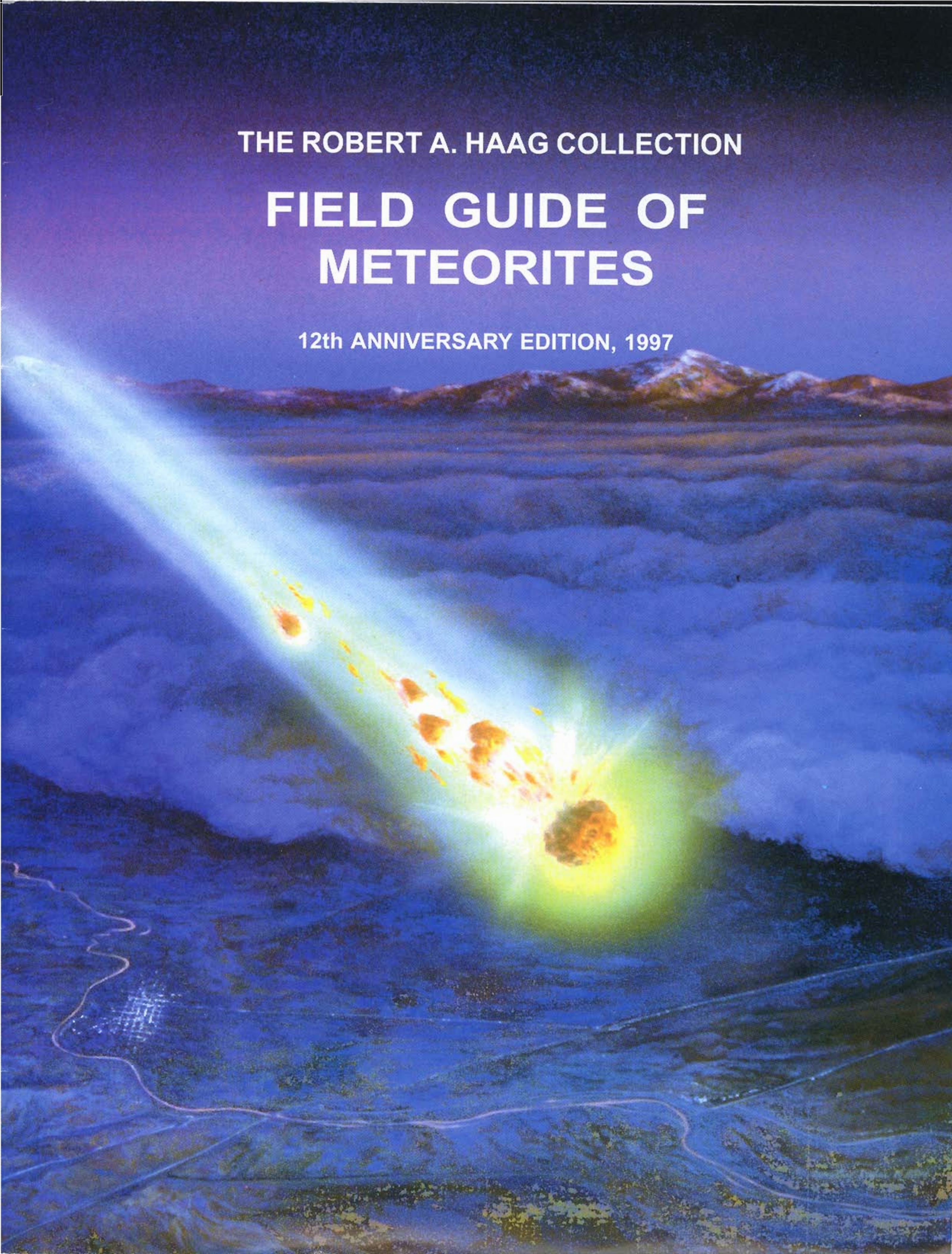
THE ROBERT A. HAAG COLLECTION

FIELD GUIDE OF METEORITES

12th ANNIVERSARY EDITION, 1997



Bob at Mount Rushmore

About the author, Robert A. Haag... explorer, (wanna-be) space traveler. Robert has been fortunate enough to spend his life pursuing meteorites, his true passion. His imagination and real-life adventures have taken him from the jungles of Africa to the plains of Australia, to the moon, Mars and beyond. We hope you will enjoy this 12th Anniversary Edition Field Guide of Meteorites.

Send meteorite orders and inquiries to:

Robert A. Haag
P. O. Box 27527
Tucson, AZ 85726
USA
Ph: 520-882-8804 Fax: 520-743-7225
E-MAIL: bobhaag@primenet.com

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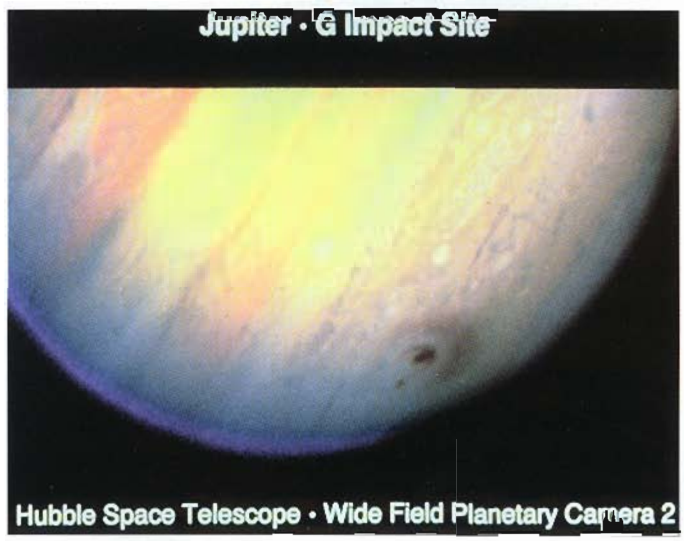

Comet Shoemaker - Levy impact on Jupiter, July 1994. Next time Earth? and end of the world? We sure hope not!

COVER PAINTING BY DOROTHY SIGLER NORTON. Thanks to Richard Norton for his encouragement.

NOTE: 2.5 cm. = 25 mm. = 1 in.
454 grams = 1 lb.
1 kilo = 2.2 lbs.

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FIELD GUIDE OF METEORITES

12th ANNIVERSARY EDITION, 1997

City Lights, by Chris Butler

INTRODUCTION

Hello! Welcome to the12th Anniversary Edition of the *Robert A. Haag Collection Field Guide of Meteorites*. It is my way of sharing 18 years of buying, selling, swapping, collecting and studying meteorites with you. My "rock album", of sorts. The stars have been good to me.

In those 18 years I've learned that 99% of all the rocks that drop out of the sky will look like those pictured in this field guide. Yet even the rarest, most exotic meteorites ever found have been recognized by something as simple as the melted crust. Fushion crust, other surface features and the presence of iron, and rust, are key factors involved in finding meteorites. Study this book and you can learn to recognize meteorites as well many "experts".

The recent discovery of possible micro fossils in the Alan Hills (AL84001) Mars meteorite rocked the world, and the potential for future discoveries is staggering. The best part about it is that you can be part of the excitement of discovery. It may well be a piece that you find that will contain the first footprints of a non-terrestrial species.

This field guide is intended to sell meteorites, naturally, but it is also a beginning course in meteoritics. There are lots of great tips here for recognizing and recovering meteorites, terrific pictures to help you pick the meteorite out from the background, and lots of stories of adventure to spur you on to momentous discoveries of your own. The best thing to do is to meet some aliens from outer space "up close and personal" at your local university or museum. Or better yet, start a small (or large! large is better) *private* museum of your own by investing in some meteorites. They are *excellent* investments; appreciating far more reliably than virtually any other collector's items.

If you have thumbed through the catalogue already, you'll have noticed that there are no prices listed. This is because my inventory is constantly changing. (I can't manufacture them, you know, and the delivery schedules are hopelessly erratic!) So the only thing to do is e-mail, call, write or fax me, and *I will let you know the prices and availability of the meteorites you are looking for.* Incidentally, nearly all of the photographs refer to pieces in my private collection and are not for sale, which is a big tease, but I **have material just as spectacular for sale.** So call, write, e-mail or fax today, before someone else gets whatever it is you've been longing for.

Some people wonder why I sell meteorites at all, if they are so valuable. But by selling my extra material, I can finance risky expeditions to some forsaken places in order to find more. Sometimes I do, and sometimes... I don't. Many specimens shown in here represent thousands of man-hours of searching and thousands of real dollars out of my own pocket. But new discoveries are then made available to scientists, museums, schools, and private collectors all over the world, and everyone benefits.

If you aren't ready to buy meteorites at the moment, you can go out on your own expeditions. The key is *the presence of iron*, whether great lumps of it or microscopic bits too small to see, discernable only with chemical tests. (Imagine throwing your car keys into a grinder, mixing them with hamburger and then baking the mess into "metal meatloaf" -- you'd have trouble seeing all the metal, but it would be there...) Iron, in whatever form, is virtually *always* present in meteorites, making them considerably heavier than most Earth rocks, as well as susceptible to rust. This is why the most important tool of a meteorite hunter is a magnet-on-a-string. A true meteorite will *almost always* draw the magnet, even if it's only a slight deflection, and will usually show some rust.

So-called shooting stars are actually meteors. If they are big enough, they may make it all the way to the ground, at which point the remaining pieces become meteorites. The speed of a fireball, angle of entry, mass and makeup of the original *bolide*, or meteor, determine how much survives. Unfortunately, most meteors burn up entirely when they hit the atmosphere, especially stones, being softer than irons. Either way, what survives will have a distinctive melted skin called a *fusion crust*. Fusion crust is very important to finding meteorites. Most fresh falls will have a thin black or brown skin covering the surface of the specimen, yet the inside will remain untouched and pristine, uneffected by its firey journey.

Tons of meteoritic material makes it to Earth every year, and the vast majority is never found. It's out there, waiting for someone to pick it up. Armed with a magnet, sharp eyes, a burning desire to find a space invader, and a *Robert A. Haag Collection Field Guide Of Meteorites*, you can recover specimens that might otherwise be lost to the world. The key is to get out there and *look* for them.

Family affair - Gao, Africa, stone meteorites; Onnie, my daughter and Drax, well-fortified with cosmic iron & minerals. (He actually tried to *eat* them ...)

If I've convinced you, then read on, study the photos, visit a museum, and then go search in places where meteorites have already been found. Usually, some pieces were missed in the initial search. Talk to the people there, be friendly, offer rewards. Start your own "Meteorite Recovery Team". (If you don't who will?) It's worth the energy and time. And when you find that exotic new meteorite, I want to buy it or trade for it.

Life has been action-packed and lots of fun. Spaceship Earth has been good to Robert Haag, Meteorite Man. It's been an incredible amount of hard work, too, but it's all been worth it. Especially if, after you read and study the 12th Anniversary Edition of the *Field Guide To Meteorites*, you go out and make some contributions to meteoritic science of your own. Meteorites let you be a part of the space program right here on Earth. Look in your own back yard, or look on the other side of the solar system. One way or another, you'll find adventure!

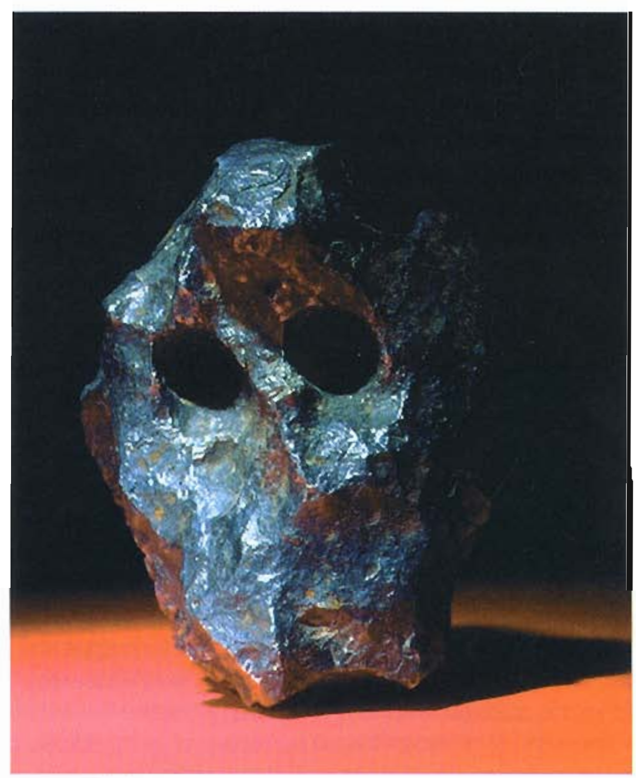
Good hunting!

