deeply pitted. Found in 1804.

EICHSTÄDT, BAVARIA, GERMANY. No. 127.

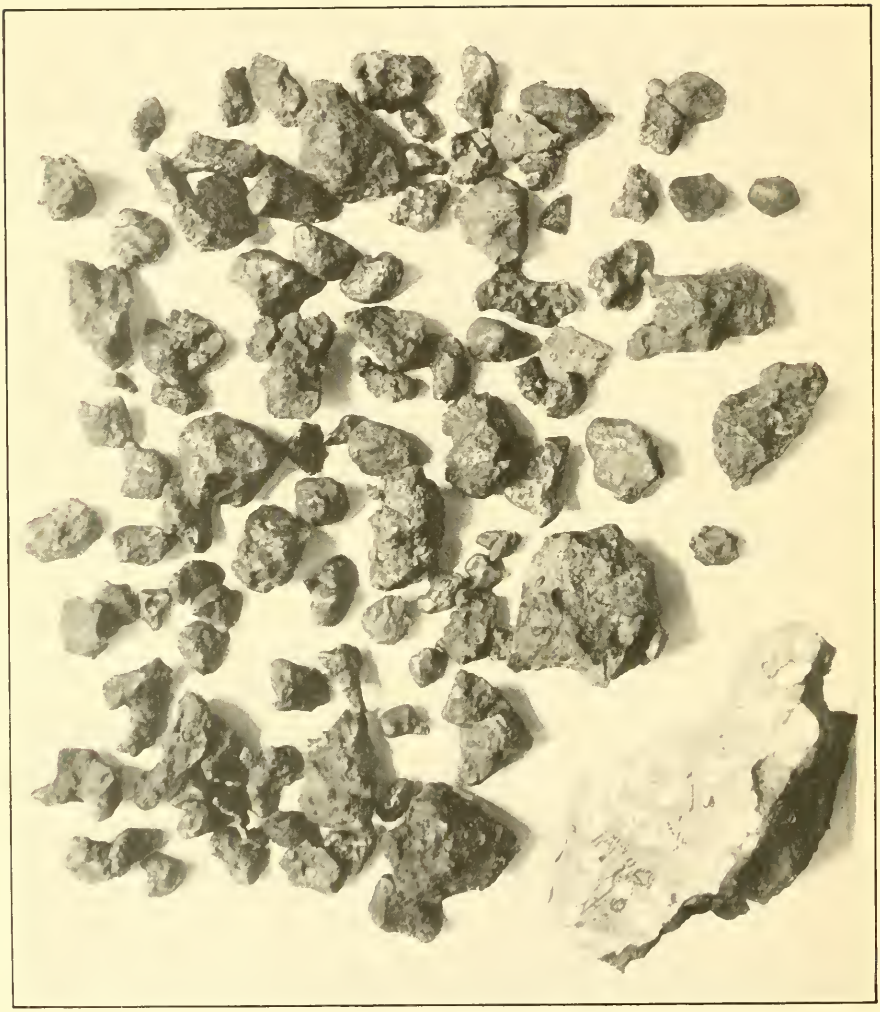
Stone, Cc. Fragment from interior, weighing 1 gram. Groundmass coarse granular. Fell February 19, 1785.

EISENBERG, SAXE ALTENBERG, GERMANY. No. 85.

Iron, Pseudometeorite. Fragment weighing 9.7 grams. Found in 1873.

ELBOGEN, BOHEMIA, AUSTRIA. No. 1.

Iron, Om. Fragment weighing 4.45 grams. Found in 1400.



SPECIMENS OF THE ESTHERVILLE MESOSIDERITES.

FOR DESCRIPTION SEE PAGE 183.

EMMITSBURG, FREDERICK COUNTY, MARYLAND. No. 56.

Iron, Om. Etched fragment weighing 5.5 grams; shows Widmanstätten figures. Found in 1854.

ENSISHEIM, ALSACE, GERMANY. No. 122.

Stone, Ckb. Two fragments from interior, weighing 4.3 grams; one vial of powder weighing 0.098 gram. Fell November 16, 1492, 11.30 p. m.

ERXLEBEN, SAXONY, GERMANY. No. 140.

Stone, Ck. Weight, 30.60 grams. Fragment with crust; also fragment from interior and vial of powder. Fell April 15, 1812, 4 p. m.

ESTHERVILLE, EMMET COUNTY, IOWA. Nos. 121, 230, 231, 232.

Stony-iron, Mesosiderite. Weight, 3,575 grams. Fell May 10, 1879, 5 p. m. One hundred and nine complete individuals varying in size from that of a pea to that of a hen's egg; their surfaces show rounded knobs and are partly steel white and partly steel blue to black in color (pl. 40). A section shows the iron in spongiform masses, nodules and irregular flakes distributed through the stony groundmass. The olivine nodules from above show a vitreous crust with marked lines of flow, again they are coated with nickel-iron. Five masses composed chiefly of stone show deeply pitted crust. Groundmass containing large nodules of olivine, nickel-iron, and troilite.

FARMINGTON, WASHINGTON COUNTY, KANSAS. No. 242.

Stone, Cs. Mass, weighing 489 grams, having the appearance of a dark gray dolerite. Crust smooth, showing scales or blisters in spots. Groundmass containing black chondrules; also white radiated chondrules and bronze yellow metallic grains. Fell June 25, 1890, 1 p. m.

FORSYTH, MONROE COUNTY, GEORGIA. No. 156.

Stone, Cwa. Two fragments, one with crust and one from interior, weighing 9.50 grams. Fell May 8, 1829, 3.30 p. m.

FORT DUNCAN, MAVERICK COUNTY, TEXAS. No. 96.

Iron, H. Slab weighing 116 grams, one surface etched. Etching develops Neumann lines as a network on a granular or stippled ground. Small grains of troilite are seen. Found in 1882.

FRANKFORT, FRANKLIN COUNTY, ALABAMA. No. 205.

Stone, Ho. Fragment weighing 47 grams, with shining, black, papillated crust having well-marked lines of flow. Fell December 5, 1868.

FUTTEHPUR, UNITED PROVINCES, INDIA. No. 148.

Stone, Cwa. Fragment with crust and polished surface, weighing 2.22 grams. Fell November 30, 1822.

GARGANTILLO (TOMATLAN), JALISCO, MEXICO. No. 229.

Stone, Cc. Weight, 511 grams. Mass with crust showing lines of flow and pittings; fragment from interior; one lot of fragments and powder. Fell August 17, 1879.

