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Meteorites in Kansas

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Introduction

Meteorites have been found all over the world, and Kansas has yielded more than its share. Of the 1,530 verified meteorites from the United States (as of July 2009), 137 came from Kansas, according to the Washington University in St. Louis website on meteorites (http://epsc.wustl.edu/admin/resources/meteorites/numbers_by_state.htm). The recent discovery (autumn 2005) of a 1,400-pound meteorite in Kiowa County, Kansas, spurred renewed interest in the subject for many Kansans, especially in view of the potential monetary value of some specimens. But how do you know if the rock you found is a meteorite? This publication offers some initial guidance to answer that question, or at least information to help eliminate obvious non-meteorites from consideration. It also describes some common types of meteorites and discusses meteorites in Kansas.

What is a Meteorite?

The term **meteor** is used to describe the streak of light produced when matter from space falls through the earth's atmosphere and is heated by atmospheric friction to the point of incandescence, otherwise known as a "falling star." **Meteoroid** refers to any matter in interplanetary space that is too small to be called an asteroid or comet. A **meteorite** is a meteoroid that reaches the surface of the earth without being completely vaporized.

Falls are meteorites whose fall to earth was witnessed and recorded, noting place and time of arrival. **Finds** were not seen to fall, but were found on the ground, often long after their arrival.

Types of Meteorites

Meteorites are classified into three main types: stones, stony-irons, and irons. Stones are similar to rocks found on the earth in that they are composed primarily of silicate minerals, that is, compounds consisting of silicon, oxygen, and various metallic elements. Irons are made primarily of iron and nickel in varying proportions. Stony-irons contain both silicates and metals in approximately equal proportions. Within these three main categories, meteorites are further subdivided into a number of classes. Of the witnessed meteorite falls on the earth, 94.5% are stones, 4.5% are irons, and 1.0% are stony-irons (from http://meteorites.wustl.edu/meteorite_types.htm). However, because stones resemble terrestrial rocks, especially if weathered, and irons are easier to spot and to find using metal detectors, most collections of meteorite finds are dominated by irons.

The most common type of stony meteorite, called a chondrite, contains chondrules, tiny mineral spherules on the scale of a millimeter or so, in a fine-grained background matrix of light-green to black minerals (figs. 1 and 2). About 82% of witnessed meteorite falls are chondrites. They are among the oldest objects to have formed in our solar system, estimated at about 4.5 billion years old, thus providing clues to the nature of the solar system at that time.

Stony-irons are divided into three main groups (pallasites, mesosiderites, and lodranites) based on their mineral and metal contents. Pallasites, the most beautiful of meteorites, are made of olivine crystals embedded in an iron-nickel alloy (fig. 3). Iron meteorites are made up largely of iron-nickel alloys (fig. 4). They are classified according to crystal structure and chemistry, including the percentage of nickel content. In etched and polished sections, many exhibit the characteristic Widmanstätten pattern of crystallization, as shown in fig. 5.

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Figure 1—Photo of an ordinary chondrite. Chondrites contain chondrules, small spherical bodies believed to have originated during the formation of the solar nebula. Ordinary chondrites are rich in the mineral olivine and contain free metal up to 22% by weight. The metallic particles in this one have weathered to a rust color. The outer surface shows a fusion crust, regmaglypts (impressions that look like thumb prints), and rounded edges, all formed by frictional heating during atmospheric entry.

The majority of meteorites are believed to have come from asteroids. A few may have come from Mars, or the moon, or perhaps other solar system planets. In this scheme, the stony meteorites probably originated from undifferentiated asteroids or from the surfaces of larger asteroids, planets, or moons. The irons and stony irons are thought to have come from the cores or core-mantle boundaries, respectively, of differentiated bodies such as planets and large asteroids that were massive enough to have produced a metallic core, a mantle, and a stony crust during their formation.

Figure 2—Carbonaceous chondrites, as shown here, range from gray to black and contain large amounts of carbon and organic compounds and also whitish calcium-aluminum-rich chondrules (arrows).

Figure 4—Iron meteorite made entirely of an iron-nickel alloy; note fusion crust and regmaglypts on outer surface. This type is believed to have originated from the core of a planetary body.

