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ANALYSES OF IRON METEORITES COMPILED AND CLASSIFIED

BY

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CHICAGO, U. S. A.

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Chemical analyses may be collected and grouped for purposes of record and of comparison. For the first purpose it is desirable that all known analyses of the substances under consideration be collected; for the second, only those known to be complete and reliable are needed. A combination of these two purposes may perhaps be gained, however, by collecting all analyses and leaving to the judgment of the investigator the selection of those suited for the study of any particular phase of the subject. This plan is practically that which has been adopted in presenting the analyses here collected. In many cases obviously incomplete analyses are given because they represent all that is known of the chemical constitution of the meteorite in question, or because they mark a stage in its study. On the other hand, analyses which amount to little more than a qualitative determination of the presence of iron and nickel, or whose connection with a particular meteorite is uncertain, are omitted. About three hundred and sixty analyses are here included, and it is believed that they comprise practically all of importance that have been made of iron meteorites. When more than one analysis of a meteorite is given, the analyses have been arranged chronologically. For the most part the later analyses are the most complete and reliable ones, though this is not always the case. Thus those by J. Lawrence Smith, although made thirty and in some cases forty years ago, accord well with what is known of the constitution of the iron meteorites at the present day and may be considered generally accurate and reliable. The same is true of analyses by Jackson, Berzelius, Damour, and others. As shown later, the relations between structure and composition brought out by the analyses as here grouped are so definite that at the present time a knowledge of the structure of a meteorite will give a more accurate idea of its composition than inferior chemical analyses. The general plan of arrangement which has been adopted

for the analyses is that now generally known as the Rose-Tschermak-Brezina classification. This seemed the classification most desirable to employ on account of its wide use, and when it was found, as will be seen by the tables, that the chemical constitution of the meteorites follows its main divisions, its adaptation to the work in hand seems unquestionable. Under each group of the classification the arrangement of the meteorites is alphabetical. Synonyms of the meteorite names will be found on subsequent pages. The characterization of the meteorite groups which head the tables have largely been summarized from Cohen.* In considering the analyses it should be realized that some of the groups are much better known than others. Thus the ataxites and hexahedrites were thoroughly studied by Cohen and their composition satisfactorily determined. The fine octahedrites have also been mostly investigated. The coarse and medium octahedrites, however, though more numerous than the groups just mentioned, are but imperfectly known and need detailed modern study. In a list following the tables meteorites of which no analysis is known are marked with an asterisk. These number about forty. In addition, many meteorites, analyses of which are reported in the tables, have never in fact been properly studied. The only extensive list of analyses of iron meteorites which has lately been previously compiled of which the writer is aware is that of Wadsworth, published in 1884.† This list includes one hundred and ninety-three analyses of iron meteorites and terrestrial irons, arranged in order of the per cent of nickel. No further attempt at classification is made. While Wadsworth's list is fairly complete as regards older analyses, it includes several pseudo-meteorites, and obviously does not adequately represent present knowledge.

The first recorded attempt at analysis of an iron meteorite is probably to be found in the examination in 1802, by Count de Bournon,‡ of some so-called native irons from Bohemia, Senegal, and South America. In these Count de Bournon found percentages of nickel ranging from five to ten per cent, but it is stated by Howard elsewhere in the paper that owing to lack of knowledge of the peculiarities of nickel these figures are little more than estimates. The next year Klaproth§ reported one and one-half to three and one-half per cent of nickel in the iron meteorite of Hraschina, and expressed the opinion that the presence of nickel might serve as a criterion for

* Meteoritenkunde, Heft III.

† The Rocks of the Cordilleras, Memoirs Museum Comparative Zoölogy, Cambridge, Mass., Vol. XI, Part I, pp. vi-xvi, Table II.

‡ Phil. Trans. Roy. Soc., London, 1802.

§ Abhandl. Akad. Wiss., Berlin, 1803, 21-41.

judging the meteoric origin of a body. Cobalt was reported by Stromeyer in the iron meteorite of Cape of Good Hope in 1816,* and copper by the same investigator in 1833.† Stromeyer expressed the belief that copper was, with cobalt, a constant ingredient of meteoric nickel-iron, and this conclusion was later corroborated by Smith‡ on the basis of more than one hundred analyses. Chromium was discovered as a component of meteoric nickel-iron by Laugier in 1817.§ The presence of manganese and tin in meteoric nickel-iron was also early reported. The presence of other metals or semi-metals reported at different times, such as zinc, lead, arsenic, and antimony, has not been confirmed, while the presence of aluminum, calcium, magnesium, potassium, and sodium, noted by several analysts, is doubtless to be referred to small quantities of silicates which either formed a constituent of the meteorite, as in Tucson, Tula, etc., or accidentally contaminated the material analyzed. The occurrence of phosphorus in meteoric nickel-iron seems first to have been noted by Berzelius|| in the undissolved residue of Bohumilitz. It was similarly reported by analysts who followed Berzelius, but percentages were not commonly given until later times. Sulphur was early noted as an ingredient of meteoric stones and later of irons. Since it occurred as a soluble constituent, it was more often reported in the early analyses than phosphorus. The presence of carbon as graphite was noted by Tennant¶ in 1806 in the Cape of Good Hope meteorite. Being, like the phosphides, insoluble, its presence was often later reported in insoluble residues, but its amount was rarely given. Silicon, as reported in the earlier analyses, whether as metal or oxide, is probably for the most part to be referred to accessory silicates. With later methods, however, its detection in small quantities as an ingredient of the nickel-iron has become possible. The first detection of chlorine as an essential constituent of iron meteorites seems to have been by Jackson in 1838,** in the meteorite of Limestone Creek. Its presence has been occasionally but not commonly reported by later analysts. Determinations of specific gravity of the iron meteorites examined seem to have been common. While these are probably for the most part fairly reliable, some of the values reported are too anomalous to seem trustworthy.

* Gottingische Gelehrte Anzeigen, 1816, 2041-2043.

† Gottingische Gelehrte Anzeigen, 1833, 369-370.

‡ Am. Jour. Science, 1870 (2), 49, 332.

§ Ann. Chem. Pharm., 1817, IV, 363-366.

|| Pogg. Ann., 1832, XXVII, 128-132.

¶ Tillocks Phil. Mag., London, 1806, XXV, 182.

** Am. Jour. Science (1), 34, 332-337.

IRON METEORITES.

These are meteorites consisting essentially of nickel-iron. Most of them contain, in addition, an appreciable amount of sulphides, carbides, and phosphides, but the presence of silicates in quantity removes a meteorite from this class. The iron meteorite of Tucson contains about five per cent of forsterite, and the meteorites of Kodaikanal, Persimmon Creek, and Tula also contain silicate aggregates, but in small quantities. In general, it may be said that if the quantity of silicate grains exceeds five per cent the meteorite is not considered as belonging to the class of iron meteorites. About two hundred and fifty iron meteorites are now recognized, the exact number being indeterminate on account of differences of opinion as to identity of origin in several cases. The chief divisions of iron meteorites, according to the Rose-Tschermak-Brezina classification, are hexahedrites, octahedrites, and ataxites. These are sub-divided as follows:

CLASSIFICATION OF IRON METEORITES ACCORDING TO
ROSE, TSCHERMAK, BREZINA, AND COHEN

- I. Hexahedrites.
 - A. Normal hexahedrites.
 - B. Brecciated hexahedrites.
- II. Octahedrites.
 - A. Normal octahedrites.
 - 1. Coarsest octahedrites.
 - 2. Coarse octahedrites.
 - 3. Medium octahedrites.
 - 4. Fine octahedrites.
 - a. Prambanan group.
 - b. Rodeo group.
 - 5. Finest octahedrites.
 - a. Salt River group.
 - b. Tazewell group.
 - c. Cowra and Victoria West.
 - B. Hammond octahedrites.
 - C. Brecciated octahedrites.
- III. Ataxites.
 - A. Nickel-poor ataxites.
 - 1. Siratik group.
 - 2. Nedagolla group.
 - 3. Rafruti group.

- B. Nickel-rich ataxites.
 - 1. Smithland group.
 - 2. Cristobal group.
 - 3. Octibbeha.
- C. Ataxites with forsterite.
- D. Ataxites with cubic streaks.

The iron meteorites enumerated according to groups sum up as follows:

Octahedrites:

Coarsest.....	13
Coarse	30
Medium	98
Fine	33
Finest.....	14
Brecciated.....	6
Hammond	3
Unclassified	4
	<hr/>
	201
Ataxites.....	30
Hexahedrites	17
	<hr/>
Total	248

ALPHABETICAL LIST OF IRON METEORITES.

The following is an alphabetical list of iron meteorites, showing the classification of each. An asterisk indicates that no analysis of the meteorite is reported.

Abert Iron.....	Medium octahedrite	Bald Eagle.....	Medium octahedrite
*Adargas.....	Medium octahedrite	Ballinoo.....	Finest octahedrite
Algoma	Medium octahedrite	Barranca Blanca...	Brecciated octahedrite
Alt Biela.....	Fine octahedrite		
*Amates	Medium octahedrite	Beaconsfield.....	Coarse octahedrite
Angara.....	Medium octahedrite	Bear Creek.....	Fine octahedrite
*Apoala	Fine octahedrite	Bella Roca.....	Fine octahedrite
Arispe.....	Coarsest octahedrite	Bendego.....	Coarse octahedrite
Arlington	Medium octahedrite	Bethany.....	Fine octahedrite
Asheville.....	Medium octahedrite	Billings.....	Coarse octahedrite
Auburn.....	Hexahedrite	Bingera	Hexahedrite
*Augustinowka.....	Fine octahedrite	Bischtube	Coarse octahedrite
		Black Mountain....	Coarse octahedrite
Babb's Mill.....	Ataxite	*Blue Tier.....	Medium octahedrite
Bacubirito	Finest octahedrite	Bohumilitz	Coarse octahedrite

Boogaldi.....	Fine octahedrite	*Dellys.....	Medium octahedrite
Botetourt.....	Ataxite	Denton County.....	Medium octahedrite
Braunau.....	Hexahedrite	Descubridora.....	Medium octahedrite
Bridgewater.....	Fine octahedrite	De Sotoville.....	Hexahedrite
Buckeberg.....	Fine octahedrite	Duell Hill.....	Coarse octahedrite
Burlington.....	Medium octahedrite	Elbogen.....	Medium octahedrite
Butler.....	Finest octahedrite	El Capitan.....	Medium octahedrite
Cabin Creek.....	Medium octahedrite	*El Tule.....	Medium octahedrite
Cacaria.....	Hammond octahedrite	*Emmitsburg.....	Medium octahedrite
Cachiyuyal.....	Medium octahedrite	Forsyth County.....	Ataxite
Cambria.....	Fine octahedrite	Fort Duncan.....	Hexahedrite
Campo del Cielo.....	Ataxite	Fort Pierre.....	Medium octahedrite
Canton.....	Coarsest octahedrite	Franceville.....	Medium octahedrite
Canyon Diablo.....	Coarsest octahedrite	Frankfort.....	Medium octahedrite
Canyon City.....	Coarse octahedrite	Glorieta.....	Medium octahedrite
Cape of Good Hope.....	Ataxite	Grand Rapids.....	Fine octahedrite
Caperr.....	Medium octahedrite	Greenbrier County.....	Coarse octahedrite
Cape York.....	Medium octahedrite	Groslee.....	Fine octahedrite
Carlton.....	Finest octahedrite	Guilford County.....	Medium octahedrite
Carthage.....	Medium octahedrite	Hammond.....	Hammond octahedrite
Casas Grandes.....	Medium octahedrite	*Haniel el-Beguel.....	Medium octahedrite
*Casey County.....	Coarsest octahedrite	Hassi Jekna.....	Fine octahedrite
Central Missouri.....	Coarsest octahedrite	*Hayden Creek.....	Medium octahedrite
*Chañaral.....	Coarse octahedrite	Hex River.....	Hexahedrite
*Charcas.....	Medium octahedrite	Holland's Store.....	Hexahedrite
*Chambord.....		Hopewell Mounds.....	Medium octahedrite
Charlotte.....	Fine octahedrite	Hopper.....	Medium octahedrite
Chesterville.....	Ataxite	Hraschina.....	Medium octahedrite
*Chichimeguilas.....		*Ilimae.....	Medium octahedrite
Chilkoot.....	Medium octahedrite	Illinois Gulch.....	Ataxite
Chulafinnee.....	Medium octahedrite	Indian Valley.....	Hexahedrite
Chupaderos.....	Fine octahedrite	Iquique.....	Ataxite
Cincinnati.....	Ataxite	Iredell.....	Hexahedrite
Cleveland.....	Medium octahedrite	Ivanpah.....	Medium octahedrite
Coahuila.....	Hexahedrite	*Jackson County.....	Medium octahedrite
Colfax.....	Medium octahedrite	Jamestown.....	Fine octahedrite
Coopertown.....	Medium octahedrite	Jennie's Creek.....	Coarse octahedrite
Cosby Creek.....	Coarse octahedrite	Jewel Hill.....	Fine octahedrite
Costilla.....	Medium octahedrite	Joel's Iron.....	Medium octahedrite
Cowra.....	Finest octahedrite	Joe Wright.....	Medium octahedrite
*Cranberry Plains.....	Octahedrite	Jonesboro.....	Fine octahedrite
Cranbourne.....	Coarse octahedrite	Juncal.....	Medium octahedrite
Cuba.....	Medium octahedrite	Kendall County.....	Hexahedrite
Cuernavaca.....	Fine octahedrite	Kenton County.....	Medium octahedrite
Dalton.....	Medium octahedrite		
Deep Springs.....	Ataxite		
Dehesa.....	Ataxite		

