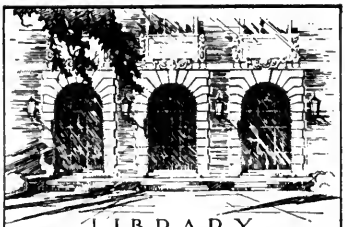

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THE BENLD METEORITE

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Of the nearly fourteen hundred recorded falls of meteorites, only twelve or so are known to have struck and damaged property. Benld is one of these. It is also the second meteorite known from Illinois, the first one being Tilden. Both of these meteorites are aerolites.

Important data regarding the Benld meteorite (fig. 68) were collected on the spot by Mr. Ben Hur Wilson and Mr. Frank M. Preucil of Joliet, Illinois. They were also instrumental in securing it for Field Museum of Natural History and we wish to acknowledge our indebtedness to them.

BENLD

Benld, Macoupin County, Illinois, United States of America.
Latitude 39° 05′ 14″ N., Longitude 89° 48′ 52″ W.
Aerolite, veined gray chondrite (Cga).
Fell September 29, between 9:00 and 9:10 o'clock A.M., 1938.
Weight 1770.5 grams (3.9 pounds).
Catalogue number, Me 2259.

CIRCUMSTANCES OF THE FALL

On the morning of September 29, 1938, an unusual event stirred the quiet of the little mining town of Benld, Illinois. Between 9:00 and 9:10 o'clock A.M., Mrs. Carl Crum and her neighbor, Mrs. Edward McCain, while doing their daily chores, heard a violent hissing roar, followed by a sharp crack that sounded like the breaking of boards. Fearing that a plane had crashed on her barn, Mrs. Crum rushed to the alley, but she could see no damage to the building nor any sign of a plane. Mrs. McCain, who was pumping water at the moment, was startled, but she showed little concern, thinking that it was the roar of a passing plane. In reality, it was the roar that usually accompanies the fall of a meteorite.

Out of a cloudless sky, unobserved by anyone, and unattended by any luminous phenomena or detonations, the meteorite came whizzing to earth like a plane in a power dive and struck the roof of the frame garage (fig. 69) owned by the McCains. As it struck, it made a 4 by 5 inch rectangular hole in the pine board of the roof, passed through it, and hit and penetrated the top of the family car, a 1928 Pontiac coupe (fig. 70). Continuing its course, its momentum not yet quite spent, the meteorite next went through the seat cushion, making a ragged hole, then struck and broke through the floor board and hit the muffler hard enough to make an inch-deep dent in it. Finally, at the journey's end, the meteorite bounded back and came to rest entangled in the seat springs (fig. 71).

FIG. 68. The Benld meteorite; approximately ×¾.

Neither the damage nor the presence of the meteorite was discovered until late in the afternoon when Edward McCain went to

FIG. 69. Benld meteorite on garage roof it penetrated.

FIG. 70. Edward McCain holding meteorite and showing damage done to the car.

the garage to take his car out. The meteorite was found so badly entangled in the seat springs that the wires had to be cut before it could be removed. Examination of the material of the seat cushion bordering the damage showed no sign of charring. Apparently the meteorite was cold or at best lukewarm when it fell.

The damage to the garage and the car was not without its bright side. Because of the damage, two points in the path of the meteorite —the point where it crashed through the roof, and the point where it penetrated the seat cushion—were known, and Wilson and Preucil were able, by use of a surveying instrument, to determine accurately the azimuth and inclination of the path at the end of the meteorite's travel. When it struck, the meteorite was traveling in a course 64° 26′ east of north in a path inclined 77° 31′ to the horizontal. This was the first time such a precise measurement had been possible for any meteorite.

