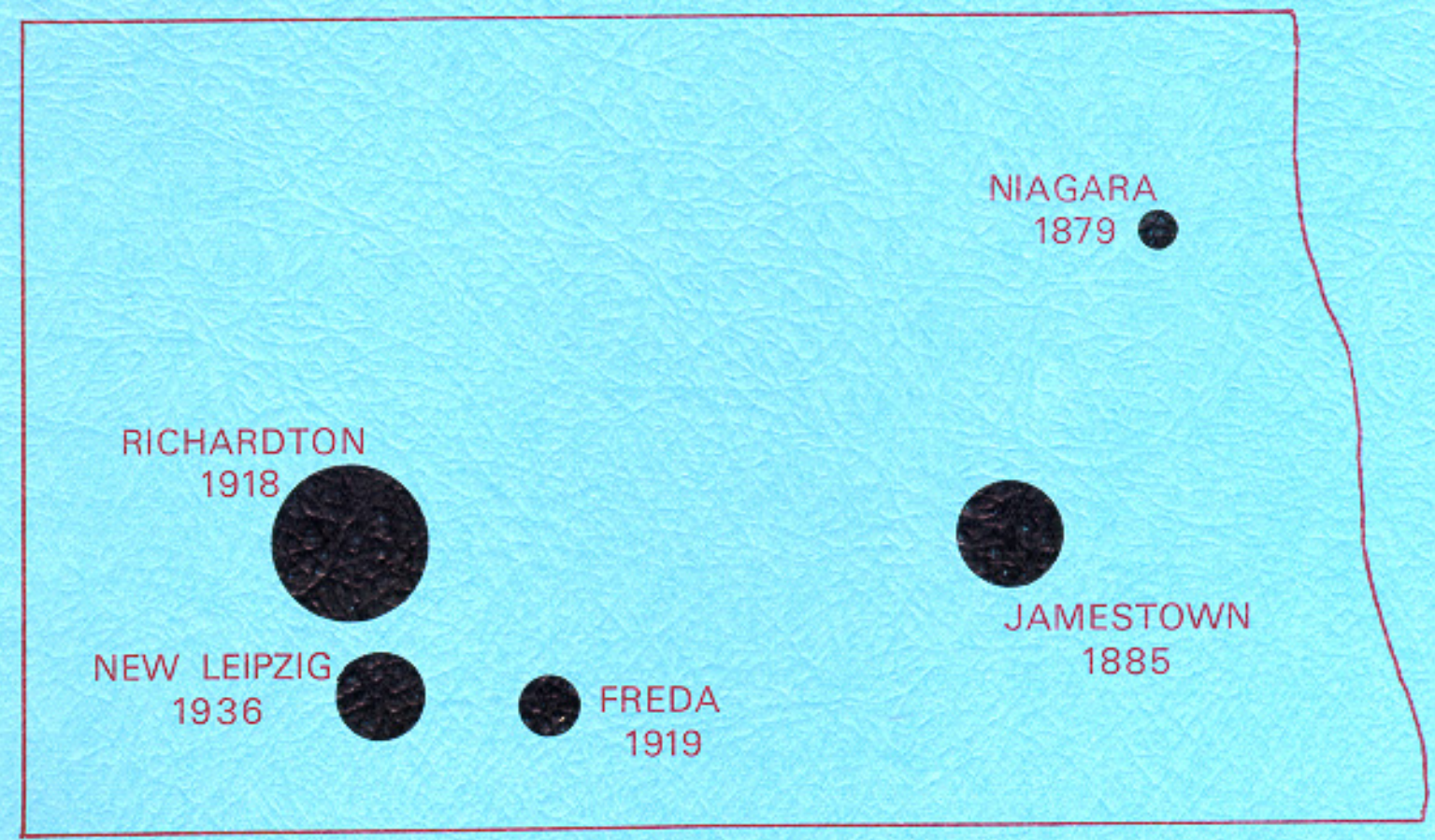
METEORITES IN NORTH DAKOTA

A GUIDE TO THEIR RECOGNITION

Frank R. Karner



NORTH DAKOTA GEOLOGICAL SURVEY

Wilson M. Laird, State Geologist

GRAND FORKS, NORTH DAKOTA

Miscellaneous Series 37

1968

The Richardton Meteorite ... An Introduction

This circular is especially written for those who frequently have the opportunity to see North Dakota outdoors. It is a guide for the recognition of meteorites and an introduction to their scientific meaning. The following description of the fall of the Richardton, North Dakota meteorite is quoted from Quirke (1919).*