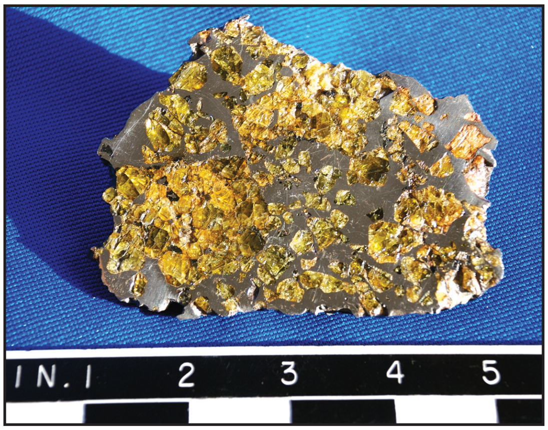

Figure 3—Polished section of a pallasite meteorite, believed to have originated from the core-mantle boundary of a planetary body. Note the greenish-yellow olivine crystals embedded in an iron-nickel alloy.

Figure 5—Polished section of an iron-nickel meteorite, showing Widmanstätten pattern.

Meteorites in Kansas

Kansas, especially its western part, is considered a good place to find meteorites because it is open country with few terrestrial rocks at the surface, heavily cultivated, and clear of trees and human development. Thus, anything out of the ordinary shows up readily. In addition, western Kansas is a relatively arid region where meteorites may disintegrate more slowly than in some other regions.

One of the most significant meteorite finds in Kansas, known as the Brenham meteorite, was discovered by a farmer's wife, Eliza Kimberly, in 1882 near the town of Brenham, in Kiowa County. She collected many samples and subsequently convinced Professor F. W. Cragin, of Washburn College, Topeka, Kansas, to come, examine them, and purchase a few. Later, Clyde Fisher, of the American Museum of Natural History, came to examine them and to excavate more pieces (fig. 6). In the 1920's and 1930's, Harvey Nininger, famed meteorite hunter, unearthed many more from the same area. In 1949, H. O. Stockwell discovered a 1,000-pound specimen that is temporarily on display in the City Building on Main Street in Greensburg, Kansas, while plans for rebuilding the Big Well museum are underway (fig. 7). In the fall of 2005, a specially designed metal detector located the largest piece yet from the Brenham site, a 1,400-pound meteorite. This latest large specimen is an oriented pallasite, a stony-iron body that remained oriented in one position as it fell, rather than tumbling, thus creating a rounded or conical

Figure 6—Clyde Fisher, of the American Museum of Natural History, and assistant, inspect the Brenham meteorite "crater." This is one of many Brenham landfall sites scattered over a large area.