*Kodaikanal.....	Fine octahedrite	Orange River.....	Medium octahedrite
Kokomo.....	Ataxite	*Oroville.....	Medium octahedrite
Kokstad.....	Medium octahedrite	Oscuro Mountains..	Coarse octahedrite
La Caille.....	Medium octahedrite	Pan de Azucar.....	Coarse octahedrite
Lagrange.....	Fine octahedrite	*Persimmon Creek..	Brecciated octahedrite
Laurens County...	Finest octahedrite	Petropawlowsk ...	Medium octahedrite
Lenarto.....	Medium octahedrite	Pittsburg.....	Coarsest octahedrite
Lexington County..	Coarse octahedrite	Plymouth.....	Medium octahedrite
Lick Creek.....	Hexahedrite	Ponca Creek.....	Coarsest octahedrite
Limestone Creek...	Ataxite	Prambanan.....	Fine octahedrite
Linville.....	Ataxite	Primitiva.....	Ataxite
Locust Grove.....	Ataxite	Puquois.....	Medium octahedrite
*Lonaconing.....	Coarse octahedrite	Putnam County...	Fine octahedrite
Lostown.....	Medium octahedrite	Quesa.....	Fine octahedrite
*Lucky Hill.....	Medium octahedrite	Rafruti.....	Ataxite
Luis Lopez.....	Medium octahedrite	*Rancho de la Pila..	Medium octahedrite
*Madoc.....	Fine octahedrite	Rasgata.....	Ataxite
Magura.....	Coarse octahedrite	Red River.....	Medium octahedrite
Mantos Blancos...	Finest octahedrite	Reed City.....	Hammond octahedrite
Marshall County...	Medium octahedrite	Rhine Valley.....	Medium octahedrite
Mart.....	Finest octahedrite	Rodeo.....	Fine octahedrite
Matatiela.....	Medium octahedrite	Roebourne.....	Medium octahedrite
Mazapil.....	Medium octahedrite	*Rosario.....	Octahedrite
Merceditas.....	Medium octahedrite	Rowton.....	Medium octahedrite
Misteca.....	Medium octahedrite	Ruff's Mountain...	Medium octahedrite
*Moctezuma.....	Medium octahedrite	Russel Gulch.....	Fine octahedrite
*Mooranoppin.....	Coarsest octahedrite	Sacramento Moun-	
Moonbi.....	Fine octahedrite	tains.....	Medium octahedrite
Morito.....	Medium octahedrite	St. Francois County..	Coarse octahedrite
Morradal.....	Ataxite	St. Genevieve Coun-	
Mount Joy.....	Hexahedrite	ty.....	Fine octahedrite
*Mount Stirling....	Coarse octahedrite	Salt River.....	Finest octahedrite
Mungindi.....	Finest octahedrite	San Angelo.....	Medium octahedrite
Murfreesboro.....	Medium octahedrite	San Cristobal....	Ataxite
Murphy.....	Hexahedrite	San Francisco del	
*Nagy-Vazsony....	Medium octahedrite	Mezquital.....	Ataxite
Narraburra Creek..	Finest octahedrite	*Santa Apolonia...	
Nedagolla.....	Ataxite	Santa Rosa.....	Brecciated octahedrite
Nejed.....	Medium octahedrite	Sao Juliao.....	Coarsest octahedrite
Nelson County....	Coarsest octahedrite	Sarepta.....	Coarse octahedrite
Nenntmannsdorf..	Ataxite	Schwetz.....	Medium octahedrite
N'Goureyma.....	Brecciated octahedrite	Scottsville.....	Hexahedrite
Niagara.....	Coarse octahedrite	Seelasgen.....	Coarsest octahedrite
*Nochtuisk.....	Coarse octahedrite	Seneca Falls.....	Medium octahedrite
*Nocoleche.....	Medium octahedrite		
Oktibbeha County..	Ataxite		

Shingle Springs....	Ataxite	Tula.....	Brecciated octahe- drite
*Sierra Blanca.....	Coarse octahedrite		
Silver Crown.....	Coarse octahedrite	*Union County.....	Coarsest octahedrite
Siratik.....	Ataxite	Ute Pass.....	Coarsest octahedrite
Smithland.....	Ataxite		
Smith's Mountain..	Fine octahedrite	Varas.....	Fine octahedrite
Smithville.....	Coarse octahedrite	Victoria.....	Medium octahedrite
Ssyromolotow.....	Medium octahedrite	Victoria West.....	Finest octahedrite
Staunton.....	Medium octahedrite		
Summit.....	Hexahedrite	*Wallen's Ridge....	Coarse octahedrite
Surprise Springs...	Medium octahedrite	Walker County....	Hexahedrite
		Weaver.....	Ataxite
Tabarz.....	Coarse octahedrite	Welland.....	Medium octahedrite
*Tajgha.....	Medium octahedrite	*Werchne Dniep-	
*Tanogami.....	Medium octahedrite	rowsk.....	Finest octahedrite
Tazewell.....	Finest octahedrite	Werchne Udinsk..	Medium octahedrite
*Teocaltiche.....	Octahedrite	Wichita County....	Coarse octahedrite
Ternera.....	Ataxite	Willamette.....	Medium octahedrite
Thunda.....	Medium octahedrite	Wooster.....	Medium octahedrite
Thurlow.....	Fine octahedrite		
*Tlacotepec.....	Octahedrite	Yanhuitlan.....	Fine octahedrite
Toluca.....	Medium octahedrite	Yardea Station....	Medium octahedrite
Tonganoxie.....	Medium octahedrite	*York.....	Medium octahedrite
Toubil.....	Medium octahedrite	Youndegin.....	Coarse octahedrite
Trenton.....	Medium octahedrite		
Tucson.....	Ataxite	Zacatecas.....	Brecciated octahe- drite

SYNONYMS.

The following are synonyms of the iron meteorites given in the preceding list:

Aeriotopos.....	Bear Creek	Caille.....	La Caille
Agram.....	Hraschina	Caney Fork.....	Carthage
Ainsa.....	Tucson	Carleton Iron.....	Tucson
Albuquerque.....	Glorieta	Catorze.....	Descubridora
Allen County.....	Scottsville	Chatooga County....	Holland's Store
Amakaken.....	Caperr	Cherokee County, 1867:	Losttown
Arva.....	Magura	Cherokee County, 1894:	Canton
Atacama, 1858.....	Joel's Iron	Chilkat.....	Chilkoot
Atacama, 1874.....	Cachiyuyal	Claiborne.....	Lime Creek
Augusta County....	Staunton	Cocke County.....	Cosby Creek
		Concepcion.....	Adargas
Bahia.....	Bendego	Cross Timbers.....	Red River
Baird's Farm.....	Asheville	Crow Creek.....	Silver Crown
Bates County.....	Butler		
Batesville.....	Joe Wright	Dakota.....	Ponca Creek
Bonanza.....	Coahuila	Ellenboro.....	Colfax
Brazos River.....	Wichita		
Butcher Iron.....	Coahuila	Floyd County.....	Indian Valley

Floyd Mountain.....	Indian Valley	Mukerop.....	Bethany
Great Fish River.....	Bethany	Netschaevo.....	Tula
Green County.....	Babb's Mill	Obernkirchen.....	Buckeberg
Hamilton County.....	Carlton	Oldham County.....	La Grange
Hastings County.....	Madoc	Penkarring Rock....	Youndegin
Hauptmannsdorf.....	Braunau	Ranchito.....	Bacuburito
Henry County, 1857...	Locust Grove	Saltillo.....	Coahuila
Henry County, 1889...	Hopper	Sanchez Estate.....	Coahuila
Honduras.....	Rosario	San Gregorio.....	Morito
Howard County.....	Kokomo	Saskatchewan.....	Victoria
Independence County.	Joe Wright	Senegal.....	Siratik
Independence.....	Kenton County	Serrania de Varas....	Varas
Iron-Creek.....	Victoria	Sierra de la Ternerá..	Ternerá
Johnson County.....	Cabin Creek	Southeast Missouri...	St. Francois County
Knoxville.....	Tazewell	Teposcolula.....	Yanhuitlan
La Primitiva.....	Primitiva	Tocavita.....	Santa Rosa
Lea Iron.....	Cleveland	Tombigbee River....	De Sotoville
Lime Creek, 1832.....	Walker County	Tucuman.....	Campo del Cielo
Lime Creek, 1834.....	Limestone Creek	Waldron's Ridge....	Wallen's Ridge
Lion River.....	Bethany	White Sulphur	
Lockport.....	Cambria	Springs.....	Greenbrier County
Miller's Run.....	Pittsburg	Whitfield County....	Dalton
Muchachos.....	Tucson	Wohler's Iron.....	Campo del Cielo

ANALYSES OF IRON METEORITES.

I. HEXAHEDRITES.

The hexahedrites are characterized by cubic cleavage and Neumann lines. They consist of the single alloy kamacite, the composition of which, Fe_{11}Ni , shows a close approximation to the iron-nickel content of the hexahedrites. The content of phosphorus in the hexahedrites is usually relatively high, $\frac{1}{4}$ to $\frac{1}{2}$ per cent. This appears char-

NORMAL

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous.
Auburn.....	94.58	3.01	.....	.....	.....	.13	.....	.52	.....	.....	.....	.....
"	94.49	4.67	1.03	.101	.024	.46	.002	.....	.....	.....	.....	.....
Braunau.....	91.88	5.52	.53	.....	.....	.....	.....	.....	.....	.....	.....	2.07
"	93.62	5.21	.92	.07	.05	.24	.08	.09	.....	.....	.....	.....
Coahuila.....	94.82	5.62	.60	.....	tr.	.29	.....	.....	.....	.....	.06	.....
(Bonanza).....	97.90	2.10	tr.	.....	tr.	tr.	.....	.....	.....	.....	.....	Mg. tr.
(Butcher).....	92.95	6.62	.48	tr.	.....	.02	.....	.....	.....	.....	.....	.....
(Saltillo).....	94.62	4.79	.60	.04	tr.	.18	tr.	.....	.....	.....	.....	.....
(Santa Rosa).....	96.07	3.26	.55	.....	.....	1.05	.....	.....	.....	.....	.....	.....
" "	91.86	7.42	.50	.....	.....	.27	.....	.....	.....	.....	.....	.....
De Sotoville.....	95.02	4.11	.40	.....	.....	.32	tr.	.16	.....	.....	.....	.....
"	95.14	4.82	.....	.05	.01	.29	.06	.....	.....	.....	.....	.....
"	95.18	4.32	.69	.04	.....	.20	.....	.07	.....	.....	.....	.....
"	95.41	4.04	.74	.04	.....	.14	.05	.....	.....	.....	.02	.....
Fort Duncan.....	94.90	4.87	.....	.....	.....	.23	tr.	tr.	.....	.....	.....	.....
" "	92.02	6.10	.....	.....	.....	.....	.....	.....	.....	.....	1.80	.....
" "	91.90	7.03	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
" "	92.58	6.66	.73	.....	.....	.28	.....	.....	.....	.....	.01	.....
" "	94.65	4.82	1.07	.04	.04	.23	.32	.....	.....	.....	.....	.....
(Sancha).....	96.04	3.11	.42	.....	.....	.....	.....	.....	.....	.....	.57	.....
"	95.82	3.18	.35	tr.	.....	.24	.....	.....	.....	.....	.....	.....

acteristically in the hexahedrites in the form of rhabdite, and often constitutes $1\frac{1}{2}$ to 3 per cent of their mass. Another characteristic mineral of the hexahedrites is daubreelite. Graphite and troilite are rare, although the latter mineral occurs in some members of the group in visible nodules. The hexahedrites may be divided into normal and brecciated hexahedrites, according to whether they are one or several individuals.

A. NORMAL HEXAHEDRITES.

In these hexahedrites the cleavage planes and Neumann lines run without change of direction throughout the mass.

HEXAHEDRITES.

Loss	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.....		98.24	7.-7.17	C. U. Shepard	1869, A. J. S. (2), XLVII, 230-233
.....		100.77	.....	O. Hildebrand.....	1905, Meteoritenkunde, III, 217
.....		100.00	7.782	Duflos & Fischer....	1847, Ann. Phy. Chem., LXXII, 475-480
.....	.02	100.30	7.8516	R. Knauer.....	1905, Meteoritenkunde, III, 207
.....		101.39	7.8678	E. Cohen.....	1894, Meteoreisen-Studien A. N. H., IX, 104
.....		100.00	7.825	C. U. Shepard	1867, A. J. S. (2), XLIII, 385
.....		100.07	7.692	J. L. Smith	1869, A. J. S. (2), XLVII, 385
.....		100.22	.....	O. Bürger.....	1905, Meteoritenkunde, III, 194
.....		100.935	.....	H. Wichelhaus.....	1863, Ann. Phy. Chem., CXVIII, 631-634
.....		100.05	.....	N. F. Lupton.....	1885, A. J. S. (3), XXIX, 233
.....		100.01	.....	J. E. Whitfield.....	1899, A. J. S. (4), VIII, 154
.....		100.37	.....	R. Knauer.....	1905, Meteoritenkunde, III, 213
.....		100.50	.....	Hildebrand & Cohen	Same
.....		100.46	.....	Knauer & Cohen....	Same
.....		100.00	7.522	J. B. Mackintosh....	1886, A. J. S. (3), XXXII, 306
.....		99.92	7.699	Meunier.....	1887, C. R., CIV, 872-873
.....		98.93	7.72	"	1893, B. S. H. N., VI, 17
.....		100.26	.....	E. Cohen.....	1889, Neues Jahrb., 227
.....	.02	101.19	7.84	O. Hildebrand.....	1905, Meteoritenkunde, III, 194
.....		100.14	8.13	F. A. Genth.....	1854, A. J. S. (2), XVII, 239-240
.....		99.59	7.81	J. L. Smith.....	1855, A. J. S. (2), XIX, 160-161

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous.
Hex River.....	93.33	5.58	.84	....	....	....	....	....	....	....	....	....
“ “	93.59	5.68	.66	.04	.02	.23	.08	....	....	....	.03	....
Iredell.....	93.75	5.51	.52	....	....	.20	.06	....	....	....	....	....
Lick Creek.....	93.00	5.74	.52	tr.	....	.36	tr.	....	....	tr.	....	....
Murphy.....	93.93	5.52	.61	.02	....	.34	....	.04	....	.06	....	....
Scottsville	94.32	5.01	tr.	....	....	.16	.34	.12	....	....	....	....
“	93.14	5.73	.99	.10	....	.15	....	....	....	....	.02	....
“	94.03	5.33	.95	.04	.02	.23	.07	....	....	....	.01	....
Walker County....	94.14	5.30	.64	.06	.05	.28	.19	....	....	....	....	....

B. BRECCIATED HEXAHEDRITES.

These hexahedrites are characterized by a structure which gives them the appearance of being aggregates of individual grains. Not only do apparent outlines of grains occur, but the directions of the Neumann lines are different on the different grains. The size of the grains differs in different falls, but is fairly uniform for meteorites of the same fall. The contour of the grains may be rounded, polygonal, elongated, or ragged, and as a rule the grains are sharply separated from one another. When the divisions between grains widen to a cleft, some accessory constituent usually occupies the gap. Accessory minerals are not, however, abundant. The presence of dau-

BRECCIATED

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous.
Bingera.....	93.76	4.39	.57	....	....	.23	....	.14	....	....	.54	Na. tr.
“	93.50	5.54	.51	.01	....	.26	....	.03	.01	....	....	Sa. .02 Mn. Pt. Ir. tr.
Holland's Store....	93.06	5.35	1.00	....	.23	.31	.08	....	....	....	.08	....
“	94.60	4.97	.21	....	....	.21	tr.	tr.	....	....	....	....
Indian Valley.....	93.59	5.56	.53	tr.	....	.27	.01	....	tr.	....	....	....
Kendall County....	92.65	5.64	.78	.03	.01	.34	.03	1.62	....	.01	....	....
Mount Joy	93.80	4.81	.51	.005	....	.19	.01	....	....	....	....	....
Summit.....	93.39	5.62	.58	....	....	.31	....	....	....	....	....	....