> At 9:48 p.m. Mountain time, June 30, 1918, a meteorite was seen to fall in the country between Richardton and Mott, North Dakota. Pieces fell on both sides of the line between Stark and Hettinger counties within a strip about 9 miles wide from north to south and 5 miles wide from east to west. The center of this area lies in latitude 46° 37' 30" N. and longitude 102° 16' 17" W., about 20 miles south of Richardton.
>
> At Mandan, 70 miles east and about 10 miles north of the locality of the fall, several people saw the meteorite. It happened that there were two troop-trains in the yards at the time and any noise the meteorite made was not noticed during the celebration.
>
> At Dickinson, 30 miles northwest of the locality, the meteorite appeared as a bright light which went out suddenly, accompanied by a rushing, roaring sound which seemed to shake the air.
>
> A person interviewed in Richardton was in New Leipzig, about 20 miles southeast of the locality, at the time the meteorite fell. He had just gone to bed when he was startled by a brilliant light, which he took momentarily for the headlight of a locomotive; however, he went to the window and saw a meteorite passing to the west of the town, going apparently in a northwest direction and falling at a low angle. The witness recalled that there was a roaring sound like that of an airship for about two minutes, followed by a violent explosion; it was a fearful and terrifying noise, rattling the windows and shaking the house severely, resembling an earthquake. To others at New Leipzig it sounded like rolling artillery.
>
> Mr. Bernard Kuntz, Section 27, Township 137, Range 92 west of the fifth principal meridian, saw the fall. To him the flight seemed to be from southwest to northeast, making the countryside as bright as day. He described the noise as like that of an airship or a motorcycle. He found several specimens.
>
> Mr. Nickolas Kuntz lives on another quarter of the same section as Bernard Kuntz. All his family were in bed and asleep at the time, but they were awakened by the light and noise, which they took to be caused by lightning, thunder, and rain. Mr. Kuntz found one boloid weighing 11½ lbs., which was in a shallow hole on plowed land; another weighing 2 lbs. 10 oz., which was lying on the surface in a pasture; and a third weighing about 9½ lbs.
>
> Mr. Leo Kern, Section 18, Township 136, Range 92, saw the fall. He was walking home about 10 o'clock at night, when suddenly there was a bright light. At first it was like a bright shooting star; then it became a streak of fire until it burst like a Roman candle. It appeared to be coming from the southeast, falling at an angle of about 15° to the

---

*Reprinted from Journal of Geology, The Richardton Meteorite by T. T. Quirke by permission of the University of Chicago Press.

horizontal. It made a "rattling sound like an airship," and when it burst the earth all about him trembled, and the house shook with the violence of the explosion. He prudently took shelter behind a telegraph pole, as the meteorite appeared to be coming directly toward him. After the explosion he heard pieces flying through the air like whistling bullets, and pieces rattled against the roof of his barn, where he found some later. After the meteorite had burst there appeared to be a trail of "smoke or steam" in the line of flight.

Mr. N. R. St. Marie, of Hettinger, North Dakota, wrote on February 27 as follows:

The writer was lucky enough to get an almost perfect view of the meteorite. I was seated in an auto sky-gazing, when it attracted my attention as a shooting star. In a moment I saw that it was out of ordinary. Starting from very high it fell rapidly earthward, a little to the east of north, about 10 or 15 degrees, I judged. As it came down it illuminated the landscape to almost the brilliancy of sunlight, but the light was first of a green and later of a yellow hue. A faint whistling was discernable to part of our party; others, however, said they didn't notice any sound.

I was 65 miles south and 15 miles west of Hettinger at the time.

In answer to further inquiry, on March 1, 1919, Mr. St. Marie added:

I first noticed it very high in the heavens giving the appearance of being nearly over me; as it approached the earth it appeared more and more to the northeast.

This observer was 100 miles south and 30 miles west of the locality of the fall at the time.

Mr. Lewis Loran, Section 33, Township 137, Range 92, found several specimens of the fall, and was a witness of the phenomena. On December 12, 1918, he wrote the following detailed description of the fall:

It was June 30, at 10 p.m.; my wife and I were in my yard, and I looked at the sky and I discovered the meteor. It was as large to me as about two inches in diameter, and it was just where the sun is about the first week in November at fifteen minutes after twelve. It came nearer and nearer, and larger and larger, so at last I thought I must go out of its way or it would strike me. It was at least as big to me as the sun is sometime in August when it sets, but more than three times as light; then it flashed out (it was a cloudless night and no wind), and it was all still. I said to my wife, "Where is it now? It has to come. It is so near to the surface of the earth." It just took this long to say these words when we heard a great racking in the air in the same direction, and in a few seconds we heard the pieces sounding through the air like shells. We could hear that there were some smaller and some larger pieces, and that some went beyond us and some fell south of us. But the worst racking and noise was the exploding in the air. It seemed that it shook the ground under my feet, and I could hear the windows in my house rattle. We could not see the pieces, but we could hear them, and we could tell that they came from the direction from which the meteorite came.