GIRGENTI, SICILY. No. 177.

Stone, Cwa. Fragment from interior, weighing 1.5 grams. Groundmass ash gray, fine granular. One surface shows a metallic slickenside. Fell February 10, 1853, 1 p. m.

GLORIETA, SANTA FE COUNTY, NEW MEXICO. No. 98.

Iron, Om. Section weighing 853.40 grams. Etched surface shows poor Widmanstätten figures, with one large nodule of troilite and several smaller ones. Found in 1884.

GRAND RAPIDS (WALKER TOWNSHIP), KENT COUNTY, MICHIGAN. No. 97.

Iron, Of. Weight, 34.5 grams. Found in 1883.

GROSSLIEBENTHAL, NEAR ODESSA, CHERSON, RUSSIA. No. 233.

Stone, Cwa. Fragment from interior, weighing 8 grams. Groundmass ash gray, containing white chondrules and metallic grains. A thin vein composed apparently of nickel-iron, more or less oxidized, passes through the specimen. Fell November 19, 1881.

HAINHOLZ, MINDEN, WESTPHALIA, GERMANY. No. 114.

Stony-iron, Mesosiderite. Fragment with polished surface, weighing 12.15 grams. Metallic grains small and scattered through a mass of bronzite in which are relatively large grains of olivine, with some asmanite and troilite. Found in 1856.

HARRISON COUNTY, INDIANA. No. 187.

Stone, Cho. Fragment with crust and polished surface, weighing 36.4 grams. Fell March 28, 1859.

HARTFORD (MARION), LINN COUNTY, IOWA. No. 170.

Stone, Cwa. Weight, 1,602.35 grams. Mass with thick, dull black crust, pitted and marked with swells and furrows as a result of flow. Interior ash gray, one surface marked with a metallic slickenside, much oxidized. The mass is traversed by metallic veins or lines of fracture which mark slipping zones with slickensided surfaces. Fell February 25, 1847, 2.45 p. m.

HESSLE, LAKE MALAR, SWEDEN. No. 206.

Stone, Cc. Four fragments with thin, dull black, papillated crust, weighing 259.8 grams. Fell January 1, 1869, 12.30 p. m.

HEX RIVER, CAPE COLONY, SOUTH AFRICA. No. 95.

Iron, H. Section weighing 14.3 grams. Etched surface shows Neumann lines. Found in 1882.

HOMESTEAD (WEST LIBERTY), IOWA. No. 219.

Stone, Cgb. Weight, 3,185 grams. Four complete individuals covered with crust and indented with broad shallow pits. Crust dull black, thin, and somewhat blebby. Three fragments showing interior having an abundance of metallic grains and chondritic structure. Fell February 12, 1875, 10.15 p. m.

HONOLULU, HAWAIIAN ISLANDS. No. 152.

Stone, Cwa. Fragment with crust, weighing 1.35 grams. Fell September 27, 1825.

HRASCHINA, AGRAM, CROATIA, HUNGARY. No. 2.

Iron, Om. Etched fragment showing Widmanstätten figures. Weight, 0.737 gram. Fell May 26, 1751.

IMILAC, ATACAMA, CHILE. No. 111.

Stony-iron, Pallasite. Fragment, the metallic matrix as well as the olivine of which have undergone decomposition; vial of fragments of matrix with little or no olivine; vial of fragments of iron and olivine but little altered. Total weight, 25.75 grams. Found in 1827.

IVAN, ODENBURG, HUNGARY. No. 163.

Pseudometeorite. Weight, 0.94 gram.

IVANPAH, SAN BERNARDINO COUNTY, CALIFORNIA. No. 92.

Iron, Om. Etched section showing Widmanstätten figures. Weight, 11.75 grams. Found in 1880.

JAMESTOWN, STUTSMAN COUNTY, NORTH DAKOTA. No. 101.

Iron, Of. Cross section of mass with polished surface, weighing 74.15 grams. Found in 1885.

JEFFERSON (30 MILES FROM DENVER), COLORADO. No. 81.

Iron. Fragment weighing 41 grams, containing troilite nodule; somewhat decomposed from occluded chlorides. Fell in June, 1867.

JEWELL HILL, MADISON COUNTY, NORTH CAROLINA. No. 54.

Iron, Of. Rectangular section showing portion of surface. Weight, 31.85 grams. Etched face showing Widmanstätten figures; taenite plates well developed. Found in 1854.

JOE WRIGHT MOUNTAIN, INDEPENDENCE COUNTY, ARKANSAS. No. 100.

Iron, Om. Weight, 20 grams. Section showing typical Widmanstätten figures. The markings are broad and regular with large plates of troilite. Found in 1884.

JONZAC, CHARENTE-INFERIEURE, FRANCE. No. 143.

Stone, Eu. Fragment weighing 0.17 gram. Fell June 13, 1819.

JUVINAS, ARDECHE, LANGUEDOC, FRANCE. No. 146.

Stone, Eu. Fragment from interior, weighing 39.5 grams. Fell June 15, 1821, 3.30 p. m.

KABA, NEAR DEBRECZIN, HUNGARY. No. 182.

Stone, K. Fine powder; weight, 6.20 grams. Fell April 15, 1857.

KERILIS, CÔTES-DU-NORD, FRANCE. No. 218.

Stone, Cga. Fragment with crust, weighing 2.70 grams. Fell November 26, 1874.

KERNOUVÉ, MORBIHAN, BRITTANY, FRANCE. No. 207.

Stone, Ck. Fragment from interior, weighing 52.65 grams. Fell May 22, 1869, 10 p. m.

KHAIRPUR, BHAWALPUR, INDIA. No. 217.

Stone, Ck. Fragment with polished surface and crust, weighing 26.75 grams. Crust dull black, blebby, and showing lines of flow. Groundmass dark gray, compact. Fell September 23, 1873.

KNYAHINYA, NEAR NAGY-BEREZNA, HUNGARY. No. 200.

Stone, Cg. Weight, 32.83 grams. Complete individual covered with thin black crust and having a pitted surface; fragment with crust and polished surface. Fell June 9, 1866, 5 p. m.

KRASNOJARSK, JENISEISK, SIBERIA. No. 110.

Stony-iron, Pallasite. Section weighing 327 grams. The spongiform metallic matrix incloses nodules of olivine of varying diameters, more or less transparent and vitreous and varying in color from honey-yellow to nearly black. Also fragments of matrix from which the olivine has disappeared. Found in 1749.