Loss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
....	.94	100.69	.....	Cohen & Weinschenk	1891, <i>Meteoreisen-Studien</i> A. N. H., VI, 143
....		100.43	7.8225	R. Knauer.....	1905, <i>Meteoritenkunde</i> , III, 225
....		100.04	.....	J. E. Whitfield.....	1899, A. J. S. (4), VIII, 415-416
....		99.62	.....	Smith & Mackintosh	1880, A. J. S. (3), XX, 324-326
....		100.52	7.7642	J. Fahrenhorst	1900, <i>Meteoreisen-Studien</i> A.N.H., XV, 368
....		99.95	7.848	J. E. Whitfield.....	1887, A. J. S. (3), XXXIII, 500
....		100.13	.....	Fischer.....	1889, <i>Neues Jahrb.</i> , I, 227
....		100.68	7.7959	R. Knauer.....	1905, <i>Meteoritenkunde</i> , III, 220
....		100.66	7.7806	O. Hildebrand.....	1905, <i>Meteoritenkunde</i> , III, 173

breelite has not been noted, and schreibersite is not common, either in nodules or as rhabdite. The view that the brecciated hexahedrites are aggregates is not accepted by Brezina, except in the case of Kendall County. He regards the structure and cleavage of the other members of the division as uniform, and explains the varying orientation as caused by twinning. Mount Joy, placed by Berwerth, Cohen, and Brezina among the coarsest octahedrites, because of an apparent octahedral structure observed by Berwerth, seems to the present writer to belong more properly to the hexahedrites. In composition and structure it agrees fully with the hexahedrites, and it shows no trace of cohenite, a characteristic mineral of the coarse octahedrites. Its individual grains are the largest of any of the following group:

HEXAHEDRITES.

Loss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
....		99.63	7.834-7.849	A. Liversidge.....	1882, <i>Proc. Roy. Soc. N. S. W.</i> , XVI, 31-34
....		99.88	7.761	J. C. H. Mingaye.....	1904, <i>Rec. Geol. Sur. N. S. W.</i> , VII, 308-310
....		100.11	.....	Zaubitzer	1905, <i>Meteoritenkunde</i> , III, 240
....		99.99	7.801	J. E. Whitfield.....	1887, A. J. S. (3), XXXIV, 472
....		99.96	7.95	L. G. Eakins.....	1892, A. J. S. (3), XLIII, 424
....		101.11	.....	Scherer	1900, <i>Meteoreisen-Studien</i> , A. N. H., XV, 387
....		99.33	.....	L. G. Eakins.....	1892, A. J. S. (3), XLIV, 416
....		99.90	6.949	F. P. Venable.....	1890, A. J. S. (3), XL, 322

II. OCTAHEDRITES.

The meteorites of this class are the most abundant among iron meteorites. According to the width of the lamellæ as seen in etched sections, they are divided as follows: Coarsest octahedrites, lamellæ, many mm. to 2.5 mm. in width; coarse octahedrites, lamellæ 2–1.5 mm. in width; medium octahedrites, lamellæ 1.0–0.5 mm. in width; fine octahedrites, lamellæ 0.4–0.2 mm. in width; finest octahedrites, lamellæ from 0.2 mm. down. While no sharp line of separation can be drawn between these groups, the members of each group present as a rule characters more or less peculiar to themselves. As compared with the hexahedrites, the octahedrites differ in structure in being made up of lamellæ arranged in accordance with the planes of the octahedron. These lamellæ in turn are composed of two or more alloys of nickel-iron. In composition a higher percentage of nickel-cobalt may be noted among the octahedrites, as compared with the hexahedrites, and schreibersite and troilite are far more abundant than in the hexahedrites. Cohenite, which is not known to occur in the hexahedrites, is characteristic of certain groups of the octahe-

COARSEST

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous.
Arispe	92.27	7.04	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Canyon Diablo....	95.370	3.945	.....	.....	.....	.144	tr	.....	tr.	.....	.26	.....
“ “	91.396	7.94	.....	.....	.....	.179	.004	.417	.047	.....	.....	.....
Canton	91.96	6.70	.50	.03	.....	.11	.01	.....	tr.	.....	.....	.....
Central Missouri...	94.73	4.62	.18	.....	.....	.44	.02	.01	.....	.....	.....	.....
Nelson County....	93.10	6.11	.41	tr.	.....	.05	.....	.....	.....	.....	.....	.....
Pittsburg.....	92.81	4.66	.39	.03	.....	.25	.04	.....	.....	.....	.....	Mn..... .14
“	93.38	5.89	1.24	.05	.02	.15	.07	.....	.....	.....	.....	Chromite. .07
Ponca Creek.....	91.74	6.53	.....	.....	.....	.01	.....	.....	.....	.....	.....	Sn..... .06
“ “	91.74	7.08	.....	.....	.....	.01	.....	.....	.....	.....	.....	Sn..... .06
São Julião.....	89.39	8.27		tr.	.....	.26	.....	.....	.....	.....	.....	.....
Seeläsgen.....	90.00	5.31	.43	.10	.....	.....	.....	.....	1.16	.....	.83	Mn..... .91
“	92.33	6.23	.67	.....	.....	.....	.....	.52	.02	.....	.18	Cu. + Sn... .03

drites, while graphite and diamond are also largely confined to the octahedrites. Daubreeelite and chromite, which are common constituents of the hexahedrites, are rare in the octahedrites. The nickel-cobalt content of the octahedrites varies from $5\frac{1}{2}$ to $15\frac{1}{2}$ per cent.

A. NORMAL OCTAHEDRITES.

In the normal octahedrites the lamellar structure extends without change of direction, except for occasional curving, through the individual. This is true even for large masses like those of Charcas, Chupaderos, and Willamette.

1. COARSEST OCTAHEDRITES.

Width of lamellæ from many millimeters down to 2.5 mm. The nickel-cobalt content is as a rule slightly higher than in the hexahedrites, reaching in some cases 7 per cent. The presence of cohenite and graphite is characteristic of the group. Canyon Diablo contains diamond. The octahedral structure and presence of lamellæ is often difficult to discern, so that some members of the group have been classed as hexahedrites.

OCTAHEDRITES.

Loss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.....		99.31	7.853	J. E. Whitfield.....	1902, Proc. Roch. Acad. Sci., IV, 85
.....		99.719	7.703	H. Moissan.....	1904, Comptes Rendus, CXXXIX, 776
.....		99.983	.....	Booth, Garrett & Blair	1905, Proc. Phil. Aca. Sci., LVII, 875
.....		99.31	.....	H. N. Stokes.....	1895, A. J. S. (3), L, 252-4
.....		100.00	.....	Mariner & Hoskins..	1900, A. J. S. (4), IX, 286
.....		99.67	.....	J. L. Smith.....	1860, A. J. S. (2), XXX, 240
.....		98.32	7.74	F. A. Genth.....	1876, A. J. S. (3), XII, 72-73
.....		100.87	.....	O. Hildebrand.....	1903, Mitt. f. Neu Vorp. u. Rügen, XXXV, 4
.....		98.34	7.952	C. T. Jackson.....	1863, A. J. S. (2), XXXVI, 261
.....		98.89	7.952	" ".....	1863, A. J. S. (2), XXXVI, 261
.....		97.92	7.783	C. v. Bonhorst.....	1888, Neues Jahrb., 372
.....		98.74	7.63 -7.71	A. Duflos.....	1848, Ann. Phy. Chem., LXXIV, 61-65
.....		100.00	7.73	C. Rammelsberg....	1848, Ann. Phy. Chem., LXXIV, 443-448

2. COARSE OCTAHEDRITES.

Width of lamellæ 2.0-1.5 mm. The lamellar or octahedral struc-

COARSE

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous.
Beaconsfield.....	92.56	7.34	.48	.02	....	.26	.04	.05	....	.01	....	.....
Bendego.....	91.90	5.71	....	....	....	....	....	....	....	....	.46	.....
“	88.46	8.59	....	....	....	....	....	.07	....	....	....	P. Fe. Ni. .37
Billings.....	91.99	7.38	.42	.01	....	.15	.06	....	.08	....	....	.....
Bischtübe.....	93.39	6.48	.87	.03	tr.	.05	....	....	....	....	.01	.....
Black Mountain...	96.04	2.52	....	....	....	....	....	....	....	....	1.44	.....
Bohumilitz.....	94.06	4.01	....	....	....	....	.81	....	....	....	....	C. etc. 1.12
“½	93.12	4.74	.23	....	....	....	....	....	....	....	1.91	.....
“½	94.77	3.81	.20	....	....	....	....	....	....	....	2.20	.....
Canyon City.....	88.81	7.28	.17	....	....	.12	....	....	....	....	....	.....
“ “½	91.25	7.85	.17	....	....	.10	....	....	....	....	....	.....
Cosby Creek.....	87.00	12.00	....	....	....	....	....	.50	....	....	....	.....
“ “½	93.91	4.55	....	....	....	....	....	....	....	....	.10	.....
“ “½	91.64	5.85	.81	*.22	....	.19	....	....	.08	....	....	Mn. .09 Graphite .80
“ “½	91.90	6.70	.33	....	....	.09	....	....	.18	....	....	.....
“ “½	92.75	6.91	.51	.02	....	.37	....	....	....	....	....	.....
Duell Hill.....	94.24	5.17	.37	tr.	....	.14	....	....	....	....	.15	.....
Greenbrier County.	91.59	7.11	.60	tr.	....	.08	....	....	....	....	....	.....
Jennie's Creek	91.56	8.31	....	....	....	.13	....	....	....	....	....	.....
Lexington County..	92.42	6.08	.93	....	....	tr.	....	....	....	....	.26	Sn. tr.
Magura.....½	93.62	5.68	....	....	....	....	....	....	....	....	....	.....
“½	89.42	8.61	....	....	....	....	....	....	....	....	....	C. Cu. Si. Sch. 1.41
“½	90.91	7.32	....	....	....	....	....	....	....	....	....	Co. C. Si., etc., 1.17
“½	92.55	7.08	.51	.02	....	.24	.02	.03	....	.01	....	.....
Niagara.....	92.67	7.37	.13	....	....	....	....	....	....	....	....	.....
Oscuro Mountains..	90.79	7.66	.57	....	....	.27	....	.07	....	....	....	.....

*Cu. Sn. †By diff.

ture is more obvious than in the coarsest octahedrites, and the nickel-cobalt content in some members slightly higher. Cohenite and graphite are characteristic and common ingredients.

OCTAHEDRITES.

Loss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.....		100.76	.....	O. Sjöström.....	1897, Sitzber. Berl. Akad., 1047
.93		100.00	7.73	Flickentscher.....	1863, Buchner, Meteorites, 144
.96		99.45	7.47	Wohler & Martius..	1867, Phipson, Meteorites, 94
.....		100.09	.....	H. W. Nichols.....	1905, A. J. S. (4), XIX, 242
.....		100.82	.....	Scherer & Sjöstrom.	1897, Meteoreisen-Studien, V, A.N.H., XII, 55
.....		100.00	7.261	C. U. Shepard.....	1847, A. J. S. (2), IV, 81-83
.....		100.00	7.15	J. Steinman.....	1830, A. J. S. (1), XIX, 384-386
.....		100.00	.....	J. J. Berzelius.....	1833, Ann. Phy. Chem., XXVII, 118-132
.....		100.98	.....	".....	1853, A. J. S. (2), XV, 12
.....		96.38	7.1	C. U. Shepard.....	1885, A. J. S. (3), XXIX, 469
.....		99.37	7.68	J. M. Davison.....	1904, A. J. S. (4), XVII, 383
.50		100.00	.....	G. Troost.....	1840, A. J. S. (1), XXXVIII, 254
.....		98.56	6.22	C. U. Shepard.....	1842, A. J. S. (1), XLIII, 354-357
.....		99.68	.....	C. A. Joy.....	1853, Ann. Chem. Pharm., LXXXVI, 39-43
.....		99.20	7.26	C. Bergmann.....	1857, Ann. Phy. Chem., C, 254-255
.....		100.56	.....	J. Fahrenhorst	1900, Meteoreisen-Studien, XI, A.N.H. XV, 373
.....		100.07	7.46	B. S. Burton.....	1876, A. J. S. (3), XII, 439
.....	.12	99.50	.....	L. Fletcher.....	1887, Min. Mag., VII, 183
.....		100.00	7.344	J. B. Mackintosh....	1886, A. J. S. (3), XXXI, 147
.....		99.69	7.00-7.405	C. U. Shepard, Jr ...	1881, A. J. S. (3), XXI, 119
.....		99.30	7.814	A. Patera.....	1847, Östr. Blätt. f. Lit., No. 169,-670
.....		99.44	7.814	".....	Same
.....		99.30	7.01-7.22	A. Löwe.....	1849, Neues Jahrb., 199
.....		100.46	.....	J. Fahrenhorst.....	1900, Meteoreisen-Studien, XI, A.N.H. XV, 378
.....		100.07	7.12	J. M. Davison.....	1902, Jour. Geol., X, 518-519
.....		99.36	.....	R. C. Hills.....	1897, Proc. Colorado Sci. Soc.

