2 inches

Weston (stone). The largest specimen of the celebrated Weston (Connecticut) meteorite, America's first documented meteorite fall.

The Peabody Museum Meteorite Collection: A Historic Account

Barbara L. Narendra

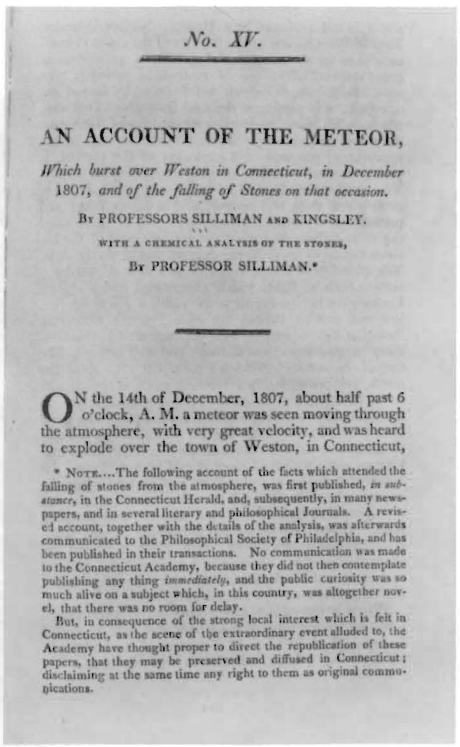
"In Europe I had become acquainted with meteorites and the phenomena that usually attend their fall . . . I did not dream of being favored by an event of this kind in my own vicinity and occurring on a scale truly magnificent."[1] Thus did Professor Benjamin Silliman (1779–1864), writing his memoirs many years later, recall the circumstances of the first recorded fall of a meteorite in the New World, and of the beginning of Yale's Meteorite Collection. Amazingly, the fall took place only 19 months after his return from England and Scotland, where he had spent a year purchasing books and scientific equipment for Yale and pursuing his studies in chemistry, medicine, geology, and mineralogy.

The Legacy of Benjamin Silliman

The Weston Meteorite At 6:30 on the morning of 14 December 1807 a blazing fireball, appearing to be about two-thirds the size of the moon, was seen travelling southwards by early risers in Vermont and Massachusetts. Three loud explosions were heard over the town of Weston in Fairfield County, Connecticut. Stone fragments fell in at least six places. Two or three days later Silliman heard of it, dropped everything he was doing, and with Professor James L. Kingsley immediately went to Weston to investigate. They visited every locality where stones had been reported to fall and interviewed many eyewitnesses. Several large stones (including one of about 200 pounds) had been smashed to bits on the rocky ground. Others were smashed by the finders: "Strongly impressed with the idea that these stones contained gold and silver, they subjected them to all the tortures of ancient alchemy, and the goldsmith's crucible, the forge, and the blacksmith's anvil, were employed in vain to elicit riches which existed only in the imagination."[2] With difficulty Silliman and Kingsley managed to procure fragments of each stone that had fallen, and came away with "a considerable number of specimens." On 29 December they published a detailed description in the *Connecticut Herald* of the fireball, the explosions (heard more than 40 miles away), and the fall of the stones. The description was quickly reprinted in other publications. A revised version—with a chemical analysis of the meteorite made by Silliman, the first to be performed in this country and among the first few in the world—was read before the American Philosophical Society in March 1808, and published in its *Transactions* the following year. "The case was deemed so interesting and important that the published account was read aloud in the Philosophical Society of London & in the Academy of Sciences of Paris. It was admitted to be one of the most extensive and best attested occurrences of the kind that has happened and of which a record has been preserved."[3]

Silliman's luck in this instance was extraordinary. Fireballs had been seen in New England and other settled parts of this country in the 17th and 18th centuries, but it is likely that the fall of a single stone, or even of a few, would have gone unnoticed or reports of them disbelieved. In fact, it was only around 1800 that a few mineralogists and chemists in Europe had begun to realize that the stones and chunks of iron reported to fall from the heavens were distinctly different from Earthly rocks. Final proof came with the huge meteorite shower that occurred at L'Aigle, France, in 1803. This, once and for all, because of the sheer numbers of specimens (between 2,000 and 3,000) and "respectable" witnesses, forced the scientific world to admit that stones do indeed fall from the sky. Silliman was therefore established as the first active American participant early in the development of the field of meteoritics. He presented pieces of **Weston** to important friends as well as to scientific institutions. Some of them eventually found their way into museum collections around the world, thereby ensuring their preservation. Out of the approximately 350 pounds of the meteorite that fell on the town of Weston, less than 50 pounds can now be accounted for. Much of the rest undoubtedly gathered dust on numerous 19th century mantelpieces in western Connecticut before being thrown away.

The largest and only unbroken stone of the Weston fall, which weighed 36.5 pounds, was found some days after Silliman and Kingsley had spent several fruitless hours hunting for it. The owner was urged to present it to Yale by local people who had met the professors during their



No. XV.

AN ACCOUNT OF THE METEOR,

Which burst over Weston in Connecticut, in December 1807, and of the falling of Stones on that occasion.

BY PROFESSORS SILLIMAN AND KINGSLEY.

WITH A CHEMICAL ANALYSIS OF THE STONES,

BY PROFESSOR SILLIMAN.*

ON the 14th of December, 1807, about half past 6 o'clock, A. M. a meteor was seen moving through the atmosphere, with very great velocity, and was heard to explode over the town of Weston, in Connecticut,

* NOTE....The following account of the facts which attended the falling of stones from the atmosphere, was first published, *in substance*, in the Connecticut Herald, and, subsequently, in many newspapers, and in several literary and philosophical Journals. A revised account, together with the details of the analysis, was afterwards communicated to the Philosophical Society of Philadelphia, and has been published in their transactions. No communication was made to the Connecticut Academy, because they did not then contemplate publishing any thing *immediately*, and the public curiosity was so much alive on a subject which, in this country, was altogether novel, that there was no room for delay.