KULESCHOWKA, POLTAWA, RUSSIA. No. 139.

Stone, Cwa. Fragment with crust, weighing 5.95 grams. Fell March 12, 1811 (midnight).

LA BECASSE, INDRE, FRANCE. No. 228.

Stone, Cw. Fragment with crust, weighing 5 grams. Fell January 31, 1879.

LA CAILLE, NEAR GRASSE, VAR, FRANCE. No. 4.

Iron, Om. Fragment weighing 1.48 grams. Found in 1600.

LA GRANGE, OLDHAM COUNTY, KENTUCKY. No. 69.

Iron, Of. (1) Section marked "Oldham," weighing 1,019 grams; Widmanstätten figures slightly indicated. (2) Section weighing 983 grams, with well-marked Widmanstätten figures. Found in 1860.

L'AIGLE, ORNE, FRANCE. No. 132.

Stone, Cib. Fragment with crust, weighing 11.35 grams. Fell April 26, 1803, 1 p. m.

LANCÉ, LOIR-ET-CHER, FRANCE. No. 215.

Stone, Cc. Fragment with dull black blebby crust, weighing 7 grams. Groundmass dark gray, fine grained, compact. Fell July 23, 1872.

LENARTO, GALICIA, AUSTRIA. No. 17.

Iron, Om. Two fragments, one polished, weighing 1 gram, the other weighing 16.52 grams, etched on both sides and showing Widmanstätten figures. Found in 1814.

LES ORMES, YONNE, FRANCE. No. 183.

Stone, Cw. Fragments from interior, weighing 0.70 gram. Fell October 1, 1857.

LEXINGTON COUNTY, SOUTH CAROLINA. No. 93.

Iron, Og. Weight, 2,820 grams. Part of mass containing large troilite nodule. Found in 1880.

LICK CREEK, DAVIDSON COUNTY, NORTH CAROLINA. No. 91.

Iron, H. Fragment weighing 9.72 grams. Found in 1879.

LION RIVER, GREAT NAMAQUALAND, SOUTH AFRICA. No. 51.

Iron, Of. Section weighing 20.85 grams, showing original surface. Etched portion shows fine Widmanstätten figures, the plates narrow and distinct. First described in 1853.

LITTLE PINEY, PULASKI COUNTY, MISSOURI. No. 161.

Stone, Cc. Fragment from interior, weighing 75.44 grams. Fell February 13, 1839.

LIXNA, DÜNABURG, VITEBSK, RUSSIA. No. 145.

Stone, Cga. Fragment with crust, weighing 1.19 grams. Fell July 12, 1820.

LOSTTOWN, CHEROKEE COUNTY, GEORGIA. No. 77.

Iron, Om. Weight 75.4 grams. Section, one surface etched showing Widmanstätten figures; three vials of powder. Found in 1864.

LUCIGNANO D'ASSO (SIENA), TUSCANY, ITALY. No. 243.

Stone, Cho. Fragments weighing 3.7 grams. Fell June 16, 1794.

LUMPKIN, STEWART COUNTY, GEORGIA. No. 209.

Stone, Cc. Fragment with crust and polished surfaces, weighing 1.62 grams. Fell October 6, 1869, 11.45 a. m.

MADOC, HASTINGS COUNTY, ONTARIO, CANADA. No. 57.

Iron, Of. Section weighing 12 grams, showing coarse Widmanstätten figures. Found in 1854.

MAGURA (ARVA), SZLANICZA, HUNGARY. No. 35.

Iron, Og. Fragment weighing 123.50 grams. Found in 1840.

MARSHALL COUNTY, KENTUCKY. No. 62.

Iron, Om. Two fragments weighing 68.23 grams. First described in 1860.

MARYLAND. No. 15.

A shaving, weighing 2.735 grams, from burned museum in Baltimore, Maryland.

MAUERKIRCHEN, AUSTRIA. No. 125.

Stone, Cw. Fragment from interior, weighing 0.5 gram. Fell November 20, 1768, 4 p. m.

MENOW, MECKLENBURG, GERMANY. No. 191.

Stone, Cck. Fragment from interior, weighing 2.1 grams. Fell October 7, 1862, 1.30 p. m.

MEZÖ-MADARAS, TRANSYLVANIA, HUNGARY. No. 175.

Stone, Cgb. Nearly complete individual with crust, weighing 86.8 grams. Fell September 4, 1852, 4.30 p. m.

MIGHËI, TRANSCAUCASIA, RUSSIA. No. 241.

Stone, K. Fragment weighing 10 grams, dull black and soft friable, soiling the fingers. Carbonaceous meteorite. Fell June 18, 1889.

MILENA (PUSINSKO SELO), WARASDIN, CROATIA, HUNGARY. No. 164.

Stone, Cw. Fragment from interior, weighing 46.25 grams; one surface appreciably slickensided. Fell April 26, 1842, 3 p. m.

MISTECA, OAXACA, MEXICO. No. 12.

Iron, Om. Two fragments, one polished, weighing 2.5 grams; the other etched, developing Widmanstätten figures, and weighing 16 grams. Found in 1804.

MOCS, TRANSYLVANIA, HUNGARY. No. 234.

Stone, Cwa. Fragment with crust, one surface polished, weighing 17.85 grams. Fell February 3, 1882, 4 p. m.

MOLINA, MURCIA, SPAIN. No. 186.

Stone, Cgb. Fragment with crust, weighing 3.67 grams. One surface apparently slickensided. Fell December 24, 1858.

MONROE (CABARRUS COUNTY), NORTH CAROLINA. No. 173.

Stone, Cga. Two fragments, one with crust and another with two surfaces polished, weighing 343.6 grams. Fell October 31, 1849, 3 p. m.

MONTEMILONE (MACERATA), ITALY. No. 169.

Stone, Cwb. Fragment with crust, weighing 0.73 gram. Fell May 8, 1846.

MOORESFORT (TIPPERARY), IRELAND. No. 137.

Stone, Cga. Fragment with dull black crust, weighing 1 gram. Fell in August, 1810.

MORDVINOVKA, PAVLOGRAD, EKATERINOSLAV, RUSSIA. No. 153.

Stone, Cw. Three fragments; one with crust. Weight, 3.11 grams. Fell May 19, 1826.

MOTTA DE CONTI, PIEDMONT, ITALY. No. 202.

Stone, Cc. Fragment with papillated shiny black crust, weighing 1.53 grams. Fell February 29, 1868.

