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METEORITES OF NORTHEASTERN NEW MEXICO

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INTRODUCTION

Meteorites are naturally occurring, solid objects which reach the earth from space. Man has known about meteorites for millennia, and classical Chinese and ancient Greek and Latin literature have recorded the fall of stones from the sky. The oldest fall from which material is definitely known is the Ensisheim meteorite which fell on the 16th of November in 1492 near Ensisheim, Alsace, France. Until the early 1800's scientists remained skeptical about stones that fell from the sky. Then on April 26, 1803, a fireball was observed over France and a shower of several thousand stones fell near L'Aigle. Biot (1803) described this fall and established that meteorites do indeed fall from the sky.

Brown (1961) has estimated that about 500 meteorites arrive on the earth each year of which about five are recovered (about one fall per year is recovered in the U.S.). Meteorites are named after their place of fall or find (closest village or well-known landmark). Meteorites vary in size, with the smallest weighing 0.0003 gm (Sikhote Alin, USSR) and the largest weighing about 60 metric tons (Hoba, Southwest Africa). Meteorites frequently break apart during entry into the earth's atmosphere, producing meteorite showers. The largest known meteorite shower in terms of the number of specimens occurred near Pultusk, Poland, in 1868, from which about 100,000 stones were recovered.

Meteorites are divided into four broad classes: achondrites, chondrites, stony-irons and irons. Chondrites are the most abundant meteorites, making up 86% of the known meteorite falls, and stony-irons and irons the least abundant with 1.3 and 3.7%, respectively (Table 1). The irons and stony-irons, however, make up over 50% of the finds, because they are easier to recognize and are more resistant to terrestrial weathering.

The achondrites (Figs. 1, 2) are generally divided into eight groups on the basis of mineralogical and chemical composition: enstatite, bronzite, olivine, olivine-pigeonite, augite, diopside-olivine, polymict orthopyroxene-pigeonite-plagioclase and monomict pigeonite-plagioclase achondrites. Achondrites exhibit textures similar to terrestrial rocks: for example, cumulate textures are present in olivine-pigeonite achondrites; basaltic textures, in monomict pigeonite-plagioclase achondrites; brecciated textures, in polymict orthopyroxene-pigeonite-plagioclase achondrites.

Table 1. Number of falls and finds and frequency of meteorites (after Wasson, 1974).

Class	# Falls*	Frequency (%)	# Finds
Achondrites	63	9.0	10
Chondrites	604	86.0	448
Stony-irons	9	1.3	52
Irons	26	3.7	441
	702		951

* A fall is a meteorite actually seen to fall and a find is a meteorite recognized but not seen to fall.

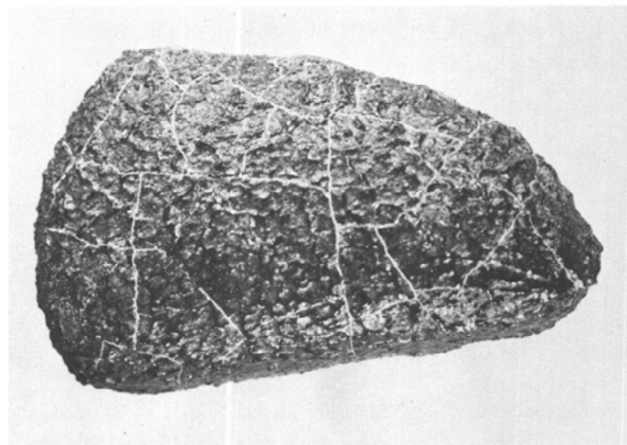

Figure 1. One of the Pasamonte stones encrusted with a black fusion crust. The cracks were formed by contraction of the fusion crust when cooled. Specimen is 6.5 cm long.

Figure 2. Photomicrograph of the Pasamonte meteorite exhibiting basaltic texture. Field of view is 2 mm. Plane polarized light.

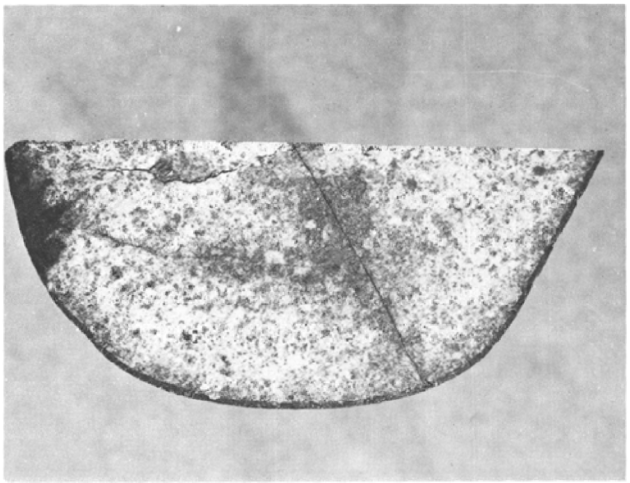

Figure 3. Cut face of the Roy (1934) chondrite. Note the thin rind (∿1 mm thick) of fusion crust and veinlets running through the slice which are due to shock. Specimen is 6.5 cm long.