Robert A. Haag, The Meteorite Man

P.S. If you're on the web, check out our new electronic price list and catalogue of current inventory on our cool web site at **www.meteoriteman.com**, or, e-mail us at **bobhaag@primenet.com**. Check my prices, selection and quality. No one else even comes close. Not on *this* planet, anyway...

Chicken Little was absolutely right. The sky *is* falling...

THE SPACE PASSPORT! Don't leave Earth without it! An early, pre-meteorite man venture. I stood around shopping malls in a tight, silver space-suit, hitting on matrons for small change. (I nearly starved. This is definitely better.)



The "other" Meteorite Man - Arizona's Canyon Diablo, iron meteorite. 7.75 kg. Collected by author in Two Tree Canyon.

Iron meteorites are one of the most durable and easiest to recognize of all meteorites, but only one in ten meteorites that fall from the sky is of the iron variety. The other 90% are stone meteorites. Iron meteorites are fragments of the once-molten metal core of an asteroid or demolished moon, probably from the asteroid belt. As these moons cooled, their cores crystallized and through later collisions, were destroyed. Chemically, they are an alloy, or combination, of iron (Fe) and nickel (Ni), of approximately the same density and hardness as a blacksmith's anvil. Unlike a common anvil, however, these originated, melted and crystallized in the vast, frigid (near absolute zero) expanses of outer space before arriving on Earth as your basic cosmic cannon balls.

It is the amount of nickel relative to the amount of iron that determines the type or classification of the iron meteorite and also creates the crystalline pattern seen after etching a cut surface with weak acid. This crystalline pattern is known as a Widmanstätten pattern and is definitive of meteoritic metal.

Most iron meteorites show a Widmanstätten pattern of eight-sided crystals and are therefore known as *octahedrites* (Fig. 4-A, below). Other varieties of irons show six-sided crystals (cubes), or *hexahedrite* patterns when etched, known as *Newman lines.* Yet another type of iron meteorite, the very nickel-rich *ataxites*, show virtually no Widmanstätten pattern when etched.

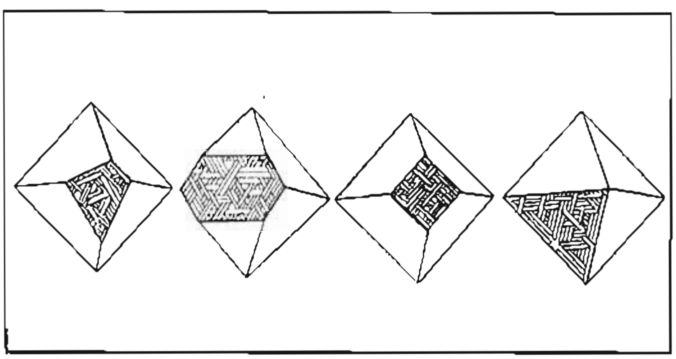


Fig. 4-A. Octahedrite crystal configuration in nickel-iron meteorites. (Picture two pyramids stuck base-to-base.)

Widmanstätten lines were named for one of the discoverers, Count Alois von Widmanstätten, who first described them in Vienna in 1804. This pattern appears when Ni-Fe meteorites are etched with a weak (about 10%) nitric acid solution, and is the result of the meteorite being made up of two different *polymorphs* of the Ni-Fe alloy. *Kamacite* (Fig. 4-B) contains 6% nickel in it's molecular structure. *Taenite* (Fig. 4-C) contains 19% nickel in its molecular structure. These two phases of Ni-Fe alloy crystallize at separate temperatures and form different crystal structures, which etch at different rates. The longer you etch, the deeper the 3-D effect becomes.

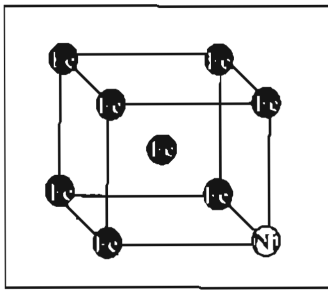


Fig. 4-B. Kamacite
6% Ni

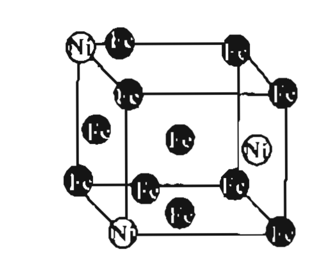
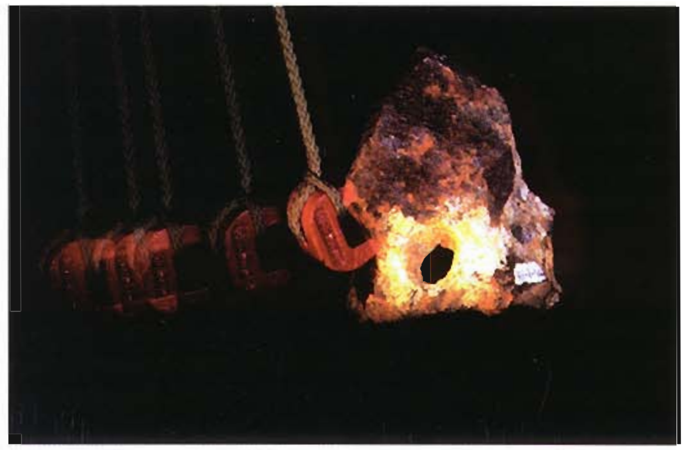


Fig. 4-C. Taenite
19% Ni



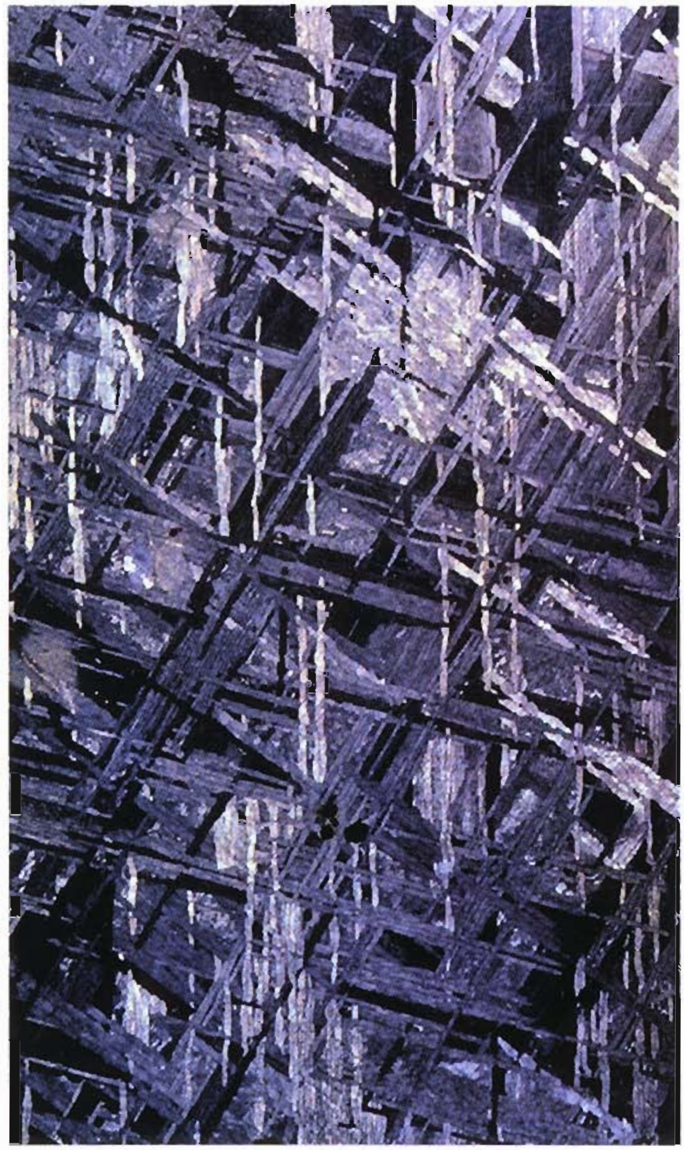
Strong magnet on a string test. A strong magnet will swing towards virtually ALL meteorites, whether stone, stony iron or iron, making this one of the best preliminary tests for meteoritic material. Other field tests include checking for *fusion crust* and *rust*, and filing off a tiny corner to look inside for bright metal, or, in the case of stones, chondrules. In addition to iron and nickel, the so-called iron meteorites can also contain elements such as sulfur, silicon, phosphorus and carbon, among others.

Odessa, Texas, USA. A tumble-polishing process turns old rusty iron into nuggets of bright space metal.

Mark Carlton manning the cosmic rotisserie. A star is born! Only water-cooled, carborundum and diamond blades with lots of horsepower can do the job.

Jeff Kline puts it through the paces. Saw marks must be polished out through at least 220 grit to properly prepare an iron meteorite for the etching process.

A weak (10%) nitric acid solution is applied to the face of this Campo del Cielo iron meteorite slice. Adding alcohol prevents the bleeding of inclusions. Note safety gear!!!



The final product - Gibeon, Namibia, Africa
Clear, crisp Widmanstatten lines and a knock-out polish make your specimen even more exciting.

METEORITE ETCHING, 101-A

You can give your iron meterorite a great etch on your own. After polishing the cut face, apply a well-mixed solution of 10% nitric acid diluted with 50% water and 50% drugstore isopropyl alcohol at room temperature. With a cotton cloth, rub mixture briskly across the newly cut face until desired pattern depth is achieved (2 to 3 minutes). **Be sure you have good ventilation, chemical-resistant gloves and eye protection!!! The acid can burn you severely!** To neutralize, wash piece thoroughly in warm, soapy water. Dry thoroughly. To protect the etched face, coat the specimen with a good quality machine oil or a good quality spray lacquer. Admire your work!

#1 **Atacama, North Chile Hexahedrite.** The low nickel content of this type of meteorite puts it in the hexahedrite category of irons. When etched, it shows a fine pattern of lines called *Newman lines*. This laid in Chile's Atacama Desert for thousands of years.

#2 **Henbury, Central Australia, Australia.** These octahedrites have 7% to 9% nickel. This particular specimen is well-oriented, showing that it did not tumble as it passed through the atmosphere, but maintained a stable flight pattern.

#3 **Chinga, Turvinskaya, USSR.** An ataxite, these have the most nickel of all - 12% or more. This meteorite shows signs of heavy shock and deformation during break-up in the atmosphere.

#4 **Sikhote Alin, USSR.** This Feb. 12, 1947 fall was the largest recorded fall in history. When this main mass exploded, it blasted twisted, jagged fragments in every direction; pieces were found embedded in nearby trees.

#5 **Toluca, Mexico.** Recovered from a remote mountain location near Mexico City, where local farmers still occasionally run into these heavy "rocks" with their plows. Toluca might once have looked like Sikhote Alin, but years of weathering have dulled the edges and left a rusty shell.

#6 **Boxhole, Northern Territory, Australia.** A medium octahedrite similar to Henbury. When it hit, it formed a small crater from which some large masses were recovered, along with many smaller, old weathered-out meteorites, called "shale balls".

#7 **Aldama, Mexico.** This specimen is unusual because it shows signs of having gone through an extended and intense heating and re-crystallizing process, possibly as a result of passing too near the Sun. The Widmanstätten pattern was completely altered by this encounter, and there seem to have been some other strange consequences as well...

#8 **Mundrabilla, Australia.** This photo was pulled right from a Tokyo, Japan, television program. This is a popular game show where contestants try to guess the price of the featured item. (Japan loves meteorites.)

