THE PEÑA BLANCA SPRING METEORITE, BREWSTER COUNTY, TEXAS

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ABSTRACT

The Peña Blanca Spring meteorite fell August 2, 1946, in the swimming pool at the headquarters of the Gage Ranch near Marathon in Brewster County, Texas. Twenty-four people were within a few hundred feet of the point of fall, and one person saw the meteorite in flight. Many interesting incidents were accurately reported.

Approximately 70 Kg. (155 lbs.) of the meteorite were recovered, consisting of one fragment of 47 Kg. (104 lbs.), one fragment of 13 Kg. (29 lbs.), and many smaller pieces down to mere grains. Reconstruction of the shape indicate that all but a few pounds of the stone have been recovered.

The meterorite is a white *aubrite* with a cream colored crust and remarkably coarse cataclastic-porphyritic texture. One phenocryst of pyroxene is 10×6×8 cm.; another, 6×3×1.5 cm.; and a number are larger than 3×3×3 cm. An approximate mode of the meteorite is iron free enstatite 93%, iron free diopside 5.0%, iron free forsterite 0.5%, oligoclase 0.5%, iron-nickel (iron rich) 0.5%, troilite 1.25%, and miscellaneous minerals 0.25%.

INTRODUCTION

As far as known, man has never constructed a device in which to trap a meteorite falling to the earth. Had he done so, possibly he could not have improved upon the swimming pool at the headquarters of the Gage ranch about 9.5 miles southeast of Marathon in Brewster County, Texas. This swimming pool received the Peña Blanca Spring meteorite with a violent splash at about 1:20 P.M. on August 2, 1946. The meteorite is named from the spring which forms the swimming pool and which is an historic landmark in the region. The exact location is longitude 103°7.1′ west longitude 30°7.5′ north latitude. The unusual location of the fall, the fact that the meteorite fell within a few hundred feet of twenty-four people, and its unusual petrographic character appear to warrant a fairly complete account.

PHENOMENA OF FALL

Peña Blanca (White Bluff) is formed by nearly vertical beds of white Caballos novaculite which outcrop as a ridge striking northeast-southwest. Springs issue at a point where a water gap has been eroded through the ridge and form a creek which flows southeast. About 400 feet below the springs, the creek is confined by a dam 4 feet high. At the head of the pool the water is about 10 feet in depth and 20 feet wide. A road parallels the northeast bank of the valley and the pool. Houses and other ranch installations are grouped around the body of water. The house of Mr. John Catto, Jr., is on the southeast flank of the novaculite ridge overlooking the downstream part of the pool. It is about 75 yards from the upper part of the pool where the meteorite fell but that part of the pool is masked from the house by the steep slope. The house of Mr. D. E. Forker is about 150 yards southwest of the Catto house and from it only the lower part of the pool near the dam is visible. Corrals are located on the northeast side of the valley below the dam, and east of them about 150 yards is the house of the Mexican caretaker.

The meteorite was seen in the very final portion of its flight by one person. Two others had arrived in a motor truck opposite the point of impact almost at the instant of fall, and their truck was splashed with water. Horses grazing near the pool were startled by the noises of the fall, ran, and then stopped and all turned to look over their shoulders toward the point of impact. All of the twenty-four people nearby heard all or part of the noises accompanying the fall. The shock-wave explosion, the first phenomenon observed, was heard through the country generally at reported distances of 65, 35, 12, and 10 miles from the point of fall. However, the region is sparsely settled so that a relatively small number of people were in a position to hear noises or see anything unusual in the sky.

The first evidence of the fall was a loud explosion, the shock wave, likened to "a loud boom," "an explosion of fifteen sticks of dynamite," "a strong concussion," "heavy blasting some distance away," or "like a big shotgun at some distance." The explosion was followed by the flight noise generally likened to the noise of a falling airplane. Other descriptions included "more a movement of air than sound," "as though a blast had created a vacuum," and "there was a rush of air to fill the vacuum," "a sizzling sound," and "a sound like something burning awfully fast, not just like an airplane." The flight noise lasted an appreciable time, difficult to estimate but certainly several seconds and possibly as much as 20 seconds.