But, in consequence of the strong local interest which is felt in Connecticut, as the scene of the extraordinary event alluded to, the Academy have thought proper to direct the republication of these papers, that they may be preserved and diffused in Connecticut; disclaiming at the same time any right to them as original communications.

From the *Memoirs of the Connecticut Academy of Arts and Sciences,* 1810.

investigation, but he insisted on putting it up for sale. It was purchased by Colonel George Gibbs for his large and famous collection of minerals; when the collection became the property of Yale in 1825, Silliman finally acquired this stone—the only specimen of the Weston meteorite that remains in our collection today.

And so Yale's Meteorite Collection was begun—the oldest in this country. This brief summary of the next 170 years will follow the varying fortunes of the collection under its Curators and others responsible in some way for its well-being (otherwise). Some of our meteorites have had unusual adventures since their arrival on this planet, and some have been mistreated to the point of near destruction.

The Saga of the Red River Meteorite In 1808, a party of explorers in the interior of Texas was shown a large mass of metal venerated by the Pawnee Indians and celebrated for its disease-curing powers. In the expectation that the mass consisted of platinum, two rival expeditions were soon after organized to retrieve it from the wilderness, each led by a member of the original party that had seen it. The first group to arrive did indeed find it, but in their greedy haste had neglected to take along a means of carrying away this unwieldy mass that weighed the better part of a ton. They hid it "under a flat stone" and left in search of horses. The second group "arrived a few days afterwards, and after searching several days succeeded in finding their object. Being provided with tools they made a truck-waggon [sic] to which they harnessed six horses, and set off with their prize towards the Red River."[4] After a long and difficult journey overland, made more difficult when Indians stole all their horses one night, they managed to reach the Red River, and proceeded by boat to the Mississippi and New Orleans. The mass was then shipped to New York; the owners intended to send it on to Europe and sell it for a large amount of money, but were stopped by Colonel Gibbs, who recognized it for what it was—not platinum, but only iron, possibly a meteorite. After a chemical analysis by Benjamin Silliman confirmed the meteoritic nature of the mass by showing the presence of nickel, Colonel Gibbs bought it from the disappointed owners, and lent it to the New-York Historical Society, of which he was a member.

In 1829, the Society's collections were given to the Lyceum of Natural History of New York (of which Colonel Gibbs was also a member). In 1831, the Lyceum was forced to vacate its temporary headquarters, a building on the edge of Central Park, and the large meteorite was placed outside on the ground. Colonel Gibbs died in 1833. One day in 1835, "it happened fortunately that Mrs. Gibbs . . . was passing through the Park when she saw some Irish laborers digging a hole in the earth. Approaching them, she enquired what they were doing, when they replied that they were going to bury *that great ugly mass of iron* out of sight as it was no use. She was, of course, displeased . . ."[5] Mrs. Gibbs rescued the meteorite, known today as **Red River,** and presented it to Yale in memory of her husband. At that

Meteorites—What They Are and Where They Come from

Most meteorites have their origin in the asteroid belt, between Mars and Jupiter, and are fragments resulting from the collisions of little planets that were originally no more than a few hundred miles in diameter. (Some meteorites may have been parts of comets.)

All of us have seen meteors—shooting stars—that are completely consumed by the heat of friction with the atmosphere during their descent towards the earth. A meteorite (by definition, solid matter that succeeds in reaching the earth's surface), on the other hand, almost always arrives in a spectacular way, with a brilliant fireball that can be seen crossing the sky even in broad daylight, leaving behind it a long, smoky trail, and with loud, reverberating explosions. The mass breaks up while still miles above the ground, and a thin, black crust forms on each piece during its descent. If the meteorite is then exposed to the weather, its crust turns brown with rust and eventually disintegrates.

On the average, one meteorite lands somewhere on the earth every day, but 70 percent of them fall into the oceans, and others fall in uninhabited areas. Each year only four or five meteorites are seen to fall and are recovered. A meteorite is now commonly given the name of the nearest town large enough to have a post office, or, lacking that, as in Antarctica, the name of the prominent and permanent geographical feature which is closest to the place of discovery.

Meteorites have been divided into many categories on the basis of their chemical composition, but all fall into three main groups: irons (actually composed of a nickel-iron alloy); stony irons, which are approximately half metal and half stone; and stones. Most stony meteorites contain substantial amounts of metallic nickel-iron and are consequently somewhat denser than earth rocks of the same size. There are about 20 minerals that are unique to meteorites.*

*For further reading, see Turekian, K. K., 1966, Stones from the Sky. *Discovery* 1(2):2–8.

time, and for many years to come, it was the largest meteorite in any collection in the world. Several pieces had been removed from it while it was in New York; it weighed 1635 pounds when it came off the boat that brought it to New Haven, and is probably close to that today.

Spreading the Word on Meteorites In 1818 Silliman founded the *American Journal of Science*, for many years the principal outlet in this country for papers announcing and describing newly found meteorites—some written by him. He gave lectures on meteorites to large audiences in New York, Boston, Hartford, and other cities. The lectures included a compilation of historical accounts of meteorite falls down through the ages, and a presentation and critical discussion of the current theories on the origin of meteorites. For props, he used to carry with him, in a specially constructed compartment of his carriage, about 50 pounds of different kinds of meteorites, including the prize specimen of Weston. In short, Silliman's interest in meteorites had been continuously well known since the widely publicized Weston fall. This situation resulted in gifts to him of new meteorites from unexpected sources.