#9 **Gibeon, Namibia.** This is one of the best "space art" specimens I've ever seen - almost a mini-Tucson Ring. I got this specimen at the Munich, Germany show, as it was being unpacked. I couldn't believe my eyes. Luckily, I saw it first! I love it. 63 kg.

Chaco Province, Argentina. Author with the 37-ton "alien" that tried to possess him. Inset: Author with the Argentine police. They *did* possess him... for a while, anyway. (It was a big misunderstanding.) Hey, this *does* have its risks... .

1 NORTH CHILE
Hexahedrite with Newman lines; IIA.
Smaller: 4.7 kg.: 230 x 80 x 70 mm.

2 HENBURY
Med. octa. IIIA. Complete specimen.
30 kg.: 250 x 250 x 150 mm.

3 CHINGA
Nickel-rich iron ataxite, IVB. Complete specimen. 1.6 kg.: 100 x 95 x 50 mm.

4 SIKHOTE-ALIN
Good flight markings. Coarest octahedrite. 130 kg.

5 TOLUCA
Complete specimen, IA. Coarse octahedrite. 3 kg.: 230 x 130 x 75 mm.

6 BOXHOLE
Med. octa. specimen. IIIA.
4 kg.: 230 x 50 x 50 mm.

7 ALDAMA
Complete w/ nice flight markings.
Med. octa 7.2 kg.: 350 x 130 x 100

8 TOKYO GAME SHOW
The Meteorite Man on Tokyo TV.

9 GIBEON
Natural ring formation. IVA. 63 kg.: 450 x 320 x 130 mm.

#10 **Cape York, Greenland.** A 3-ton specimen was found in 1982 by an Eskimo who spotted it in several feet of water at low tide. Drax as a puppy with a 50 kg.slice.

#11 **Gibeon, Namibia, Africa.** This nut and bolt was machined directly from Gibeon meteorite. Gibeon works like a dream - you can weld, drill, or machine it into anything - even an orbiting space station!

#12 **The Asteroid Belt.** Buck Roger's favorite fashion accessory. Hand-stamped conchos are of versatile Gibeon meteorite. Made it myself! Keeps my pants up.

#13 **Uruachi, Chihuahua, Mexico.** Another new iron recently discovered by ranchers in Mexico. Coarse octahedrite. 13 kilograms total weight were recovered.

#14 **Wolsey, South Dakota, USA.** An alert farmer "discovered" this 70 kilogram specimen while plowing his field. He sold it after reading a notice in a local farm journal which offered a reward for such things.

#15 **Fairview, Texas, USA.** Pappa Yeates, a friend of mine and authority on all things meteorite-like, saved this one for me after a farmer brought it to him for sale.

#16 **Bear Creek, Colorado, USA.** A large 230 kg. mass was discovered in 1866 in a deep gulch at nearly 8000 ft.elevation, on a slope in the Rocky Mountains. Meteorites were often turned up by prospectors who mistook them for silver nuggets.

Etched Toluca face in gold watch case. We now have these with nickel or gold-plated watch cases. A "show-and-tell" meteorite is something to be proud of and by talking about it, everyone learns something.

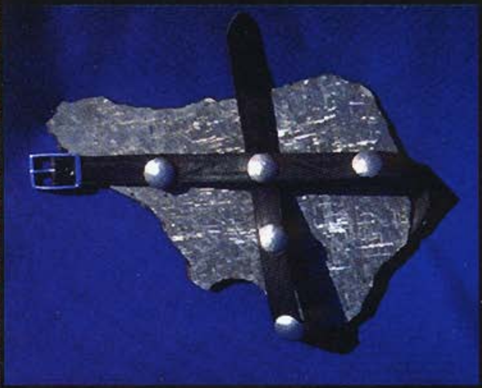
#17 **Arispe, Sonora, Mexico.** This is also a coarse octahedrite. This slice is almost free of inclusions. Note the obvious and clear crystal boundaries. When an iron meteorite hits the atmosphere, it usually breaks along these boundary lines. Look out!

#18 **Seymour, Missouri, USA.** A mass of some 26 kilos was found in 1940 but it wasn't recognized as meteoritic until 1963. I received this specimen in trade with a major American museum, a great way to acquire new and different pieces without hassle and red tape. Trade promotes diversity and collections grow accordingly.

Iron meteorite coin medallion. We melted iron meteorite scrap at 3,400 degrees Fahrenheit and poured it into molds to create these unique coin medallions. A limited edition series, only 600 of these cool medallions exist in the universe.

10 CAPE YORK
The troilite (FeS) and graphite (C) nodules are surrounded by schreibersite.
Coarse octahedrite. IA. Slice. 45.5 kg.: 1287 x 630 x 25 mm.

11 NUT AND BOLT
Machined from Gibeon fine octahedrite.

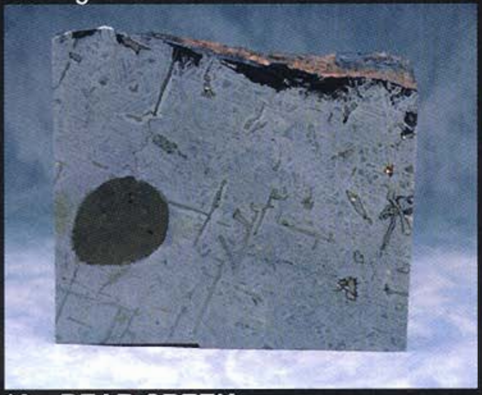


12 ASTEROID BELT
Handworked Gibeon conchos.

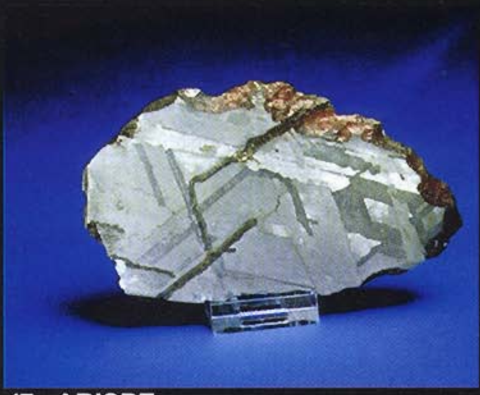
13 URUACHI
Octahedrite. IIIB. Etched end piece.
2.37 kg.:140 x 80 x 60 mm.

14 WOLSEY
Coarse octahedrite, IA. Slice. 3.0 kg.:
270 x 220 x 10 mm.

15 FAIRVIEW
Medium octahedrite. Etched slice.
296 gr.: 220 x 125 x 7 mm



16 BEAR CREEK
Med. octa. IIIB. Partial slice w/ large
troilite nodule. 1.7 kg.: 117 x 95 x 22



17 ARISPE
Coarse octahedrite. IC. Slice. 348
gr.: 145 x 70 x 10 mm.

18 SEYMOUR
Coarse octahedrite, IA. Slice. 980 gr.:
200 x 95 x 9 mm.

#19 **Magura, Czechoslovakia.** The inclusions in this meteorite are tiny crystals of schreibersite. Most of this meteorite was smelted down into farming implements more than a century ago.

#20 **Maltahohe, Namibia.** This is a new discovery southwest of the Gibeon strewnfield. The shape of the specimen is very unusual. When we polished and etched a small window into the meteorite, the very different Widmanstatten pattern was proof we had found a new one.This is graphite, troilite, and silicate-rich. 294 grams.

#21 **Kenton, Kentucky, USA.** Medium octahedrite. Note smaller crystals than the coarse octahedrites, indicative of more nickel - some 7.6%.

#22 **Sacramento Mountains, New Mexico, USA.** This has a nice medium octahedrite pattern and a brassy-colored troilite nodule. I got it in a trade with UCLA.

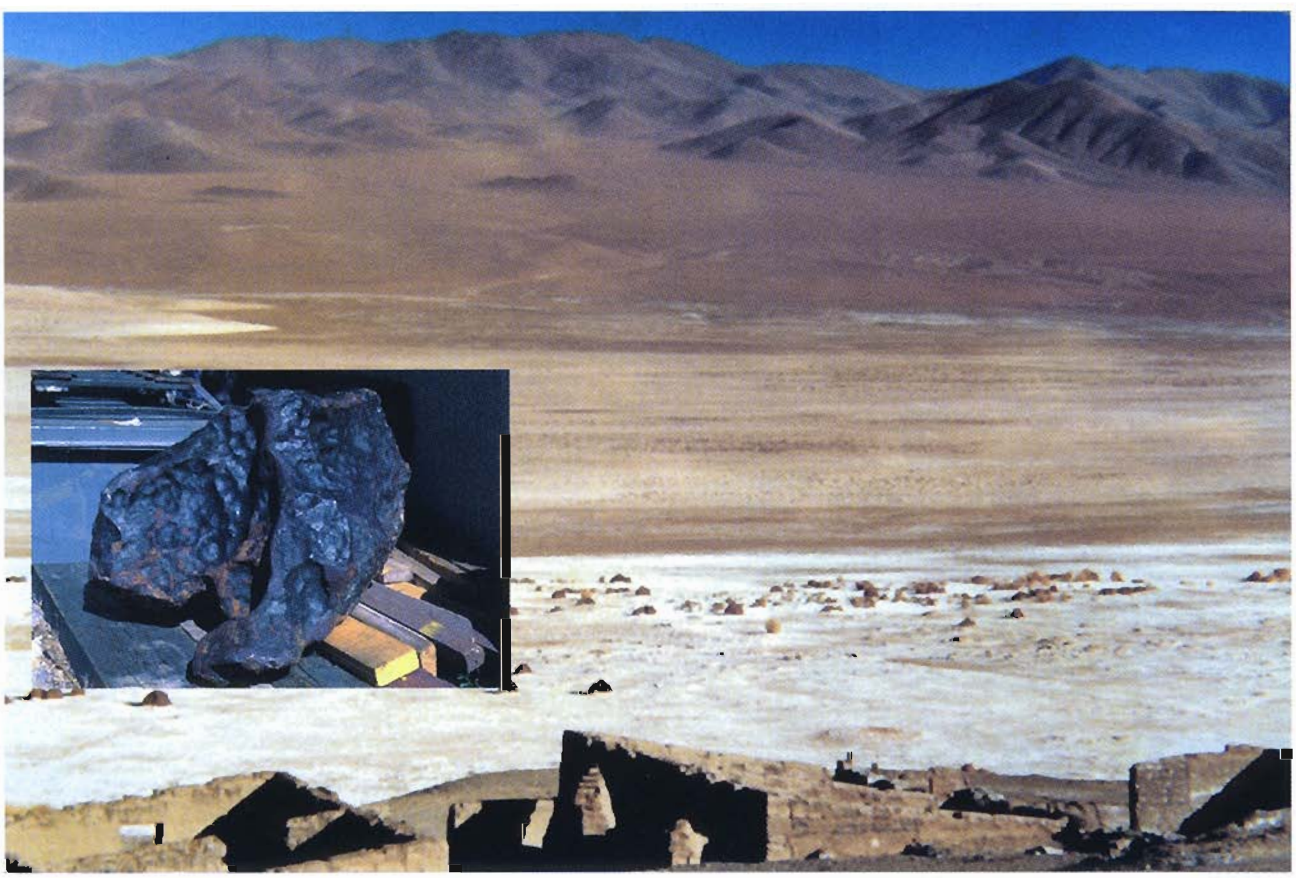
#23 **Alvord, Iowa, USA.** A fine-octahedrite pattern. Note the disruption of the pattern on the upper half of the left edge. This was caused either by a collision in space or within the bolide as it entered the Earth's atmosphere. I got this slice from the original finder.

#24 **Guadalupe y Caldo, Chihuahua, Mexico.** A single, 60 kg. specimen was discovered on a ranch by a cattle buyer. The dish-shaped space rock had been used as a dog bowl for over 20 years, and was finally traded for a new pick-up truck! (The dog got a new bowl...)

#25 **Santa Clara, Mexico.** This is an ataxite, the most nickel-rich of all irons. When etched it doesn't show a Widmanstätten pattern, making it difficult to distinguish from old canon balls, rusted tools and other earthly iron.