The families of Mr. D. E. Forker and Mr. John Catto, Jr., who were in residence at the ranch, were seated at lunch in their respective homes. Members of the Forker family heard the explosion, which sounded very close but which did not shake the floor. Some but not all heard the flight noise. All, however, realized that a heavy explosion had occurred nearby, but they did not sense its direction. Mrs. Forker heard excited voices from the house of the Mexican caretaker a few hundred feet east of the pool. She moved to the east door of the house and outside to a point from which she could see much of the ranch establishment. She saw a group of horses that had been grazing just below the Catto house rush down the creek until stopped by a fence just below the dam. They huddled there in great fright looking back up the creek. This was perhaps 30 seconds after the explosion and shows that something had occurred near the head of the pool to frighten them. This undoubtedly was the noises connected with the flight and fall of the meteorite into the pool.

The cook at the Forker home was on the back porch of the house. She heard a loud noise but did not detect the direction. Then came a sizzling sound. She looked all around and her eye caught a falling object on a line in the direction of the swimming pool. "It looked," she said, "just like a black bag falling out of the sky. You know how you might hold a flour sack up and the bottom would drop out? It looked just like that. The bag was black and what was dropping out—the dust like—was kind of white." She stated also that it was "as big as that bucket."

The Catto house is only about 75 yards from the point of impact. The members of this family group were more impressed by the flight noise than the explosion. The flight noise sounded like an airplane and it seemed to be headed directly for their roof. Mrs. Catto heard not only the explosion and flight noise but also the sound produced by the impact. She illustrated this sound by striking her closed fist into the palm of her hand. Most of the members of this group sensed a westerly direction for the flight of the meteorite.

Two men, workers on the ranch, were in a truck traveling along the road which passes alongside the swimming pool within 25 feet of the point of impact. They heard the explosion, which did not frighten them, but the flight noise sounded almost on top of the cab of the truck. They must have been within 50 feet of the meteorite when it struck the water, and one of them stated that he actually saw a splash of black water very high in the air and reaching the road. Subsequent examination showed that water had been driven 100 feet from the edge of the pool. Wisps of moss from the pool were found on rocks and bushes at the edge of the pool and on the road. The water of the pool was not muddy but seemed to be darker than usual.

The meteorite fell about $2\frac{1}{2}$ feet from the bank of the pool in about 2 feet of water. After the pool was drained about 4 feet below normal level, it was seen that a hole about 2 feet in diameter and 1.5 feet deep had been driven into the silt and earth forming the shelving bank. Novaculite and chert rocks are present beneath the silt and earth and limited the penetration of the meteoritic material. One fragment of 13 kg. (29 lbs.) was recovered about 1 foot from alongside the hole (Fig. 1). Another of 47 kg. (104 lbs.) was recovered from the deeper water about 8 feet from the hole. Numerous fragments ranging from mere grains to one of 2162 grams weight were recovered from the hole and around it. One fragment of 444.2 grams weight was found outside the pool about 3 feet from the water. The total material recovered amounted to approximately 70.37

kg. (155 lbs.). It included 13 pieces larger than 2×2×2 inches and weighing more than 100 grams.