The light of the meteor was seen over more than 400 square miles, and the noise was heard over 250 square miles.

RECOGNITION OF METEORITES

Meteorites are stones or masses of metal that have fallen to the earth's surface after entering the atmosphere from space. Many are thought to be fragments of an exploded planet (or originally smaller bodies) orbiting the sun in the Asteroidal Belt between Mars and Jupiter. Some may have been blasted from the Moon after asteroid impact. Their descent to earth may be as spectacular as that of the Richardton meteorite when they become fireballs as a result of the frictional heat generated by high-velocity movement through the air. The word meteor is used to describe the fiery passage through the atmosphere while the term meteorite is used for the solid material that strikes the earth. Fragments of the Richardton, North Dakota and the Canyon Diablo, Arizona (Meteor Crater) meteorites are shown in Figures 1-4. These photographs also illustrate meteorite characteristics given below.

Large masses often break in flight resulting in the typically irregular shape of most meteorites. Often as a result of intense heating in the atmosphere the surface is melted forming a black, glassy fusion crust and shallow pits resembling thumbprints (Fig. 1,4). The thin fusion crust may show flow ridges and furrows and upon cooling may become checked with tiny cracks. The black crust turns reddish brown after weathering. Another aid in the identification of meteorites is their high density or comparative weight; because of their iron content they often weigh two or three times as much as an ordinary stone of similar size.

Iron meteorites or siderites consist of nickel-iron alloys (about 5-10 percent nickel) which are resistant to weathering. This type is easily recognized and makes up the largest proportion of finds or recovered meteorites whose falls have not been observed. Grinding a small corner of a possible find will reveal whether it is metallic, and chemical testing for nickel will verify that the metal is of meteoritic origin. The most common iron meteorites, after etching of a polished surface with acid, show a unique intricate pattern of intersecting bands, Widmanstätten figures, which are an intergrowth of two kinds of nickel alloy (Fig. 3).*

Stony meteorites or aerolites make up the largest number of falls or recovered meteorites whose falls have been observed. However, finds of stony meteorites are relatively uncommon because once they have fallen unnoticed they are much less conspicuous than iron meteorites. After grinding or filing a small part of the surface of a stony meteorite small bright grains of iron are usually seen in a light or dark gray stone. The most common stony meteorites are named chondrites because of the globular mineral masses or chondrules which they contain (Fig. 4). Chondrules are usually about one-eighth inch in diameter and show up best on a polished surface. The chondrites are the most common type of meteorite, making up about 85 percent of all known falls of meteorites. Stony meteorites without chondrules (achondrites) are relatively rare.

Stony-iron meteorites or siderolites are a rare group of meteorites which have intermediate composition between iron and stony meteorites. They are made up of about half nickel-iron alloy and half stony material.

Summary of Meteorite Characteristics

SIZE - Meteorites may be of any size but are usually a few inches to a few feet in diameter.

---

*Meteorites of this type are called octahedrites; less common iron meteorites include both hexahedrites, which have relatively low nickel content, and the nickel-rich ataxites.

SHAPE - Usually irregular and somewhat angular with rounded corners.

SURFACE - 1) Pitted with shallow depressions or "thumbprints."
2) Covered with thin black fusion crust which weathers reddish brown.
3) Crust often shows flow lines and ridges and may have a finely cracked or checked surface.

COMPOSITION - 1) Iron - solid metal which can be seen by grinding a small corner of the specimen.
2) Stony - a surface prepared by grinding a small corner shows iron grains in a light to dark gray stony material.
3) Stony-iron - about half metal and half stony material.

HISTORY OF METEORITES

Every meteorite has several "ages" which show different events in its history. The youngest of smallest "age" for a meteorite is the time since its fall to earth. The Richardton, North Dakota meteorite, which fell in 1918 is 50 years old. The Niagara, North Dakota meteorite found in 1879 is at least 89 years old and may be much older.