The chondrites (Figs. 3, 4) are characterized by chondrules which are small, millimeter-sized, spherical bodies composed of olivine, pyroxene and plagioclase or glass. Chondrules vary in diameter from a few tenths of a millimeter up to a few millimeters and occasionally up to several centimeters. They may constitute as much as 70% of a meteorite. Chondrites are composed of olivine and pyroxene (60-70%), plagioclase (5-10%), nickel-iron (0-25%) and troilite (5-15%). The chon-drites are generally subdivided into five groups based on total iron content and ratio of oxidized to reduced iron. The E group or enstatite chondrites are the most reduced group with less than 0.5% FeO; the C group or carbonaceous chondrites are the most oxidized with little or no nickel-iron metal. The H (high total iron), L (low total iron) and LL (low total iron and low metal) group chondrites lie between these extremes and are collectively called the ordinary chondrites, since they make up about 80% of the meteorite falls. Van Schmus and Wood (1967) have subdivided H, L, and LL group chrondrites into six subgroups based on petrographic parameters, such as nature of chondrule-matrix boundaries, presence or absence of igneous glass and feldspar, and degree of homogeneity of mafic silicates. They implied that the most highly recrystallized chondrites (type 6) have formed by metamorphism of the less recrystallized types (5, 4, 3, etc.).

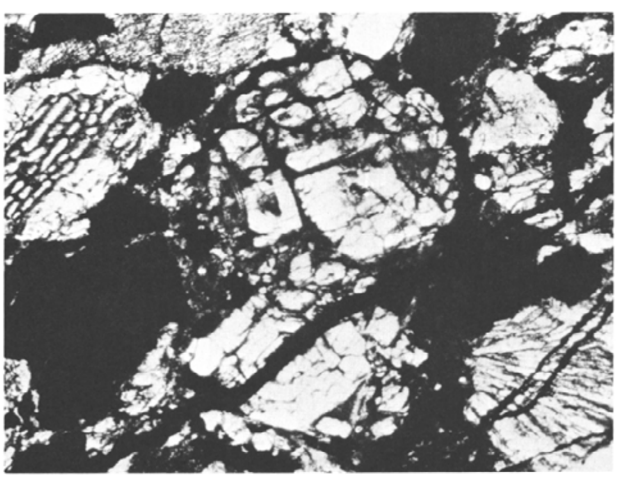

Figure 4. Photomicrograph of the Chico Hills chondrite exhibiting chondrules. Transmitted light, crossed nicols. Field of view is 2 mm.

The stony-irons are divided into four groups on the basis of mineralogy and chemistry, namely pallasites, mesosiderites, siderophyre and lodranite. The last two groups have only one member each. The pallasites are coarse-grained with centimeter-sized olivine crystals in a nickel-iron matrix. The mesosiderites are breccias with silicates similar to those of polymict orthopyroxene-pigeonite-plagioclase achondrites, but contain considerable metal.

Most iron meteorites, chondrites and stony-irons contain two nickel-iron phases, kamacite and taenite. Kamacite usually has 5 to 7% Ni, and taenite, from 20 to 50% Ni. Iron meteorites (Fig. 5) are composed entirely of kamacite crystals. Octahedrites (6-18% Ni) are composed of kamacite plates which parallel the faces of an octahedron with taenite rimming the kamacite. This structure is known as the Widmanstätten structure and is revealed by etching. Nickel-rich ataxites (>12% Ni) have a fine-grained intergrowth of kamacite and taenite. Recently, the iron meteorites have been divided into 15 groups on the basis of their trace element composition (Ni, Ga, Ge and Ir) (Wasson, 1974). This division is supported by textural and mineralogical data (for example, the occurrence of troilite, schreibersite, daubreelite, cohenite, graphite and silicates).

METEORITES OF NORTHEASTERN NEW MEXICO

Hey's Catalogue of Meteorites (1966) lists 22 meteorites from northeastern New Mexico. Here we consider northeastern New Mexico as that portion of New Mexico north of 35° N. latitude and east of 106° W. longitude. In 1970, another meteorite was found, bringing the total to 23. Three of these have been paired with other meteorites (two or more meteorites given different names, but subsequently found to belong to the same fall), and it is possible that several of the others are also paired. Of the 20 remaining meteorites (see Table 2 and Fig. 6), two are achondrites, 14 are chondrites, one is a stony-iron and three are irons.

The achondrites, Pasamonte and Palo Blanco Creek, are monomict pigeonite-plagioclase achondrites. They appear to be distinct falls with Palo Blanco Creek being more coarse-

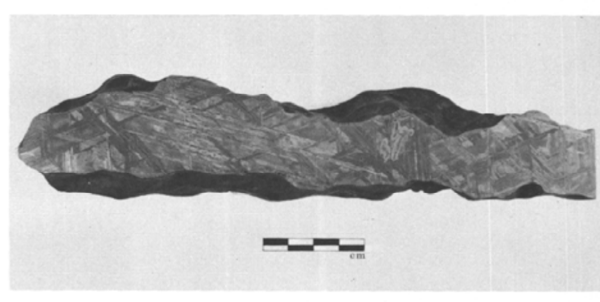

Figure 5. One of the Glorieta Mountain irons. Etched to reveal the Widmanstätten pattern. Specimen is 23 cm long.