#26 **Shingle Springs, California, USA.** I got this piece without locality. I thought I had bought a piece of another fine octahedrite, but when we went to etch it, the acid only dulled the polished surface. Tests showed more than 28% nickel!

#27 **Toluca, Mexico.** There are round nodules of troilite and graphite mixed with the nickel iron crystals in this meteorite. Toluca has one of the nicest Widmanstatten patterns when etched. One Swiss watch maker currently uses it in a wristwatch. (See photo page 8.)



Gibeon, Namibia, Africa. Nearly a million pounds of this beautiful meteorite is scattered over several thousand square kilometers of barren desert. It is plentiful, extremely easy to work, and a blessing from space for the Namibian people who collect it.

19 MAGURA
Coarse octahedrite, IA. Slice. 748 gr.: 90 x 45 x 40 mm.

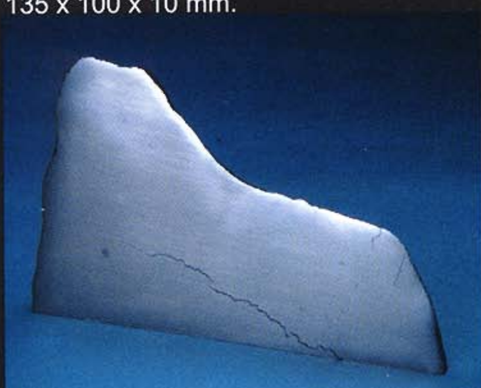
20 MALTAHOHE
Coarse octahedrite. IA.Slice. 294 gr.: 90 x 45 x40 mm.

21 KENTON
Medium octahedrite. IIIA. Slice. 205 gr.: 95 x 50 x 10 mm.

22 SACRAMENTO MOUNTAINS
Med. octahedrite. IIIA. Slice. 887 gr.: 135 x 100 x 10 mm.

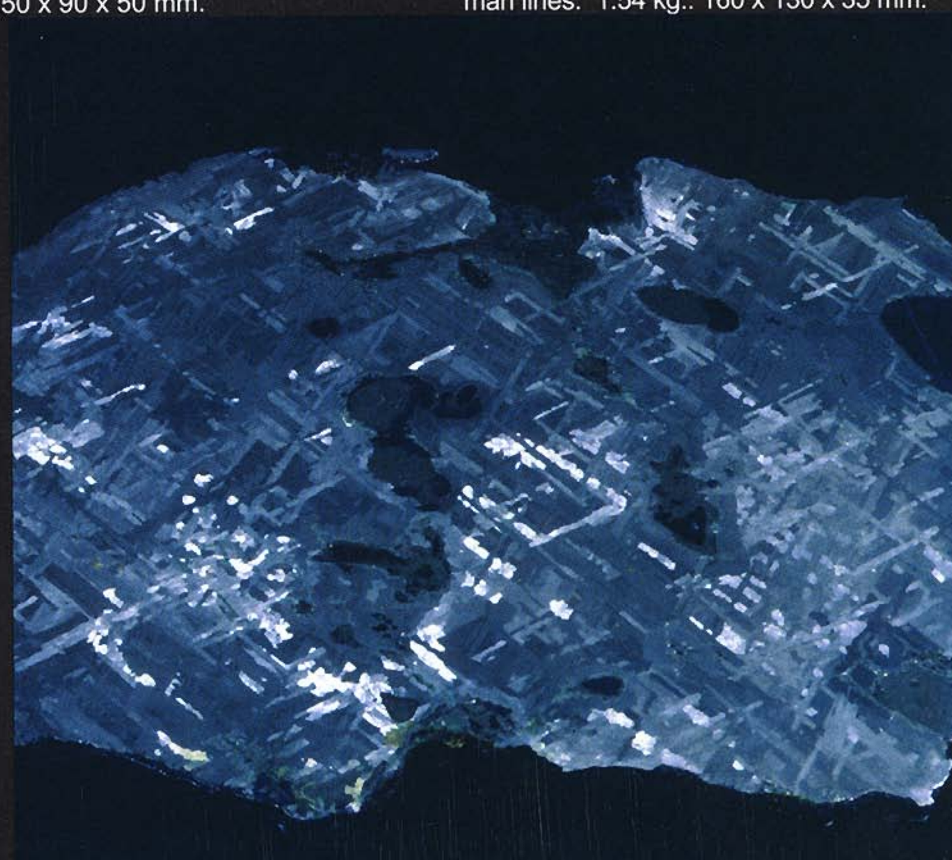
23 ALVORD
Fine octahedrite. IVA. Slice. 81 gr.: 250 x 90 x 50 mm.

24 GUADALUPE Y CALDO
Hexahedrite IIB. End piece with Newman lines. 1.54 kg.: 160 x 130 x 35 mm.



25 SANTA CLARA
Nickel-rich ataxite, IVB. SLice. 1.1 kg.

26 SHINGLE SPRINGS
Tridymite inclusion, 28% Ni, high K. End piece. 456 gr.: 110 x 55 x 20 mm.



27 TOLUCA
The troilite and graphite 2922 gr.: 295 x 185 x 9mm nodules are surrounded by schreibersite. Coarse octahedrite.

Silicated iron meteorites are sort of a group between groups. While considered irons, they nevertheless contain significant amounts of silicates and other inclusions. Occasionally, as in the case of the Caddo County specimen, two or three categories of meteorite are represented in the same piece at once. Because of their silicate content, silicated irons tend to be lighter than pure irons.

Author with metal detector. This is one of the best ways to look for meteorites, especially irons and stoney irons. Keep it set at maximum intensity.

#28 **Georgetown, Queensland, Australia.** This brand-new discovery was made by a gold prospector while metal-detecting in the rich Queensland goldfields. Of a very unusual type, it is unlike anything I've ever seen before. Only four small specimens have been found over a quarter mile area.

#29 **Mundrabilla, West Australia, Australia.** Ribbons and pockets of troilite inclusions create the distinctive Mundrabilla pattern. When this meteorite weathers, the troilite disappears, leaving deep pocks and holes.

#30 **Twannburg, Switzerland.** This beautiful meteorite is classified as an anomalous iron, meaning that it is unique. No others have ever been found. The unusual, scroll-like inclusions are of a phosphorus mineral called schreibersite, which does not occur in Earth rock.

#31 **Graphite Nodule. Canyon Diablo, Arizona, USA.** Recent studies suggest formation occurred shortly after impact! The graphic nodules carbon was born from vaporized Arizona limestone & iron meteorite mix.

#32 **Odessa, Texas, USA.** This is a close-up of an interesting inclusion from an Odessa iron meteorite slice. There seems to be a little bit of everything: the dark material in the center is black graphite and troilite. The crystals around the rim are schreibersite. There is also a bright yellow olivine crystal near the center.

#33 **Canyon Diablo, Arizona, USA.** Diamond crystal (carbonado). When we cut this piece, the much harder diamond crystal actually *moved* the saw blade over and around it. The carbonado was probably formed when carbon, in the form of graphite within the meteorite, was subjected to an intense shock, either in a collision with another asteroid or with the surface of the Earth.

#34 **Toluca (b), Mexico.** This new silicated iron meteorite was picked up from within the Toluca strewnfield where it was found by one of the local people. The minute I held it, I realized that it was different from the other Toluca pieces; half as heavy, but obviously iron, with the typical, pitted surface of silicated irons.

#35 **Zagora, Morocco.** This piece was found in the desert near the Atlas Mountains by fossil hunters. Unfortunately, the locality is near a military zone. Not much chance of getting in there with my detector! Note how the many silicate inclusions disrupt the etched medium octahedrite pattern. (Compare to Miles, below.)

#36 **Landes, West Virginia, USA.** This is a beautiful, unusual meteorite, with so many silicates that the pyroxene crystals seem to grow in the meteorite, rather than be simply mixed in, as with a mesosiderite.

#37 **Udei Station, Nigeria.** I got this cut fragment off of the main mass in Nigeria. Note silicate inclusions and the fresh fusion crust. This was a recent, witnessed fall, and this specimen was dug up from the impact hole.

#38 **Woodbine, Illinois, USA.** The silicates are obvious in this anomalous, 1B silicated, fine-octahedrite. It was discovered by a farmer in1953, when he plowed it up.

#39 **Caddo County, Oklahoma, USA.** This is an unusual piece in that one end section is highly silicated and the other end of the same specimen is very poorly silicated - nearly solid iron. The silicates and iron are very poorly mixed; sort of a borderline mesosiderite/ silicated iron. This is closely related to lodranites.

Miles, Queensland, Australia. Two specimens were found in a gold field by accident. A truly beautiful anomalous new silicated iron meteorite. 1.38 kg.

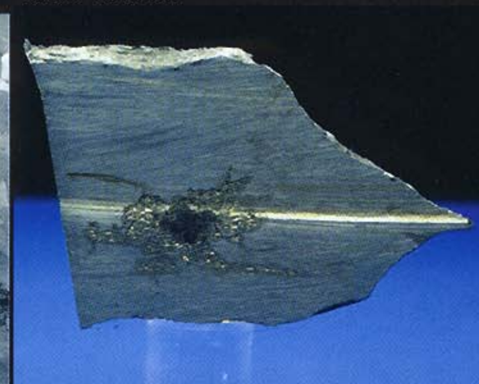
28 GEORGETOWN
Anom. iron. Troilite inclusions in matrix. Endpiece. 397 gr.: 850 X 500 X 230 mm

29 MUNDRABILLA
Medium octahedrite, anom. Slice. 1.59 kg.: 230 x 180 x 10 mm.

30 TWANNBURG
Anomalous iron. Slice. 430 gr.: 180 x 100 x 10 mm.

31 GRAPHITE NODULE
End piece. 1 kg.: 110 x 80 x 30 mm.

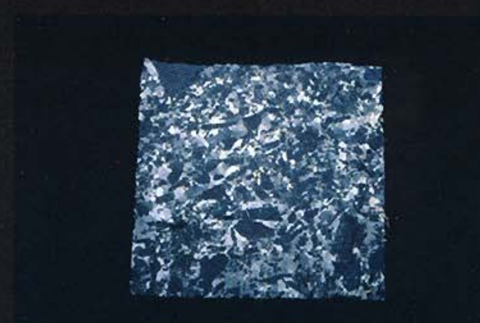
32 ODESSA INCLUSION
Graphite inclusion, close-up. Image area: 40 x 20 mm.



33 CANYON DIABLO CARBONADO
Coarse octahedrite. IA. Slice. 26 gr.: 5 x 5 x 2 mm. **Diamond inclusion in schreibersite.**

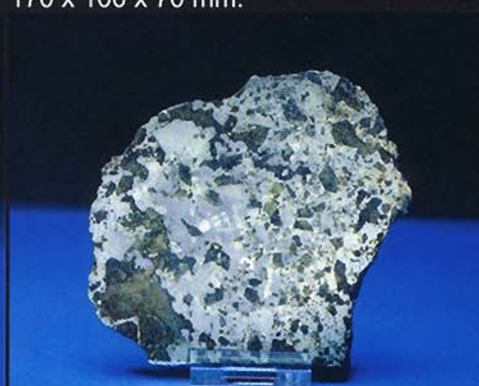
34 TOLUCA (B)
Silicated iron. End piece. 943 gr.: 110 x 110 x 30 mm.

35 ZAGORA
Silicated iron. IA. End piece. 1.97 kg.: 170 x 100 x 70 mm.



36 LANDES
Silicated iron. IA. Slice. 206 gr.: 100 x 90 x 10 mm.

37 UDEI STATION
Coarse octahedrite. IA. Endpiece. 855 gr.: 100 x 80 x 40 mm.



38 WOODBINE
Silicated iron, anom. Slice. 471 gr.: 110 x 110 x 10 mm.

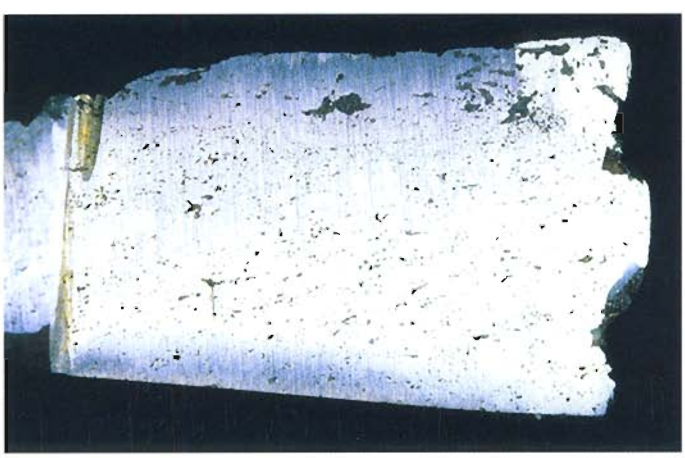
39 CADDO COUNTY
Silicated iron. IA. Partial piece. 17 kg.: 280 x 150 x 80 mm.