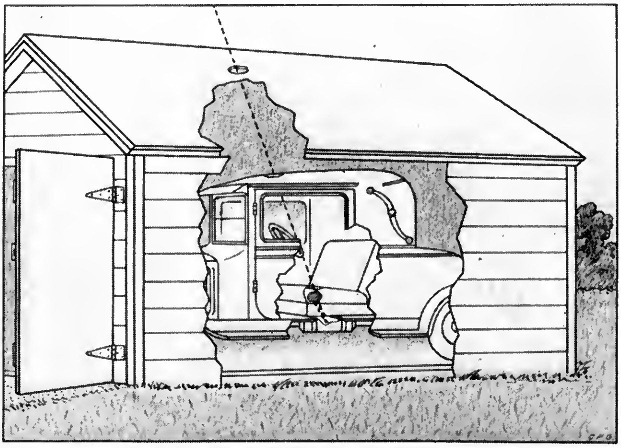

FIG. 71. Sketch of garage and automobile, showing the path of the meteorite.

LOCATION

The garage where the meteorite fell is located at the south edge of the town of Benld, Macoupin County, Illinois (near southwest corner of SW ¼, SW ¼, Sec. 31, Twp. 8 North, R. 6 West of 3rd Principal Meridian; Lat. 39° 05′ 14″ N., Long. 89° 48′ 52″ W.).

SHAPE, SIZE, AND WEIGHT

The meteorite is cubo-rectangular in shape. When received at the Museum it measured 110 by 90 by 80 mm. (4⅜ by 3½ by 3⅛ inches) and weighed 1770.5 grams (3.9 pounds). It now weighs 1748.5 grams, 22 grams having been used in making thin sections and chemical analysis. Wilson (1938, p. 555) states that a small fragment was broken off one corner of the meteorite by a local physician to see what the interior was like. The weight of this fragment is not known. Wilson (op. cit.) also states that "one other much smaller fragment about the size of one's finger nail has been broken off, apparently in striking the building when falling." Close examination, however, shows that the broken surface is partially charred. This would indicate that the breaking was not the result of impact but that it took place somewhere near the end of the meteorite's flight.

FIG. 72. Enlarged surface of crust; ×4.

CRUST AND SURFACE MARKINGS

The meteorite is completely and rather uniformly coated with a dull black fusion crust having an average thickness of 0.4 mm. To the naked eye the crust appears smooth save for some scattered, glazed patches that have resulted from the flow and quick congealing of fused matter. Under the microscope, the crust is slaggy and finely cellular, and dotted with numerous shiny metallic particles that have resisted fusion (fig. 72). Contraction cracks in the crust are plentiful and are present on all sides. These have a zigzag course and are so fine that only a few can be seen without the aid of a lens. Some of the cracks are filled with melted siliceous matter having a whitish to orange-brown color. The nature of this siliceous constituent has not been determined.

Only two zones of the crust can be distinguished: the outer or the fusion zone, and the inner or the impregnation zone. The intermediate, the absorption zone, is not present. The outer zone is black and glassy and has a somewhat spotted appearance. Most of the spots are nickel-iron, which has resisted fusion and discoloring.

FIG. 73. Polished section showing crustal zones; metallic (left) and black (right) veins; and cracks; ×2.5.

The surface is marked with shallow pits that are subcircular to elliptical. A typical pit is about seven-eighths of an inch long and about one-half inch wide in its widest part and about one-sixteenth of an inch or less deep. In places, the pits have coalesced so as to resemble a network of thumbmarks. A few pits are considerably deeper and narrower, suggesting that a fusible constituent has melted out at these points.

Nothing in the arrangement of the shape or size of the pits gave any indication as to the position of the meteorite in falling. It has not been possible to determine the apex of the mass. The angularity of the meteorite suggests that it has disrupted during its flight, but as no detonation of an explosion was heard it can be surmised that the disruption occurred high in the air but not high enough for the corners to be rounded. The uniformity in the thickness of the crust, the lack of any marked difference in the character of the surface pittings, and the absence of a determinable apex of the meteorite suggest that it had changed positions during its flight.