Name.	Fe.	Ni.	Co.	Cu	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous.
St. Francois County	92.10	2.60	tr.	....	....	tr.	.....	tr.	tr.	.....	....	Schreibersite . . 5.0
" " "	92.68	6.97	.52	.02	....	.34	.01	.....	.....	.03	.01	.....
Sarepta.....	95.94	2.66	....	....	....	....	....	....	.02	.....	....	Sn.02 P.Fe.Ni. 1.32
Silver Crown.....	91.57	8.31	tr.	....	....	.07	.....	tr.	.....	.....	....	.....
Smithville.....	91.57	7.02	.62	tr.	....	.18	.....	.....	.....	.....	....	Res. Mainly Carb. .15
Tabarz.....	92.76	5.69	.79	....	....	.86	.....	.....	.....	.....	....	P. Fe. Ni. .28
Wichita.....	89.99	10.01	tr.	....	....	....	.....	.....	.....	.....	....	.....
Willamette.....	91.46	8.30	....	....	....	....	.....	.....	.....	.....	....	.....
"	91.65	7.88	.21	....	....	.09	.....	.....	.....	.....	....	.....
Youndegin.....	92.67	6.46	.55	tr.	....	.24	.....	.....	.....	.....	.04	Mg. .... .42

3. MEDIUM OCTAHEDRITES.

Width of lamellæ 1.0-0.5 mm. More than one-third of the iron meteorites belong to this class. They present, as a rule, quite uniform characters. The lamellar structure is, as a rule, well-defined, and

MEDIUM

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous.
Abert Iron.....	92.92	6.07	.54	....	....	....	....	....	....	....	....	Schreibersite. .56
"	92.04	7.00	.68	....	....	.08	.01	.02	.....	.....	....	Graphite. .03
Algoma	88.62	10.63	.84	....	....	.15	tr.	.....	.02	.....	....	.....
Angara	92.64	7.10	....	....	....	.16	.....	tr.	.04	.....	tr.	Ca. tr. Mg. .06
Arlington	90.78	8.60	1.02	tr.	tr.	.05	.....	tr.	.....	.....	....	.....
Asheville	96.50	2.60	....	....	....	....	....	....	.50	.20	....	.....
Bald Eagle	91.36	7.56	.70	....	....	.09	.06	.....	tr.	.....	....	.....
Burlington	92.29	8.14	....	....	....	....	....	....	....	....	....	.....
"	95.20	2.13	....	....	....	....	....	....	....	....	.50	S. & loss. 2.17
"	89.75	8.90	.62	tr.	....	....	....	....	....	....	.70	Mn. tr.
Cabin Creek.....	91.87	6.60	tr.	....	....	.41	.05	Comb'd .15	.....	tr.	.34	.....
Cachiyuyal	93.92	4.93	.39	....	....	.08	.....	....	.20	.....	....	Ca. Mg. .30

Loss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.....		99.70	7.02-7.11	C. U. Shepard	1869, A. J. S. (2), XLVII, 233-234
.....		100.58	7.746	J. Fahrenhorst	1900, Meteoreisen-Studien, XI, A.N.H. XV, 371
.....		99.96	.....	J. Auerbach.....	1864, Sitz. Wien Akad., XLIX (2), 497
.....		99.95	7.63	H. L. McIlwain.....	1888, A. J. S. (3), XXXVI, 277
.....		99.54	.....	O. W. Huntington...	1894, Proc. Am. Acad. Arts & Sci., XXIX, 253
.....		100.38	7.74	W. Eberhard.....	1855, Ann. Chem. Pharm., XCVI, 286-289
.....		100.00	.....	W. P. Riddell.....	1860, Trans. St. Louis Acad. (1), 623
.....		99.76	.....	J. E. Whitfield.....	1904, Proc. Rochester Acad. Sci., IV, 148
.....		99.83	7.7	J. M. Davison.....	Same
.....		100.38	.....	L. Fletcher.....	1887, Min. Mag., VII, 125

the three alloys—kamacite, taenite, and plessite—are usually present. Among accessory constituents, troilite and schreibersite predominate. These are often in the form of nodules of appreciable size.

OCTAHEDRITES.

Loss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.....		100.09	7.589	C. U. Shepard, Jr. ...	1876, A. J. S. (3), XII, 119
.....		99.86	7.89	R. B. Riggs	1887, Bull. U. S. Geol. Sur. VIII, 94-97
.....		100.26	7.75	A. A. Koch	1903, Bull. Geol. Soc. Amer. XIV, 104
.....		100.00	.....	M. A. Gobel	1874, Bull. St. Petersburg Akad. XIX, 544-54
.....		100.45	.....	F. F. Sharpless	1896, Amer. Geol. XVIII, 270
.....		99.80	6.50-7.50	C. U. Shepard	1839, A. J. S. (1), XXXVI, 81-84
.....		99.77	7.06	W. G. Owens.....	1892, A. J. S. (3), XLIII, 423-424
.....		100.43	.....	C. H. Rockwell	1844, A. J. S. (1), XLVI, 402
.....		100.00	.....	C. U. Shepard.....	1847, A. J. S. (2), IV, 77-78
.....		99.97	7.72	W. S. Clark	1852, Metallic Meteorites, 61-62
.....		99.42	7.837	J. E. Whitfield.....	1887, A. J. S. (3), XXXIII, 500
.....		99.82	.....	J. Domeyko	1875, Comptes Rendus, LXXXI, 597

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous.
Caperr	89.87	9.33	.53	tr.	tr.	.24	.....	.....	.....	.....	.....	.....
Cape York	90.14	8.18	.54	.....	.....	.18	.19	.15	.....	.....	.....	.....
“	$\frac{3}{8}$ 91.31	7.94	.53	.02	.....	.19	.01	.04	.....	.....	.....	.....
Carthage	89.47	7.72	.25	.....	.....	.09	.40	.....	.60	tr.	.....	1.19
Casas Grandes....	95.13	4.38	.27	tr.	.....	.24	.....	tr.	.....	.....	.....	.....
“	92.66	7.26	.94	...	.03	.18	.02	.....	.....	.....	.....	Chromite .03
Chilkoot	92.56	7.11	.12	tr.	.....	.12	.04	tr.	.....	.....	.....	.....
Chulafinnee.....	91.61	7.37	.50	.....	.....	.17	.....	.....	.....	.....	.....	.....
Cleveland.....	$\frac{3}{8}$ 89.59	8.79	.67	.12	.....	.32	.006	.....	.....	.....	.....	.....
Colfax	$\frac{2}{3}$ 88.45	10.31	.57	.04	.....	.19	.09	.....	.02	.....	.....	.....
“	88.05	10.37	.68	.04	.....	.21	.08	.....	.02	.....	.....	.....
Coopertown.....	89.59	9.12	.35	tr.	.....	.04	.....	.....	.....	.....	.....	.....
Costilla	91.65	7.71	.44	.....	.....	.10	High. .26	.....	.....	.....	.....	.....
Dalton	94.66	4.80	.34	.....	tr.	tr.	.....	.....	.....	.....	.....	Mn. tr.
Denton County....	94.02	5.43	tr.	.....	.....	.....	.....	.....	.....	.....	.33	.....
“	92.10	7.53	tr.	.....	.....	.001	.....	.....	.....	.....	.....	.....
Descubridora	89.51	8.05	1.94	.....	.....	.....	.45	.....	.....	.....	.....	P. Cr. and loss. .05
“	90.09	9.07	.....	.24	.....	.....	.....	.....	.....	.....	.66	.....
Elbogen	97.50	2.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
“	87.50	8.75	.....	.....	tr.	.....	.....	.....	.....	.....	.....	Mn. tr.
“	88.23	8.52	1.85	.....	.....	.....	tr.	.....	.....	.....	.....	P. Fe. Ni. 2.21 Mg. 28, Mn. tr.
“	89.90	8.43	.76	.....	.....	.....	.....	.....	.....	.....	.....	.....
“	94.69	2.47	.61	.....	.12	.....	.....	.....	.....	.....	.....	Al. 19, Mn. .88
El Capitan	90.51	8.40	1.59	.05	.....	.24	tr.	.....	.....	.....	.....	.....
Fort Pierre	94.29	7.19	.60	.....	.....	.....	tr.	.....	.....	.....	.....	Ca. 35, Mg. .65
“	90.76	7.61	.89	tr.	.....	tr.	.....	.....	.....	.....	.05	.....
Franceville	91.10	8.06	.....	.....	.....	.....	.....	.....	tr.	.....	.....	*Pt. tr.
Frankfort	90.58	8.53	.36	tr.	.....	.05	.....	.....	.....	.....	.....	.....
Glorieta	88.76	9.86	.51	.03	.....	.18	.01	.....	.04	.....	.....	Zn. .03, Mn. tr.

*Schreibersite, .84; Graphite, tr.; Silicate, tr.

Loss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.....		99.97	7.86	L. Fletcher.....	1899, Min. Mag. XII, 167-170
.....		99.38	.....	J. K. Phelps.....	1898, Northward Over the Great Ice, (2) 600
.....		100.04	.....	J. E. Whitfield.....	" " " " " 602
.....		99.72	7.48-7.50	E. Boricky.....	1866, Neues Jahrb, 808-810
.....		100.02	.....	W. Tassin.....	1902, Proc. U. S. Nat. Mus. XXV, 71
.....		101.12	7.885	Cohen & Hildebrand	1903, Mitt. Nat. Ver. f. Neuvoorp. u. Rügen, XXXV, 13
05		100.00	7.76	.....	1905, Label, State Mining Bureau Collection, San Francisco, California
.....		99.65	.....	J. B. Mackintosh....	1880, A. J. S. (3), XX, 74
.....		99.496	7.521	F. A. Genth.....	1886, Proc. Phila. Acad. Sci. 366-368
.....		99.67	.....	S. W. Cramer.....	1890, Trans. N. Y. Acad. Sci. IX, 197-198
.....		99.45	.....	L. G. Eakins.....	1890, A. J. S. (3), XXXIX, 395-396
.....		99.10	7.85	J. L. Smith.....	1861, A. J. S. (2) XXXI, 266
.....		100.16	.....	L. G. Eakins.....	1895, Proc. Colo. Sci. Soc.
.....		99.80	7.986	C. U. Shepard, Jr...	1883, A. J. S. (3), XXVI, 338
.....		99.78	7.67	W. P. Riddell.....	1860, Trans. St. Louis Acad. I, 623
.....		99.63	7.42	A. Madelung.....	1863, Buchner, Meteoriten, 193
.....		100.00	7.38	P. Murphy.....	1875, Neues Jahrb, 26
.....		100.00	7.609	J. B. Mackintosh....	1887, A. J. S. (3), XXXIII, 235
.....		100.00	7.80-7.83	M. H. Klaproth....	1815, Beit. Mineralkörper, VI, 306-308
.....		98.10	7.76	J. F. John.....	1821, Jour. Chem. Phys. XXXII, 253-261
.....		100.00	7.74-7.87	J. J. Berzelius.....	1834, Ann. Phys. Chem. XXXIII, 135-137
06		99.00	7.78	A. Wehrle.....	1863, Buchner, Meteoriten, 151-152
.....		99.94	.....	P. A. v. Holger.....	" " " "
.....		99.80	.....	H. N. Stokes.....	1895, A. J. S. (3), I, 252-254
.....		102.48	7.73	H. A. Prout.....	1860, Trans. St. Louis Acad. I, 711-712
.....		99.31	7.74	A. Madelung.....	1863, Buchner, Meteoriten, 197
.....		100.00	7.87	J. M. Davison.....	1902, Proc. Roch. Aca. Sci. IV, 75-78
.....		99.52	7.69	J. L. Smith.....	1870, A. J. S. (2), XLIX, 331
.....		99.42	.....	L. G. Eakins.....	1885, Proc. Colo. Sci. Soc. II, 14

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous.
Glorieta	88.81	7.28	.17	....	....	.12	....	....	....	....	....	....
"	87.93	11.15	.33	....	....	.36	....	....	....	....	....	....
Guilford County ..	92.75	3.15	tr.	....	....	....	....	....	....	....	....	Fe ₂ O ₃ + FeO. .75
Hopewell Mounds.	95.20	4.64	.40	.04	....	.07	.13	....	....	....	....	Mn. tr., Sn. tr.
Hopper	90.54	7.70	.94	....	....	.13	....	....	.04	.35	....	....
Hraschina	96.50	3.50	....	....	....	....	....	....	....	....	....	....
"	83.29	11.84	1.26	....	....	....	....	....	.68	....	....	Mn. .64, Mg. .48 K. .43, Al. 1.38
"	89.78	8.88	.67	....	....	....	....	....	....	....	....	....
Ivanpah	94.98	4.52	....	....	....	.07	....	.10	....	....	....	....
Joel's Iron	90.45	8.80	.54	tr.	....	.26	....	tr.	....	....	....	....
Joe Wright	91.22	8.62*		....	....	.16	....	....	....	....	....	....
Juncal	92.03	7.00	.62	....	....	.21	....	....	....	....	....	....
Kenton County....	91.59	7.65	.84	tr.	....	tr.	tr.	.12	....	....	....	....
Kokstad	91.21	8.01	.63	.02	....	.22	tr.	.03	....	.05	....	....
La Caille..... ² / ₂	92.50	5.90	tr.	....	tr.	....	....	....	.90	....	....	....
" ² / ₂	89.63	9.83	....	....	....	....	....	.12	....	....	....	Insol. & less. .42
Lenarto	85.04	8.12	3.59	....	....	....	....	....	.01	....	....	Ca. 1.63, Al. .77 Mn. .61, Mg. .23.
"	90.90	8.50	.665	.002	....	....	....	....	....	....	....	....
"	90.15	6.55	.50	.08	....	....	.48	....	....	1.23	....	Mn .15, Sn .08
"	90.88	8.45	.67	....	....	....	....	....	....	....	....	....
"	91.50	8.58	....	tr.	....	....	....	....	....	....	.30	....
Losttown	95.76	3.66	tr.	....	tr.	....	....	....	....	....	.58	Ca. tr.
Luis Lopez	91.31	8.17	.16	....	....	.33	.01	.01	tr.	....	....	....
Marshall County ..	90.12	8.72	.32	tr.	....	.10	....	....	....	....	....	....
Matatiela	92.20	7.30	.67	.03	....	.19	.03	.08	....	.03	....	....
Mazapil	91.26	7.84	.65	....	....	.30	....	....	....	....	....	....
Merceditas	92.38	7.33	.61	.02	....	.08	.07	....	....	....	.02	....
Misteca	86.86	9.92	.74	....	....	.07	.55	....	....	....	.97	....
Morito	95.01	4.22	.51	tr.	....	.08	....	....	....	....	....	....