THE TUCSON IRON METEORITES

The Tucson Iron meteorites are shrouded in mystery. Known for centuries by the local Indians and later by ranchers in the area, only two masses were ever recovered. These came from somewhere in the Santa Rita Mountains, south of Tucson, Arizona.

Searching the Santa Ritas for a piece of the ring... UPDATE!! An additional four, dime-to-quarter- sized pieces have now been found, just to tease and tempt us.

Both pieces were eventually transported overland to the tiny frontier settlement of Tucson, where they ended up as working blacksmith's anvils. It wasn't until 1850 that a U.S. Cavalry officer recognized the huge chunks of iron as meteorites and contacted the National Museum in Washington. Both specimens were transported there and now reside in the Smithsonian, far from the Sonoran Desert. Unusual in more ways than a lost location, the larger, 688 kg. meteorite is shaped in a natural, perfect ring. They are both of a rare *anomalous* iron: uncategorizable, highly unusual and unique. Even though it is labeled an ataxite, it is full of nearly microscopic crystals of enstatite and olivine. It contains 9.45 % nickel and shows no Widmanstätten pattern when etched.



Anomalous iron. This is a close-up of the internal structure of the Tucson Ring meteorite. Note the pinpoint sized silicates throughout the metal. It almost looks "fuzzy" inside. Area shown 100% enlarged.

This is the ultimate "lost treasure", far surpassing the "Lost Dutchman Gold Mine". Gold is gold, but more of an anomalous iron like the Tucson would have scientists and collectors banging at my door... . I've been fascinated with the story for years-- ever since I heard my rock-hound parents talk about it. When I saw a copy in the Flandrau Science Center at the University of Arizona, I decided to find the *rest* of that sucker.

So, a bunch of crazy friends and I have been searching up and down ravines, in and out of box canyons, over dozens of square miles, freezing our rears or broiling our brains, for years. We've had near misses with rattlesnakes, dead hits from dagger plants that ram two inches of hard spike into your shins, and tumbles down steep slopes, but I wouldn't have missed it for the world, even though we *still* haven't found the strewnfield. (Er... did you say there was beer back at camp...?)

Photo courtesy Arizona Historical Society

The Carleton Meteorite. The smaller, less famous of the two iron meteorites found near Tucson. The photo shows the Carleton Meteorite in San Francisco in 1862 just before its long sea voyage around Tierra del Fuego to the Smithsonian, where it is proudly displayed.

During a year long expedition across Antarctica's blue ice fields, scientists from Japan's National Institute of Polar Research encountered numerous hazards and challenges. One of their two snow cat vehicles crashed through a hidden snow bridge and fell nearly 40 meters down into the crevice below . Incredibly enough, no one was critically injured. The snow cat vehicle **is forever** entombed in the ice.

Many exciting new meteorites have been found as a result of the combined efforts of the Japanese and American expedition teams, such as the fabulous find of the Alan Hills 84001 Mars rock,
(see pg.29).

Some fun. Robert Haag, Dave Spatz, Joe Knue and Steve glad to still be alive. Getting back across the water took four days and the plane stayed behind.

OBEY GRAVITY - IT'S THE LAW. Another Latin American adventure that didn't exactly "pan out" (left). While flying over Baja in search of the Santa Rosalia pallasite, my brother-in-law, David Spatz's small plane met severe, unexpected turbulence and crashed into the desert. I think we made a crater. Though it looks like no one could possibly have survived the crash, amazingly, no one was even hurt! Talk about lucky stars.

IMILAC PALLASITE

The Imilac pallasites were found high in the Chilean Andes, one of the most remote places on Earth, in the Atacama Desert, a high, barren, *dry* desert - no rain, no plants, nothing but meteorites, llamas and loco gringos.

Several years ago, the "Meteorite Recovery Team", consisting of me, two buddies and three Chileans, went in search of more specimens. Two trucks, six crazy guys and a lot of supplies, all crawling up the side of the Andes searching for Imilac pallasites.

Among the light background rocks of the desert, the rusty-looking pallasites seemed to jump out at us. Most of the larger specimens were dumped high on the sides of a steep hill. Near the end of the strewnfield was an impact crater where a big one hit, blew up and scattered fragments for a kilometer or more.

At night, we gazed at the stars of the southern hemisphere from our camp at nearly 10,000 feet elevation. Without city lights, smog or dust to obscure their light, the Milky Way was like a white blanket, which is the reason that the Andes are one of the best locations in the world for astronomical observatories.

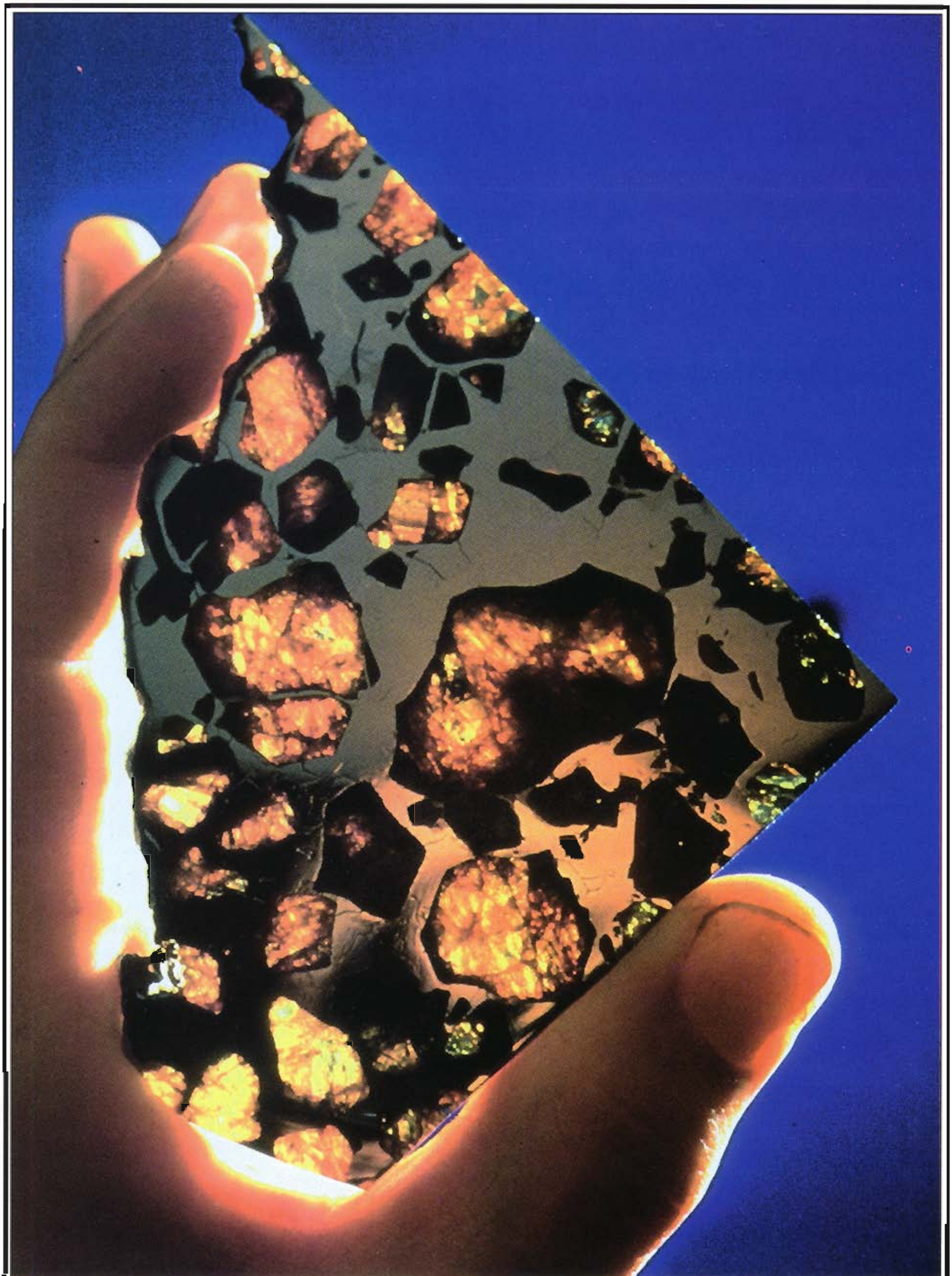
By day, we searched the area with detectors, finding fragments and complete stones all along the sides of the peaks. The air was thin and cold, which seemed to suit the meteorites; they were perfectly preserved and some of the most beautiful meteorites I've ever collected.

Atacama Desert, Northern Chile. Author parasailing over the Atacama Desert, looking for impact craters. An outrageous sense of adventure isn't absolutely necessary for hunting meteorites, but it sure doesn't hurt!

Imilac fragment, as found. Most of the recovered pieces were right on the surface.

Imilac, Atacama, Chile. This 17 kg. specimen was found in its own impact crater. The buried part retained some fusion crust, while the exposed section was sand-blasted for thousands of years, keeping it rust-free.

Atacama Desert, Northern Chile. The boys with the booty. Martin Holt and Jeff Kline show off the day's discoveries. Cosmic treasure don't come easy - you have to go where it lives.



Esquel pallasite. Extremely thin slice with back-lighting. This meteorite is composed of approximately 50% nickel-iron alloy and 50% stone, in the form of beautiful olivine ($[Mg,Fe]_2SiO_4$) crystals. Sometimes called peridot, olivine constitutes a great deal of the "stone" in stone meteorites, along with other minerals, such as hypersthene, plagioclase, troilite and others. Pallasites are the most popular selling stony-iron meteorites, for obvious reasons. 80 grams.

The term "mesosiderite" (*meso* - meaning between, *siderite* - meaning metal-bearing) is a remnant of a classification system devised in 1863 by Maskelyne. Confusion over the classification of meteorites has been going on for decades and persists today. Now scientists are realizing that much of the classification is arbitrary and that many meteorites cross categories.

#40 **Emery, South Dakota, USA.** The iron and stone portions of this meteorite are very well mixed, indicating that it was smashed together sometime during its formation. For instance, there is evidence of grinding and folding in its past. Meteorites like this give scientists an opportunity to study the composition of the universe and to understand more about the formation of planets and solar systems such as our own. It is important to remember that meteorites such as Emery come to us just the way they occurred in space. The deformation of the crystals is not a result of terrestrial impact.