MURFREESBORO, RUTHERFORD COUNTY, TENNESSEE. No. 41.

Iron, Om. Fragment weighing 5.88 grams. First described in 1848.

NANJEMOY, CHARLES COUNTY, MARYLAND. No. 151.

Stone, Cc. Fragment with crust, weighing 31.22 grams. Fell February 10, 1825, 12 m.

NEJED (WADEE BANEE KHALED), CENTRAL ARABIA. No. 73.

Iron, Om. Sawn section weighing 37 grams. Fell in spring of 1863.

NELSON COUNTY, KENTUCKY. No. 68.

Iron, Ogg. Section of mass, weighing 58.3 grams. Found in 1860.

NENNTMANNSDORF, NEAR PIRNA, SAXONY, GERMANY. No. 83.

Iron, H. Two fragments, one weighing 2.45 grams; the other, a fragment of crust, weighing 12.70 grams and showing a green efflorescence of nickel compounds. Found in 1872.

NETSCHAEVO, TULA, RUSSIA. No. 38.

Iron, Om. Fragment weighing 61.95 grams. The iron is rich in silicates. Found in 1846.

NEW CONCORD, MUSKINGUM COUNTY, AND GUERNSEY COUNTY, OHIO. No. 188.

Stone, Cia. Nearly complete individual covered with a somewhat pitted black crust, and weighing 3,311.87 grams (pl. 39). Fell May 1, 1860, 12.45 p. m.

NEWSTEAD, ROXBURGHSHIRE, SCOTLAND. No. 22.

Iron, Dn. Triangularly shaped fragments; weight, 51 grams. Found in 1827.

NIAKORNAK, GREENLAND.

Telluric iron. Weight, 5.7 grams. Found in 1848 or 1850.

NOWO-UREI, KRASNOSLOBODSK, PENSA, RUSSIA. No. 240.

Stone, Cu. Fragment from interior, weighing 4 grams. Groundmass black (ureilite); coarse granular. Fell September 22, 1886.

OBERNKIRCHEN, SCHAUMBURG-LIPPE, GERMANY. No. 71.

Iron, Of. Two sections, one showing troilite nodule and weighing 30.3 grams; the other weighing 23.1 grams. Found in 1863.

OKTIBBEHA, MISSISSIPPI. No. 55.

Iron, Db. Weight, 1.89 grams. Found in 1854. Doubtfully meteoric.

ORANGE RIVER, SOUTH AFRICA. No. 64.

Iron, Om. Etched section with original surfaces. Widmanstätten figures coarse, taenite plates narrow. Weight, 21.41 grams. First described in 1856.

ORGUEIL, MONTAUBAN, TARN-ET-GARONNE, FRANCE. No. 196.

Stone, K. Coarse, black, friable powder, weighing 9.62 grams. Fell May 14, 1914, 8 p. m.

ORNANS, DOUBS, FRANCE. No. 203.

Stone, Cco. Fragment from interior, weighing 6 grams. Groundmass dark ash gray. Chondrules made up of ornansite and ngawite. Fell July 11, 1868.

ORVINIO, UMBRIA, ITALY. No. 216.

Stone, Co. Fragment with crust, weighing 0.12 gram. Fell August 31, 1872.

ÖSEL (KAANDE), LIVONIA, RUSSIA. No. 178.

Stone, Cw. Fragment from interior, weighing 4 grams. Fell May 11, 1855, 3.30 p. m.

OVIFAK (DISCO), GREENLAND.

Telluric iron. Weight, 18.97 grams. Found in 1870.

PACULA, JACALA, HIDALGO, MEXICO. No. 236.

Stone, Cwb. Two fragments from interior, weighing 13 grams. Groundmass traversed by several delicate veins. Fell June 18, 1881.

PARNALLEE, NEAR MADURA, MADRAS, INDIA. No. 181.

Stone, Cga. Two fragments with crust, weighing 331.48 grams. Crust black, pitted, and in swellings. Fell February 28, 1857, 12 m.

PAVLOVKA, SARATOV, RUSSIA. No. 235.

Stone, Ho. Fragment with crust, also a vial of fragments; weight, 5.61 grams. Fell August 2, 1882.

PETERSBURG, LINCOLN COUNTY, TENNESSEE. No. 179.

Stone, Ho. Two fragments with crust, weighing 30.7 grams. Crust shiny black, pitted, and in swellings. Fell August 5, 1855.

PILLISTFER (AUKOMA), POLAND, RUSSIA. No. 192.

Stone, Ck. Fragment from interior, weighing 2.6 grams. Fell August 8, 1863, 12.30 p. m.

POLITZ, NEAR GERA, REUSS, GERMANY. No. 144.

Stone, Cwa. Fragment with crust, weighing 0.163 gram. Fell October 13, 1819, 8 a. m.

PRAIRIE DOG CREEK, DECATUR COUNTY, KANSAS. No. 244.

Stone, Cck. Mass with crust, weighing 220 grams. Crust scorified on one surface, papillated on another. Known in 1893.

PRAMBANAN, JAVA. No. 11.

Iron, Of. Fragment weighing 2.3 grams. Found in 1797.

PULTUSK, POLAND, RUSSIA. No. 201.

Stone, Cga. Weight, 304.76 grams. Seven complete individuals. Crust dull black, more or less papillated and pitted. Also a cross section of an individual with crust and polished surface. Fell January 30, 1868, 7 p. m.

PUTNAM COUNTY, GEORGIA. No. 28.

Iron, Of. Four fragments weighing 68.55 grams. Found in 1839.

QUENGGOUK, PEGU, BURMA. No. 184.

Stone, Cc. Fragment with crust and one vial of powder weighing 19.65 grams. Fell December 27, 1857.

RAKOWKA, TULA, RUSSIA. No. 227.

Stone, Ci. Fragment with crust indented with broad shallow pits, weighing 23.5 grams. Fell November 20, 1878.

RANCHITO, NEAR BACUBIRITO, SINALOA, MEXICO. No. 102.

Iron, Off. Weight, 171.4 grams. Part of mass with original and etched surfaces; delicate Widmanstätten figures. Found in 1871.

RASGATA (TOCAVITA), COLOMBIA. No. 16.

Iron, Ds. Small polished section weighing 15 grams. Found in 1810.

RENAZZO, NEAR CENTO, FERRARA, ITALY. No. 149.

Stone, Cs. Fragment with crust weighing 7.20 grams. Fell January 15, 1824.