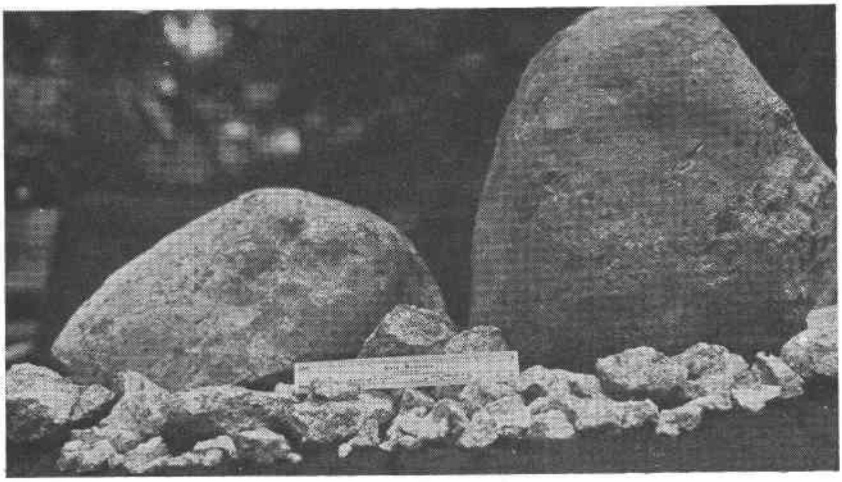

FIG. 1. Two largest fragments and other material, Peña Blanca Spring meteorite. Rounded surfaces and pits are shown on larger fragments.

There is evidence to suggest that the meteorite was broken by impact against a large boulder of novaculite. The boulder which was beneath the water was freshly broken. It appears probable, likewise, that upon impact and breaking, the two larger fragments rebounded, the smaller one a foot or so, the larger one several feet. In falling, the meteorite passed through the upper part of a willow tree on the bank of the pool. Smaller limbs were broken, and inconclusive evidence suggests that one about 2 inches in diameter was broken with a twisting motion and thrown upward about 4 feet, lodging in the upper part of the willow tree.

One additional feature of this remarkable fall deserves mention. The novaculite previously mentioned occurs as nearly vertical beds some 75 feet thick. At the point where the meteorite fell there is a virtual water gap through the novaculite, about 100 feet in depth, 100 feet wide at the top, and 50 feet wide at the bottom. The meteorite fell almost exactly in the middle of the gap and obviously at a high angle. A slightly different course would have resulted in impact on a bare novaculite surface and probably extensive fragmentation.

The major part of the recovery was made by Mr. O. E. Monnig, an ardent student and collector of meteorites, and Mr. Harrison H. Morse, both of Fort Worth, Texas. The residents of the ranch had recovered the

13 kg. and the 2162 gram fragment soon after the fall. Mr. Monnig and Mr. Morse arrived at the locality August 6 and made a very intensive search for material. It is believed that the combined efforts resulted in recovery of all except a few kilograms of the material. Mr. Monnig and Mr. Morse also made a very thorough investigation of observed astronomical phenomena of the fall. These along with a description of the general features of the meteorite were reported by Mr. Monnig before the Society for Research on Meteorites (now the Meteoritical Society) and will be published in its contributions.

Physical Properties and General Structure

Reconstruction of the shape of the meteorite shows that it was roughly one-half of an elongated spheroidal body bounded by undulating plane surfaces whose junctions are rounded (Fig. 1). The dimensions of the largest piece recovered are 15×13.5×11 inches and of the next largest

Fig. 2. Mottled light gray crust of the Peña Blanca Spring meteorite. Irregular line at lower right shows area from which crust has been flaked.

14.5×5.5×5.5 inches. One major external plane on the larger fragment is fresher than the others, only partly crusted and possibly is a separation plane recording a disruption of the mass prior to its fall at Peña Blanca.

Much of the original surface was covered by cream colored to mottled gray crust less than 1 mm. thick (Fig. 2). There is a distinct separation plane between the crust and the deeper material, and a good deal of the crust has been lost through flaking along this plane. Only a part of a flake which separates is isotropic, minute grains of crystalline materials forming the lower part of the flakes. Mottled gray areas of the crust have resulted from the diffusion of grains of opaque minerals in the crust melt. Minute sub-parallel flow lines are present in the crust, and with a hand lens the crust material appears vesicular or frothy.