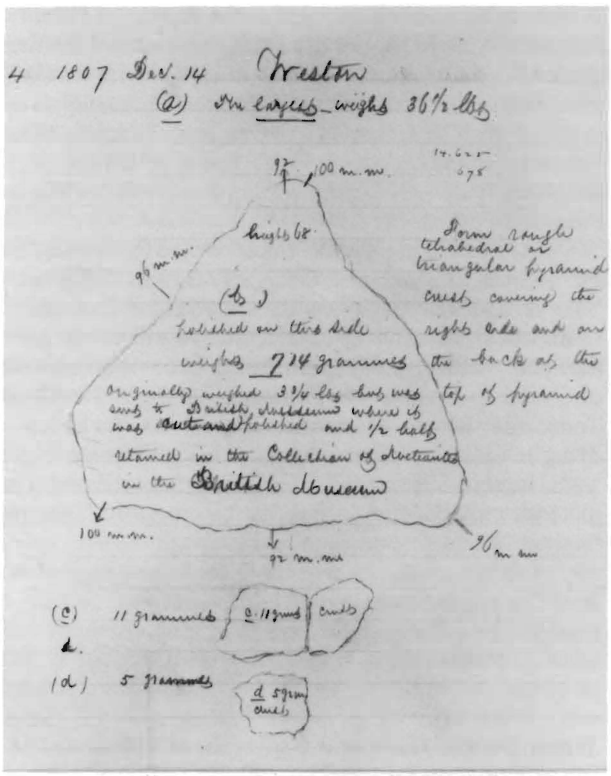
One of these meteorites almost was lost to science and narrowly escaped falling into the Pacific Ocean. With loud explosions that were thought at the time to be from cannon on board some nearby ship, a shower of stones fell "during divine service" on a Sunday morning in September, 1825, mostly into the water between the islands of Lanai, Molokai, and Oahu. Several stones fell at **Honolulu;** one was brought to the Reverend Hiram Bingham, Yale M.A. (Hon.) 1819, the leader of the first group of American missionaries in Hawaii. He carefully preserved his meteorite until he returned to the mainland in 1841, when he presented it to Benjamin Silliman. (The Reverend Bingham was the grandfather of Hiram Bingham, Yale '98, famous for his discoveries at Machu Picchu in Peru in 1911.)

A touching story concerns a devoted former student and assistant of Silliman's, George T. Bowen. While at Yale, he had analyzed a new mineral found at Saybrook, Connecticut, to which he later, from a safe distance, gave the name "sillimanite." Shortly after becoming Professor of Chemistry and Natural Philosophy at the University of Tennessee, Bowen contracted tuberculosis. As he lay dying in 1828, only six years after his graduation from Yale, he sent Silliman an affectionate farewell and a meteorite, one of five stones that had recently fallen not far from Nashville, named **Drake Creek.**

Altogether Silliman accumulated about 30 meteorites. The purchase of Colonel Gibbs's mineral collection brought him a few in addition to those already mentioned, and so did an exchange with the Royal Museum at Vienna in 1842.

James Dwight Dana and Benjamin Silliman, Jr. When Benjamin Silliman retired, his professorship was divided. Along with the teaching of geology and mineralogy, James Dwight Dana inherited Silliman's curatorial duties in the 1850s. He was actively involved with the

Benjamin Silliman, Jr., 1816–1885.



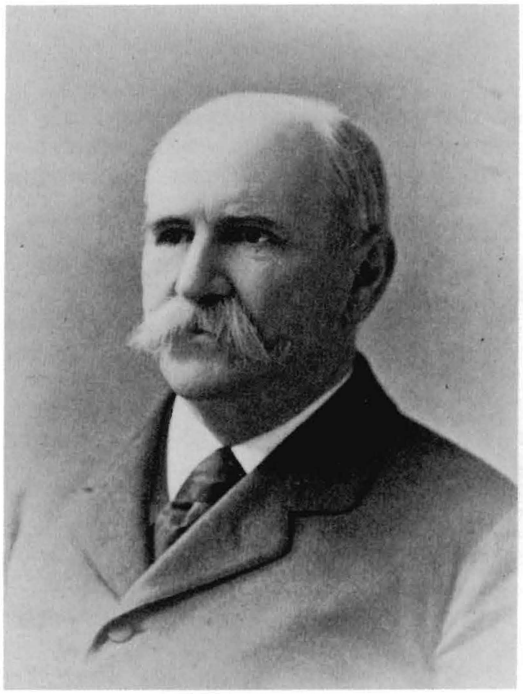
Page from G. J. Brush's manuscript catalogue.

Mineral Collection at that time (meteorites were part of the Mineral Collection until 1960), and it was probably at his urging that the Yale Corporation approved special payment for a 15-pound meteorite in 1861, but we have found no evidence that he made any curatorial purchases or exchanges of meteorites. It would seem, rather, that meteorite affairs were conducted by his colleague, Benjamin Silliman, Jr., who was interested in meteorites and had a collection of his own.

Benjamin Silliman, Jr., his father's successor as Professor of Chemistry, and co-editor (with Dana) of the *American Journal of Science,* acquired and described a number of iron meteorites found in this country. The destiny of smallish iron meteorites has generally been to be discovered by farmers and then to suffer irrevocable damage at the hands of blacksmiths. That is just what happened to several of Silliman, Jr.'s meteorites.

A Pennsylvania farmer, while ploughing his field, reached down for a stone with which to kill a snake, and to his surprise found that the "stone" weighed nearly 30 pounds! Except for a few small fragments, most of this meteorite, **Pittsburg,** was unfortunately forged into a bar, and lost soon afterwards. In **Burlington,** N.Y., another farmer found a mass weighing between 100 and 200 pounds. By the time it was seen by someone familiar with meteorites, less than 12 pounds remained. "The smith assured me that he never worked stronger, tougher, or purer iron; that it made the best horse-shoe nails."[6]

Benjamin Silliman, Jr. exchanged portions of his irons and of specimens from Yale's collection with several



George J. Brush, 1831–1912.

individuals and institutions, particularly the British Museum and the Mineralogical Museum of the University of Berlin. About 25 of our meteorites are directly traceable to his efforts; it is certain that more of them passed through his hands, but documentation of their origin is lacking.