RICHMOND, VIRGINIA. No. 155.

Stone, Cck. Fragment from interior weighing 3.69 grams. Fell June 4, 1828, 8.30 a. m.

ROCHESTER, FULTON COUNTY, INDIANA. No. 221.

Stone, Cc. Two fragments with dull black, blebby crust, weighing 48.27 grams. Fell December 21, 1876.

ROEBOURNE (200 MILES SOUTHEAST OF), WEST AUSTRALIA. No. 109.

Iron, Om. Weight, 157 grams. Etched section showing typical Widmanstätten figures with scattering grains of troilite. Found in 1892.

RUFF'S MOUNTAIN, LEXINGTON COUNTY, SOUTH CAROLINA. No. 46.

Iron, Om. Weight, 5461 grams. Large block, etched on one face and showing Widmanstätten figures, and two small fragments. Found in 1844.

SAINT FRANCOIS COUNTY, SOUTHEASTERN MISSOURI. No. 72.

Iron, Og. Fragment weighing 5.6 grams. Found in 1863.

SAINT-MESMIN, NEAR TROYES, AUBE, FRANCE. No. 199.

Stone, Cib. Fragment with crust weighing 1.59 grams. Fell May 30, 1866.

SALLES, NEAR VILLEFRANCHE, RHONE, FRANCE. No. 130.

Stone, Cia. Gray powder, weighing 2 grams. Fell March 12, 1798.

SALT RIVER, KENTUCKY. No. 47.

Iron, Hch(?). Two sections weighing 26.2 and 25.36 grams, respectively. Found in 1850.

SANCHEZ ESTATE, COAHUILA, MEXICO. No. 61.

Iron, H. Two fragments weighing 183.7 grams, one showing fracture. Known prior to 1837.

SANTA CATHARINA, RIO SAN FRANCISCO DO SUL, BRAZIL. (1) No. 87, (2) No. 88, (3) No. 105.

Iron, Og. (1) Section weighing 234 grams, and showing no evidence of alteration; one surface etched, Widmanstätten figures broad with scattering plates of taenite and some troilite. Analysis shows 36 per cent of nickel. (2) Two fragments weighing 15 grams, somewhat oxidized on surface, but with a compact metallic interior. (3) Complete mass apparently altered to limonite; surface somewhat pitted by decay. Known in 1873.

SAREPTA, SARATOV, RUSSIA. No. 60.

Iron, Og. One lot of turnings weighing 3.3 grams. Found in 1854.

SCHWETZ, PRUSSIA, GERMANY. No. 48.

Iron, Om. Fragment weighing 10.55 grams. Found in 1850.

SCOTTSVILLE, ALLEN COUNTY, KENTUCKY. No. 80.

Iron, H. Cross section etched showing Neumann lines, and weighing 713 grams. Found in 1867.

SCRIBA, OSWEGO COUNTY, NEW YORK. No. 23.

Iron, Dn. Polished section weighing 61.33 grams. Found about 1835.

SEARSMONT, WALDO COUNTY, MAINE. No. 211.

Stone, Cc. Fragment with dull black papillated crust, weighing 62.5 grams. Fell May 21, 1871, 8.15 a. m.

SEELÄSGEN, BRANDENBURG, PRUSSIA, GERMANY. No. 44.

Iron, Ogg. Etched slab weighing 111.6 grams; shows irregular lines of troilite and plates of nickel-iron alloy. Found in 1847.

SENECA FALLS, SENECA COUNTY, NEW YORK. No. 49.

Iron, Om. Section of mass, weighing 80.2 grams. Found in 1851.

SHYTAL, NEAR DACCA, BENGAL, INDIA. No. 193.

Stone, Cib. Fragment from interior weighing 1.32 grams. Fell August 11, 1863.

SIENA, TUSCANY, ITALY. No. 128.

Stone, Cho. Complete individual showing crust and interior, weighing 6.75 grams. Fell June 16, 1794.

SKI, AMT AKERSHUS, NORWAY. No. 172.

Stone, Cwa. Fragment with crust, weighing 1 gram. Fell December, 27, 1848.

SMITHLAND, LIVINGSTON COUNTY, KENTUCKY. No. 30.

Iron, Db. Section weighing 12.935 grams. Found 1839–40.

SMITHVILLE, DEKALB COUNTY, TENNESSEE. No. 106.

Iron, Og. A portion of mass, weighing 1,937 grams; natural surface in part altered from occluded chlorides; one surface showing nodules of troilite. Found in 1893.

SOKO-BANJA (SARBANOVAC), SERBIA. No. 224.

Stone, Cc. Fragment with crust, weighing 15.98 grams. Fell October 13, 1877, 2 p. m.

STÄLLDALEN, NEAR KOPPARBERG, SWEDEN, No. 220.

Stone, Cgb. Two fragments with crust, weighing 151.7 grams. Crust surface indented with broad, shallow pits. Groundmass shows fragmentary slickensides. Fell June 28, 1876, 11.30 a. m.

STANNERN, NEAR IGLAU, MORAVIA, AUSTRIA. No. 136.

Stone, Eu. Fragment with glossy black to shiny crust, weighing 25.70 grams. Fell May 22, 1808, 6 a. m.

STAUNTON, AUGUSTA COUNTY, VIRGINIA. No. 78.

Iron, Om. Cross section of mass containing large troilite nodules, weighing 1,662 grams. Etched surface shows typical Widmanstätten figures. Found in 1869.

STEINBACH (RITTERSGRÜN), SAXONY, GERMANY. (1) No. 113, (2) No. 115.

Stony-iron, Pallasite. Found 1847. (1) Section with crust, weighing 65.45 grams. The stony portion exceeds the metallic, which consists chiefly of nickel-iron with some small masses of troilite. On one surface the metallic portion has been etched showing Widmanstätten figures. (2) Fragment weighing 16.8 grams.

SUPUHEE, GORUCKPUR, INDIA. No. 197.

Stone, Cgb. Fragment with crust, weighing 4.3 grams. Crust contains small globules of nickel-iron. Fell January 19, 1865.

TABOR, BOHEMIA, AUSTRIA. No. 123.

Stone, Ccb. Section from interior, weighing 2.45 grams. Fell June 3, 1753, 8 p. m.

TAJGHA, KRASNOJARSK, SIBERIA. No. 246.

Iron, Om. Fragment with original surface, weighing 64 grams. Etch figures coarse and poor. Found in 1891.