Table 2. Meteorites of Northeastern New Mexico.

Name	Class[1]	Composition[2]	Date found	No. of fragments	Total known weight, kg
Pasamonte*	Ap	Fs 32-49	1933, 24 March	75	3-4
Palo Blanco Creek	Ap	Fs 61.3	~1954	1(?)	?
Beenham	L5	Fa 23.6	1937	30	44.4
Roy (1933)	L5	Fa 26.1	1933, spring	1	47
Chico	L6	Fa 24.2	1954, Jan.	1	105
Point of Rocks (stone)	L6	Fa 25.2	~1954	1	.9
Roy (1934) Tequezquito Creek[3]	L6	Fa 25.1	1934	2	5.6
Abbott	H3-5	Fa 19.4	1951	370	17
Aurora	H4	Fa 19.3	1938	1	1
Chico Hills	H4	Fa 19.4	1951	35	6.5
Gladstone	H4	Fa 18.7	1936	3	57.3
Mosquero	H4			1(?)	1.6
Ute Creek	H4	Fa 18.8	1936	several	2
Farley	H5	Fa 18.7	1936	2	19.4
Tafoya	H5	Fa 19.2	~1951	2	.5
Mills	H6	Fa 19.8	1970	6	88
El Rancho Grande	Pallasite		1954	1(?)	?
Glorieta Mountain[4]	Pal-an	Ni 12.04	1884	28	186
Santa Fe[5]			1930	1	10
Pojoaque[5]			1931	1	.1
Costilla Peak	IIIA	Ni 7.49	1881	1	35
Point of Rocks (iron)	IIIA	Ni 8.4	1956	1(?)	?

* Observed fall.
1 Abbreviations used: Ap = monomict pigeonite-plagioclase achondrite; Pal-an = anomalous iron with pallasitic areas.
2 Pyroxene composition for achondrites; olivine for chondrites; metal for irons. Ni data from Wasson (1974), all other data from this work.
3 Synonym for Roy (1934).
4 Includes Santa Fe and Pojoaque.
5 Paired with Glorieta Mountain.

grained, shocked and recrystallized. The pyroxene composition trends are also different; the pigeonite in Pasamonte is zoned and varies in composition from En63 Fs32 Wo5 to En24 FS49 W027 (Fig. 7) whereas pyroxene in Palo Blanco Creek varies from ferro-pigeonite (En35 Fs61 Wo3) to ferroaugite (En28 Fs30 Wo42)•

Of the 14 chondrites, five are L-group and nine are H-group chondrites. Beenham.and Roy (1933) are L5 chondrites differing in composition (Fa 23.6 *vs* 26.1, respectively) and degree of weathering; Beenham is very fresh whereas Roy (1933) is weathered. Chico, Point of Rocks (stone) and Roy (1934) are L6 chondrites. Roy (1934) is quite distinct from the others and is a very fresh find. Both Chico and Point of Rocks (stone) are weathered finds with similar appearances. Both have been heavily shocked and have undergone subsequent recrystallization, giving them very similar textures. Their olivine compositions differ, however (Fa 24.2 *vs* 25.2, a -±0.7) and thus, it can not be conclusively stated that they are paired.

The H-group chondrites present a complex picture. Seven belong to subgroups H4 or HS, and all but two were found within 35 km of each other. Levi-Donati and Jarosewich (1974) compared Mills with Farley, Gladstone and Ute Creek and suggested that they may all be paired. They have classified Mills as an H5 and Gladstone and Ute Creek as H4's; the present work agrees with their classification of Gladstone and Ute Creek but indicates that Mills should be classified as an H6. The presence of well-developed plagioclase indicates a petrologic type 6 rather than 5. Abbott, Farley and the second Tafoya stone have been classified as H5; and the others (Aurora, Chico Hills, Gladstone, Ute Creek and the first Tafoya stone) as H4. Two of the three Abbott stones which have been studied are less crystalline than the material described by Fodor and others (1976) and more closely resemble H3 or H4 chondrites. Microprobe analyses of 50 olivine grains in one of the sections shows a wide range in composition (Fa 8.5 to 24.8, ave. 18.5; % mean deviation of FeO 5%, % MD of FeO contents in olivine is > 5% for type 3 chondrites and < 5% for types 4, 5, and 6) which indicates an H3 chondrite. Fodor and others (1976) have described Abbott as a polymict breccia containing light-colored and carbonaceous chondrite type II lithic fragments, as well as equilibrated and unequilibrated portions. The variation in texture from H3 to HS makes it difficult to assign Abbott to a specific class. It is interesting to note that Gladstone was classified as an H6 chondrite by Van Schmus and Wood (1967) and as an H4 by Levi-Donati and Jarosewich (1974). The UNM section is an H4; perhaps Gladstone exhibits a range in textures similar to Abbott and they may indeed be paired. Except for Mills, the other H chondrites from this area exhibit textures intermediate between the extremes noted in Abbott. Carbonaceous chondrite lithic fragments have not been noted in any of the other chondrites from this area, but this may be a sampling problem. At the present time no definite conclusions can be drawn as to the pairing of the H-group chondrites.