By diff.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.....		96.38	7.1	C. U. Shepard	1885, A. J. S. (3), XXIX, 469
.....		99.77	7.66	J. B. Mackintosh....	1885, A. J. S. (3), XXX, 238
.....		96.65	7.67	C. U. Shepard	1841, A. J. S. (1), XL, 369-370
.....		100.48	.....	H. W. Nichols.....	1902, Field Col. Mus. Pub. Geol. Ser. I, 308
.....		99.70	.....	F. P. Venable	1890, A. J. S. (3), XL, 163
.....		100.00	7.73-7.80	M. H. Klaproth....	1807, Beit. Mineralkörper, IV, 99-101
.....		100.00	7.82	P. A. v. Holger	1830, Beit. u. vor. Ett. Zeit. f. Phys. u. Math. VII, 2, 129-149
.....		99.33	7.785	A. Wehrle	1852, Clark, Metallic Meteorites, 42-44
.....		99.67	7.65	C. U. Shepard.....	1880, A. J. S. (3), XIX, 381-382
.....		100.05	7.863-7.958	L. Fletcher.....	1889, Min. Mag. VIII, 264
.....		100.00	.....	J. B. Mackintosh....	1886, A. J. S. (3), XXXI, 462
.....		99.86	.....	A. A. Damour	1868, Comptes Rendus, LXVI, 569-571
.....		100.20	.....	J. M. Davison	1892, A. J. S. (3), XLIV, 164
.....		100.17	7.7876	Fahrenheit.....	1900, Ann. S. Afr. Mus. II, 14
.....		99.30	7.43	L. E. Rivot	1854, Ann. Mines (5), VI, 554-555
.....		100.00	7.64	J. Boussingault	1872, Comptes Rendus, LXXIV, 1287-1289
.....		100.00	.....	P. A. v. Holger	1830, Beit. u. Ett. Zeit. f. Phys. u. Math. VII, 2, 129-149
.....		100.067	7.79	A. Wehrle	1841, Rammelsberg, Handwörterbuch, 423
.....		99.22	7.73	W. S. Clark	1852, Metallic Meteorites, 40
.....		100.00	7.98	A. Wehrle	" " " "
.....		100.38	7.73	J. Boussingault	1872, Comptes Rendus, LXXIV, 1288-1289
.....		100.00	.....	C. U. Shepard	1869, A. J. S. (2), XLVII, 234
.....		99.99	.....	Mariner & Hoskins .	1900, A. J. S. (4), IX, 284
.....		99.26	.....	J. L. Smith.....	1860, A. J. S. (2), XXX, 240
.....		100.53	7.8084	J. Fahrenheit.....	1900, Ann. So. Afr. Mus. II, 17
.....		100.05	.....	J. B. Mackintosh....	1887, A. J. S. (3), XXXIII, 225.
.....		100.51	.....	J. Fahrenheit.....	1900, Meteoreisen-Studien, XI, A. N. H. XV, 380
.....		99.11	7.58	C. Bergeman	1857, Pogg. Ann. C. 246
.....		99.82	7.84	J. L. Smith	1871, A. J. S. (3), II, 335-338

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous
Murfreesboro	96.00	2.40										
Nejed	91.04	7.40	.66	tr.		.10	tr.					
Orange River.....	90.48	8.94			tr.							Chladnite .5 Schreib. .0
Petropawlowsk....	97.29	2.07										
"	93.57	6.98										
Plymouth.....	88.67	8.55	.66	.24		1.25	.07					Graph. . . 1
Puquios	88.67	9.83	.71	.04		.17	.09	.04	tr.			
Red River	90.02	9.67										
"	90.91	8.46									.50	
Rhine Valley	88.85	9.07	.34			.27	.75					
Roebourne	90.91	8.33	.06			.16	tr.	tr.	.01			Mn. tr.
Rowton	91.05	9.08		tr.								
"	91.25	8.58	.37	tr.								
Ruff's Mountain...	96.00	3.12										
"	90.95	6.01	tr.		tr.						2.35	Schreib. . . 5
Sacramento Mts...	91.39	7.86	.52									
San Angelo.....	91.96	7.86	tr.	.04		.10	.03	tr.	.01			Mn. tr.
Schwetz	93.18	5.77	1.05								.10	
Seneca Falls.....	92.40	7.60			tr.	tr.	fr.					Mg. tr. Mn. ? Sn. tr.
Staunton	91.44	7.56	.61	.02		.07	.02	.14	.11	tr.		Sn. tr.
"	90.29	8.85	.49	.02	tr.	.24	.01	.18	.09	tr.		Sn. 00
" No. 1... ..	88.71	10.16	.40	.003		.34	.02	.17	.07	.003		Mn. tr. Sn. 00
" No. 2... ..	88.36	10.24	.43	.003		.36	.008	.18	.06	.002		Mn. tr. Sn. 00
" No. 3... ..	89.01	9.96	.39	.003		.37	.03	.12	.06	.004		Sn. 00
" No. 7... ..	89.85	7.56	.60	.06		.16	.01	.05	.05			Mn. tr. O. 1.5
Surprise Springs ..	91.01	7.65	.89	.07	.04	.22	.08	.02		.02		
Thunda	91.54	8.49	.56	.02	tr.	.17	.02				.01	
Toluca	91.38	8.62										
"	90.40	5.02	.04			.16						P. Fe. Ni. 2.9 Mn. tr.

Undet.	Total.	Sp. Gr.	Analyst.	Reference.
1.60	100.00	.....	G. Troost	1848, A. J. S. (2), V, 351-352
.59	99.79	7.89	L. Fletcher	1887, Min. Mag. VII, 179-182
.....	100.00	7.3	C. U. Shepard	1856, A. J. S. (2), XXI, 213
.....	99.36	7.76	Sokolowsky	1841, Arch. Kunde Russ. I, 317
.....	100.55	.....	Iwanow	1841, Arch. Kunde Russ. I, 723-725
.....	99.55	.....	J. M. Davison	1895, A. J. S. (3), XLIX, 53-55
.....	99.55	7.93	L. G. Eakins	1890, A. J. S. (3), XL, 226
.....	100.00	7.54	C. U. Shepard	1829, A. J. S. (1), XVI, 217-219
.....	99.87	7.40-7.82	B. Silliman, Jr. & T. S. Hunt.	1846, A. J. S. (2), II, 372-374
.....	99.31	.....	W. S. Chapman	1900, Ann. Rep. So. Aust. Sch. Mines, 227-228
.....	100.00	.....	Mariner & Hoskins	1898, A. J. S. (4), V, 136
.....	100.13	.....	W. Flight	1882, Phil. Trans. 894-896
.....	100.20	.....	" .....	" " "
.....	99.121	7.01-7.10	C. U. Shepard	1850, Proc. A. A. A. S. III, 152-154
.....	99.81	.....	Boecking	1856, Neues Jahrbuch, 51
.....	100.00	7.7	Mariner & Hoskins	1898, A. J. S. (4), V, 272
.....	99.77	.....	J. E. Whitfield	1897, A. J. S. (4), III, 66
.....	100.10	7.77	C. Rammelsberg	1851, Ann. Phys. Chem. LXXXIV, 153-154
.....	100.00	.....	C. U. Shepard	1853, A. J. S. (2), XV, 366
.....	99.97	7.69	J. P. Santos	1878, A. J. S. (3), XV, 337-338
.....	100.175	.....	J. W. Mallet	1887, A. J. S. (3), XXXIII, 59
.....	99.878	7.85	"	1871, A. J. S. (3), II, 13
.....	99.345	7.86	"	" " "
.....	99.95	7.84	"	" " "
.....	99.90	.....	J. E. Whitfield	1903, A. J. S. (4), XV, 469-471
.....	100.00	7.7308	E. Cohen	1900, Mitt. Nat. Ver. f. Neu Vorp. u. Rügen,
.....	100.81	.....	J. Fahrenheit	³² 1900, Meteoreisen-Studien, XI, A. N. H. XV,
.....	100.00	7.72	Berthier	³⁸² 1853, A. J. S. (3), XV, 20
.....	99.72	.....	E. Uricoechea	1854, Jour. Prakt. Chem. LXIII, 317-318

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneo
Toluca	90.37	7.79	.....	.....	.....	.....	.....	.....	.....	.....	1.01	.....
"	90.72	8.49	.44	.....	.....	.18	.....	.....	.25	.....	.....	.....
"	87.88	8.86	.89	.....	.....	.86	.....	.....	.....	.....	.....	Graph.. 1
"	87.89	9.06	1.07	tr.	.....	.62	.....	.....	.....	.....	.....	*C.Graph.
"	88.29	8.90	1.04	.....	.....	.78	.....	.....	.....	.....	.....	.....
"	90.08	7.10	.....	.....	.....	.....	1.24	.....	.....	.....	.....	.....
"	90.43	7.62	.72	.....	.....	.15	.03	.....	.....	.....	.....	†Cu. & Sn.
"	87.09	9.80	.77	.01	.....	.....	.79	.....	.....	.....	.02	Schreib...
"	89.07	7.29	.98	tr.	.....	.....	.85	.....	.....	.....	.04	Mn. tr. Fe. S. tr.
"	90.13	7.24	.....	.....	.....	.38	.....	.....	.....	.....	.22	.....
"	91.89	6.32	1.58	.....	.....	.....	.....	.....	.....	.....	.....	Mn. tr.
(Los Reyes).....	90.56	7.71	1.07	.14	.....	.24	.03	.01	.01	.....	.....	Mn. tr.
Tonganoxie.....	91.18	7.93	.39	tr.	.....	.10	.....	.....	.....	.....	.....	.....
Toubil	95.18	3.38	.14	.....	.....	.05	.....	.12	.08	.04	.....	Mn. .09 As. Mg. .03 Ca.
Trenton	91.03	7.20	.53	tr.	.....	.14	.....	.....	.....	.....	.45	.....
"	89.22	10.79	tr.	.....	.....	.69	.....	.....	.....	.....	.....	.....
Victoria	91.33	8.83	.49	.....	.....	.....	.....	.....	.....	.....	.....	.....
Welland.....	91.17	8.54	.06	.....	.....	.....	.07	.....	.....	.....	.....	.....
Werchne Udinsk..	91.02	7.31	.70	.13	.....	.07	.....	.03	.....	.....	.....	Mg..... Fe. Ni. P.
Wooster	93.61	6.01	.73	tr.	.....	.13	.....	.....	.....	.....	.....	Mn. tr.

*P. Fe. Ni., .34; Mn., .20; Sn., tr.
†Graph., etc., .34; P., Fe., Ni., .56.

Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.....	100.07	.....	W. J. Taylor.....	1856, Proc. Phil. Aca. Sci. VIII, 3
.....	100.46	.....	“ .....	1856, A. J. S. (2), XXII, 374-376
.....	98.73	.....	E. Pugh.....	1856, Ann. Chem. u. Pharm. XCVIII, 383-386
.....	99.40	.....	“ .....	“ “ “ “
.....	99.00	.....	“ .....	“ “ “ “
.....	98.42	.....	“ .....	“ “ “ “
.....	99.88	.....	“ .....	“ “ “ “
.....	99.21	.....	Boecking.....	Neues Jahrbuch, 304
.....	99.20	.....	“ .....	“ “
3.....	100.00	.....	H. B. Nason.....	1857, Jour. Prakt. Chem. LXXI, 123
.....	99.79	.....	C. H. L. v. Babo	1863, Buchner, Meteoriten, 141
.....	99.85	.....	H. W. Nichols.....	1902, Pub. Field Col. Mus., Geol. Ser, I 308
.....	99.60	7.45	E. H. S. Bailey	1891, A. J. S. (3), XLII, 386
.....	99.34	.....	J. Antipoff.....	1898, Bull. St. Petersburg Acad. Sci. V, 9, 91- 103
.....	99.35	7.82	J. L. Smith.....	1869, A. J. S. (2), XLVII, 271
.....	100.70	7.33	G. Bode.....	1869, Ann. Rep. Smith. Inst. 417-419
.....	100.65	7.78	A. P. Coleman.....	1887, Proc. and Trans. Roy. Soc. Can., IV, 97
.....	99.84	7.87	J. M. Davison.....	1890, Proc. Roch. Acad. Sci. I, 87
.....	99.41	.....	H. Laspeyres.....	1895, Zeit. Kryst. XXIV, 494
.....	100.48	7.90	J. L. Smith.....	1864, A. J. S. (2), XXXVIII, 385-386

4. FINE OCTAHEDRITES.

Width of lamellæ 0.4-0.2 mm. The nickel-cobalt content ranges between 8 and 10½ per cent. The fields are usually equal in amount to the lamellæ and contain minute shining flakes, probably of taenite.

α. PRAMBANAN.

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous
Augustinowka	91.91	7.70	.25	....	....	....	....	....	....	....	....	....
Bella Roca.....	91.48	7.92	.22	....	....	.21	.21	.06	....	....	....	....
"	89.68	9.78	.55	.02	tr.	.31	.05	....	....	....	....	....
Bethany (Mukerop) ..	91.07	8.18	.63	.03	.02	.06	.04	.01	....	....	....	....
" " ..	92.29	7.77	.57	....	....	.06	....	....	....	....	....	Cu, C, Cr. (l. 8.
" " ..	90.96	8.19	.46	.04	....	.18	tr.	.02	....	.01	.01	....
" " ..	91.37	7.97	.50	.02	.04	.03	.02	.05	....	....	....	....
" (Lien River) ..	93.30	6.70	....	....	....	tr.	tr.	....	....	....	....	K ₂ O tr. Sn.
" " ..	92.06	7.79	.69	.03	.01	.05	.10	....	....	....	....	....
Boogaldi	91.13	8.05	.48	.28	....	....	....	....	....	....	.04	....
Bridgewater	88.90	9.94	.76	.35	....	....	....	....	....	.02	....	....
Bückeberg.....	90.95	8.01	....	....	....	.64	....	....	....	....	....	....
"	92.45	7.55	.83	.02	.01	.12	.01	.01	....	.02	....	....
Cambria	94.88	5.69	....	....	....	....	....	....	....	....	....	....
"	92.58	5.71	....	tr.	....	....	....	....	....	....	1.40	As. tr.
"	89.06	10.65	.08	.04	....	....	.17	....	....	....	....	....
Charlotte	91.15	8.01	.72	.06	....	....	....	....	....	....	....	....
Chupaderos.....	90.23	8.76	1.21	....	....	tr.	....	....	....	....	....	....
"	88.78	9.80	.81	.02	tr.	.13	.13	....	....	....	....	....
Cuernavaca.....	88.98	10.30	....	....	....	....	....	....	....	....	....	....
"	89.70	8.76	1.19	.05	....	.33	.12	....	....	....	....	....
Grand Rapids.....	94.54	3.82	.40	....	....	....	....	....	....	....	.12	....
"	88.71	10.69	....	.07	....	.26	.03	.06	....	....	....	Mg. Graph.
Hassi Jekna.....	91.32	5.88	.81	tr.	....	....	tr.	....	....	....	1.04	....
Jamestown.....	90.24	9.75	....	tr.	....	.05	....	....	....	....	....	....

Cohen divides the fine octahedrites into two groups, the Prambanan group and the Rodeo group. The Prambanan group includes the greater number. They have a fairly uniform composition. Accessory constituents are usually present, but not in large quantity.