TARAPACA, CHILE. No. 31.

Iron, Db. Fragment, weighing 84 grams. Found in 1840.

TAZEWELL, CLAIBORNE COUNTY, TENNESSEE. No. 52.

Iron, Off. Cross section showing crust, one side polished, weighing 1,593.5 grams; sawed section, weighing 350 grams, shows crust. One surface etched showing fine Widmanstätten figures, the plates narrow and distinct. One vial of turnings. Found in 1853.

TENNASILM (SIKKENSAARE), ESTHLAND, RUSSIA. No. 214.

Stone, Cca. Two fragments with a small portion of crust, weighing 1.76 grams. Fell June 25, 1872.

TIESCHITZ, PRERAU, MORAVIA, AUSTRIA. No. 226.

Stone, Cc. Fragment with dull black crust, weighing 27 grams. Fell July 15, 1878.

TIMOSCHIN, JUCHNOW, SMOLENSK, RUSSIA. No. 134.

Stone, Cc. Fragment from interior, weighing 15 grams. Fell March 25, 1807.

TJABE, REMBANG, JAVA. No. 208.

Stone, Ck. Fragment with crust, weighing 29.1 grams. Fell September 19, 1869.

TOLUCA (XIQUIPILCO), MEXICO. (1) No. 5, (2) No. 6.

Iron, Om. Total weight, 18,573 grams. Complete individual, weighing 17,800 grams, having a pitted surface, and two polished and etched slices, weighing 85 and 688 grams, showing Widmanstätten figures. Found in 1784.

TOMHANNOCK CREEK. RENSSELAER COUNTY, NEW YORK. No. 195.

Stone, Cgb. Two slices, polished and showing crust, weighing 8.74 grams. Found in 1863.

TOURINNES-LA-GROSSE, NEAR TIRLEMONT, BELGIUM. No. 194.

Stone, Cw. Fragment with crust, weighing 9.04 grams. Fell December 7, 1863.

TRENTON, WASHINGTON COUNTY, WISCONSIN. No. 66.

Iron, Om. Two fragments, weighing 91.46 grams. Found in 1858.

TRENZANO, NEAR BRESCIA, LOMBARDY, ITALY. No. 180.

Stone, Cca. Fragment weighing 3.8 grams. Fell November 12, 1856, 4 p. m.

TRINITY COUNTY (CANYON CITY), CALIFORNIA. No. 108.

Iron, Og. Fragments weighing 22.55 grams. Found in 1870.

TUCSON (CARLETON), ARIZONA. No. 39.

Iron, Dt. Weight, 36.84 grams. Found in 1846.

TUCSON (RING), ARIZONA. No. 40.

Iron, Dt. Fragment from inner circle of ring meteorite, weighing 84.5 grams. 1846?

TUCUMAN (CAMPO DEL CIELO), ARGENTINA. No. 7.

Iron, Ds. Fragment having one surface polished and weighing 23.8 grams. Found in 1788.

TYSNES, NORWAY. No. 238.

Stone, Cgb. Fragment from interior, weighing 29.3 grams. Fell May 20, 1884.

UNION COUNTY, GEORGIA. No. 53.

Iron, Ogg. Section having a much oxidized surface and showing cleavage lines, weighing 87 grams; section weighing 36.5 grams and a vial of oxidized crust. Found in 1853.

UTRECHT (BLAAUW KAPEL), HOLLAND. No. 167.

Stone, Cca. Two fragments, one weighing 3.1 grams, with crust; another from interior, weighing 5.79 grams. Fell June 2, 1843.

VACA MUERTA, ATACAMA, CHILE. (1) No. 119, (2) No. 116.

Stony-iron, Mesosiderite. (1) Three fragments, two of which are thin sections; the third shows original and polished surfaces. Structure somewhat granular, with the metallic and nonmetallic portions about equally distributed. Weight, 27.63 grams. Found in 1862. (2) Mejillones. Thin section in which the metallic portion is distributed in occasional nodules and filiform shapes throughout the stony groundmass. Weight, 29.8 grams. Found in 1867–68.

VICTORIA (SASKATCHEWAN RIVER), BRITISH COLUMBIA. No. 79.

Iron, Om. Weight, 125 grams. Found in 1871.

VICTORIA WEST, CAPE COLONY, SOUTH AFRICA. No. 70.

Iron, Ofv. Fragments of crust almost completely altered to limonite, weighing 2.15 grams. Found in 1862. Fell? 1862.

VOUILLE, NEAR POITIERS, VIENNE, FRANCE. No. 158.

Stone, Cia. Fragment from interior, weighing 14.57 grams. Fell May 13, 1831.

WACONDA, MITCHELL COUNTY, KANSAS. No. 213.

Stone, Ccb. Weight, 884 grams. Mass with pitted and blebby crust showing lines of flow; also a fragment from the interior. Found in 1874.

WARRENTON, WARREN COUNTY, MISSOURI. No. 222.

Stone, Cc. Fragment with crust, weighing 27.25 grams. Groundmass friable, bluish gray, and resembling indurated arenaceous blue clay. Fell January 3, 1877, 7 a. m.

WELLAND, ONTARIO, CANADA. No. 103.

Iron, Om. Section having original and etched surface, weighing 36.5 grams. Widmanstätten figures coarse and regular with scattering grains of troilite. Lines of octahedral cleavage well marked. Found in 1888.

WERCHNE-UDINSK, TRANSBAIKALIA, EAST SIBERIA. No. 58.

Iron, Om. Etched section, weighing 36.30 grams. Widmanstätten figures coarse. Found in 1854.

WESTON, FAIRFIELD COUNTY, CONNECTICUT. No. 135.

Stone, Ccb. Three fragments, one without crust, weighing 74.37 grams. Fell December 14, 1807, 6.30 a. m.

WICHITA COUNTY (BRAZOS RIVER), TEXAS. No. 26.

Iron, Og. Two sections, one with original and etched surface, weighing 143 grams, and another weighing 69.40 grams. Both show coarse Widmanstätten figures with nodules of troilite and flakes of schreibersite. Found in 1836.

WOLD COTTAGE, YORKSHIRE, ENGLAND. No. 129.

Stone, Cwa. Fragment with crust and polished surface, weighing 13.02 grams. Fell December 13, 1795, 3.30 p. m.

WOOSTER, WAYNE COUNTY, OHIO. No. 65.