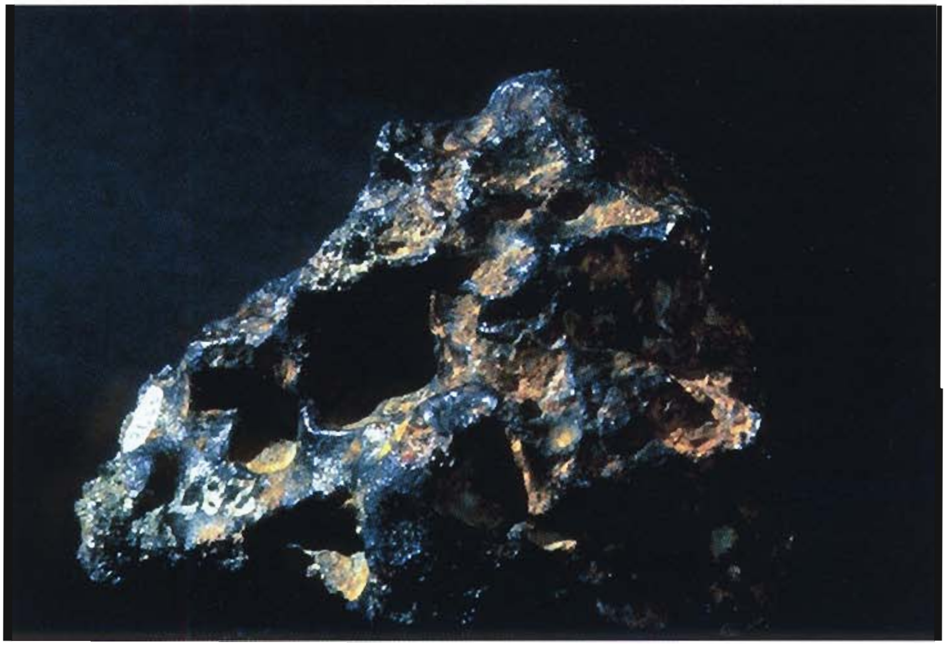
#41 **Clover Springs, Arizona, USA.** This photo shows the nice mixing of the metals and silicates in this well-preserved meteorite. I searched among the pine trees for this one, and I'm sure there's more to be found.

#42 **Mt. Padbury, Western Australia, Australia.** This meteorite is quite old and weathered on the outside, making it hard to recognize. However, if you grind a corner of this rough, rusty rock, you'll see lots of metal. Then you can get excited!

#43 **Chinguetti, Mauritania.** According to legend, an iron meteorite as big as a two-story house was known to the Bedouins. One of them showed the location to two French Legionnaires, and was fatally poisoned a few days later. The Legionnaires noted the episode in a journal, but when they went to find the "meteorite", it was lost under the shifting sands of the Sahara, and was never seen again. Sadly, the mystery was recently solved: the long-lost "Chinguetti meteorite" turned out to be an enormous, natural bank of hematite. This meteorite specimen was an unrelated find from nearby.

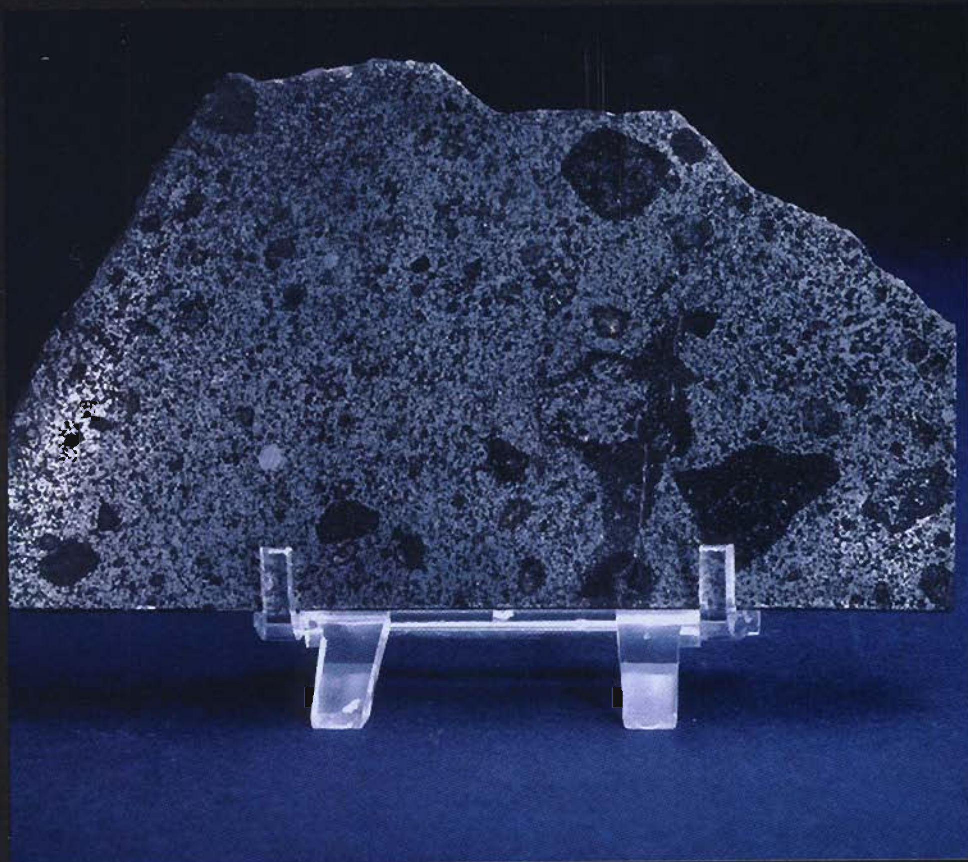
#44 **Budulan, Buryat National District, USSR.** This specimen is just half of an original 4 kilogram mass found in 1994. More of this rare and valuable mesosiderite is sitting out there, waiting to be found.

#45 **Lamont, Kansas, USA.** This new mesosiderite discovery was made by Mr. Haas while ranching. Only one specimen of approximately 37 kilos was found. Of that, half has gone to museums, half has been sold.

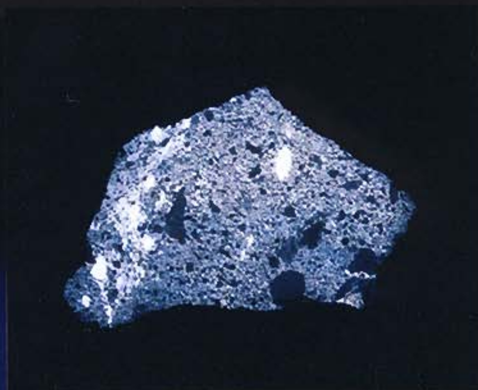


Lowicz, Poland. (Above) Mesosiderite fall, March, 1935. In this rare meteorite, bright metal and stone are mixed together. This area would be a good place to search for more pieces. 979 gram end piece.

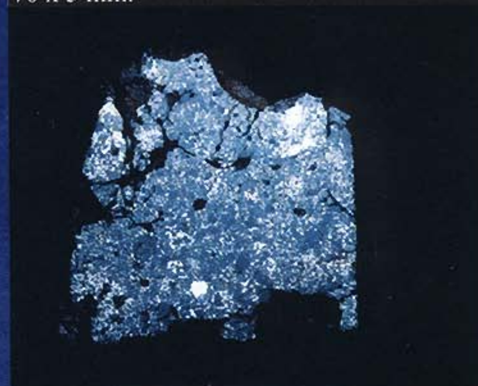
Esterville, Iowa, USA. (Left) The blue-black fusion crust is very important in the identification of meteorites and often gives clues to as to the type of material within. Close examination of this photo reveals two different types of fusion crust. The softer, grainy stone material melted out faster and left a different fusion crust than the harder iron.



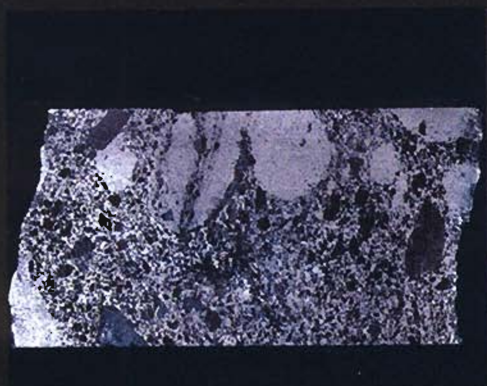
40 EMERY
Stony-iron mesosiderite. Slice. 211 gr.: 150 x 80 x 5 mm.



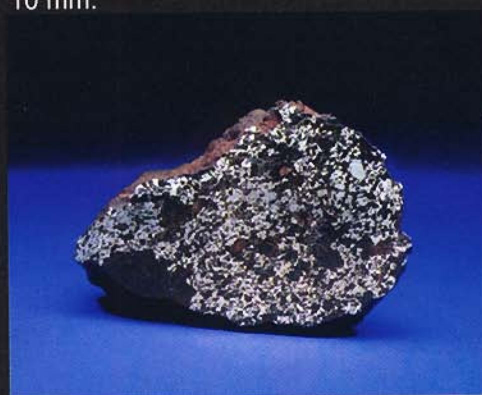
41 CLOVER SPRINGS
Mesosiderite. Slice. 90 gr.: 100 x 70 x 5 mm.



42 MOUNT PADBURY
Mesosiderite. End piece. 564 gr.: 80 x 70 x 50 mm.



43 CHINGUETTI
Mesosideite. Slice. 264 gr.: 90 x 45 x 10 mm.



44 BUDULAN
Rare mesosiderite. 1.89 kg.: 145 x 100 x 60 mm.

45 LAMONT
Mesosiderite. 6.5 kg.: 165 x 135 x 130 mm.

#46 **Bencubbin, Western Australia, Australia.** Occasionally a meteorite will occupy a class by itself. Bencubbin is one such specimen. A mesosiderite, it has enstatite and olivine crystals as well as clasts of chondritic material, mixed with troilite and finely laced silicates. It has a hexahedrite metal matrix (6.6% nickel), yet shows no Newman lines when etched. Very unusual.

#47 **Mincy, Missouri, USA.** Large stony chunks are mixed into the mesosiderite. More specimens of Mincy (1857 fall) would be welcome.

#48 **Vaca Muerta, Chile.** This is an example of stone meteorite material (pyroxene and plagioclase) being mixed in with a mesosiderite. Clasts, or inclusions, of this stone material, such as the large, dark rectangle at the top, are similar to the calcium-rich achondrites (eucrites). From examples such as Vaca Muerta, scientists have concluded that both eucrites and mesosiderites may come from the same parent body.

#49 **Bondoc, Luzon, Phillppines.** This mesosiderite had huge, baseball-sized spheres of iron set into a matrix of stony material, putting it on an entirely different scale than any other mesosiderite. As if that weren't odd enough, when the spheres of iron were cut open, they revealed yet more inclusions of stony material within.

#50 **Crab Orchard, Tennessee, USA.** A beautiful, unusual mesosiderite. Note the big clasts of iron and stone. This probably fell in the late autumn of 1880, when a meteor passed over the area, leaving a dense, narrow trail of light-colored smoke. Seven years later, this meteorite was found by Mr. Elihu Humbree who knocked off several large chunks, looking for "native silver". Mr. Lenoir, the owner of the land on which it fell, suspected its true nature and sold the specimen.

Vermillion, Kansas, USA. Beautiful, brand-new type of pallasite, called a pyroxene pallasite. Complete slice from a 35 kg specimen found in 1994. 190 x 150 x 5 mm.

While all pallasites are by definition a mix of nickel- iron and olivine, the nickel-iron matrix can vary in relative nickel content, and the olivine crystals can range from nearly perfect spherules to smashed, angular fragments. The olivine crystals can also be anywhere from a few milimeters in diameter to groups of crystals literally the size of footballs!

#51 **Huckitta, Northern Territory, Australia.** These meteorites represent a type of stony iron called pallasites, whose constituents consist of approximately equal parts of olivine and iron. The olivine crystals can vary from nearly perfect spherules to broken up, angular fragments. This particular type is highly weathered; the iron has metamorphosed into its oxide, hematite.

#52 **Tarahumara, Mexico.** This new discovery was first thought to be a nugget of native silver! Crystals of almost pure silica have been found in this meteorite. It is currently being studied by UCLA. Maybe a new class?

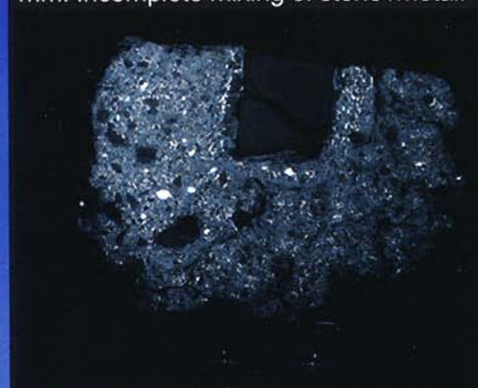
#53 **Glorieta, New Mexico, USA.** This pallasite has small traces of fusion crust covering both the crystals and the metal, with bits of rust here and there. Some pieces of this meteorite have been found to contain alternating sections of pure nickel-iron and olivine-rich pallasite. Note the amazing and unusual heart shape!