Specimens of at least 50 different meteorites were added to our collection over the years by exchanges with the two most important American figures in the field of meteoritics in the mid-19th century, Charles Upham Shepard (1804–1886) and J. Lawrence Smith (1818–1883). Both of them published many papers on meteorites, often after acquiring the one under discussion. Shepard had worked on meteorites in Yale's collection while he was Benjamin Silliman, Sr.'s assistant. He was a Lecturer in Natural History at Yale from 1833 to 1847, and was for many years Professor of Chemistry and Natural History both at the Medical College at Charleston, S.C., and at Amherst College, his alma mater. Shepard's meteorite collection, in the mid-1800s second in size only to the collection at Vienna, went to Amherst. In his later years he formed another, smaller collection for his son, which is now in Washington.

J. Lawrence Smith's career was a mixture of consulting, teaching, and research. After 12 years as Professor of Chemistry at the University of Louisville, in 1866 he retired completely from teaching to devote himself to studies of meteorites and minerals in his own very well-equipped laboratory in Louisville. His fine meteorite collection was purchased for Harvard just before his death.

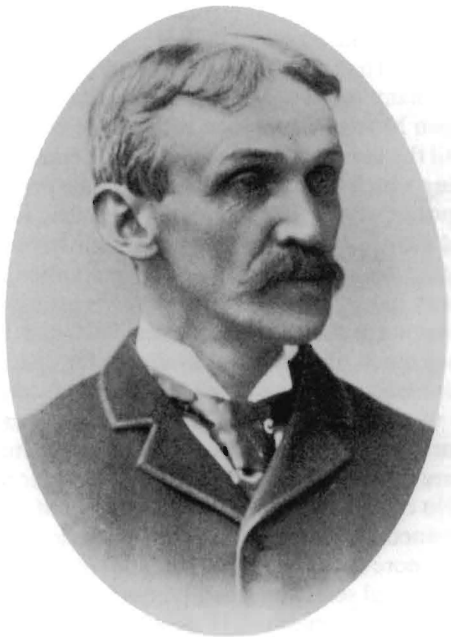
With a few exceptions like C. U. Shepard, who began serious collecting in the 1830s, and the Vienna Museum, where some of the pioneers in the field worked on a large collection that had been tended faithfully since early in the century, many meteorite collections, such as Yale's and the British Museum's, did not receive systematic attention until the late 1850s or early 60s. The enthusiasm for collecting which began about 1860 was due partly to the development of new techniques for scientific investigation and the need for as large and representative a collection as possible upon which to work; in addition, by this time many more meteorites were known (nearly 200 meteorites were seen to fall between 1800 and 1870) so there was much new material available for distribution. Extensive trading, fierce competition, and flourishing dealers were characteristic of the following decades. In the attempt to accumulate long lists of meteorite names, collectors and curators alike were willing to accept, and offered in exchange as well, tiny fragments of meteorites which sometimes had not been overly large to begin with. Thirty or more of the meteorite localities in our collection are represented solely by small pieces weighing less than ten grams (about one-third of an ounce).

The Curatorship of George J. Brush, 1867–1874

In 1866 George Peabody made his famous gift of $150,000 to found a museum of natural history at Yale. The institution known as the Peabody Museum dates from that time, although it did not have a building of its own for another ten years. In 1867 the first official Curators of the Museum's collections were appointed, among them G. J. Brush. J. D. Dana later wrote, "Professor George J. Brush was appointed Curator of the Yale College Mineral Cabinet on my earnest recommendation and against his desire; and the choice proved to be greatly to the interests of the collections . . ."[7] In Brush's first year and a half as Curator he added 49 new meteorites, bringing the total number of localities in the collection to 103, with a total weight of 1740 pounds. Some of Benjamin Silliman, Jr.'s meteorites were included in the new acquisitions, as well as 10 in exchange from the British Museum, and gifts from J. Lawrence Smith and Brush himself.

The earliest catalogue of the collection that I have found so far is a set of two manuscript notebooks, one for stony meteorites and one for irons, compiled by Brush in late 1868 and early 1869. In addition to listing most of the minimum data that must be included in an individual entry (name of the place where the meteorite fell or was found, date, type of meteorite, weight of each specimen, source, and date of acquisition) to the limited extent that they were available to him, Brush placed each meteorite, flattest side down, directly on the catalogue page and traced around it with a pencil. The outlines produced this way have turned out to be an almost infallible means of identification of meteorites in the Yale collection.

In March 1869 Brush issued a printed catalogue in pamphlet form, apparently the collection's first, and in September he published a description of the most recently acquired meteorite; though there are incomplete notations recording two exchanges a few years later, his active attention to the Meteorite Collection seems to have ended



Edward S. Dana, 1849–1935.

in 1869. George J. Brush had been a member of the Class of 1852, the first class to receive a degree from Yale's budding Scientific School. Later, as the Sheffield's Secretary and Treasurer, he had been greatly responsible for the school's steady development. He was appointed Director in 1872 and this position, in addition to the duties of the Professorship of Mineralogy, made it impossible for him to continue his curatorial work as well, and he resigned from the Curatorship in 1874.

The Achievements of E. S. Dana, 1874–1922

The first Peabody Museum was under construction when Edward Salisbury Dana (son of J. D. Dana), still two years away from his Ph.D., was appointed Curator of the Mineral Collection in 1874. His first undertaking, and the reason for his appointment at that time, was the mammoth job of selecting, organizing, and labelling material for display in the Mineralogical Hall of the new museum, as well as overseeing the transfer of the whole collection from the Cabinet Building, its previous home. E. S. Dana was to be the Curator for nearly 50 years, and the Meteorite Collection benefitted greatly from his care; with about 120 different meteorite localities added by exchange, purchase, and gift, it more than doubled in size.

In 1895 he hired an assistant for one year to catch up on the cataloguing of recently-acquired minerals and meteorites, which had fallen behind. This assistant was **Henry Stephens Washington,** Yale '86, Ph.D. Leipzig, 1893, later to become a well-known petrologist at the Geophysical Laboratory of the Carnegie Institution in Washington, D.C. Washington copied over Brush's catalogues in two fresh notebooks, adding the many new meteorites acquired by E. S. Dana, and he published a catalogue of the collection—updating E. S. Dana's of 1886—in the *American Journal of Science*.