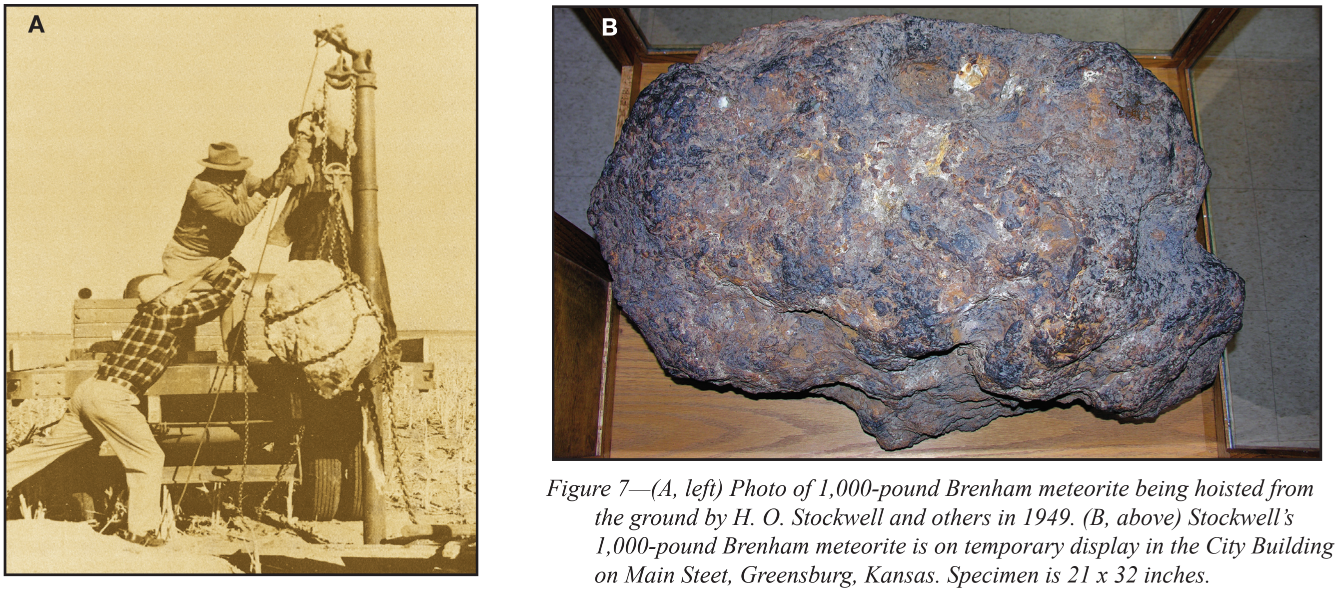

Figure 7—(A, left) Photo of 1,000-pound Brenham meteorite being hoisted from the ground by H. O. Stockwell and others in 1949. (B, above) Stockwell's 1,000-pound Brenham meteorite is on temporary display in the City Building on Main Steet, Greensburg, Kansas. Specimen is 21 x 32 inches.

shape on the side that took the brunt of the heat upon entering the atmosphere. Only two larger ones of that type are known to have been found in the world. All of the Brenham specimens are believed to have come from one meteorite that broke up during its fall. Scientists previously estimated that this fall occurred about 20,000 years ago, but recent evidence suggests it fell around 10,000 years ago. Over three tons of Brenham material have been found.

Many other meteorites have been found in Kansas, including representative samples of most of the various types of meteorites. Several colleges and universities in the state have small collections, either in museums or in their geology departments. The Chicago Field Museum, noted for its early meteorite collections and studies, has 86 named meteorites from Kansas, including pieces of the Brenham meteorite (table 1). Harvey Nininger, in the 1920's and 1930's, described several other large Kansas meteorite finds, pieces of which ranged in size from about 7 pounds to over 700 pounds, including the Long Island meteorite from Phillips County, now in the Chicago Field Museum, and the 715-pound Hugoton stone, found in 1927 in Stevens County, now at Arizona State University.

So far the only convincingly described impact "crater" in Kansas is the Brenham "crater" mentioned above and shown in fig. 6. This "crater," which represents only one of many impact sites for the Brenham shower, was relatively small and was originally regarded simply as a "buffalo wallow." Nininger, in the 1930's, excavated many small meteorite samples from it, but by the time he did his work there, it had been cultivated for years and partially filled in by the landowners. Impact craters are difficult to identify in Kansas partly because they normally fill quickly with sediments and thus are disguised. Additionally, other circular surface features are present that may be mistaken for impact craters. Some have suggested that Big Basin in Clark County is an impact crater, though most consider it to be the result of dissolution of salt beds in the subsurface. Cheyenne Bottoms also has been put forward as a possible candidate, but the prevailing thought is that it resulted from structural movement and possibly salt dissolution in the subsurface. The Winkler crater in Riley County was once suggested as an impact site, but it was later shown to be a kimberlite pipe, a strictly terrestrial feature of igneous origin. Clearly, more work needs to be done to unmistakenly identify any impact craters in Kansas.

Tests for Suspected Meteorites

Most rocks suspected of being meteorites usually are not. Some basic tests can help to determine if your sample merits further examination:

1) Is it unlike other rocks in the area?
2) Is it heavier than most rocks? Many meteorites are dense and contain sizeable proportions of iron and nickel. Those that contain the greatest proportions of these metals are quite heavy.
3) Is a magnet attracted to it? Meteorites that contain iron will attract a magnet, but, as discussed above, not all meteorites contain iron. Also, some terrestrial rocks will attract a magnet as well.
4) Does it have a black or brown coating on the outside? Meteorites that have recently fallen to the earth may have a black coating on the order of 1-2 mm thick, called a fusion crust, caused by the frictional heating

Table 1—Notable Kansas meteorites in the Chicago Field Museum.