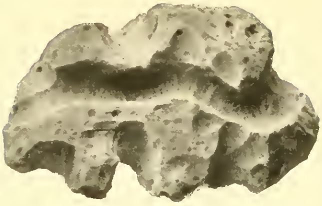
Iron, Om. Rectangular fragment weighing 2.86 grams. Found in 1858.

YATOOR, NEAR NELLORE, MADRAS, INDIA. No. 174.

Stone, Cc. Fragment from interior, weighing 2.81 grams. Fell January 23, 1852, 4.30 p. m.

ZACATECAS, MEXICO. No. 9.

Iron, Obs. Fragments with original and etched surfaces, weighing 175.3 grams. Widmanstätten figures good. Found in 1792.



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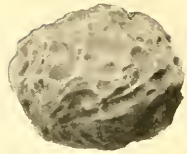

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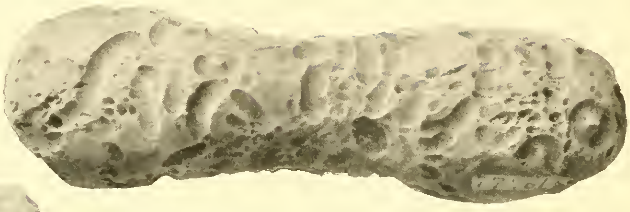

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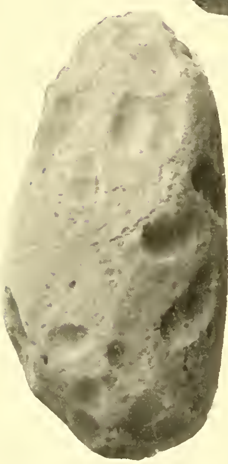

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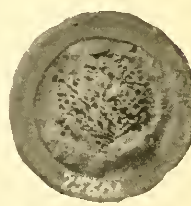

9

Moldavites and Similar Sporadic Glasses.

For description see page 201.

APPENDIX A.

MOLDAVITES, BILLITONITES, AND OTHER GLASSES OF SUPPOSED METEORIC ORIGIN.[1]

Peculiar pebbles of a greenish, chrysolite-like glass found in the gravels in regions remote from volcanoes or manufactories attracted the attention of observers in Bohemia and Moravia as long ago as 1787. The literature since that date contains numerous references to these and somewhat similar occurrences in India, Australia, and other widely separated localities, the descriptive matter as a rule being accompanied by speculations regarding the ultimate source of the materials.

In Moravia and Bohemia the objects are found with quartz pebbles in the late Diluvian and Tertiary conglomerates, but are never referable directly to the same. In Java they are found in Quaternary tuffs, and in the platinum mines southeast of Borneo. On the island of Billiton they are found in the Quaternary and perhaps Pliocene tin-bearing gravels. In Australia they have been found mainly on the surface of the ground, and no positive proof of their existence in Tertiary beds has as yet appeared. According to information received from George W. Card, of the Mining and Geological Museum. Sydney, the examples from Bimbowrie in southern Australia were found on a plain thickly covered with weathered quartz which resulted from the denudation of the adjacent quartz reefs. Most of them were broken and shattered as though by a fall; all lay loosely on the surface.

In appearance and general physical properties these various bodies from widely separated sources possess certain points in common, but are yet so different in appearance that examples from any one locality are readily distinguished from those of another. The Moravian and Bohemian forms, as will be noted by reference to Nos. 54093–98, 77525, and 77872, pl. 41, figs. 4–6, are more or less rounded pebbles or flattened slag-like masses, the surfaces of which are pitted in a way which has been compared by some writers to the thumb-like

[1] For a full bibliography of this subject up to and including 1898, see Franz E. Suess, Die Herkunft der Moldavite und verwandter Gläser, Jahrb. d. k. k. geol. Reichsanstalt, Heft 2, vol. 50, 1900, pp. 193–381. This includes 55 titles referring to the occurrences in Europe, the Sunda Archipelago, and Australia. A bibliography of the Australian and Tasmanian occurrences is given by R. H. Walcott in his paper on The Occurrence of So-called Obsidian Bombs, in the Proc. Roy. Soc. Victoria, 1898, pp. 23–52.

pittings on meteorites. In addition to this, they are dulled and rendered opaque through abrasion from other stony particles, very much like ordinary pebbles from the bed of a stream. In some instances they are deeply cut or notched as in fig. 5. The colors are chrysolite green. and the refractive index so high that they have in some instances been cut and utilized as gems.

The examples from Billiton (No. 77761), shown in pl. 41, figs. 1–3, are much more remarkable both on account of their shape and the extraordinary groovings which traverse the surface in all directions. They are of a deep, lustrous black color and translucent only on the thinnest edges.

The Australian and Tasmanian occurrences have more the appearance of water-worn pebbles which have been abraded by wind-blown sand (Nos. 77611–12, 77525, and 88454, pl. 41, figs. 7–9). These are also black and opaque excepting on the thinnest edges. In all, the glass is wholly amorphous without trace of the trichites so characteristic of obsidian and other volcanic glasses. A few characteristic forms only are shown.

Chemically, as will be noted in the selected analyses referred to later, these forms are all acid glasses approximating in composition the glassy forms of terrestrial rhyolites but unusually rich in lime and magnesia. They are also remarkable for their small water content as indicated by loss on ignition, and their high fusing point.

In none of the occurrences are the objects found in regions of volcanic rocks or under conditions which seem to render it at all likely that they are of local derivation. It is seemingly impossible to conceive of their having been ejected as volcanic bombs and drifted by winds, and equally impossible, apparently, that they should belong to either stream or glacial drift. An artificial origin is likewise considered impossible by the majority of those who have given the subject consideration, and of late those who should be best qualified to judge have been disposed to consider them as of a meteoric nature.

In recognition of a possible doubt on this point, however, the exhibit is accompanied by a small series of undoubted obsidian fragments and pebbles which bear somewhat similar markings, in some cases natural, in others produced artificially by means of fluorhydric acid. These are described below:

(1) *Obsidian pebbles from near Cali, Department of Cauca, Colombia, South America* (Cat. No. 63471).—These were received at the Museum from B. S. Hobbs through Dr. George F. Kunz, with the simple labeling "Obsidian" from the locality above given.