OUP.

s.	Undet.	Total.	Sp. Gr.	Analyst.	References.
.....		99.86	.....	W. F. Alexejew	1893, Verh. Russ. Min. Ges. II, 30, 470
.....		100.10	.....	J. E. Whitfield.....	1889, A. J. S. (3), XXXVII, 440
.....		100.39	7.8244	Knauer	1905, Meteoritenkunde, III, 377
.....		100.04	7.8408	J. Fahrenhorst.....	1900, Ann. S. Afr. Mus. II, 28
.....		100.79	7.8408	"	" " "
.....		99.89	.....	O. Hildebrand.....	1902, Jb. d. Ver. f. Vaterl. Naturk. Würtem- berg, LVIII, 292-306
.....		100.00	7.783	Krupp Lab.....	1902, Jb. d. Ver. f. Vaterl. Naturk. Würtem- berg, LVIII, 292-306
.....		100.00	7.45	C. U. Shepard.....	1853, A. J. S. (2), XV, 1-4
.....		100.73	.....	Sjöström & Fahren- horst.	1897, Meteoreisen-Studien, V, A. N. H. XII, 43
.....		99.98	7.85	A. Liversidge.....	1902, Jour. Roy. Soc. N. S. W. XXXVI, 341- 359
.....		99.97	6.617	F. P. Venable	1890, A. J. S. (3), XL, 312-313
.....		99.60	7.12	Wohler & Wicke...	1863, Göttingen Nach. 364-367
.....		101.01	.....	J. Fahrenhorst.....	1900, Meteoreisen-Studien, XI, A. N. H. XV, 367
.....		100.57	7.52	D. Olmsted, Jr.....	1845, A. J. S. (1), XLVIII, 388-392
.....		99.69	.....	B. Silliman, Jr., & T. S. Hunt.	1846, A. J. S. (2), II, 374-376
.....		100.00	.....	C. Rammelsberg ...	1870, Ber. Berl. Akad. 444
.....		99.94	7.717	J. L. Smith	1875, A. J. S. (3), X, 351
.....		100.20	.....	Cohen & Weinschenk	1891, Meteoreisen-Studien, VI, A. N. H. VI, 147-148
tr.		99.67	.....	O. Bürger.....	1905, Meteoritenkunde, III, 354
.....		99.28	7.725	J. E. Whitfield	1902, Proc. Roch. Aca. Sci. IV, 79-88
.....		100.15	7.748	O. Hildebrand.....	1902, Mitt. d. Nat. Ver. f. Neu. Vorp. u. Rügen, XXXIV, 2
.....		98.88	.....	F. W. Taylor.....	1884, A. J. S. (3), XXVIII, 300
.....		99.91	7.87	R. B. Riggs	1885, A. J. S. (3), XXX, 312
.....		99.05	7.67	S. Meunier.....	1892, Comptes Rendus, CXV, 531-533
.....		100.04	.....	O. W. Huntington ..	1890, Proc. Am. Acad. (2), XVII, 229-232

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous
Jewel Hill	91.12	7.82	.43	tr.	....	.08	.....	.....	.....	.....	.....	.....
Lagrange.....	91.21	7.81	.25	tr.	....	.05	.....	.....	.....	.....	.....	.....
"	91.92	7.61	.62	.01	.02	.03	.02	.....	.....	.....	.....	.....
Mantos Blancos...	90.77	8.83	.55	tr.	....	.10	.....	.....	.....	.....	.....	.....
Moonbi.....	91.35	7.89	.56	tr.	tr.	.22	.....	.07	.04	.....	.....	Sn. tr.
Prambanan	96.71	2.86	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
"	94.36	5.37	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
"	88.60	11.20	.....	.....	.....	.20	.....	.004	tr.	.....	.....	MgO. tr.
"	90.03	9.39	.97	.....	.....	.16	.....	.....	.....	.....	.....	.....
"	94.38	4.70	.....	.....	.....	.53	.....	.....	.....	.....	.....	.....
Putnam County ...	89.52	8.82	tr.	.....	.....	.....	.....	.....	.....	.....	.....	Sn. P. S. M.
"	90.28	7.89	.79	.07	.17	.11	.25	.....	.....	.....	.....	Ca..... 1.
Russel Gulch	90.61	7.84	.78	tr.	....	.02	.....	.....	.....	.....	.....	.....
"	90.65	7.87	.01	.....	.....	.....	.....	.....	.....	.....	.....	Insol. Si, Sel., Cr. Sn. .02
St. Genevieve. ...	91.58	7.98	.29	.....	.....	.20	tr.	.....	.02	.....	.....	.....
Smith's Mountain..	90.68	9.07	.....	.11	....	.14	.....	.....	.....	.....	.....	.....
"	90.88	8.02	.50	.03	....	.03	.....	.....	.....	.....	.....	.....
Thurlow	89.17	9.92	1.04	.....	.....	.25	.05	.....	.....	.....	.....	Cu. & Cr.,
Varas	91.28	8.00	.44	tr.	....	.05	.....	.....	.....	.....	.....	.....
Yanhuitlan	96.58	1.83	.....	.....	.....	.....	.....	tr.	.01	.....	.....	CaO..... Al ₂ O ₃ ...
"	91.87	7.36	.65	.02	.01	.09	.02	.....	.....	.....	.....	.....

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..		99.45	.....	J. L. Smith.....	1860, A. J. S (2), XXX, 240
..		99.32	7.89	J. L. Smith.....	1861, A. J. S. (2), XXXI, 265-266
..		100.23	.....	O. Bürger.....	1905, Meteoritenkunde, III, 358
..		100.25	7.904	L. Fletcher.....	1889, Min. Mag. VIII, 258
..		100.13	7.83	J. C. H. Mingaye ..	1893, Jour. Roy. Soc. N. S. W. XXVII, 82-83
..		99.57	7.48	M. Van der Boom Mesch ...	1866, Archives Neerl. I, 468
..		99.73	7.83	E. H. von Baumhauer	" " " "
..		100.004	.....	Vlaanderen	1867, Nat. Tij. Ned. Ind., XXIX, 268-270
..		100.55	.....	O. Sjöström	1897, Meteoreisen-Studien, A. N. H. XII, 42-62
..		99.61	.....	De Jong	1904, Javabode, July 12, 5
..		100.00	7.69	C. U. Shepard	1854, A. J. S. (2), XVII, 331-332
..		99.56	.....	Knauer & Bürger...	1905, Meteoritenkunde, III, 345
..		99.25	7.72	J. L. Smith.....	1866, A. J. S. (2), XLII, 218-219
..		99.50	7.692	C. T. Jackson	1867, A. J. S. (2), XLIII, 281
..		100.07	.....	J. E. Whitfield.....	1901, Proc. Roch. Acad. Sci. IV, 65-66
..		100.00	.....	F. A. Genth.....	1877, A. J. S. (3), XIII, 214
..		99.46	7.78	J. L. Smith.....	" " "
..		100.43	.....	O. Bürger.....	1905, Meteoritenkunde, III, 379
..		99.77	7.863	L. Fletcher.....	1889, Min. Mag. VIII, 259
36		100.00	7.827	L. R. DeLoza.....	1876, Proc. Phila. Acad. Sci., 126
..		100.02	.....	O. Bürger.....	1905, Meteoritenkunde, III, 320

b. RODEO GROUP

The nickel-cobalt content is somewhat higher than in the Pram-

RODEO

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous
Alt-Biela	85.34	12.89	.41	....	....	.39	.06	.02	....	....	.86	....
Bear Creek	83.89	14.06	.83	tr.	....	.21	....	....	....	....	....	....
Quesa	87.97	10.75	1.07	.04	....	.19	tr.	....	....	....	....	....
Rodeo	86.95	11.27	1.20	.01	.03	.25	.01	....	....	....	.07	....
"	89.84	8.79	.28	.07	....	.80	.02	.09	....	....	....	....

5. FINEST OCTAHEDRITES.

Width of lamellæ not exceeding 0.2 mm. The nickel-cobalt content lies, as a rule, between 10 and 15 per cent. Plessite strongly developed. Cohen divides the class into two groups, the Salt River group and the Tazewell group.

SALT RIVER

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous
Bacubirito	88.94	6.98	.21	....	....	.15	.005	....	tr.	....	....	....
"	89.54	9.40	.98	.02	.02	.12	.02	.01	....	.02	....	Chromite,
Ballinoo	89.34	9.87	.60	.06	....	.48	.03	.02	....	....	....	....
"	89.01	8.85	.74	tr.	....	.50	tr.	tr.	tr.	....	....	....
Butler ² / ₂	89.12	10.02	.26	.01	....	.12	....	....	....	....	....	....
Salt River	90.74	9.36	....	....	....	....	tr.	....	....	....	.26	Mg. Na., tr.
" ² / ₂	90.89	8.70	.85	.04	....	.34	tr.	.02	....	....	....	....

banan group, so that the group is a transition to the finest octahe-
drites.

ROUP.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..		99.97	7.525	M. Neff & A. Stocky	1899, Prog.d.Böhm Gym.in Mahr-Ostrow
..		98.99	.....	J. L. Smith	1867, A. J. S. (2), XLIII, 280
..		100.02	.....	J. Fahrenheitst	1900, Meteoreisen-Studien, XI, A. N. H. XV,
..		99.79	.....	O. Bürger	1905, Meteoritenkunde, III, 299 ³⁷⁹
..		99.89	.....	H. W. Nichols	1905, Field Col. Mus. Geol. Ser. III, 4

a. SALT RIVER GROUP.

The content of nickel-cobalt is lower than in the Tazewell group,
not exceeding 10½ per cent. Plessite predominates as compared with
the Tazewell group. Schreibersite is common in numerous small,
elongated individuals.

ROUP.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..		96.285	7.69	J. E. Whitfield	1902, Proc. Roch. Acad. Sci. IV, 74
..		100.14	7.59	Cohen & Hildebrand	1903, Mitt. N. Ver. f. Neu Vorp. u. Rügen, XXXV, 13
..		100.40	7.8432	O. Sjöström	1898, Ber. Berlin Akad., 19-22
..		100.00	7.8	Mariner & Hoskins	1898, A. J. S. (4), V, 137
..		99.53	7.72	J. L. Smith	1877, A. J. S. (3), XIII, 213
..		100.36	.....	W. H. Brewer	1851, Proc. A. A. A. Sci. IV, 36-38
..		100.84	7.6648	J. Fahrenheitst	1900, Meteoreisen-Studien, X, A. N. H. XV, 76

age of nickel-cobalt. It reaches 15 per cent. and more. Taenite is strongly developed.

GROUP.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..		100.26	7.95	L. G. Eakins.....	1890, A. J. S. (3), XL, 223-224
..		99.70	.....	J. B. Mackintosh....	1886, A. J. S. (3), XXXI, 463-465
..		99.43	.....	H. N. Stokes	1900, Proc. Wash. Acad. Sci. II, 53
..		100.00	7.4	Mariner & Hoskins.	1898, A. J. S. (4), V, 139
..		100.32	.....	R. Knauer	1905, Meteoritenkunde, III, 269
..		99.98	7.57	A. Liversidge.....	1903, Proc. Roy. Soc. N. S. W. XXXVII,
..		99.22	7.89	J. L. Smith.....	1855, A. J. S. (2), XIX, 153

certain, however, and it seems desirable therefore to group them separately. Their percentage of nickel-cobalt resembles that of the finest octahedrites, 11 to 15 per cent.

ACTORIA WEST.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..		99.80	7.805	J. C. H. Mingaye ...	1904, Rec. Geol. Sur. N. S. W., VII, 31
..		99.78	7.692	J. L. Smith.....	1873, A. J. S. (3), V, 108

accord with octahedral planes. In the meshes of this web the nickel-poor remainder is deposited as a homogeneous, granular aggregate. If the structure is secondary, it may be explained by supposing that a normal octahedrite was somewhat softened by heat, so as to destroy the lamellar structure in part, after which solidification took place. If this latter be the correct explanation, the softening was carried farther in Hammond than in Cacaria and Reed City.

TAHEDRITES.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..		100.64	7.7070	J. Fahrenhorst.....	1900, Meteoreisen-Studien, XI, A. N. H., XV,
..		100.58	.....	" .....	362-363 Same
..		99.82	7.601-7.703	Fisher & Allmendinger	1887, A. J. S. (3), XXXIV, 383
..		100.62	7.288-7.506	J. Fahrenhorst.....	1900, Meteoreisen-Studien, XI, A. N. H., XV,
..		97.57	7.6	J. E. Whitfield	356 1903, Jour. Geol., XI, 233

C. BRECCIATED OCTAHEDRITES.

In these, as in the brecciated hexahedrites, the mass appears to be

BRECCIATED

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous
Barranca Blanca..	91.50	8.01	.65	tr.	...	.15	.13	.....	.....	.....	.03	.....
N'Goureyima	89.28	9.26	.60	.04	.11	.05	.77	.04	.....	.....	.24	Ce..... .c Chromite .c Fe.S..... .c Graphite, etc. .
"	91.99	7.15	tr.	.....	.....	.....	.....	.....	.....	.....	.....	.....
Santa Rosa ^{3/8}	91.46	7.72	.....	.....	.....	.....	.....	.....	.....	.....	.28	.....
"	92.30	6.52	.78	.02	tr.	.36	.04	.18	.....	.....	.....	.....
Tula	93.50	2.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	Sn. tr. Schreibersite .
"	96.40	2.63	.....	.....	.....	.....	.....	.....	.....	.....	.....	Sn. .07 Sch.
Zacatecas.....	89.84	5.96	.62	tr.	.....	.....	.13	.....	.....	.....	3.08	Mg. tr.
"	90.91	5.65	.42	.....	.....	.23	.07	.....	.50	.....	2.17	.....
"	91.30	5.82	.41	tr.	.....	.25	.....	.....	.....	.....	2.19	Mg., tr.
"	92.09	5.98	.91	.....	.74	1.02	.....	.....	.....	.....	.04	.....

made up of numerous individuals, the direction of whose lamellæ differs in the individual grains.

CTAHEDRITES.

Ass.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.....		100.47	7.823	L. Fletcher	1889, Min. Mag., VIII, 263
.....		100.49	7.6722	E. Cohen	1901, Mitt. Nat. Ver. f. Neu. Vorp. u. Rügen, XXXIII, 14
.....		99.36	7.31	S. Meunier	1901, Compt. Rendus, CXXXII, 444
.....		99.46	7.30-7.60	Rivero and Boussingault ..	1824, Ann. Phys. Chem., XXV, 438-443
.....		100.20	7.6896	O. Sjöström	1899, Meteoreisen-Studien, VIII, A. N. H., XIV, 138
.....		96.90	7.332	W. Haidinger	1861, A. J. S. (2), XXXII, 144
.....		100.00	.....	J. Auerbach	1863, Neues Jahrb., 362
.....		99.63	7.20	H. Müller	1860, Jour. f. prakt. Chemie, LXXIX, 25
.....		99.95	7.625	"	" " " "
.....		99.97	7.50	"	" " " "
.....		100.78	.....	E. Cohen	1897, Meteoreisen-Studien, V, A. N. H., XII, 51

III. ATAXITES.

These iron meteorites are characterized by a fine granular to compact structure throughout. They show no evidence of the cubic cleavage and Neumann lines which characterize the hexahedrites, nor of the lamellar structure, octahedrally arranged, of the octahedrites. The individual grains are in some cases visible to the naked eye, but for the most part are of microscopic or sub-microscopic dimensions. In some occur peculiar streaks which seem to have crystallographic arrangement, but their exact relations have not been determined. These form a special group, which, while not ataxites in the strictest sense of the term, may be included among them for present purposes. The ataxites show the greatest variation among all iron meteorites in their nickel-cobalt content. This varies from 6 to 16 per cent, and in the doubtful Oktibbeha to 63 per cent. Two general

SIRATIK

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous.
Campo del Cielo .. (Wöhler's Iron.)	92.33	7.38		....	....	....	....	....	....	....	....	P. Fe. Ni. .4 Sn ..... .0 Schreibersite. .0 C. etc. .... .2
.....	89.22	9.51		....	....	.20	....	tr.	....	....	....	
.....	94.25	5.11	.57	.03	.03	.18	.05	....	....	tr.	....	
Cincinnati	94.47	5.43	.68	.01	....	.05	.05	....	....	....	....	
Locust Grove	94.30	5.57	.64	tr.	....	.18	.05	.02	....	.01	....	
San Francisco del Mezquital	93.38	5.89	.39	....	....	.23	....	....	....	....	....	
" "	93.36	5.46	.87	.03	....	.16	.15	....	....	....	....	
Siratik (Senegal) ..	94.07	5.21	.77	.01	....	.26	.04	.01	....	....	....	

subdivisions may be made of the ataxites, according as they are nickel-poor or nickel-rich. Transitions occur between these, but a general grouping is practicable. Accessory constituents are not usually abundant in the ataxites, and when occurring are of small dimensions as a rule.