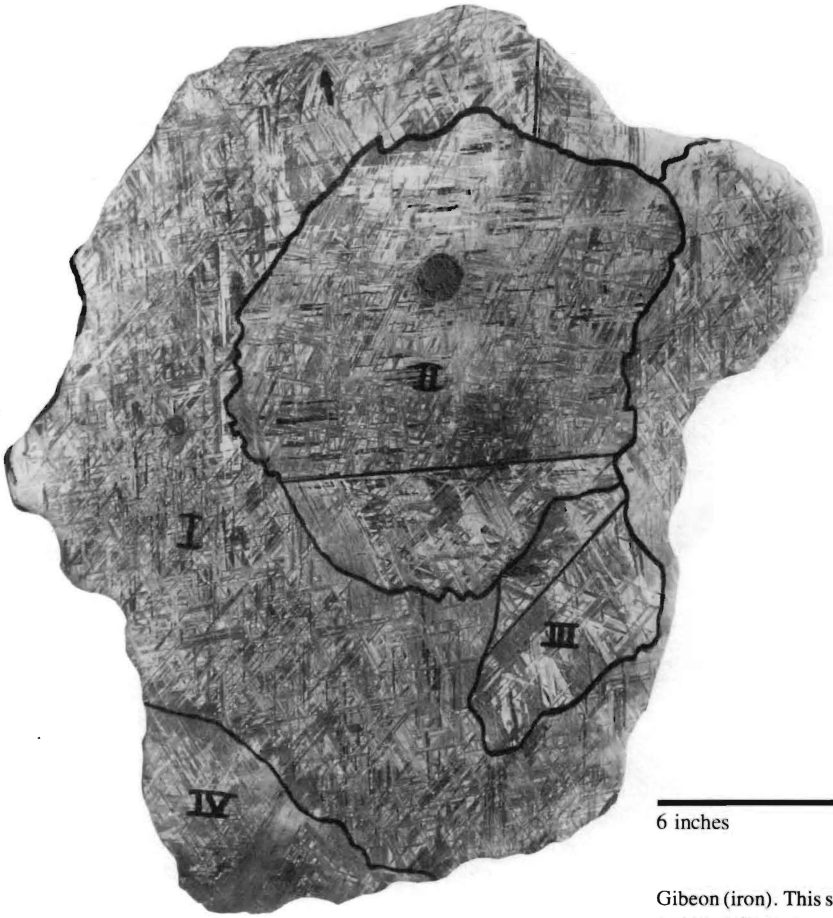
E.S. Dana's acquisitions were notable for their size, quality, and scientific interest, and some of them are described here. By enlisting the aid of fellow professors and citizens of New Haven he was able to buy important specimens whose cost was beyond the resources of his annual budget.

Iowa Meteorite Showers A curious coincidence is that three large unrelated meteorite showers occurred in the state of Iowa in the short span of 15 years—one in 1875 (Homestead), one in 1879 (Estherville), and another in 1890 (Forest City). Each of these falls is especially well represented in Yale's collection.

A fine suite of 21 stones of assorted sizes (the largest, over 26 pounds) of the **Homestead** fall was procured for the Museum through the generosity of R. S. Fellowes, Yale 1832, of New Haven and "several officers of the University." A special case was prepared for these stones, apart from the rest of the meteorite display. About 100 stones fell; Yale has the largest share. This stone is classified as a chondrite.

The fireball associated with **Estherville** appeared about five in the afternoon. "~~The sounds produced scribable,~~' as scaring cattle and terrifying the people over an area many miles in diameter. At first they were louder than that of the largest artillery; these were followed by a rumbling noise, as of a train of cars crossing a bridge. The concussion when it struck the ground was sensible to many persons . . ." Five good-sized masses were eventually found; the largest, weighing 437 pounds, was luckily seen to land, as it penetrated 8 feet into the ground at the bottom of a previously dug 6-foot hole filled with water. We have the third largest, 92.5 pounds, found nine months later when "a trapper on the prairies, who had witnessed the original occurrence, observed a hole in a dried-up slough; on sounding it with his rat spear, he detected a hard body at the bottom, and on digging found the stone at a depth of five feet."[8]

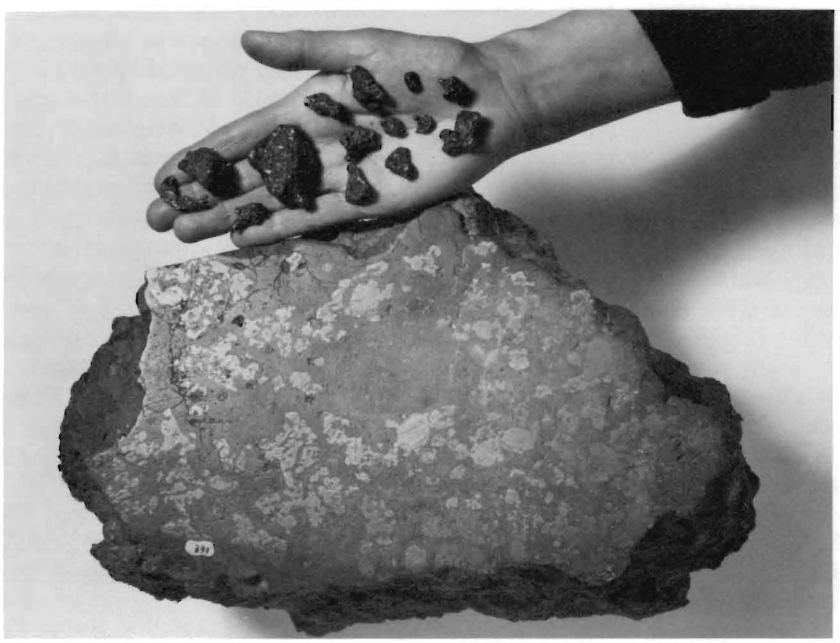
Estherville is one type of stony-iron, a mesosiderite. Its structure is unusual in that the iron is concentrated in nodules within the surrounding stony material instead of being dispersed throughout the mass in smaller particles, as in most mesosiderites. In the meteorite's fiery passage through the atmosphere, much of the stony matter disintegrated, releasing nuggets of pure metal. "A number of boys, herding cattle near a lake about four miles west of Estherville on the day of the fall, reported that when the meteor passed over them, a great shower of what appeared to them hailstones fell, and that the surface of the water was alive with the falling bodies." A year later, "the people of that neighborhood began to find, on the freshly burnt prairies, small pieces of meteorites from the size of a pea to one pound in weight;" shortly afterwards, "thousands of men, women, and children were on the ground daily,"[9] gathering them up. About 600 of these