The El Rancho Grande pallasite is different in appearance from the pallasitic portions of Glorieta Mountain, but has not yet been analyzed. It is severely weathered, with no metal present in the small specimen in the University of New Mexico Institute of Meteoritics' collection.

The three irons (Table 3), all octahedrites, are distinct. Glorieta Mountain is an anomalous iron with regions of pallasitic structure. The other two, Costilla Peak and Point of Rocks, are group IIIA irons; however, their trace element contents are different (particularly the Ir contents, 14 ppm for Costilla Peak *vs.* 0.46 ppm for Point of Rocks), making them distinct. Two meteorites, Santa Fe and Pojoaque, have been paired with Glorieta Mountain. The Santa Fe iron was found about 1930, and a poor analysis of it gave a nickel content much lower than that reported for Glorieta Mountain (4.64% *vs.* 11.15%, Henderson, 1934). Reanalysis of the Santa Fe iron gave 11.79% nickel (Henderson, 1941), indicating its similarity to Glorieta Mountain. The Pojoaque meteorite was found in an old Pueblo; it has a pallasitic structure and analyses of olivine in it and Glorieta Mountain (Fa 13.2 *vs.* 13.1; Buseck and Goldstein, 1969) are the same within analytical error.

Sixteen of the 20 meteorites found in northeastern New Mexico were recovered by two groups doing surveys in the area in attempts to recover meteorites from fireballs. Eight meteorites were recovered in five years by Dr. H. H. Nininger, following the fireball of March 24, 1933. He recovered fragments of this fireball (the Pasamonte achondrite), and then continued work in the area to recover seven additional meteorites which are not related to Pasannonte (Roy (1933), Roy (1934), Beenham, Gladstone, Farley, Ute Creek and Aurora). The other eight meteorites were recovered by Dr. L. LaPaz, following a fireball in March, 1951. Although no material was recovered from the fireball, eight meteorites were found in the following five years (Abbott, Chico, Chico Hills, El Rancho Grande, Palo Blanco Creek, Point of Rocks (iron), Point of Rocks (stone) and Tafoya).

In the following section, a brief account is given of each meteorite:

1. PASAMONTE; monomict pigeonite-plagioclase achondrite, fell 24 March, 1933, 0500 hrs. local time.

About 5:00 A.M. on the 24th of March, 1933, a brilliant meteor was observed heading WSW over Kansas, Oklahoma, Texas and terminated over northeastern New Mexico (Nininger, 1934a). One observer, Charles M. Brown, a foreman on