A. NICKEL-POOR ATAXITES.

The nickel-cobalt content lies between 6 and 7 per cent, the composition thus corresponding to that of kamacite. The structure is, as a rule, plainly granular, seldom compact, the size of the grains reaching 0.75 mm.

1. SIRATIK GROUP.

An etched surface appears rough through the presence of irregularly arranged depressions, due perhaps to the solution of some accessory constituent, such as troilite or schreibersite. The smaller the depressions the more plainly the boundaries of the grains appear. The latter range from 0.33 to 0.75 mm. in dimension.

GROUP

ss.	Unde.	Total.	Sp. Gr.	Analyst.	Reference.
..		100.16	7.547	N. S. Manross.....	1853, A. J. S. (2), XV, 22
..		99.23	7.85	C. Martius	Ann. Chem. u. Pharm., CXV, 92
..		100.28	7.7679	O. Sjöström	1898, Meteoreisen-Studien, VIII, A. N. H., XIII, 124
..		100.69	7.6895	"	1898, Ber. Berlin Akad., 428-430
..		100.77	7.7083	"	1897, Ber. Berlin Akad., 76-81
..		99.89	7.83	A. A. Damour.....	1868, Comptes Rendus, LXVI, 573-574
..		100.03	7.7687	J. Fahrenhorst	1900, Meteoreisen-Studien, XI, A. N. H., XV, 365
..		100.37	7.7752	O. Sjöström	1898, Meteoreisen-Studien, VIII, A. N. H., XIII, 131

2. NEDAGOLLA GROUP.

Both granular and compact irons occur in this group. They lack the rough appearance of the Siratik group on etched surfaces. The

NEDAGOLLA

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous
Chesterville.....	95.00	5.00	.....	.....	tr.	tr.	.....	.....	.....	.....	.....	.....
"	93.15	5.82	.73	.....	.....	.34	.....	.....	.....	.....	.....	.....
"	93.80	5.50	.75	.02	tr.	.34	.03	.02	.....	.....	.....	.....
Forsyth County...	94.90	4.18	.33	.....	.....	tr.	.22	.....	.....	.....	.....	.....
(Compact portion.)	94.03	5.55	.53	.02	.....	.23	.03	.02	.....	tr.	.....	.....
(Granular portion.)	94.18	5.56	.60	.02	.....	.19	.05	.04	.....	.17	.....	.....
Nedagolla	92.61	6.20	.49	tr.	.....	.02	.05	.....	.25	.....	.....	.....
Nenntmansdorf ...	94.50	5.31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
"	93.04	6.16	.....	.....	.....	.22	.....	.....	.....	.....	.....	.....
"	94.33	5.48	.71	.....	.....	.29	.....	.....	.....	.....	.....	.....
Primitiva	94.72	4.72	.71	tr.	.....	.18	.02	.03	.....	.....	.....	.....
Rasgata	90.76	7.87	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
"	92.35	6.71	.25	tr.	.....	.35	tr.	.....	.....	.....	.....	P. Fe. Ni. Silicates Sn.
"	92.81	6.70	.64	.01	tr.	.28	.08	.19	.....	.....	.....	.....

3. RAFRUTI GROUP.

The members of this group resemble the granular members of the

RAFRUTI

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous
Illinois Gulch.....	92.51	6.70	.16	.....	.....	.62	.....	.01	tr.	.....	.....	.....
" ² / ₂	86.77	12.67	.81	.02	.01	.08	tr.	.....	.....	.....	.....	.....
Rafrüti	89.87	9.54	.61	.03	.01	.06	.11	.18	.....	.....	.....	.....

size of the grains in the granular members is generally less than 0.5 mm., rarely 0.75 mm. No granular structure is visible, even on strong magnification, in the compact members. Chesterville and Rasgata are rich in rhabdite.

GROUP.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference
..		100.00	7.82	C. U. Shepard	1849, A. J. S. (2), VII, 449
..		100.04	.....	O. Sjöström	1897, Meteoreisen-Studien, V, A. N. H., XII,
..		100.46	7.8209	"	⁴⁷ 1898, Meteoreisen-Studien, VIII, A. N. H.,
..		99.63	.....	E. A. de Schweinitz	^{XIV, 150} 1896, A. J. S. (4), I, 208-209
..		100.41	7.4954	O. Sjöström	1897, Ber. Berlin Akad., 386-396
..		100.81	7.3357	"	" " "
..		99.62	7.8613	"	1897, Meteoreisen-Studien, VI, A. N. H., XII, 121
..		99.81	.....	G. E. Lichtenberger	1873, Sitz. Isis. p. 4, Dresden
..		99.42	6.21	E. Geinitz	1876, Neues Jahrb., 609
..		100.81	7.8241	E. Cohen	1897, Meteoreisen-Studien, V, A. N. H., XII,
..		100.38	.....	O. Sjöström	⁴² 1897, Meteoreisen-Studien, VI, A. N. H., XII,
..		98.63	7.6	Riviero and Boussingault	¹²³ 1824, Ann. Chem. Phys., XXV, 442-443
..		100.11	7.33-7.77	F. Wöhler	1852, Ann. Chem. Pharm., LXXXII, 243-248
..		100.71	7.654	O. Sjöström	1898, Meteoreisen-Studien, VIII, A. N. H., XIII, 143

Nedagolla group, but have an essentially higher nickel-cobalt content, and thus form a transition to the nickel-rich ataxites.

GROUP.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..		100.00	7.7	Mariner and Hoskins	1900, A. J. S. (4), IX, 201-202
..		100.36	7.8329	J. Fahrenheit	1900, Meteoreisen-Studien, XI, A. N. H., XV,
..		100.41	7.596	Cohen and Hildebrand	³⁵³ 1902, Mitt. Nat. Ver. f. Neu. Vorp. u. Rügen, XXXIV, 87

B. NICKEL-RICH ATAXITES.

These ataxites are fine-grained to compact, and acquire, as a rule, on weak etching, a characteristic varnish-like luster. Stronger etching produces a dull surface, having a peculiar velvety sheen. The

SMITHLAND

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous
Babb's Mill	85.30	14.70	.....	.....	.....	.....	.....	.....	.....	.....	.....	Al. Mg. Ca., t
(Troost Iron)												
"	87.16	9.76	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
"	80.59	17.10	2.04	.....	.....	.....	.....	.....	tr.	.....	.12	Mn. .... .t P. Fe. Ni. .j
"	81.54	17.74	1.26	.....	.....	.11	.....	.....	.....	.....	.....	P. Fe. Ni. .c
"	81.45	17.30	1.67	.03	.03	.12	.01	.07	.....	.....	.....	.....
(Blake Iron)												
"	91.42	7.95	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
"	86.30	12.58	1.66	.....	.....	.....	.....	.....	.....	.....	.....	.....
"	88.23	11.01	.72	.....	.02	tr.	tr.	.03	.....	.01	.....	.....
"	88.41	11.09	.66	.....	.02	tr.	tr.	.03	.....	.02	.....	.....
Botetourt	85.88	18.23		.....	.....	.....	.....	.....	.....	.....	.....	.....
Deep Springs	87.01	11.69	.79	.....	.....	.04	.....	.....	.53	.39	.....	.....
"	85.99	13.44	.70	.03	.03	.06	.....	.02	.....	.02	.....	.....
Dehesa	86.20	14.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Linville	84.56	14.95	.33	.....	.....	tr.	.12	tr.	.....	.....	.....	.....
"	83.13	16.32	.76	.02	.....	.23	.02	.11	.....	.....	.....	.....
Morradal	79.67	18.77	1.18	.06	.06	.18	.27	.....	.....	.....	.....	.....
Smithland	82.83	16.42	.94	.....	.06	.09	.17	.....	.....	.....	.....	.....
Weaver	80.78	17.92	.84	.....	.....	.12	.15	.....	.....	.....	.15	.....

nickel-cobalt content lies, for the most part, between 14 and 20 per cent, though it drops to 12 and rises to 26½ per cent.

1. SMITHLAND GROUP.

The nickel-cobalt content does not exceed 20 per cent.

GROUP.

ss.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..		100.00	7.548	C. U. Shepard	1847, A. J. S. (2) IV, 76-77
..		96.92	.....	G. Troost	1845, A. J. S. (1), XLIX, 342-344*
..		99.85	7.839	W. S. Clark	1852, Metallic Meteorites, 65-66
..		100.70	7.7948	E. Cohen	1892, Meteoriten-Studien, II, A. N. H., VII, 147, 148
..		100.68	.....	J. Fahrenheit	1900, Meteoriten-Studien, X, A. N. H., XV, 93
..		99.37	7.858	W. P. Blake	1886, A. J. S. (3), XXXI, 44
..		100.54	.....	Cohen and Weinschenk	1891, Meteoriten-Studien, I, A. N. H., VI, 142-143
..		100.02	.....	J. Fahrenheit	1900, Meteoriten-Studien, X, A. N. H., XV, 93
..		100.23	.....	" .....	Same
..		104.11	8.186	O. Sjöström	1898, Meteoriten-Studien, VII, A. N. H., XIII, 49
..		100.45	.....	F. P. Venable	1890, A. J. S. (3), XL, 162
..		100.29	7.4538	J. Fahrenheit	1900, Meteoriten-Studien, XI, A. N. H., XV, 355
..		100.40	7.8892	J. Domeyko	1879, Mineralojia, Santiago
..		99.96	.....	J. E. Whitfield	1888, A. J. S. (3), XXXVI, 276
..		100.59	7.4727	O. Sjöström	1898, Meteoriten-Studien, VIII, A. N. H., XIII, 147
..		100.19	7.8543	"	1898, Videnskabselskabets Skrifter (1), VII, 11
..		100.51	7.7115	"	1898, Meteoriten-Studien, VII, A. N. H., XIII, 47
..		99.96	7.12	Lindner	1904, Sitzb. K. Preuss. Akad. der Wiss. XXXII

*As recalculated by Cohen, Meteoritenkunde, Heft III, p. 104.

2. CRISTOBAL GROUP.

The nickel-cobalt content exceeds 20 per cent.

CRISTOBAL

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous
Limestone Creek..	65.18	27.71	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
" " ..	66.56	24.71	.....	.....	.....	.....	4.0	.....	.....	1.48	.....	Cr.&Mn. 3.
" " ..	83.57	12.67	.....	.....	.....	.....	.....	.....	.....	.91	.....	FeS ₂ 2.
" " ..	65.03	29.99	1.48	.....	.....	.19	.....	.....	.....	.....	.....	.....
San Cristobal	73.72	25.60	1.0	.....	.....	.18	.....	.....	.....	.....	.....	.....

3. OKTIBBEHA.

The meteoric origin of Oktibbeha is doubtful, on account of its

OKTIBBEHA

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In-sol.	Miscellaneous
Oktibbeha	37.69	59.69	.40	.90	.....	.10	.....	.....	.12	.....	.....	Al.....
"	37.24	62.01	.72	.28	.....	.15	.....	.....	.....	.....	.....	Ca.....

C. ATAXITES WITH ACCESSORY FORSTERITE.

The accessory occurrence of forsterite is characteristic. It forms about five per cent of the mass, occurring in small spheroidal grains or elongated aggregates of grains, and is accompanied by some plagioclase. In nickel-cobalt content the metallic portion of the meteorite

ATAXITES WITH

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	SiO ₂	Cl.	In-sol.	Miscellaneous
Tucson	85.54	8.55	.61	.03	.....	.12	.....	.....	3.02	.....	.....	MgO 2.04 Cr ₂ O ₃ ..
"	83.55	9.20	.39	.01	.17	.13	.....	.....	3.01	.....	.....	Al ₂ O ₃ , tr. Labradorite. 1.
(Carleton Iron).....	81.56	9.17	.44	.08	.....	.49	.....	.....	3.63	.....	.....	CaO .51 MgO 2.3
"	84.56	8.89	1.36	.03	.02	.16	tr.	.04	1.72	.04	.....	FeO .12 CaO 1 MgO 2.43 0
(Ainsa Iron)	84.60	9.24	.95	.02	.02	.17	.01	.04	1.76	.04	.....	MgO .. Chrys. res. 3. MgO .. Chrys. res. 3.

* K₂O, .10; Na₂O, .17.

OUP.

Is.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..		92.89	5.75	C. T. Jackson.	1838, A. J. S. (1), XXXIV, 335
..		99.99	5.75-6.40-6.50	"	" " " "
5		100.00	6.82	A. A. Hayes.....	1845, A. J. S. (1), XLVIII, 153
..		96.89	.....	R. Knauer	1905, Meteoritenkunde, III, 131
..		100.50	7.8593	"	1899, Ber. Berlin Akad., 607-608

anomalous composition. It may however for the present be included among meteorites.

OUP.

Is.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..		99.19	6.854	W. J. Taylor	1857, A. J. S. (2), XXIV, 294
..		100.40	.....	E. Cohen	1892, Meteoreisen-Studien, II, A. N. H., VII, 146

lies between the nickel-rich and nickel-poor ataxites. On etching, irregularly shaped areas appear, 0.2-2 cm. in area, which under the microscope have a spotted look and are generally bordered, as are most of the silicate grains, by narrow, zigzag bands the nature of which cannot be further determined.

CESSORY FORSTERITE.

Is.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
..		100.12	6.52-7.13	J. L. Smith	1855, A. J. S. (2), XIX, 161-162
..		100.55	.....	F. A. Genth.....	1855, A. J. S. (2), XX, 119-120
..		99.69	7.29	G. J. Brush.....	1863, A. J. S. (2), XXXVI, 153
..		101.09	7.2248	J. Fahrenheitst.....	1900, Cohen-Festschrift, Greifswald, 39
..		100.75	.....	" .....	" " " "

D. ATAXITES WITH CUBIC STREAKS.

Upon etching appear bands or spots which seem to be oriented according to cubic faces, and which according to the position of the plates toward impinging light appear brighter or darker than the principal mass of the nickel-iron without a structural distinction being discernible. In one position the reflection of the whole face is plainly uniform. On weak etching appears, as a rule, a characteristic luster.