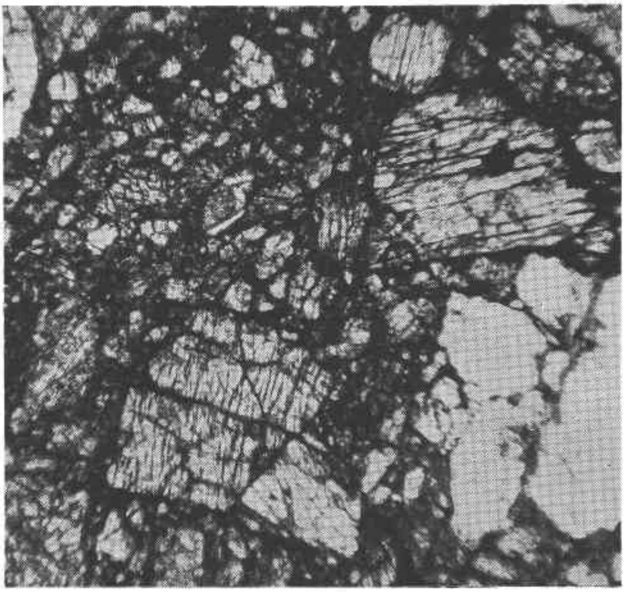

FIG. 3. Micro-section of the Peña Blan a Spring meteorite showing cataclastic texture.

FIG. 4. Fresh surface of Peña Blanca Spring meteorite. The large crystal, about 2.5 inches long is enstatite. The oval black spot at end of crystal is metal and sulfide.

Original surfaces of the meteorite are pitted with shallow pits up to 6.5 cm. in diameter (Fig. 1). These are irregularly spaced, and it is possible that they were the loci of larger crystals. A crack which appears to have been healed runs diagonally across nearly the complete external surface of the 13 kg. fragment.

Thin sections of the meteorite reveal a pronounced cataclastic texture (Fig. 3). However there are many subhedral crystals, and a few which are euhedral. In addition there are a few crystals so large that they are considered to be phenocrysts (Fig. 5). It seems probable that these crystals originally were larger than the others but that smaller original crystals may have been reduced in size during the development of the calaclastic texture.

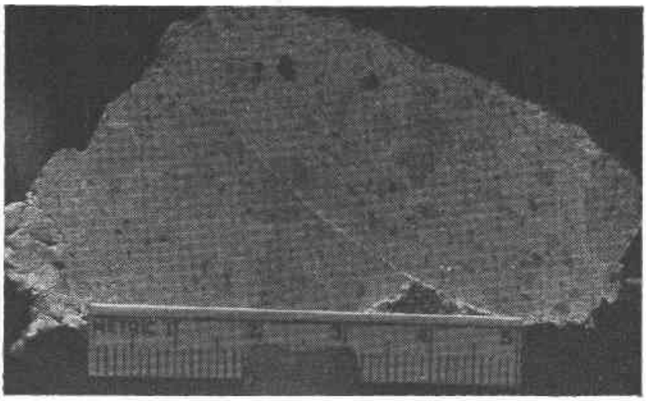

FIG. 5. Cut surface of Peña Blanca Spring meteorite showing darker enstatite grains and crystals in lighter matrix also mainly enstatite.

A freshly broken surface of the meteorite exhibits a light gray, nearly white, medium-grained groundmass in which are crystals of silicate minerals of various shades of color from light gray to dark gray and small grains of metal and brass colored sulfide (Figs. 4–5). Oxidation of the sufide was extremely rapid, producing brown areas of iron oxide within a few hours. The oxidation was accompanied by a distinct sulfur dioxide odor which still persists in the larger fragment five months after the fall. It is possible that the contact with water in the swimming pool promoted this rapid oxidation.

Except for the phenocrysts there is a great range in size of the crystals practically down to that of the grains of the groundmass which average a little more than 1 mm. The largest crystal observed is 10×7.5×6 cm. Another is 6×3×1.5 cm., another 2×3×3.8 cm. Many of the crystals are larger than 1 cm. Rare smaller crystals are euhedral. But a good many even of the larger ones show at least one well developed crystal face.