#54 **Otinapa, Durango, Mexico.** The surface of this meteorite reveals what's to come on the inside: mixed metal and stone. I was extremely lucky to have acquired the only piece ever recovered of this meteorite, a beautiful 8 kilo mass. I have since traded slices of it for other terrific pallasite pieces. (I *love* pallasites.)

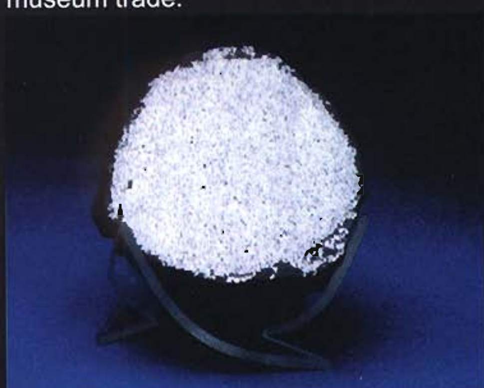
Acomita, New Mexico, USA. This was found by an elderly man who saw it by the side of the road while changing a tire, and used it to prop up the axle of his truck. Instead of leaving it , he threw it in the back, where it rolled around for several years before it was recognized as a meteorite. Slice. 161 grams: 100 X 75 X 6 mm.

46 BENCUBBIN
Stony-iron mesosiderite. Slice. 436 gr.: 114 x 92 x 11 mm. West Australian museum trade.

47 MINCY
Mesosiderite. Slice. 224 gr.: 90 x 70 x 10 mm. Incomplete mixing of stone /metal.



48 VACA MUERTA
Unusual mesosiderite. End piece. 2.3 kg.: 250 x 230 x 80 mm.



49 BONDOC
Stony-iron mesosiderite. 1.45 kg.: 85 x 85 x 50 mm. Fe nodule laced w/ silicates.

50 CRAB ORCHARD
Mesosiderite. Slice. 181 gr.: 60 x 50 x 20 mm.

51 HUCKITTA
Pallasite. Highly weathered end piece. 500 gr.: 90 x 90 x 80 mm.

52 TARAHUMARA
Pallasite. 1.03 kg.: 110 x 84 x 40 mm.

53 HEART-SHAPED GLORIETA
Pallasite. Complete specimen. 127 gr.: 55 x 53 x 28 mm.

54 OTINAPA
Pallasite. Half-specimen. 2.5 kg.: 180 x 80 x 60 mm.

Faceted space peridot crystals. These beautiful faceted gems came from an Esquel pallasite. It's rare to find such large, unshocked gem material outside the asteroid belt.

#55 **Albin, Wyoming, USA.** This meteorite was found on a grassy slope by a rancher who had seen a meteorite display in Denver and recognized it. His neighbor has since found a second specimen across the street!

#56 **Admire, Kansas, USA.** This is a slice off a find from Kansas. This pallasite is difficult to maintain, as sulfides in the metal promote rust, and the crystals are often smashed and crumbling.

#57 **Theil Mountains, Antarctica.** This unusual specimen was found on a glacier in 1962. The single crystals of olivine appear as nearly perfect round "bubbles" in the iron matrix. Such perfect crystal structure indicates little change since the original cooling took place within the parent body.

#58 **Dora, New Mexico, USA.** This would be a good pallasite to look for, as there may be more in the area that were missed on the first sweeps.

#59 **South Bend, Indiana, USA.** This specimen was found resting next to a fence. If you live nearby, it might be worthwhile to look for more of this nice pallasite.

#60 **Ahumada, Mexico.** This pallasite has unusually large olivine crystals. It comes from a vast mesquite desert, with only a few isolated farms scattered around.

#61 **Springwater, Saskatchewan, Canada.** The Springwater pallasite is very similar to the Brenham pallasite, but the crystals of olivine are approximately 30% smaller, nor is any troilite visible, as in Brenham.

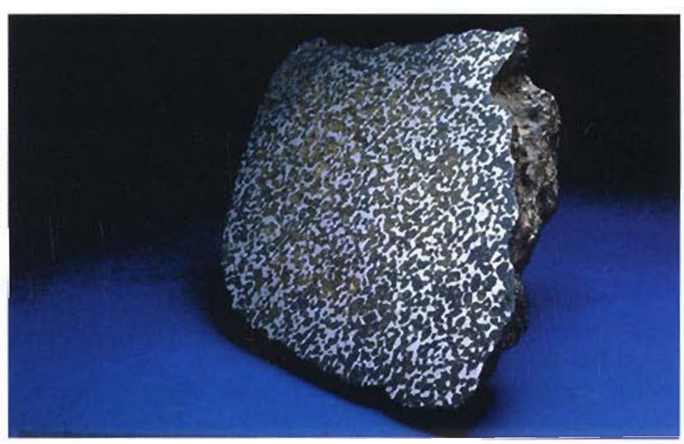
#62 **Otinapah, Durango, Mexico.** This pallasite contains both large and small crystals of olivine, many are crushed. (See photo 54, pg. 21.)

#63 **Brahin, Minsk, Byelorussia, USSR.** The Soviet Union's answer to Brenham. This beautiful, 11 kg end piece is one of my favorites. Note the chromeite inclusion.

#64 **Mount Vernon, Kentucky, USA.** This specimen may have been a witnessed fall. As with all pallasites, it's hard to imagine just how they formed. Did the elements form together or were they mixed later? Perhaps pallasites represent a transition or contact zone deep in some asteroid where separation was taking place.

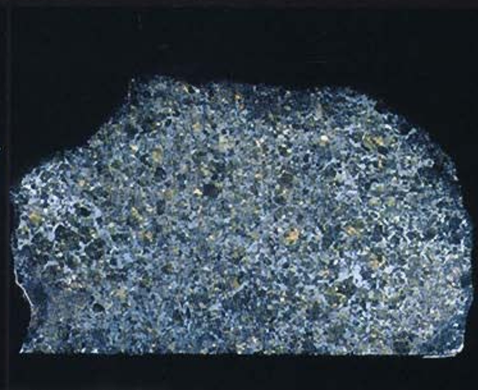
#65 **Mount Dyrring, New South Wales, Australia.** This pallasite was found in 1903. Fragments totaling about 12 kg. were picked up and brought to the museum as bits of unusual "rock". This has had a long Earth exposure time; nearly all the metal has weathered away, leaving behind almost exclusively limonite, hematite and olivine.

#66 **Esquel, Argentina.** This is the largest, thinest, complete slice off of the 750 kg main mass. This piece weighs 8.5 kg and measures 1m x 35cm x 5mm. Notice the big clasts of gemstone olivine throughout. This is a fantastic, world-class specimen, and the pride of my collection. Cutting this monster took hundreds of man-hours. All equipment was custom-designed to accommodate this extraordinary meteorite. It was worth the effort.



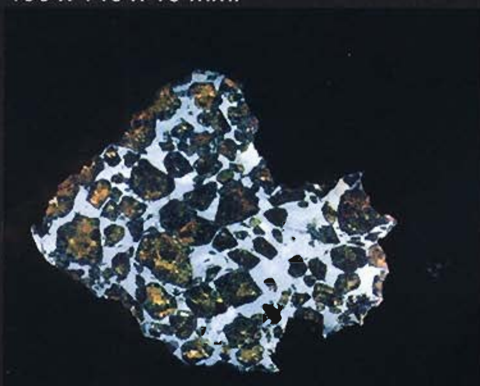
Brenham, Kansas, USA. The photo on the left is of an etched slice of Brenham pallasite that is only iron with no stone inclusions at all. The olivine just "ran out" at the end of the specimen when the "normal" pallasite structure abruptly changed to iron. Compare the piece on the right with that on the left: they both came from the same meteorite! Examples like this sometimes create more questions for scientists than they answer.

55 ALBIN
Stony iron pallasite. Slice. 740 gr.: 190 x 140 x 10 mm.



56 ADMIRE
Pallasite. Slice. 2 kg.: 220 x 150 x 20 mm.

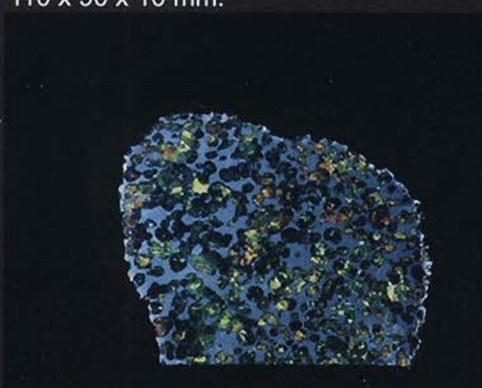
57 THIEL MOUNTAINS
Pallasite. Slice. 535 gr.: 130 x 90 x 15mm.



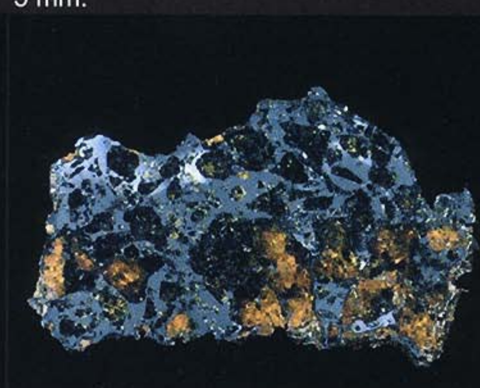
58 DORA
Pallasite. Complete slice. 162 gr.: 110 x 90 x 10 mm.

59 SOUTH BEND
Pallasite. Slice. 264 gr.: 110 x 70 x 5 mm.

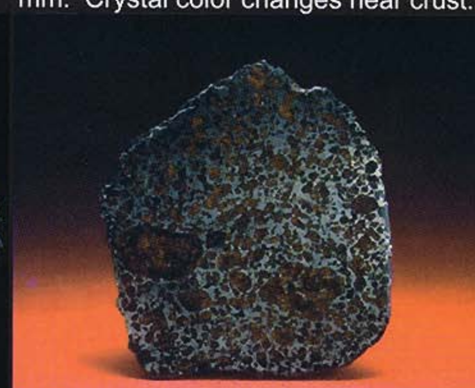
60 AHUMADA
Pallasite. Slice. 295 gr.: 90 x 70 x 10 mm. Crystal color changes near crust.



61 SPRINGWATER
Pallasite. Slice. 357 gr.: 110 x 100 x 10 mm.



62 OTINAPA
Pallasite. 2.5 kg.: 180 x 80 x 40 mm.



63 BRAHIN
Pallasite. 11 kg.: 240 x 200 x 90 mm.

64 MOUNT VERNON
Pallasite. Slice. 3.3 kg.: 340 x 230 x 18 mm. 11.5 % Ni. Smithsonian trade.

65 MOUNT DYRRING
Pallasite. 317 gr.: 70 x 55 x 45 mm. Oxide veins outline the olivine. Old.

66 ESQUEL
Pallasite. Bob with largest complete slice in the world. 8.5 kg.

Stones represent the third main group of meteorites, by far the most diverse group of the three. Nine out of ten meteorites that fall from the sky are stone meteorites. Fewer are found, however, primarily because they resemble Earth rocks, and are therefore harder to recognize. Stone meteorites also decompose more rapidly under terrestrial conditions than do irons.

Stone meteorites are divided into two main groups; those with chondrules, the *chondrites* and those without, the *achondrites*. Chondrules, from the Greek word for "seed", are the inclusions for which the two types are named. These round spheres of silicates range in size from the microscopic, to the size of marbles. Most, however, are the size of steel shot pellets. These chondrules are time-travelers, dating from the very beginnings of the solar system, some 4.6 billion years ago.

Formed as clouds of pre-solar dust began to condense, these tiny balls were packed into larger and larger masses, eventually forming small moons and asteroids. Some of these "parent bodies" were destroyed before they accumulated enough matter to cause remelting of their core material. Bits of this material usually contains chondrites in their earliest form.

Other parent bodies continued to accrete material until the mounting high-pressures within destroyed all evidence of the original chondritic structure. Bits of this material represent the achondrites, or those without chondrules.