ATAXITES WITH

Name.	Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	C.	Si.	Cl.	In- sol.	Miscellaneous
Cape of Good Hope	78.90	15.28	1.0	....	....	....	....	....	....	....	....	Ca. 1.41, Al. Mg. .15, Mn. .1 Graphite
"	85.61	12.27	.89	....	....	....	....	....	....	....	....	
"	81.20	15.07	2.56	tr.	....	.09	tr.	....	....	....	.95	Sn.....
"	81.30	15.23	2.01	tr.	....	.08	tr.	....	....	....	....	P. Fe. Ni. Sn.....
"	82.77	14.32	2.52	tr.	....	.26	....	....	....	....	....	
"	82.87	15.67	.95	.03	.04	.09	....	.03	....	.01	....	
Iquique.....	83.83	15.86	.19	....	....	.05	....	....	....	....	.07	
"	83.49	15.41	.94	.02	tr.	.07	.02	.03	....	....	....	
Kokomo.....	87.02	12.29	.65	tr.	....	.02	....	....	....	....	....	
"	83.24	15.76	1.07	.01	....	.08	tr.	....	....	....	....	
Shingle Springs...	88.02	8.88	....	....	....	....	....	....	....	....	3.5	
"	80.74	15.73	....	....	....	....	....	....	....	....	....	Sn.....
"	81.48	17.17	.60	....	.02	.31	.01	.07	.03	....	....	P. etc....3. Ca. .16, Al. Mg. .01, K.
"	82.21	16.69	.65	.02	.02	.34	.05	.03	....	....	....	
Tenera	83.02	16.22	1.63	tr.	....	....	....	....	....	....	....	
"	82.17	16.22	1.42	....	....	.11	.13	....	....	....	....	

On strong etching the surface becomes dull with a peculiar velvet sheen. No cleavage has been observed. On the other hand, a certain orientation of similarly situated particles is indicated by the appearance in reflected light. The structure of the nickel-iron is compact; the content in nickel plus cobalt 16–17 per cent. Except for the etch bands, the members of this group are similar in chemical composition and luster to the etched faces of members of the Morradal group.

BIC STREAKS.

s.	Undet.	Total.	Sp. Gr.	Analyst.	Reference.
.		100.00	7.544	V. Holger.....	1830, Zeit f. Phys. u. Math., VIII, 279–284
.		98.77	7.66	A. Wehrle.....	1835, Zeit. f. Phys. u. Math. (2), III, 222–229
.		99.89	6.63–7.94	E. Uricoechea.....	1854, Ann. Chem. u. Pharm., XCI, 252
.		99.50	7.60	M. Böcking	1855, Ann. Chem. u. Pharm., XCVI, 243–246
.		99.87	7.71	Baumhauer and Seelheim ...	1867, Arch. Neerland, II, 376–384
.		99.69	7.8543	J. Fahrenhorst	1900, Meteoreisen-Studien, X, A. N. H., XV, 87
.		100.00	7.925	C. Rammelsberg....	1873, Fest. Ges. Natur. Freunde, Berlin, 37
.		99.98	7.8334	O. Sjöström.....	1898, Meteoreisen-Studien, VIII, A. N. H., XIII, 153
.		99.98	7.821	J. L. Smith.....	1874, A. J. S. (3), VII, 392
.		100.16	7.8606	O. Sjöström.....	1898, Meteoreisen-Studien, VIII, A. N. H., XIII, 118–158
.		100.00	7.80	C. U. Shepard.....	1872, A. J. S. (3), III, 438
.		100.00	7.9053	C. T. Jackson.....	1872, A. J. S. (3), IV, 495
.		99.98	7.875–8.024	F. A. Cairns.....	1873, A. J. S. (3), V, 21
.		100.01	7.8943	O. Sjöström.....	1898, Meteoreisen-Studien, IX, A. N. H., XIII, 479–480
.		100.87	7.694	E. Weinschenk.....	1892, A. J. S. (3), XLIII, 425
.		100.05	.....	Lindner.....	1904, Ber. Berlin Akad., 151

ANALYSES OF OCCLUDED GASES.

The occluded gases of nine iron meteorites have been determined. These are here shown.

Name.	Vols.	H.	CO ₂	CO.	N.	CH ₄	Analyst.	Reference.
Charlotte	2.20	71.40	13.30	15.30	.....	.....	A. W. Wright..	1876, A. J. S. (3), XI, 257
Cranbourne	3.59	45.79	0.12	31.88	17.66	4.55	W. Flight	1882, Ph. Tr. Roy. Soc. London, 893 896
Lenarto	2.85	85.68	.....	4.46	9.86	.....	Th. Graham ...	1866, Proc. Roy. Soc., London, XV, 502-503
Magura	47.13	18.19	12.56	67.71	1.54	.....	A. W. Wright..	1876, <i>op. cit.</i>
Red River	1.29	76.79	8.59	14.62	.....	.....	A. W. Wright..	1876, <i>op. cit.</i>
Rowton	6.38	77.78	5.15	7.34	9.72	.....	W. Flight	1882, <i>op. cit.</i>
Shingle Springs	0.97	68.81	13.64	12.47	5.08	.....	A. W. Wright..	1876, <i>op. cit.</i>
Staunton	3.17	35.83	9.75	38.33	16.09	.....	J. W. Mallet ...	1871, Proc. Roy. Soc. London, XX, 365-370
Tazewell	3.17	42.66	14.40	41.23	1.71	.....	A. W. Wright..	1876, <i>op. cit.</i>

DISCUSSION OF ANALYSES.

The most striking feature brought out by the analyses is the relation shown between chemical composition and structure. This seems to be definite and general. All the meteorites of a hexahedral structure have a nearly uniform composition, while among the octahedral meteorites, fineness of structure increases with increase of nickel. This conclusion can best be shown by obtaining the averages from the analyses of the different groups, omitting all obviously faulty analyses. The results thus obtained are as follows:

Class.	No. of Analyses.	Width of Lamellæ in Millimeters.	Per Cent Fe.
Hexahedrites.....	29	-----	94.12
Coarsest Octahedrites....	12	+ 2.5	93.18
Coarse "	22	2.0-1.5	92.28
Medium "	88	1.0-0.5	90.64
Fine "	41	0.4-0.2	90.18
Finest "	13	0.2- —	88.51

It is worthy of note that these averages are not means between wide limits, but are derived from nearly uniform values. Practically

all of the members of the classes conform in composition to the average. Were all the groups equally well known, it is probable, too, that the gradation of percentage of Fe would be even more uniform than here shown. The medium octahedrites, for example, while numerous, have been as a whole imperfectly analyzed. Moreover, some of the meteorites classed as medium octahedrites, which are characterized by low percentage of iron, such as Algoma and Glorieta Mountain, have width of lamellæ such as to place them near if not in the fine octahedrites.

The apparent conclusion from the above results is, that the content of nickel influences the structure. It may also account for the change from a hexahedral to an octahedral structure, since the irons with a hexahedral structure have the lowest per cent of nickel. So constant and definite does this relation hold, that given a certain structure the per cent of nickel can probably be stated more accurately by this principle than it has been determined in some analyses. The per cent of nickel in iron meteorites as a whole, as shown by the reliable analyses, lies between five and twenty-six per cent. An exception to the latter figure may be found in the quoted analyses of Limestone Creek, but of this unfortunately no complete analysis exists. The somewhat doubtful Oktibbeha is also an exception, its percentage of nickel reaching sixty per cent. Cobalt in the iron meteorites rarely exceeds one per cent. No constant relation in amount appears to exist between it and nickel, although perhaps as a rule it is higher with higher nickel. Copper is doubtless, as claimed by Smith, a constant ingredient of iron meteorites. It is usually only a few hundredths of one per cent in amount, but may reach a few tenths. Chromium is shown by the analyses to be a frequent though not constant ingredient in minute quantities. In many cases it is probably present as daubreelite, but also, as suggested by Cohen, it may occur as an element alloyed with nickel-iron. Reports of the presence of manganese and tin are so frequent as to leave little doubt that they occur in many iron meteorites, perhaps alloyed as metals. The presence of platinum and iridium has been proved by Davison in Coahuila and Franceville, and doubtless could be found to exist in more meteorites if proper search were made. Gold was reported in Boogaldi by Liversidge, but in so small a quantity as to make its determination as yet not quite positive. The presence of occluded gases has been determined in but few cases. The constant presence of phosphorus in iron meteorites is a feature shown by the analyses. Apparently no iron meteorite is lacking in this element altogether, and in amount and constancy it con-

siderably exceeds sulphur. It probably occurs combined with nickel-iron as phosphide. Sulphur, though evident by its presence in many meteorites as troilite, does not appear in large amounts in the analyses, and does not seem to be so important or constant an ingredient as phosphorus. Carbon is probably more frequent in occurrence than analyses usually show, since of twenty-eight iron meteorites investigated by Cohen for carbon all but one showed appreciable percentages, ranging from .19 per cent to .012 per cent.* The silicon reported in the analyses is doubtless in some cases to be referred to silicate grains, but in other cases may be free or combined with the iron as a silicide. The analyses make plain the incompleteness of much of the work which has been done hitherto. There can be little doubt that complete analyses of iron meteorites should always show iron, nickel, cobalt, copper, and phosphorus, and in most cases sulphur, carbon, and silicon. When considerable differences occur in the analyses of the same meteorite, as, for instance, 2 per cent of nickel reported in Burlington by Rockwell and nearly 9 per cent by Shepard, the difference is probably not to be regarded as due to the meteorite, but to the analyses. In a substance made up of different alloys and accessory minerals as are the iron meteorites, especially the octahedrites, there can be no question that portions from different parts of the meteorite would of necessity show unlike composition. How wide these variations might legitimately be it is difficult to say, but some causes of error may be suggested. One of these is imperfect sampling. The proper method to secure material for mass analyses of an iron meteorite, especially if of octahedral structure, is to use dust obtained by boring. A mixture of the constituents of the meteorite is thus obtained which insures a better representation of its composition than is possible when only a fragment broken from some part of the surface is used. Such a fragment may contain an excess of taenite, or be largely composed of some accessory mineral so as to be far from representing the true constitution of the meteorite. Yet the larger number of analyses of iron meteorites have probably been made with fragments of this character, and the wonder is, not that they show so much variation, but that they do not show more. Meteorites also doubtless vary in their homogeneity, as shown especially by Canyon Diablo, in one portion of which Moissan found 2.89 per cent of nickel, and in another, only one centimeter distant, 5.06 per cent. In another piece of Canyon Diablo two analyses made by the same analyst of material obtained at distances of one centimeter showed 1.17 per cent and 7.11 per cent of

* Meteoritenkunde, Heft II., p. 243.

nickel.* While few meteorites probably vary to this extent, such determinations show the need of as thorough sampling as possible if a mass analysis is to be made. Occasionally a marked variation in the analyses of a meteorite seems explicable only on the assumption that the material analyzed did not belong to that meteorite. Such, for instance, seems the most reasonable explanation for the percentage of nickel, 12.67 per cent, reported by Hayes for Limestone Creek, as compared with the percentages, 25-30 per cent, obtained by other analysts. Errors of this sort are obviously difficult to detect, and can only be surmised in extreme cases. Another and more serious cause of discrepancies in analyses is the imperfect separation by the analyst of nickel and cobalt from the iron. The methods for this separation are not altogether satisfactory, even at the present day, and in earlier years they were much less so. Consequently the results of the earlier analysts were for the most part too low in these ingredients. The determinations of specific gravity shown in the tables appear in some cases to have been equally open to sources of error with the analyses. It can easily be calculated that the specific gravity of an iron meteorite is likely to be between 7.6 and 7.9, since the specific gravity of pure iron, 7.85, will be increased by that of nickel, 8.8, according to the proportion of the latter. It will be decreased by accessory minerals, such as troilite, which has a specific gravity of 4.7, schreibersite, 6.5, graphite, 2.2, and oxidized ingredients. Any porosity of the meteorite will also lessen its specific gravity. It is obvious, therefore, that determinations of specific gravity made on small fragments can hardly represent that of the mass as a whole, since they may contain a disproportionate quantity of accessory ingredients or may be more oxidized than the main mass. It is hardly credible that porosity or accessory ingredients of a meteorite would in any case reduce its specific gravity below 7. Determinations below this figure, therefore, probably indicate that oxidized material was used. From the showing in the tables that large numbers of meteorites have practically similar composition, it is evident that similarity of composition cannot be used, as has often been done hitherto, to prove identity of origin of meteorites found at different places. This method at one time obtained considerable vogue. Dissimilarity of composition, on the other hand, as a rule indicates separate falls. The only marked exception to this rule seems to be furnished by the two masses of Babb's Mill, one of which shows about 11 per cent, the other about 17 per cent, of nickel. The only alternative supposition possible here

* C. R., 1893, cxvi., 290.

is that two ataxites fell at different times at one locality. In view of the small number of ataxites known, this seems less likely than to suppose that two masses of the same fall differed in composition. No other case of such marked difference is known. Differences of structure seem as a rule to be a better criterion for distinguishing meteorites than differences of composition. On the other hand, similarity of structure and composition together do not positively identify meteorites found at different places as belonging to one fall, since such similarities occur in meteorites seen to fall at widely different times and places. Of the nine iron meteorites seen to fall, four are medium octahedrites and have practically similar compositions. In correlating individual meteorites, therefore, all possible characters must be taken into consideration, including the circumstances of their find, the appearance of their exterior, the probable time elapsed since their fall, etc.

No attempt has been made by the writer at summation of the analyses here given, in order to determine the average composition of iron meteorites. Such a summation, if worthy of being performed at all, will be deferred until analyses of the iron-stone and stone meteorites are also at hand for comparison. This work the writer hopes to accomplish in the near future. It is obvious, however, from an inspection of the tables that the average percentage of iron in iron meteorites as a whole is not far from 91 per cent, while that of nickel closely approximates 7.50 per cent. It is doubtful if the average percentage of the remaining minor constituents can be learned by summation of existing analyses. Not only have these constituents in many cases not been determined, but also any slight error in analyses or sampling would double or multiple their percentage. A percentage of .4 of cobalt, for instance, as compared with .2, is within the limits of error of many analyses, yet one percentage is double that of the other. The same is true in much greater degree of determinations of the amount of copper and other constituents. Until a larger number of complete and accurate determinations are at hand, therefore, summations of these constituents seem to have little value. One point in the composition of iron meteorites which may or may not be of significance may be noted. Of the four constant metallic constituents, the most abundant, iron, has the lowest atomic weight, the next in quantity, nickel, is next higher, and so on for cobalt and copper. This gradation, using percentages common in iron meteorites, appears as follows:

	Iron.	Nickel.	Cobalt.	Copper.
Per cent in iron meteorites.....	90	9	0.9	0.02
Atomic weight	55.5	58.3	58.6	63.1

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