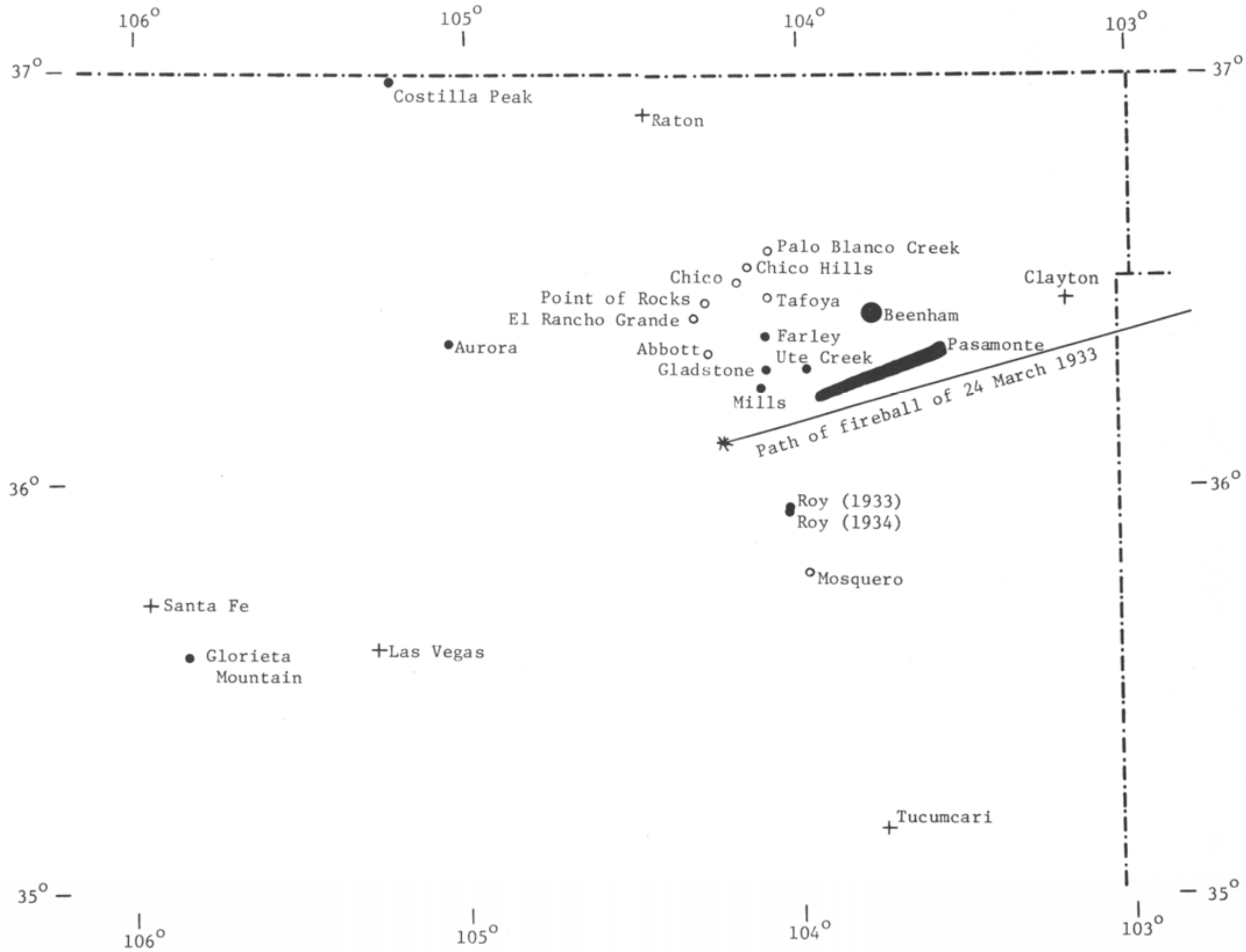

Figure 6. Location map of the meteorites recovered from northeastern New Mexico. Solid circles indicate meteorites for which the precise location(s) are known fairly well; open circles indicate only a general location. The large solid areas for Beenham and Pasamonte indicate the extent of their strewn fields. Crosses (+) are used for reference points. Note that the Pasamonte strewn field is several miles north of the flightpath of the fireball. The movement of the Pasamonte stones northward (and probably eastward) was due to strong upper atmospheric winds (Nininger, 1934, estimated winds of 165 MPH from the west to southwest).

the Lyons Ranch (25 miles southwest of Clayton), was just sitting down to breakfast as the clock struck five. The sky suddenly lit up like midday. Mr. Brown grabbed a Brownie camera which lay nearby on top of a radio, rushed out the door and was able to get a picture before the meteor dis-appeared over the house.

Dr. Nininger and his son were in Clovis at the time; unfortunately, the fine display was obscured in Clovis by clouds. Upon hearing of the bolide, Nininger began interviewing eye witnesses in New Mexico, Colorado, Kansas, Texas and Okla-homa. He determined that the meteor passed over Texhoma and Clayton and disappeared a few miles northeast of Mills at an altitude of 17 mi. The meteorite exploded four times before it disappeared and left a luminous cloud which per-sisted for several hours. Several photographs were taken of this cloud, and it is felt that the luminosity was not due to the sun's rays striking the dust cloud of the meteor, as the sun did not rise until an hour later.

The flight path Nininger obtained indicated that meteorite fragments might have landed west of Wagon Mound, and fruit-less searches were made of that area. In December of 1933, however, Nininger was passing through Clayton and decided to detour past Pasamonte. There he learned that "a Mexican sheep herder on the Pasamonte Ranch was panic-stricken by the falling of stones around his camp and that he later carried into headquarters one of the several small black ones which he picked up" (Nininger, 1936). Unfortunately, this stone was destroyed as each of the ranch hands "whittled at it with his knife." In the next two years, 70 stones were recovered with a total weight of about 2 kg; the largest weighed about 300 gm.

2. PALO BLANCO CREEK; monomict pigeonite-plagio-clase achondrite, found about 1954.

LaPaz (1965) originally listed the Palo Blanco Creek meteorite as a chondrite; subsequent examination of it showed that it is a monomict pigeonite-plagioclase achondrite.

3. BEENHAM; L5 chondrite, found 1937.

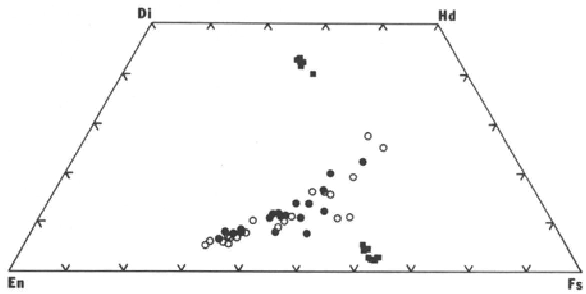

Figure 7. Pyroxene compositions in the Pasamonte and Palo Blanco Creek achondrites as determined by electron microprobe techniques. Open circles—Pasamonte matrix; solid circles—Pasamonte basaltic fragment; squares—Palo Blanco Creek. Exsolution lamellae were not detected in Pasamonte with either the microprobe or by optical microscopy.

