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...
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 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 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 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.
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 unmistakably 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>
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<th>Find or Fall?</th>
<th>Type</th>
<th>Place Found</th>
<th>Date Found or Date Fell</th>
<th>No. of Pieces</th>
<th>Total Weight (lbs)</th>
<th>Largest Piece (lbs)</th>
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<td>1882</td>
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<td>Find</td>
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<td>33</td>
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<td>Scott County</td>
<td>1905</td>
<td>6</td>
<td>9.4</td>
<td>7.0</td>
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</table>

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 Street, Greensburg, Kansas. Specimen is 21 x 32 inches.

Table 1—Notable Kansas meteorites in the Chicago Field Museum.
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.meteoritemarket.com/type.htm


Publications