STRUCTURE

The interior of the meteorite is gray, or shades of gray, intermixed with stain spots of reddish-brown color, apparently the result of oxidation of the metallic grains that are abundant and are scattered through the entire substance.

The stone is firm and compact, and it takes a good polish. It has the usual characteristic of a veined chondrite, being composed of spherules in a crystalline to granular and fragmental ground mass, traversed by metallic and black veins. Some of the spherules are deformed and some are broken and crushed. The latter, particularly those that show no trace of their original boundaries, are difficult to distinguish from the ground mass. Of the three thin sections examined, one shows no well-defined chondrules but is brecciated (fig. 76), giving the appearance of a howardite. The other two, however, show fairly well-defined chondrules, and this structure places Benld among the chondrites. In the polished sections examined (fig. 73), the two types of veins mentioned above are not mixed. They occupy distinctly separate areas. The metallic veins are nickel-iron, very thin, and approximately straight (fig. 75). They do not follow any structural pattern. The black veins are chiefly fused or charred silicates and are so fine that they are barely visible to the naked eye (fig. 74). They are marked by forking and intricate branching in the form of a network. In places, the branches are so closely set that the veins appear matted.

Besides the metallic and black veins, the interior is traversed by several deep, irregular cracks. These are unrelated to the contraction cracks of the fusion crust and are much wider and more conspicuous. It can not be ascertained if they were formed from the impact, or from the shock and air pressure during the meteorite's flight through the atmosphere, but that they were formed subsequent to the formation of the veins is apparent.

CHEMICAL AND MINERALOGICAL COMPOSITION

It will be seen from the following table of analyses that the composition of the Benld meteorite compares favorably with that

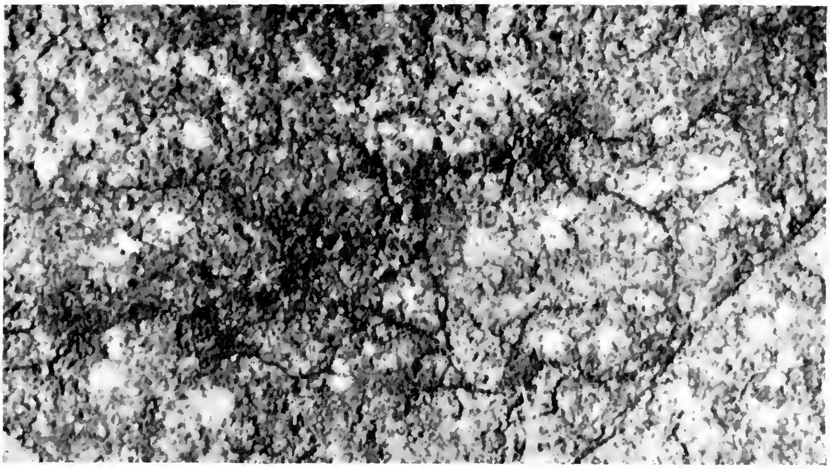

FIG. 74. Enlargement of anastomosing black veins seen in figure 73; ×42.

FIG. 75. Enlargement of the metallic vein shown to the left of figure 73; ×8.

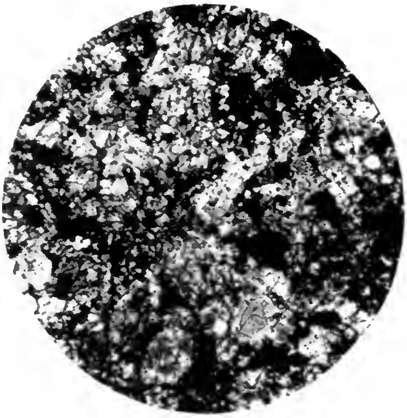

FIG. 76. Section showing brecciated nature of ground mass; ×65.