In general the phenocrysts are darker than the groundmass although there are exceptions (Fig. 5). Enstatite, the most abundant mineral, varies in color and luster in shades of gray. The cause of the variation has not been determined. The mineral exhibits fibrous to platy cleavage and rarely appears striated. Monoclinic pyroxene is white in color and not fibrous. However, these characters alone will not distinguish it from enstatite and generally it is necessary to confirm the identification with the microscope.

Olivine (forsterite) found in thin sections is so rare that it is not seen in hand specimens except in one area suggesting a chondrule. A circular area 7.5 cm. in diameter is composed mainly of stubby subhedral crystals of the mineral averaging 2 mm. in length (Fig. 6).

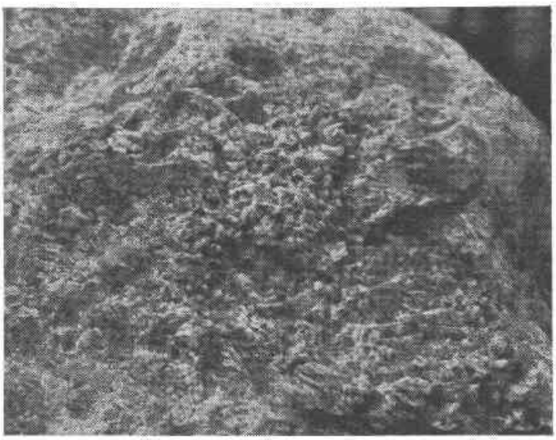

FIG. 6. Chondrule-like segregation of forsterite and enstatite. The forsterite crystals are subhedral, 1–2 mm. in size.

Metal and sulfide occur in irregular grains up to several millimeters with an occasional grain still larger in the groundmass and as inclusions in the pyroxenes. They are present together in many grains, and invariably those with sulfide are bordered by iron oxide.

The meteorite is exceedingly brittle but not friable. It does not appear to be brecciated. Fragments cannot be broken by the hands. However, numerous small cracks have developed, usually around larger crystals. Handling of larger fragments generally results in a certain amount of flaking and chipping along these cracks.

Petrography

The Peña Blanca Spring meteorite is an *aubrite* in Prior's classification. It is an achondrite in which the metal (Fe:Ni = 22:1) and sulfide are sparingly present and the bulk of the stone is composed of enstatite almost free from iron. The small amounts of monoclinic pyroxene and forsterite likewise are essentially iron-free .The feldspar, present in small amount, is oligoclase. The meteorite is not greatly different from the Shallowater aubrite described by Foshag,[1] having however still less metal and some monoclinic pyroxene not found in Shallowater. It differs in texture and probably contains the largest individual crystals yet found in meteorites.

Because of the exceedingly irregular texture a mode of the meteorite must be an estimate. The mode given below is based on a study of four thin sections, hand specimens and chemical analyses.

Mineral Composition of the Peña Blanca Spring Meteorite

Enstatite	93.0
Diopside	5.0
Forsterite	0.5
Oligoclase	0.5
Iron-nickel	0.5
Troilite	1.25
Others	0.25
	100

Enstatite occurs in the ground mass and as larger crystals including the largest observed. It varies in color from nearly white through light gray to dark gray vitreous material. As far as can be determined, no optical difference exists among the various types. A chemical analysis of material from a large crystal and optical properties are given below. It is essentially iron-free magnesian metasilicate. Optical determination checks closely with the analysis. *X*-ray diffraction patterns of two specimens of enstatite representing the range in outward appearance were very kindly made by Dr. J. W. Gruner[2] of The University of Minnesota. Dr. Gruner stated that "the patterns are very close to, if not identical with, enstatite." In thin sections many of the enstatite grains exhibit undulatory extinction, and in some, indistinct lamellar twinning appears. Some of the optical phenomena suggest intergrowths of monoclinic pyroxene but this could not be confirmed. Minute opaque inclusions are present in some grains.