Many ancient writings contain references to meteorites which fell long ago. For example, in the Old Testament the Israelites were promised " a land wherein thou shalt not lack anything...whose stones are iron" (Deuteronomy 8:9). In some ancient languages the word for iron is equivalent or similar to sky, star or heaven; in ancient Egyptian it means "metal from heaven" (Heide, 1964, p. 62). Beyond written history, meteorites have been found in mounds built by prehistoric American Indians. Craters left by ancient large meteorites and comets mark the surface of the Earth as well as that of the Moon and Mars, but on Earth they are less conspicuous. Probably many craters on our planet have been filled in or destroyed by erosion, but some remain and their ages have been determined in various ways. Meteor Crater, Arizona is several thousand years old according to data summarized by Anders (1963) and may be somewhat older (Shoemaker, 1963). Several Canadian craters are partly filled with sediments deposited about one-half billion years ago and therefore may be much older (Beals, 1963). Meteorites probably have fallen upon the earth since its formation about 4½ billion years ago.

Another "age" of meteorites dates their breakup in space into particles which are small enough (several feet across) to be thoroughly exposed to cosmic rays. For meteorites that have fallen recently, "ages" determined for this breakup vary from a few million years to over a billion years (Anders, 1963). For example, the Richardton meteorite was broken from a larger parent body several tens of millions of years ago even though it did not fall until 1918 (Anders, 1963). The large range of breakup dates for meteorites may mean that collisions in the Asteroidal Belt are continually occurring. After each collision some fragments are launched into orbits which cross that of the earth. Eventually some of these fragments are captured in the gravity field of the earth and fall to its surface as meteorites.

The "age" of solidification of meteorite material from molten matter as well as the time of later cooling of the meteorite parent bodies can also be dated. The Richardton meteorite solidified about 4 billion years ago (Anders, 1963). Although there are exceptions and complications, results of measurements show that most meteorites (or parent bodies) are very old. Their "ages" are around 4 to 5 billion years, about the same as the age of the earth. Some of the exceptions are meteorites with relatively low "ages". The low ages may be related to post-solidification events such as slow cooling of parent bodies, the time of collisional breakup of the parent bodies or variable position of the meteorite mass within the parent bodies (Anders, 1963).

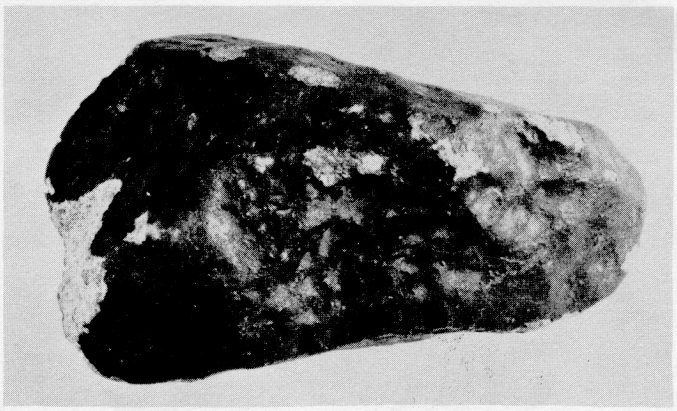


Figure 1. Richardton, North Dakota chondritic meteorite fragment showing irregular shape, pitted surface, black fusion crust and light gray stony interior. Natural size. (U.N.D. No. 2517)

Figure 2. Canyon Diablo, Arizona (Meteor Crater) octahedrite fragment showing irregular shape and large depressions on surface. Natural size. (U.N.D. No. 4941)

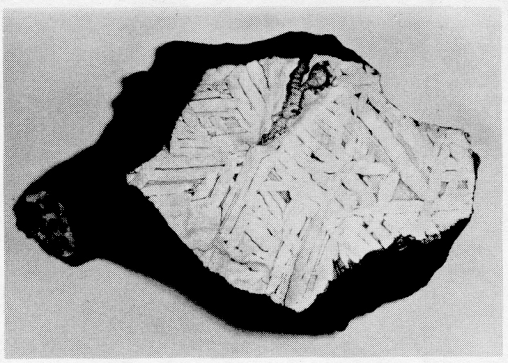


Figure 3. Polished section of Canyon Diablo, Arizona (Meteor Crater) octahedrite with metallic interior etched to show Widmanstätten figures. Natural size. (U.N.D. No. 557)