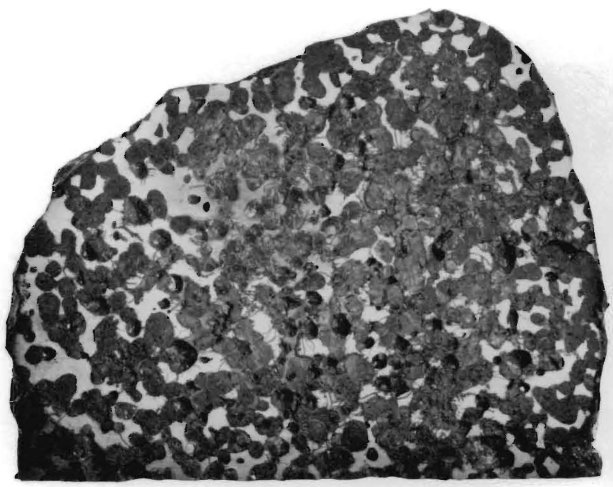


6 inches

Gibeon (iron). This slice has been polished and etched with acid to reveal its internal structure. Crystal boundaries (see text) have been drawn on the photograph. The round black spot is an inclusion of iron sulphide.

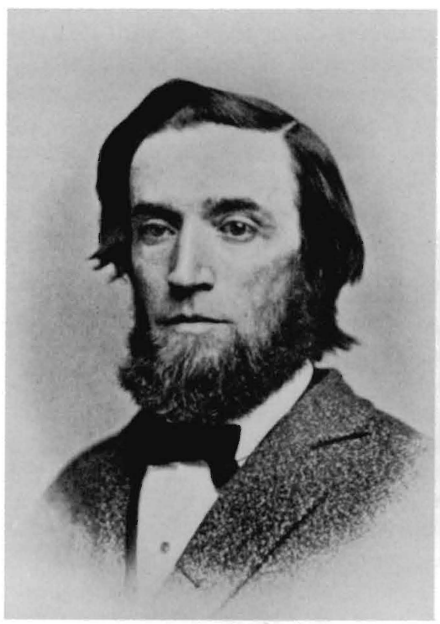
Estherville (stony-iron). Found with the aid of a rat spear. The patches of metal (light) visible on the cut surface show how the small iron pieces were originally embedded in a larger stony mass.





1 inch

Brenham (stony-iron). Polished slice shows rounded inclusions of olivine (dark) within the metal (light). From Brookhaven Collection.



Hubert A. Newton, 1830–1896.

little pieces were purchased along with the 92.5 pound mass, with funds provided by Joshua Coit, Governor J. E. English, Henry Farnam, Professor E. E. Salisbury, J. B. Sargent, Henry Trowbridge, Mason Young, and Professors G. J. Brush, O. C. Marsh, Elias Loomis, H. A. Newton, and J. D. Dana.

The third of the Iowa meteorite showers, **Forest City,** was heralded by detonations heard over a hundred miles away. Thousands of stones fell; between 900 and 1000 were given to us by Henry F. and Alice K. English. This is, again, probably the largest representation of this meteorite fall in any collection.

Mr. and Mrs. English also presented a slice of one of the 81 large iron masses (total weight over 23 tons) found in Southwest Africa, known collectively as **Gibeon.** This important slice is now on display in the Peabody Museum; it includes portions of four crystals of the iron, whereas most iron meteorites are fragments of only one.

To **O. C. Marsh,** a collector of meteorites as of almost everything else, we owe 50 specimens of Estherville (in addition to his contribution to the purchase of the large mass) and two specimens of the great shower at **Pultusk,** Poland, where, after the usual fireball and detonations, an estimated 100,000 stones fell in 1868.

The Brenham Pallasite In the 1880s, Kansas cowboys were aware that in Kiowa County there were some odd rocks sticking up out of the heavy sod of the prairie, where normally no stones at all were to be seen. Thinking that they might be of some value, one of the cowboys attempted to take three of them to the nearest town, eight miles away; they were too heavy to carry on horseback, and so he buried them in a gulch. Just before dying from typhoid fever a few months later, he disclosed the hiding-place to two of the townspeople. After about a year his strange rocks were found and dug up; the largest, weighing 101.5 pounds, was placed on the sidewalk outside a lawyer's office in the town, where it remained for three years. (This specimen is now in our collection.) In the meantime, the same area was being settled by farmers, who found more and more of these masses as they ploughed up the sod. About 20 large pieces were found in all, and the farmers put them to good use: one, of 55 pounds, weighted down a haystack against the wind; another, 75 pounds, held down the cover to a rain barrel; a 350-pound piece secured the roof of a stable. (Many more specimens, some much larger, were found years later, as well as a small crater.) In 1890, these "rocks" came to the attention of the scientific community and they were found to be pieces of a stony-iron meteorite, this time a pallasite. Pallasites consist of a continuous network of metal with inclusions of transparent green, yellow, or brown olivine, and present a striking appearance when sliced and polished. Our large specimen of this pallasite, **Brenham,** was the gift of Edward M. Reed, a member of the board and a benefactor of the Yale Observatory, and Pierce N. Welch, Yale '62. Mr. Welch is remembered also for his gift to Yale of Welch Hall, named for his father, a former mayor of New Haven.