[1] Foshag, William F., The Shallowater meterorite; a new aubrite: *Am. Mineral.*, **25**, 779–786 (1940).

[2] Gruner, J. W., Personal communication (1946).

ENSTATITE, PEÑA BLANCA SPRING METEORITE
F. A. GONYER, *Analyst*

SiO_2	59.24	
TiO_2	0.00	$\alpha=1.650$
Al_2O_3	.27	$\beta=$n.d.
Fe_2O_3	.14	$\gamma=1.658$
FeO	.45	2V=30° approximately
CaO	0.00	Z‖to elongation
MgO	39.78	$(\gamma-\alpha)=.008$
MnO	0.00	
	99.88	

Thin sections show a small amount of monoclinic pyroxene, and grains or crystals also can be isolated from hand specimens. Some of the grains occur as inclusions in larger enstatite crystals. The mineral has been identified as iron-free diopside. It is optically positive with 2V about 60°; $\alpha=1.660$, $\beta=1.670$, $\gamma=690$; $Z\wedge c=38°$. The mineral shows irregular lamellar twinning.

Forsterite, except in the segregation previously mentioned, is very rare in the meteorite. Less than a dozen grains smaller than 0.5 mm. were observed in four thin sections. The mineral is colorless and anhedral. It is optically positive with 2V about 90°; $\alpha=1.635$, $\beta=1.650$, $\gamma=1.670$; $(\gamma-\alpha)=.035$. These data indicate a forsterite essentially iron-free. This is confirmed by an analysis of the segregation which consists of about 60% forsterite and 40% pyroxene.

PEÑA BLANCA SPRING METEORITE, FORSTERITE SEGREGATION
F. A. GONYER, *Analyst*

SiO_2	50.84
TiO_2	.09
Al_2O_3	.23
Fe_2O_3	.38
CaO	.04
MgO	48.67
	100.25

Oligoclase is present in exceedingly small amounts. Only a few anhedral grains were found in the four thin sections studied. The mineral shows fine albite twinning and is Ab_{88} An_{12}.

A reddish-brown transparent mineral is present in sections in irregular grains of about the same size as the feldspar grains. The mineral is isotropic and has octahedral cleavage and a very high index of refraction. It is identified tentatively as spinel.

A chemical analysis of this meteorite presents a difficult sampling problem. It was not possible to sacrifice sufficient material for an unquestionably representative sample. Within these limitations, however, the analyses below generally confirm the mineralogical studies:

PEÑA BLANCA SPRING METEORITE
F. A GONYER, *Analyst*

Metal-Free Portion		Metal	
SiO_2	57.86	Fe	95.74
TiO_2	.06	Ni	4.22
Al_2O_3	.21	Co	.39
Fe_2O_3	0.00	Cu	0.00
FeO	2.00	P	0.00
CaO	1.08	Mn	.17
MgO	38.07		
NiO	0.00		100.52
Na_2O, K_2O	0.00		
P_2O_5	0.00		
FeS	1.21		
	100.49		

It will be noted that the alkalies were not detected. This is not surprising, because the feldspar is present in very small amount. On the other hand, the mineral or minerals in which the FeO is present have not been identified. It is possible that the minute inclusions in enstatite are responsible or that the sampling procedure produced a concentration of iron-bearing compounds.

Acknowledgments

The writer is greatly indebted to the Catto and Forker families for permission to describe the meteorite and for specimens used in the thin sections and chemical analyses. Mrs. D. E. Forker made available the very detailed information which she collected concerning the interesting incidents which occurred in connection with the fall. Mr. Oscar E. Monnig very generously supplied details concerning his investigation of the fall and recovery of the meteorite. The chemical analyses were made possible through a grant from the Graduate Council of The University of Texas.