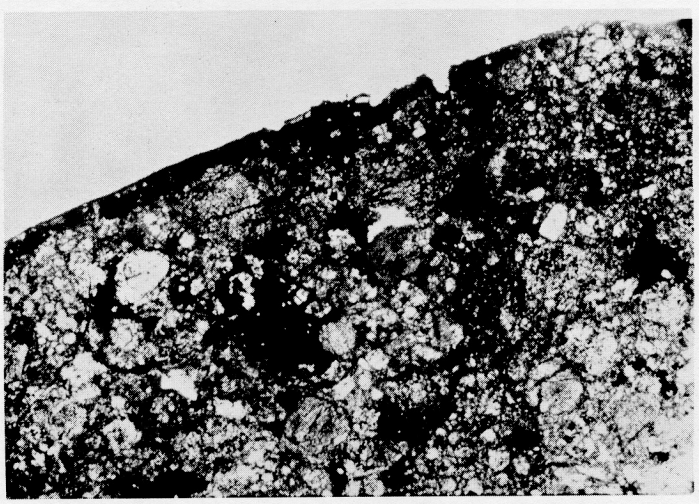


Figure 4. Thin section of Richardton, North Dakota, chondritic meteorite showing black nickel-iron grains, grey rounded chondrules and thin, black, fusion crust. Magnified X 10. (U.N.D. No. 2517)

Finally the "age" of formation of the chemical elements contained in meteorites can be considered. This event probably occurred within the interior of a star-like body, possibly the ancestor of our sun. Measurements quoted by Mason (1962) indicate that the Richardton meteorite crystallized (became part of a solid parent body) about 350 million years after the formation of the chemical elements which make up its minerals.

A possible history of the Richardton meteorite can be summarized as follows:

1) 4½ - 5 billion years ago -- elements now found in the meteorite formed in the interior of the ancestral sun.

2) 4 - 4½ billion years ago -- the minerals of the meteorite solidified near the surface of some parent asteroid in the belt between Mars and Jupiter.

3) 20 - 80 million years ago -- the meteorite was formed by breakup of the parent body upon collision with another asteroid and was ejected into an orbit which crossed that of the earth.

4) 9:45 p.m. Mountain time, June 30, 1918 -- the meteorite fell to the earth in fragments after being captured in the earth's gravity field.

NORTH DAKOTA METEORITES

Few meteorites have been found in North Dakota. Mason (1962) lists four finds and one fall (Richardton):

Name	County	Date	Weight (lbs.)	Type
Freda	Grant	1919	0.6	Nickel-rich ataxite
Jamestown	Stutsman	1885	8.8	octahedrite
New Leipzig	Grant	1936	44	octahedrite
Niagara	Grand Forks	1879	0.26	octahedrite
Richardton	Stark	1918	220	chondrite

These locations are illustrated on the front cover of this circular.

There are undoubtedly many unrecovered meteorites in North Dakota. In a state of similar size, Kansas, 53 meteorites had been found by 1949, most after a program of search had been instituted by H. H. Nininger (Nininger, 1952). In Kansas, prior to 1906, only fifteen meteorites had been recovered and only one was found between 1906 and 1923. Nininger's search was begun in 1923 and as a result 37 new finds were recovered by 1949. The search was successful largely because of public awareness of the scientific value of meteorites, and most importantly, of knowledge of the characteristics by which they can be recognized.

REFERENCES

References preceded by an asterisk contain especially good summaries of meteorites and their characteristics and are recommended as further reading for interested persons.

Anders, Edward, 1963, Meteorite Ages: The Solar System, Vol. IV The Moon, Meteorites and Comets, Middlehurst, Barbara M. and Kuiper, Gerard P., eds., University of Chicago Press, Chicago, p. 402-495.

Beals, C. S., Innes, M. J. S., and Rottenberg, J. A., 1963, Fossil Meteorite Craters: The Solar System, Vol. IV The Moon, Meteorites and Comets, Middlehurst, Barbara M. and Kuiper, Gerard P., eds., University of Chicago Press, Chicago, p. 235-284.

*Heide, Fritz, 1965, Meteorites: University of Chicago Press, Chicago, 488 pages.

*Mason, Brian, 1962, Meteorites: John Wiley and Sons, Inc., New York, 274 pages.

*Nininger, H. H., 1952, Out of the Sky, An Introduction to Meteoritics: Dover Publications, Inc., New York, 336 pages.

Quirke, T. T., 1919, The Richardton Meteorite: Journal of Geology, Vol. XXVII, no. 6, p. 431-448.

Shoemaker, Eugene M., 1963, Impact Mechanics at Meteor Crater, Arizona: The Solar System, Vol. IV The Moon, Meteorites and Comets, Middlehurst, Barbara M. and Kuiper, Gerard P., eds., University of Chicago Press, Chicago, p. 301-336.