Of Dr. Nininger's efforts in the Pasamonte area, he reports in his field notes (Nininger and Nininger, 1950

> "The first knowledge of this meteorite came as a result of the prolonged and extensive search for stones from the Pasamonte fall which the Nininger Laboratory had begun March 24, 1933. One of the sheep herders of the area brought in some thirty stones which he had gathered over several months, but which he for sometime hesitated to report for the reason that they did not seem to be the same as the Pasamonte stones. Further search resulted in the recovery of a thirty-pound stone and several more small ones. Although showing little effects of rusting, the stones were for the most part badly weather cracked."

Some 44 kg have been picked up from the Beenham fall.

4. ROY (1933); L5 chondrite, found Spring, 1933.

In the Spring of 1933, a farmer, Fidel Landfer, and a friend found an unusual, heavy stone near his home (Nininger, 1934b). Suspecting that the stone might contain precious metal, they broke it apart with a sledge.

The next Spring, upon hearing of Nininger's quest for meteorites, the farmer sent two fragments of the Roy (1933) stone to Pasamonte where Nininger was headquartered. Unfortunately, they arrived after Nininger left. Subsequently the fragments were examined by an amateur, who decided that they were not meteoritic and threw them into the yard at the Pasamonte Ranch. Nininger noticed the pieces on his next visit to the Pasamonte Ranch and inquired about them. He then proceeded to Mr. Landfer's home, where 32 kg of fragments were collected. Landfer later sent Nininger an additional 15 kg of material; one stone of 346 gm proved to be distinct from the others and is known as the Roy (1934) meteorite.

5. CHICO; L6 chondrite, found 1954.

The Chico stone was found in January, 1954 by a rancher, Charles Langley, while horseback riding. He later excavated the huge stone (105 kg) and moved it to his home. A sample was broken off and sent to the Institute of Meteoritics at the University of New Mexico. After examining the entire mass, LaPaz (1954) writes:

> "Externally, the small part of the mass that had been above ground closely resembled vesicular malpais, and the remainder was incased in a surprisingly thing, rough-surfaced caliche coating that effectively concealed its nature."

Fortunately, it was sectioned, and its true nature revealed. LaPaz (1954) makes special note of the large chondrules

Table 3. Trace element compositions of the iron meteorites from northeastern New Mexico (Ni data in %, Ga, Ge and Ir data in ppm; data from Wasson, 1974).

Meteorite	Class	Ni	Ga	Ge	Ir
Glorieta Mountain	Pal-an	12.04	13.2	10.7	0.014
Costilla Peak	IIIA	7.49	18.7	33.6	14
Point of Rocks (iron)	IIIA	8.4	21.1	41.4	.46

(largest 57 by 44 by 26 mm) in this stone. It appears, however, that they are not true chondrules but areas exhibiting degrees of shock modification, giving a chondrule-like appearance.

6. POINT OF ROCKS (STONE); L6 chondrite, found about 1954.

The Point of Rocks stone was recovered by LaPaz (1965). It is very similar to the Chico stone but differs slightly in composition (Fa 25.2 *vs* 24.2).

7. ROY (1934); L6 chondrite, recognized 1934.

One of the stones (346 gm) of the Roy find proved to be different (see Roy (1933)). A private collector, A. E. Allen, obtained a second stone of 5 kg from this fall. When he obtained this stone from Landfer, Allen noticed that it was different from the earlier Roy stones and named it Tequezyuito Creek. About the same time, Nininger obtained a fragment of the same meteorite and named it Roy (1934). The name Roy (1934) has been retained, and Tequezyuito Creek is a synonym for Roy (1934).

8. ABBOTT; H chondrite, found 1951.

LaPaz (1965) obtained some 370 chondritic stones from the Abbott area. The Abbott stones are quite interesting as they contain lithic fragments similar to carbonaceous chondrites (Fodor and others, 1976).

9. AURORA; H4 chondrite, found 1938.

The Aurora meteorite was found by Gardien Tarplay (Nininger and Nininger, 1950).

10. CHICO HILLS; H4 chondrite, found 1951.

LaPaz (1965) recovered approximately 30 stones near Chico Hills. The Chico Hills stones arc similar to the Abbott meteorites.

11.GLADSTONE; H4 chondrite, found 1936.

Having had some success in northeastern New Mexico, Nininger sent one of the helpers to Gladstone (Nininger and Nininger, 1950):

> "In 1936 we undertook to prove the hypothesis that meteorites have fallen on all areas of the earth recently enough to be yet recognizable. We sent Mr. and Mrs. Alex Richards to Gladstone, New Mexico, with instructions to stay three weeks exhibiting specimens and providing information as to their importance and how to distinguish meteorites from other rocks. We had no information or hint of any kind that meteorites were present in that area. The first two weeks brought nothing to light, but during the third week six stones were recovered aggregating 183 pounds and representing three distinct falls, namely, Gladstone, Farley and Ute Creek, all within six miles of the Gladstone post office."