Brenham has archaeological, as well as cosmic in-

Cañon Diablo (iron). Peabody's second largest meteorite. The cut surface shows its heterogeneous character. The thumbprint-like indentations often seen on meteorite surfaces are greatly exaggerated in Cañon Diablo. Approximately two feet across.

terest. Our collection contains a gift from Professor H. A. Newton, part of a 1.75-pound pallasitic mass found in 1882 on the main altar of one of the Turner Mounds built by the Hopewell Indians in the Little Miami Valley in Ohio. Numerous fragments of identical material were later found in other mounds, some fashioned into tools and ornaments. It was early suggested that they might be pieces of the Brenham pallasite, and this has been confirmed by modern analytic techniques. Kiowa County, Kansas, the source of all this metal, is nearly a thousand miles away from the Hopewell Mounds in Ohio. Other objects found in the mounds were also transported from great distances, presumably through trading—copper from Michigan, shells from the Gulf of Mexico, mica from the Appalachians, and obsidian from what is now Yellowstone National Park.[10]

A beautiful large slice of **Sacramento Mountains,** a 523-pound iron meteorite found by a shepherd in New Mexico about 1890, was the gift of E. Hayes Trowbridge, a New Haven philanthropist. The unusually severe distortion of the internal structure of this meteorite is evidence of a mighty clash with another body sometime during its years in space.

One of the most interesting meteorites that North America has produced is **Cañon Diablo.** Not only is it crammed with all sorts of meteoritic minerals, it also contains diamonds—almost microscopic, to be sure. About 30 tons of pieces of this iron meteorite have been collected since 1891 in the vicinity of Meteor Crater in Arizona, all that remains after the vaporization of most of the original mass (of perhaps 50,000 tons; estimates vary) when it collided with the Earth thousands of years ago.

This mass was too big and travelling too fast to be slowed down by the Earth's atmosphere, and a gigantic explosion took place at the moment of impact. A magnificent 826-pound specimen of Cañon Diablo was presented to the Museum in memory of Elias Loomis (1811–1889), Professor of Natural Philosophy and Astronomy at Yale, by his sons and friends.

In 1897 our collection added a 65-pound meteorite, acquired through the intermediary assistance of S. W. Williston, then Professor of Geology and Anatomy at the University of Kansas (and formerly an assistant to O.C. Marsh and Professor of Anatomy at Yale from 1886 to 1890). The meteorite had been seen near **Jerome,** Kansas, in 1894 by Handel T. Martin, a collector and preparator of fossils who had in the past collected for both Marsh and Williston. While camped near the Smoky Hill River in western Kansas, Martin was eating breakfast one wet and chilly April morning when his attention was caught by an odd, rusty-looking rock nearby. Two years later he was at the American Museum of Natural History in New York talking with the curator of mineralogy when a dealer walked up and began to show them some meteorites. Realizing that the strange rock he had seen in Kansas was a meteorite, Martin wrote to a fellow fossil collector, gave him precise directions to the spot where it still lay, and asked him to ship it to Williston for identification and sale. Williston offered it to E. S. Dana for Yale's collection; the money to buy it was provided by one generous individual who stipulated that the gift be listed as one from "Members of the Class of 1857."

Hubert Anson Newton, Yale 1850, Professor of Mathematics from 1855 until he died in 1896, published many papers on comets, meteors, and meteorites. He had a strong interest in meteorites and in the welfare of Yale's collection: he contributed to the purchase of Homestead and Estherville, and he gave us several other meteorites, one of them a 55-pound iron meteorite found in 1883 at **Hammond,** Wisconsin. Another gift from him, mentioned earlier, was a fragment of the piece of **Brenham** found in the Indian mound in Ohio. In 1889 he showed this to his audience at a lecture entitled, "The Worship of Meteorites." Posthumously published in the *American Journal of Science,*[11] it is a fascinating account of reverence paid to stones from the sky in ancient and modern times, with numerous examples drawn from Greek and Latin literature.

After his death, H. A. Newton's own meteorite collection was given to the Museum by his daughters. It contained specimens of about 100 different localities, of which 19 were new to us, and was accompanied by an admirable manuscript catalogue. His collection was made one of the Peabody Museum's special exhibits for Yale's Bicentennial Celebration in 1901.

Professor E. S. Dana's fruitful 48-year curatorship (1874–1922) lasted longer than the first Peabody Museum building did, but his service to the Museum did not end there. After O. C. Marsh's death in 1899 Dana replaced him as Chairman of the Museum's Board of Trustees. In that capacity he played a large part in the smooth transfer to Yale University of land it wanted to build on—the property owned by the trustees on High Street on which the Museum stood. This was an early step in the developments which led to the construction of a badly needed larger building.

When the Museum was torn down in 1917, its collections went into storage. There they remained for an unexpected seven years until the much roomier new Peabody Museum building was ready to accommodate them. Unfortunately, the Meteorite Collection suffered during these moves. Some of the meteorites were separated from their labels, unrelated meteorites were put together, and quite a few were lost. (In recent years most of the confusion has been resolved, but some meteorites are still missing.)

In the Present Peabody Museum, 1925–1960

William Ebenezer Ford (1878–1939) was appointed Curator of Mineralogy in 1922. In preparation for the new meteorite display, he recatalogued the entire collection (incorporating H. A. Newton's meteorites), sensibly combining stones and irons into one list, and he hand-lettered a label for each one. Once the meteorites were on exhibit, activity concerning the collection more or less ceased, though an exchange with the U.S. National Museum brought us a large slice of the Brenham pallasite in 1926. Interest in collecting meteorites had reached a low ebb nationally shortly after the turn of the century, possibly because the major dealers and collectors who had fostered their wide distribution in the 19th century were

The Information Contained in Meteorites

In the 19th century, meteorites were of interest primarily to mineralogists and chemists, who studied their structure and composition. In mid-20th century, it is to geochemists (who could better be called ~~cosmo-chemists~~) that meteorites are most useful. With the advent of the space age, meteorites have come into their own. They have secrets to tell about the formation of a star—our Sun—and its planets, including the Earth, about 4.6 billion years ago. Some meteorites are able to tell us about events prior to that, before our solar system even existed; all of them contain evidence of what has happened to them since then.