Two of the larger forms, it will be noted, are roughly spherical, each showing on one side a flattened area as though it had at some time been attached to a larger mass or had remained in one position during the etching process, since the larger grooves are entirely absent from these portions. The surface markings are of three kinds: First, those which appear like original conchoidal fractures, the sharp angles of which have been reduced by corrosion; second, a series of shallow pits and grooves which are distributed fairly uniformly over the entire surface except the flattened portion mentioned; and, third, a very fine stipple-like pitting which gives the surface a shagreen-like appearance. This shagreen effect with numerous small, nearly circular, shallow pits occurs also on the flat areas where the larger groovings are lacking as already stated. Thin sections under the microscope show a faint smoky glass almost completely isotropic, but with an occasional minute, colorless, doubly refracting point too small for satisfactory determination. A peculiar series of anastomizing cracks much resembling the crackle structure on certain porcelain glazes, traverses the section in all directions.

The composition of this glass, as shown by an analysis of a portion cut from the larger of the specimens, is given in column I below. In columns II to IV are given analyses of tektites, as they have been comprehensively called, from Tasmania, Australia, and Bohemia.

Analyses of Tektites.

Constituent.	I.	II.	III.	IV.
SiO_2	75.87	69.80	76.25	77.96
Al_2O_3	14.35	15.02	11.30	12.20
Fe_2O_3	.22	.40	.35	.14
FeO	....	4.65	3.88	3.36
MgO	.29	2.47	1.48	1.48
CaO	.00	3.20	2.60	1.94
Na_2O	3.96	1.29	1.23	.61
K_2O	4.65	2.65	1.82	2.70
$H_2O+100°$	.33	....	.32	....
$H_2O-100°$	....	....	.02	....
TiO_2	Trace.	.80	.65	....
MnO	....	.18	.06	.10
SO_3	.23	....	....	....
Total	99.90	100.37	99.96	100.49

I. Obsidian pebble. Analyst, J. E. Whitfield.
II. Obsidianite. Upper Weld, Tasmania. Analyst, W. F. Hillebrand.
III. Obsidianite. Near Hamilton, Victoria. Analyst, G. Ampl.
IV. Moldavite. Tribitsch, Bohemia.

Although data are lacking regarding the mode of occurrence of this Colombian material, it is at once evident that it is a not unusual type of terrestrial obsidian.

(2) *Obsidian pebbles, Clifton, Arizona* (Cat. No. 53676).—These pebbles were received at the Museum in 1899 from Frank Keppler. There is apparently no question but what they are water-worn and corroded pebbles of ordinary obsidian. They are dark, smoky black

in color, and show under the microscope the characteristic black hair-like trichites. The surfaces are roughened by pits and grooves, and in addition the entire surface is shagreened.

(3) *Obsidian pebbles, near Marsh, Idaho* (Cat. No. 77784).—These pebbles, again, are of ordinary black obsidian, and were collected by Dr. W. Lindgren, of the U. S. Geological Survey, in gravel beds some 4¾ miles north and 20 degrees west of Marsh. The surfaces are everywhere pitted and grooved, but the elongated, curvilinear, and lunar crater forms so characteristic of the billitonites are quite lacking. The surfaces are coated with a thin, mammillated crust, which is in part a secondary deposit of iron.

(4) *Obsidian pebble, High Rock Canyon, Nevada* (Cat. No. 35270).—This pebble is of coal black obsidian, only faintly translucent on the thin edges. The surface is etched in a manner suggestive of the billitonites, even to the nearly circular *lunar crater* forms, as they may be termed. The surface is also considerably abraded as though the pebble had been rolled about on a beach, and the bottoms of the grooves, or flutings, are coated with a dull, brown-red material, which seems to be an original constituent rather than an extraneous substance deposited from the water as was at first supposed. It is probably a devitrification product similar to that found in the lithophysæ of obsidians.

These same markings are roughly simulated on some large weathered obsidian pebbles sent by Dr. J. Aguilera from between Guajolote Hill and Cuyamaloya, Hidalgo, Mexico. (Cat No. 77802.)

(5) *Obsidian, near Myvatn, Iceland* (Cat. No. 77616).—Perhaps the most strikingly billitonite-like markings found on any of the terrestrial rocks are those on some obsidians brought by Dr. F. E. Wright from a flow at Hrafntinnuhryggur, near Myvatn, in 1909. The material is a highly lustrous jet black glass, the outer surfaces of which are grooved and etched to a maximum depth of 2 or 3 mm. Not only are the lunar crater forms here in evidence, but there are also elongated, nearly straight grooves which, but for the position they occupy on the surface, might at first be thought to have been produced by the scoring of one mass against another while in the plastic condition. On one surface of this specimen are found only the minute circular pittings such as were described as occurring on the flattened areas of the specimens from Colombia.

To test the possibilities of a terrestrial origin for these markings, fragments of dark obsidian from near Reno, Nevada, and Yucca, in Mohave County, Arizona, were submitted for a few days to the action of dilute fluorhydric acid. The resultant forms are shown in the specimens numbered 88663.

Attention should be called to the fact that the markings on these pebbles and obsidians of known terrestrial origin more closely agree with those on some of the tektites than do the tektites from various localities agree among themselves; and, further, that the etchings produced by action of fluorhydric acid are practically indistinguishable from the markings on some of the moldavites. Further than this, again, the markings on the tektites from various sources are so wholly unlike that it is impossible to conceive of their having a common origin, or to have been formed through the same agencies, and above all it is to be noted that in no case do they resemble the flutings which are characteristic of known meteorites. Further than this the smaller meteoric stones, those corresponding in size with the tektites, rarely if ever show pittings and flutings. It is only the larger forms apparently which hold their orientation for a sufficient length of time for flutings to develop. The smaller forms are mere rounded blebs as is abundantly illustrated by the hundreds of individuals constituting the Pultusk and other noted falls.

In the above no attempt is made to controvert the theory of a cosmic origin for these bodies. Until, however, such shall be seen to fall, their source or origin must be regarded as in doubt.

APPENDIX B.

EXAMPLES OF METALLIC IRON, IN PART ALLOYED WITH NICKEL, IN TERRESTRIAL ROCKS.

Metallic iron is quickly oxidized in a moist oxygen-rich atmosphere such as exists over a large part of the earth's surface and hence is rarely found, even if once formed, in terrestrial rocks. A few of the known occurrences are shown in the exhibits:

Native Iron in Basalt, Hessen, Germany (Cat. No. 88210).

Native Iron in Basalt, Nugsauk Peninsula, Greenland (Cat. No. 58479).

Josephinite, a native alloy of nickel and iron found in pebble form in the bed of a creek in Josephine County, Oregon. (Cat. No. 85976).