Three of these stones were named after Gladstone.

12.MOSQUERO; H4 chondrite, found prior to 1963.

A chondrite of about 1600 gm is in the U.S. National Museum as part of the Allen collection (Hey, 1966). The Mosquero stone was obtained by Allen prior to his death in 1963.

13.UTE CREEK; H4 chondrite, found 1936.

Several meteorite fragments found near Gladstone appeared different from Gladstone and were named Ute Creek (see Gladstone) (Nininger and Nininger, 1950).

14. FARLEY; H5 chondrite, found 1936.

Two of the stones recovered by Richards in 1936 appeared to be different from Gladstone and were named Farley (see Gladstone) (Nininger and Nininger, 1950).

15. TAFOYA; H5 chondrite, found about 1951.

Two stones were recovered near Tafoya by LaPaz (1965); one is severely weathered and is similar to Gladstone. The other stone is fairly fresh and similar to Abbott.

16. MILLS; H6 chondrite, found 1970.

The Mills stones were found by a housewife, Mrs. Pauline Shaw, who noticed the stones in a "blow out" in the pasture of their ranch. Six stones were found almost touching in an area about 1 m in diameter (Clarke, 1972; Huss, 1976).

Levi-Donati and Jarosewich (1974) suggest that the Mills stones may be paired with Gladstone, Farley and Ute Creek. Our study of polished thin sections from three of the stones indicates that Mills is more crystalline than the other H-group chondrites of the area. The crystalline nature of this meteorite, along with absence of glass and lack of readily delineated chondrules, classify this chondrite as an H6.

17. EL RANCHO GRANDE; pallasite, found 1954.

A severely weathered pallasite was recovered by LaPaz (1965).

18. GLORIETA MOUNTAIN; anomalous iron with pallasitic areas found 1884.

Twenty eight specimens are known from the Glorieta Mountain meteorite, with a total weight of 186 kg. The initial discoveries were made in 1884 and described by Kunz (1885):

> "This mass was found by Mr. Charles Sponsler, a prospector, on some unclaimed land on Glorieta Mountain about half a mile from a house in the woods 1 mile northeast of Canoncito, Santa Fe County, New Mexico, in May (?), 1884. The mass was lying on a rock, upon which it had fallen, in three fragments, and judging from the few marks of weathering had not been long exposed. The exact date of discovery not determined.
>
> The weight of the entire mass is 317 pounds (143.76 kg). Perhaps 1 kg had been chipped off, so that the original weight may have been about 145 kg. The dimensions of the original mass were approximately 25 by 10 by 15 in (65 by 25 by 37 cm). It is quite unusual to find so large and compact a mass of iron so completely broken asunder, and in this respect the fall is unique. The fractures are very clean considering the size of the fragments, although the edges are somewhat irregular. No. 1 is filled with elongated hollows, proving that it evidently was disturbed, and the twistings in No. 2 at the point of impact would lead to the conclusion that the falling body was partly semiplastic; but Professor Thurston compares the fracture to the effect of a sudden heavy blow on cold iron as may be seen in an iron target used for heavy gun practice."

Kunz (1886) later described three additional pieces, all of which were found within 50 ft of the large mass. The first six specimens found appear to be fragments broken off when a large specimen struck a rock. Many of the specimens discovered later are completely encrusted with fusion crust and piezoglypts. The latest specimen of the Glorieta Mountain meteorite was found in January, 1954 and described by LaPaz (1956).

Although most of the Glorieta Mountain specimens show only iron meteorite structure, several exhibit patches of pallasi tic structure.

In 1931, a small meteorite was described from Pojoaque by Brady (1931):

> "The small meteorite here described was sent to the writer by Dr. J. P. Mera of the Laboratory of Anthropology at Santa Fe, New Mexico, for examination. Dr. Mera writes 'this specimen was found in the old Pueblo of Pojoaque near Santa Fe, associated with a very small black-on-white pot, and ploughed up by a native who was converting this particular part of the old village into a field.
>
> An interesting point in the appearance of this specimen is the much worn condition of the protruding parts, some of which show the lamellar structure without etching; and this fact coupled with the circumstances under which it was found strongly suggest that the iron at one time formed part of a 'medicine-man's outfit.'

Nininger (1933) noted the pallastic structure of Pojoaque, and later (Nininger, 1940) assigned it to the Glorieta Mountain fall. The similarity between the two is very great, as both are very fresh and olivine compositions determined by Buseck and Goldstein (1969) are the same within analytical error (Glorieta Mountain, Fa 13.1; Pojoaque, Fa 13.2).