Name	Find or Fall?	Type	Place Found	Date Found or Date Fell	No. of Pieces	Total Weight (lbs)	Largest Piece (lbs)
Brenham	Find	Pallasite	Kiowa County	1882	36	1083	481
Long Island	Find	Ordinary chondrite	Phillips County	1891	7	1202	1174
Admire	Find	Pallasite	Lyon County	1881	6	33	14.8
Ness County	Find	Ordinary chondrite	Ness County	1894	29	47	7.5
Saline	Find	Ordinary chondrite	Sheridan County	1901	2	45.4	42.9
Farmington	Fall	Ordinary chondrite	Washington County	1890	6	51.6	28.2
Modoc	Fall	Ordinary chondrite	Scott County	1905	6	9.4	7.0

and melting that occurred during its fall through the atmosphere. A fusion crust is usually very dark and looks very different from the interior of the specimen. This coating tends to weather away after the meteorite has been on the ground for some time. A heavily weathered iron meteorite can look like a rusty metal blob.

5) Are the edges rounded and does it have regmaglypts? Regmaglypts are shallow depressions or cavities that look like thumb prints, formed by melting of the outer surface during atmospheric entry. Edges are usually rounded by the same process. However, because many meteorites break into pieces during their fall, interior pieces may not exhibit regmaglypts, rounded edges, or a fusion crust.
6) Is its interior metallic silver? Irons and stony irons will exhibit this metallic look. Even some stony meteorites may contain small flecks of metal.
7) Does it have vesicles, that is, holes formed in a rock by bubbles of gas or steam during solidification of the rock? If so, it most likely is **not** a meteorite. These features develop in molten lavas that cool on the surface of the earth or comparably sized celestial bodies. So far, no vesicular igneous meteorites have been identified.
8) Does it contain fossils or crystals, especially quartz or calcite? If so, it definitely is **not** a meteorite.
9) Does it contain hematite or magnetite? Hematite is an iron mineral that forms in the presence of water and thus is unlikely to be part of a space rock. Magnetite is a common terrestrial rock that is magnetic. To test this, rub your sample on a porcelain tile. Hematite will leave a brown or reddish-brown streak, magnetite a gray streak. An unweathered meteorite will not leave a streak.

If you are able to answer “yes” to questions 1 through 6, or it looks like one of the examples shown, it may warrant further examination. If so, you may want to contact a local museum, university, or other professional in your area.

Some common examples of terrestrial rocks that are mistaken for meteorites include: 1) slag, a melted waste material from mining or foundry operations, commonly found along railroad tracks, but it is usually full of vesicles; 2) rocks made of magnetite, peridotite, or other iron oxide minerals, but they normally exhibit relatively large, identifiable crystals; 3) rocks covered with desert varnish; and 4) ventifacts that have erosional surfaces shaped by the action of wind and sand. However, these latter two most often are the same types of rocks as others in the area.

If you are fortunate enough to witness a fall and find the meteorite, record the exact time and place of arrival, even using a GPS unit to note the location, if possible. Also note the direction from which it came and take photos of the meteorite before disturbing it. Then notify a nearby university, museum, or geological survey.

More Information

Web Sites

Websites with meteorite classification information:
http://www.meteorlab.com/METEORLAB2001dev/clsschrt.htm
http://www.meteoritemarket.com/type.htm
http://en.wikipedia.org/wiki/Meteorite_classification.

Department of Earth and Planetary Science, Washington University — http://meteorites.wustl.edu/ — the Washington University in St. Louis meteorite website.

Arthur Ross Hall of Meteorites — http://www.amnh.org/exhibitions/permanent/meteorites/ — the American Museum of Natural History meteorite website.

Meteorites at the Field Museum — http://www.fieldmuseum.org/research_collections/geology/meteor_col.pdf — catalogue of meteorites at the Chicago Field Museum.

The Center for Meteorite Studies at Arizona State University — http://meteorites.asu.edu/ — Arizona State University meteorite website.

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Space Rocks and Buffalo Grass, E. L. Peck, 1979, Peach Enterprises, Inc., Warren, Michigan, 116 p.

See additional historical references by F. H. Snow, O. C. Farrington, O. C. Farquhar and W. E. Hill, Jr., H. H. Nininger, and other authors listed in the Bibliography of Kansas Geology, 1823–1984, by J. H. Sorensen et al., 1989, Kansas Geological Survey, Bulletin 221, 444 p.; also available online at http://www.kgs.ku.edu/Magellan/Bib/index.html

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The Geology Extension program furthers the mission of the KGS by developing materials, projects, and services that communicate information about the geology of Kansas, the state's earth resources, and the products of the Kansas Geological Survey to the people of the state.

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