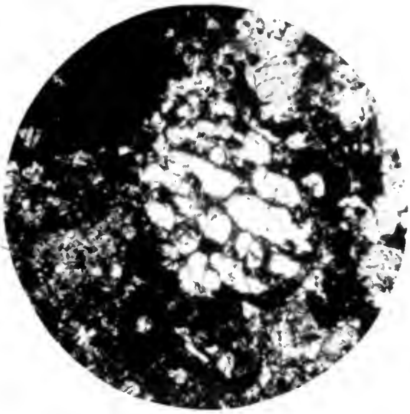

FIG. 77. Olivine chondrule; ×52.

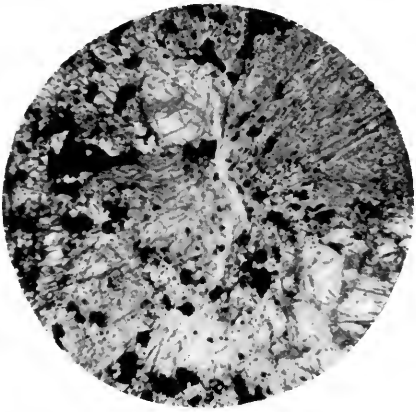

FIG. 78. Enstatite and olivine (upper left) chondrules; ×40.

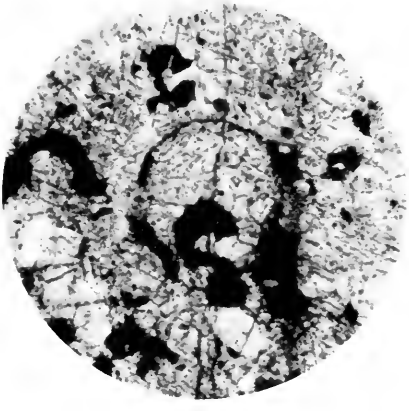

FIG. 79. Enstatite and olivine chondrule partly bordered by nickel-iron; ×42.

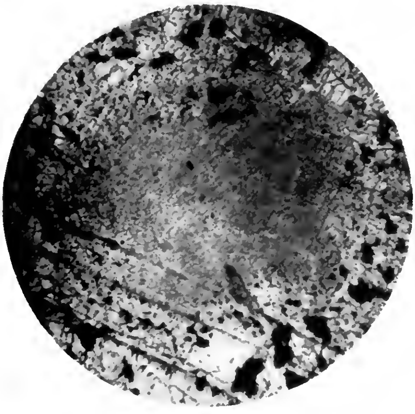

FIG. 80. Fibrous enstatite chondrule; ×40. Note cracked slide.

of Oakley (H. L. Preston, 1900; W. Wahl, 1950). The latter is a crystalline chondrite, found fifteen miles southwest of Oakley, Logan County, Kansas. The molecular ratio of the metal phase of Benld is Fe/Ni+Co=12.1, of Oakley 10.6. Another meteorite whose composition and general appearance also compare favorably but less so than Oakley is Pipe Creek, Bandera County, Texas (1888–89).

	Benld *Per cent* R. K. WYANT, *Analyst*	*Oakley* *Per cent* H. B. WIIK, *Analyst*
SiO_2	36.27	36.55
Al_2O_3	2.86	1.91
Fe_2O_3	0.16	0.00
FeO	12.25	10.21
MgO	23.80	23.47
CaO	1.92	2.41
Na_2O	0.76	0.78
K_2O	0.20	0.20
H_2O	0.08	0.21
TiO_2	0.10	0.14
Cr_2O_3	0.10	0.52
CoO	0.00	0.00
MnO	0.31	0.35
NiO	0.08	0.00
Cl	0.00	0.00
Fe	18.28	19.03
Ni	1.57	1.88
Co	0.09	0.13
Cu	0.02	0.00
P_2O_5	0.27	0.30
P	0.02	0.00
S	0.92	2.23
C	0.00	0.00
Total	100.06	100.32

The normative mineral composition of the Benld meteorite is as follows:

Mineral	*Per cent*
Orthoclase	1.18
Albite	5.45
Anorthite	4.34
Hypersthene	20.55
Diopside	2.87
Olivine	42.54
Magnetite	0.23
Chromite	0.16
Ilmenite	0.18
Merrillite	0.50
Metal	18.37
Schreibersite	Trace
Troilite	2.53
Total	98.90
Specific gravity	3.69

The most abundant silicate is olivine. It occurs as fragments and as euhedral and subhedral crystals. It also occurs as monosomatic chondrules and as one of the constituents of polysomatic chondrules (figs. 77–79). Next in abundance are feldspar and pyroxene. The feldspar is clear, shows no twinning, and has about the same index of refraction as Canada balsam. The indications are that it is one of the lime-rich members of the plagioclase family. It occurs in the interstices and is very much triturated and, for the most part, is intimately mixed with comminuted olivine and pyroxene. Because of this, optical examinations of its properties in thin sections have been limited and unsatisfactory. Examinations of feldspar grains separated by heavy solutions have also not been satisfactory. The grains seem to have been affected by one or the other of the processes of metamorphism. They seem strained, showing properties too anomalous and unrelated for a definite determination. Normative mineral composition (see table, p. 154) of the meteorite shows that the feldspars are orthoclase, albite and anorthite. It may be that these have combined to form a single plagioclase, possibly labradorite or anorthite. The percentage of feldspar in this meteorite is clearly higher than is usually found in stony meteorites, and this may be considered as one of its distinguishing characters.

As in the case of the feldspar, no conclusive mineralogical nature of the pyroxene, other than that it is chiefly orthorhombic, is at hand. It has been stated earlier that the pyroxene is either enstatite (var. bronzite) or hypersthene. It is, however, not very likely that both are present in the same meteorite. The essential difference between the ferriferous variety of enstatite and hypersthene is a matter of the percentage of FeO present. If the FeO content is higher than 15 per cent, the pyroxene is said to be hypersthene. Quantitative chemical analysis of the orthorhombic pyroxene in this meteorite denotes that there is 17 per cent FeO, and thus, by percentage definition, the pyroxene is hypersthene. Optical examination of the pyroxene in thin sections as well as of the pyroxene grains separated from other silicates, however, indicate that the mineral is a ferriferous variety of enstatite whose composition is approaching that of hypersthene, rather than a mineral possessing properties of typical hypersthene.

The occurrence of the monoclinic pyroxene, diopside, has been inferred both from normative composition and optically, from the color, relief, and nature of extinction of two small four-sided pieces, but in the absence of knowledge of other determinative properties it has not been confirmed.

X-ray studies of acid insoluble residue and of non-magnetic fractions have been made.[1] The acid insoluble sample showed lines of orthorhombic pyroxene only. Other lines of likely minerals were looked for in the sample but not found. The non-magnetic powder gave the following results: olivine, feldspar 30 per cent, troilite 5 per cent, and unidentified 5 per cent. Although the estimate of the quantity of these minerals is not based upon standard mixtures and could be in error by a factor or two or three, the percentage of feldspar is considerably higher than has been determined by optical or chemical methods. It is to be understood, however, that percentage determination of individual minerals in thin sections where the constituent minerals are triturated and intimately mixed with one another such as in Benld is a matter of guesswork and little reliance can be placed upon it.

The pyroxene occurs as granular and fragmental aggregates and as dust-like particles. It also occurs as a constituent of granular and fibrous chondrules.

Of the accessory minerals, only troilite, magnetite, and ilmenite have been detected. Nickel-iron occurs in an appreciable quantity, scattered in the ground mass and bordering some of the chondrules (fig. 79).

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[1] Courtesy of Dr. Michael Fleischer, Dr. Charles Milton, and Dr. J. M. Axelrod, Geochemistry and Petrology Branch, United States Geological Survey, Washington, D.C.

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