About 1930, a club-shaped iron was found near Glorieta by La Rue Paytiamo (Henderson, 1934). Henderson's (1934) first analysis gave 4.64% nickel, distinctly different from analyses of Glorieta Mountain (11.15% Ni), and he assigned the name of Santa Fe to this iron. Nininger (1940) noticed the great similarity of Santa Fe to Glorieta Mountain, and about the same time, Henderson (1941) reanalyzed the Santa Fe iron and found 11.79% nickel, close to that of Glorieta Mountain (Wasson, 1974 give's 12.04% Ni for Glorieta Mountain); both concluded that the Santa Fe iron is a fragment of the Glorieta Mountain fall.

19. COSTILLA PEAK; group IIIA iron, found 1881.

The Costilla Peak meteorite is the first meteorite found in New Mexico. Hills (1895) gives the following account of its discovery.

> "This meteorite, which for several years has been in the possession of the society [The Colorado Science Society], was found in August, 1881, on the north slope of Costilla Peak, about 6 miles south of the boundary line between Colorado and New Mexico. The date of the fall is unknown. The discoverer was a Mexican sheep herder named Ignacio Martin who, the same year, sold the specimen to an old settler, one Thomas Tobens, receiving in exchange a small pony. Tobens kept the specimen for several years concealed under a manure pile in his barn, until Mr. E. C. van Diest, hearing of its existence and recognizing its true character, purchased it for the society."

20. POINT OF ROCKS (iron); group IIIA iron, found 1956.

LaPaz (1965) recovered this iron during his fireball search.

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REFERENCES

Biot, J. B., Relation dun voyage fait le departement de l'Orne, pour Constater la réalité d'un météore observe a l'Aigle le 6 floréal an II: Mem. l'Institut France, v. 7, p. 224-226.

Brady, L. F., 1931, A new iron meteorite from Pojoaque, New Mexico: Am. Jour. Sci., ser. 5, v.21, p. 178.

Brown, H., 1961, The density and mass distribution of meteoritic bodies in the neighborhood of the earth's orbit: Jour. Geophys. Research, v. 66, p. 1316-1317.

Buseck, P. R., and Goldstein, J. I., 1969, Olivine compositions and cooling rates of pallasitic meteorites: Geol. Soc. American Bull., v. 80, p. 2141-2158.

Clarke, R. S., Jr., ed., 1972, The meteoritical bulletin, No. 51: Meteoritics, v. 7, p. 226-227.

Fodor, R. V., Keil, K., Wilkening, L. L., Bogard, D. D. and Gibson, E. K., 1976, Origin and history of a meteorite parent-body regolith breccia: carbonaceous and noncarbonaceous lithic fragments in the Abbott, New Mexico, chondrite: New Mexico Geol. Soc. Spec. Pub. No. 6, p.206-218.

Henderson, E. P., 1934, Two new meteoritic irons from New Mexico: Pop. Astron., v. 42, p. 511-515.

1941, Corrections to published analyses of meteorites: Am. Jour. Sci., v. 239, p. 407-409.

Hey, Max H., 1966, Catalogue of meteorites: Oxford, Alden, 637 p.

Hills, R. C., 1895, The Costilla meteorite: Proc. Colorado Sci. Soc., *v.* 5, p. 121-122.

Kunz, G. F., 1885, On three masses of meteoritic iron from Glorieta Mountain near Cafioncito, Santa Fe County, New Mexico: Am. Jour. Sci., ser. 3, v. 30, p. 235-238.

---- 1886, Further notes on the meteoritic iron from Glorieta Mountain, New Mexico: Am. Jour. Sci., ser. 3, v. 32, p. 311-313.

LaPaz, L., 1954, Preliminary note on the Chico, New Mexico, aerolite: Meteoritics, v. 1, p. 182-184.

---- 1956, A recent macro-spicular recovery from the Glorieta, New Mexico, fall: Meteoritics, v. 1, p. 488-490.

---- 1965, Catalog of the collections of the Institute of Meteoritics, The University of New Mexico: Univ. of New Mexico Publ. in Meteoritics, No. 4; Albuquerque, Univ. of New Mexico, 136 p.

Levi-Donati, G. R., and Jarosewich, E., 1974, The Mills, New Mexico, chondrite-a new find: Meteoritics, v. 9, p. 145-155.

Nininger, H. H., 1933, Observations on the Pojoaque meteorite: Mines Magazine, v.23, No. 7, p. 4.

---- 1934a, The great meteor of March 24, 1933: Pop. Astronomy, v. 42, p. 291-306.

---- 1934b, The Roy aerolite: Pop. Astron., v. 42, p. 599-600.

1936, The Pasamonte, New Mexico, meteorite: Pop. Astron., v. 44, p. 331-338.

---- 1940, New light on the Glorietta, New Mexico, meteorite; Am. Jour. Sci., v. 238, p. 56-60.

---- and Nininger, A. D., 1950, The Nininger collection of meteorites: Winslow, Arizona, American Meteorite Museum.

Van Schm us, W. R., and Wood, J. A., 1967, A chemical-petrologic classification for the chondritic meteorites: Geochim. et Cosmochim. Acta, v. 31, p. 747-765.

Wasson, J. T., 1974, Meteorites: New York, Springer-Verlag, 316 p.