Fundamental contributions to our understanding of the formation of our solar system have been made in the Yale University doctoral dissertations of two former Curatorial Assistants in the Peabody Museum Division of Meteorites, Lawrence Grossman (''Condensation, Chondrites and Planets,'' 1972) and Andrew M. Davis (''The Cosmochemical History of the Pallasites,'' 1977).

all gone. The two World Wars and the Depression doubtless contributed to the neglect of many established meteorite collections during the first half of this century.

In the 1920s one dedicated man, H. H. Nininger, began an educational campaign in the Midwest that was responsible for the discovery of more than 200 new American meteorites during the next 35 years. He visited Yale at least twice, and initiated a series of exchanges with W. E. Ford that added specimens of over a dozen meteorites to the collection. After Ford's death, C. R. Longwell (Curator of Geology) concluded another transaction that brought the total received from Nininger to 17.

During the next 20 years, the most notable addition to the Meteorite Collection was a 17-pound iron meteorite (identity uncertain) which had been given by Mexican officials to George R. Wieland, Yale's paleobotanist, while he was in Mexico in search of fossil cycads early in this century.

In the 1950s a great deal of work was done on the collection by **Kurt Servos,** a graduate student in Mineralogy, under the direction of Curator **Horace Winchell.** Servos accessioned the acquisitions of the previous 35 years, which for some reason had never been catalogued, having unearthed them from storage areas in the Museum and in Kirtland Hall, the home of the Department of Geology until 1963, and the place where the Meteorite Collection was probably temporarily housed after the old Museum was demolished. Towards the end of his stay at Yale, Servos found the old manuscript catalogues of G. J. Brush, H. S. Washington (with additions by E. S. Dana), and H. A. Newton in a drawer in the Museum, but was able to make use of them for only a short time. In 1956 he published a catalogue of the collection, the first since H. S. Washington's of 1897, as a *Postilla,* one of the Museum's publication series.

A New Museum Division: Meteorites, 1960–

With the appointment of Professor **Karl K. Turekian** as Consultant on Meteorites in 1960, the Peabody Museum Collection of Meteorites was separated from the Mineral Collection. In 1962 Professor Turekian was made Research Associate and in 1966 he became the Museum's first Curator of Meteorites.

Through a vigorous program of exchange, and with some noteworthy gifts, the collection has been increased since 1960 by specimens of 110 new meteorites; 76 of these were not previously represented. In an exchange with the Academy of Sciences in Moscow we received specimens of six Russian meteorites. One of them was a nearly two-pound piece of **Sikhote-Alin,** the largest witnessed meteorite fall of all time, when a *shower of fireballs* occurred in eastern Siberia in 1947, producing more than 100 impact holes and craters and over 25 tons of iron fragments.

Sheldon G. Morris, a Life Member of the Peabody Museum Associates and well known to Curators of other collections for his generosity, has contributed specimens to the Meteorite Collection as well.

An important recent addition of meteorites is the

1 inch

Tektites from Australia (top), South Vietnam (middle), and Indonesia (bottom).

former collection of the Brookhaven National Laboratory. This was given to us at the recommendation of Raymond Davis, Jr., Yale Ph.D. 1942, father of **Andrew M. Davis,** former Curatorial Assistant, Yale Ph.D. 1977. This collection contains good-sized specimens, totalling about 31 pounds, of 65 localities, 38 of which are new to us.

A considerable assortment of glassy **tektites** has been accumulated in recent years. Tektites are *not* meteorites but are now generally agreed to be solidified droplets of melted earth soil and rock splashed miles into the air, even above the atmosphere, during the explosive formation of a giant meteorite crater. Brian J. Skinner, Eugene Higgins Professor of Geology and Geophysics, has given us a magnificent collection of Australian tektites—over 3000 specimens gathered for him some years ago by a tribe of aborigines.

Some of the meteorites mentioned here can be seen in The Museum's Meteorite Exhibit, which opened in 1971. These include Weston, Estherville, Forest City, Gibeon, Brenham, Cañon Diablo, and Sikhote-Alin. The exhibit was prepared with the help of **Lawrence Grossman,** Yale Ph.D., 1972, Curatorial Assistant during his graduate student days.

The Meteorite Collection today contains thousands of specimens, altogether weighing probably more than two tons, representing 386 different meteorite localities. Fifteen of these are the original main masses, or what's left of them after the removal of pieces for trading and study over a hundred or more years; we have a large percentage of the total preserved anywhere of about 15 other localities. Our largest meteorite is still Red River, housed in Gibbs Laboratory on loan to Yale's Department of Astronomy.

Sources

This history has been gradually pieced together out of bits of information from many sources, and undoubtedly much remains to be brought to light. Benjamin Silliman, Sr. very kindly spent more than four years, off and on, writing his reminiscences in which he included detailed accounts of Weston and Red River. These memoirs, and whatever exists of 19th century papers and correspon-

dence concerning the collection, are on file in Manuscripts and Archives, Sterling Memorial Library. The early volumes of the *American Journal of Science* are a vast reservoir of information on probably almost every meteorite of the 19th century. The old manuscript catalogues were again hidden away after Kurt Servos left Yale, and I found them by chance in the Museum vault in 1973. With the help of the outlines methodically drawn by Brush, Washington, E. S. Dana, and Newton, meteorites which had been unidentified or mislabelled for 50 years have been restored to their proper places.

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