CHONDRITES

The group of stone meteorites known as chondrites is broken down into three classifications: *ordinary* chondrites, including amphoterites (LLs), *enstatite* chondrites (E chondrites), and *carbonaceous* chondrites, (C chondrites).

Millbillillie, West Australia, Australia. Eucrite, achondrite. No sign of any chondrules. This material has been completely re-melted and recrystallized, resulting in two different textures in the same specimen. If you saw each part separately, it would be hard to believe they came from the same piece. End piece, 31 grams. (Shown actual size.)

"Ordinary" chondrites are classified from LL for "low-low" iron content, through L for "low" iron content, through H for "high" iron content. They are further classified by a numbering system of 3 through 6; where the *lower* the number the less the chondrules have changed and the *higher* the number, the more the chondrules have been changed. This alteration may have been caused by heat, pressure or shock prior to landing on Earth. An L3 for instance, would refer to a low iron, virtually untouched ordinary chondrite with perfect chondrules.

E chondrites, or enstatite chondrites are the most metal rich of all the chondrites, and are made up primarily of the mineral enstatite, or *magnesium silicate* ($Mg_2Si_2O_6$) one of the pyroxene group of minerals. In these meteorites, the metal is not tied up in the minerals, but is visible as free, metallic iron.

Carbonaceous chondrites are those that are rich in the element carbon. These meteorites have stirred a great deal of scientific interest since the discovery that they contain amino acids, the building blocks of proteins, as well as diamonds and other complex and interesting organic compounds. (See table 36A, pg.36)

ACHONDRITES

Achondrite meteorites are stone meteorites which do not show any chondrules. They *may*, however, have round clasts or other spherical crystals that have grown out of re-melted, metamorphosed material. This can cause confusion. One clue is that achondrites very rarely contain any *visible* metal.

Moorabie, New South Wales, Australia. The Moorabie chondrite has a matrix of thousands of pure chondrules of varying sizes and shapes, all virtually unchanged since the beginnings of the solar system. (Photo shows close-up. Chondrules enlarged 100%.)

Adamana, Arizona. I call this the "Venus Stone." This new discovery from near Holbrook, Arizona was found in the desert. It is a textbook example of an oriented meteorite - the best I've seen. It clearly shows the direction of flight as the stone passed through the atmosphere. Oriented pieces such as this one are highly prized by scientists, collectors, and by me! 2kgs.

#67 **Peña Blanca Springs, Texas, USA.** This aubrite achondrite fell into a small spring, startling the dozen or so people nearby who were just sitting down to lunch. Of a very rare type, it is composed mostly of enstatite, or magnesium silicate, has little visible metal and is difficult to recognize. I was fortunate to have been able to purchase about 80% of this fall from the estate.

#68 **Mount Egarton, West Australia.** This is an anomalous aubrite. Old and weathered, most of the iron has rusted out, leaving only trace iron and brown-stained enstatite. It was found by an Australian prospector.

#69 **Peña Blanca Springs, Texas, USA.** During sawing at the shop, this meteorite was cut with kerosene as a lubricant, in order to preserve the rare, water-soluble minerals inside.

#70 **Cumberland Falls, Kentucky, USA.** Aubrite achondrite. The enstatite crystals in this specimen show signs of mixing. In some specimens, scientists have found small pieces of ordinary-type chondrite material mixed in with this achondrite material, making it hard to categorize. Several stones fell April 9, 1919.

#71 **Norton County, Kansas, USA.** Note the light-colored fusion crust on this piece, due to calcium-poor composition and low iron. The inside is a beautiful milky white. A huge fall of 100 stones on Feb. 18, 1948.

#72 **Mayo Belwa, Nigeria.** This is an aubrite achondrite with very unusual surface features, such as little or no fusion crust and gas vesicles on the surface. This was seen to fall, or it would probably never have been recognized as a meteorite. One 4.8 kg. stone fell Aug. 3, 1974.

Millbillillie, West Australia, Australia. This eucrite was a witnessed fall from the 1960's. It has a lovely, well-preserved, glossy black fusion crust, typical of Ca-rich stone meteorites, and is our most popular and available achondrite. Many of these specimens were recovered by the local Aborigines after a brief "training session" in meteorite recognition.

Peña Blanca Springs. This old photograph was taken at the site of the Peña Blanca fall in 1946. The man in the water actually dove in to recover the pieces. I sure would!

#73 **Johnstown, CO, USA.** Fell in 1924. Diogenite achondrite. Hypersthene crystals are smashed in this brecciated (mixed sizes and textures) specimen. Probably the diogenites settled out of the molten eucrite/diogenite parent body and were subjected to later stresses resulting in further mixing. This meteorite is calcium-poor and contains very little metal, making it hard to recognize. Only 27 stones were recovered.

#74 **Tatahouine, Tunisia.** This diogenite achondrite showered down from a daytime fireball over the Sahara Desert in 1931, an event observed by local Bedouins who collected the few kilos that fell. Because the larger mass blew apart late in its entry, the hypersthene crystals were not melted and fusion crust is completely lacking. With-out crust, achondrites can be very difficult to recognize.

#75 **Shalka, West Bengal, India.** This diogenite does not appear green like the others. Both diogenites and aubrites are calcium-poor (<3%) achondrites.

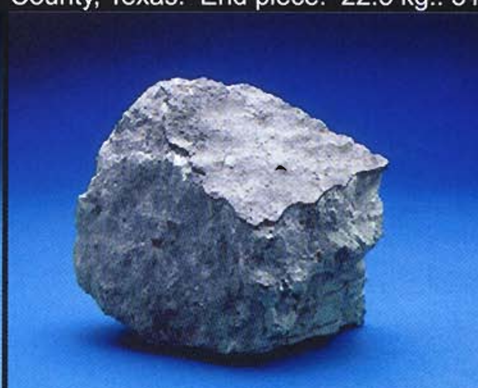
Acfer, Sahara Desert, Algeria. Renatzo-type carbonaceous chondrite. This specimen shows classic, perfectly preserved chondrules. 28 gram slice.

67 PENA BLANCA SPRINGS
Note beautiful, light-colored fusion crust.

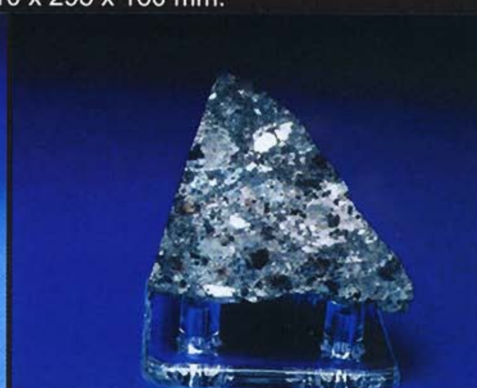
68 MOUNT EGARTON
Metal-rich aubrite. Fragment.
52 gr.: 40 x 30 x 20 mm.

69 PENA BLANCA SPRINGS
Stone achondrite. Ca-poor aubrite. Witnessed fall, Aug. 2, 1946, in Brewster County, Texas. End piece. 22.5 kg.: 310 x 295 x 160 mm.

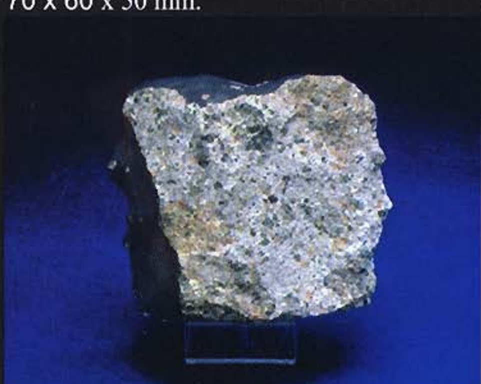
70 CUMBERLAND FALLS
Aubrite achondrite. Slice. 49 gr.: 70 x 60 x 50 mm.



71 NORTON COUNTY
Aubrite achondrite. Fragment with crust. 894 gr.: 100 x 90 x 80 mm.



72 MAYO BELWA
Aubrite. Slice. 84 gr.: 50 x 40 x 35 mm.



73 JOHNSTOWN
Diogenite achondrite. Partial stone. 762 gr.: 90 x 90 x 50 mm.

74 TATAHOUINE
Stone achondrite. Complete stone. 12 gr.: close-up image area: 20 x 20 mm.

75 SHALKA
Stone achondrite. Ca-poor diogenite. Witnessed fall. 40 gr.: 40 x 33 x 22 mm.

CALCALONG CREEK - The Lunar Meteorite Story

The town of Wiluna, Western Australia was a high-flying gold town in its heyday, boasting among other things the longest bar in the western world and the Wiluna olivine-bronzite chondrite meteorite strewnfield. This September 2, 1967 fall was witnessed by the entire town who'd turned out for an outdoor movie, and was accompanied by sonic booms, a huge fireball and peculiar electrical phenomenon: electrical power went out all over town. Even the car batteries were powerless, as the local constable found out when he jumped into his Landrover to chase down the meteor and his vehicle wouldn't start!

Seven years earlier, another fireball had startled sheep ranchers on the Millbillillie Station Homestead only about 12 kilometers from Wiluna. The locals found a few black rocks afterwards, which were eventually identified as Ca-rich eucrites; rare stone achondrite meteorites.

Mr. Harry Redford, a *real* "Crocodile Dundee" type, happened to hear of this money from heaven, and decided to look for the shiny black rocks himself. Mr. Redford camped for a few nights in the bush, and when he left, he had several pockets full . He decided to offer a reward - get everybody hunting. (Smart move.)

Soon, a few Aborigines came in with meteorites which were purchased for enormous sums, compared to their usual daily wages. Within a few days, hundreds of people were searching the outback to find stones. Another 300 kg. were collected in this way - specimens that would otherwise be lost to the world forever.

Eventually these stones made their way around the world to museums and collectors. One afternoon, I was going over some of the Millbillillie meteorites I had purchased, when I picked up one small, 19 gram complete stone that felt "different". It had some very subtle differences in color and texture that made me put it aside for more careful examination later. When I looked again, I noticed tiny gas vesicles on the fusion crust, something so rare I've only seen it in a few other meteorites. The crust also had an unusual greenish tinge, so I ground off a tiny corner to look inside. Again, it was different from the Millbillillie eucrites, and contained the same tiny white clasts I'd seen in high-definition photos of moon rocks. Slowly,it was dawning on me that this little stone looked a lot like a lunar rock I had once examined in Tokyo, at the Japanese Institute of Polar Research, thanks to Dr. Yani.

Calcalong Creek, Australia. (Moon Rock!!!)
Tell-tale white anorthosite clasts lead me to discover this Moon Rock. A diagnostic Fe/Mn ratio of 73-78 and other elemental abundances indicate a lunar breccia containing both highland and mare materials.

I called the experts, Dr. William V. Boynton and Dolores Hill at the University of Arizona Lunar and Planetary Lab and told them of my discovery. They got quietly excited and said they'd analyze it. Since the Lunar and Planetary Lab analyzed the first lunar meteorite from Antarctica, and many of the moon rocks from the Apollo moon landers, there was no place in the world better equipped to handle the job.

Then we all waited for the results. Then the official word came back from the lab:

> "We have analyzed the new meteorite by neutron activation analysis and believe it to be of lunar origin based on comparison with other meteorites and samples returned from Apollo landing sites..."

Other than the Antarctica specimens, we had discovered the *only known lunar meteorite* in the world... As the discoverer, I was allowed to give a preliminary name to the piece. I chose the name *Yuggen*, which means "moon" in the language of both the Yimigee and Wongai tribes of the Wiluna area, one of whom probably plucked my little moon rock out of the outback dust. Since then, however, it was renamed Calcalong Creek, for the Aborigine word, *kalkallupilinguta*, meaning, "seven sisters went up into the sky, chased by the Moon".

Hill, Boynton and I co-authored a scientific paper describing the lunar specimen and the conditions of its discovery in detail, which was published in the August 15th, 1991 issue of Nature, Vol. 352.

The importance of this specimen is significant in that most of the Antarctic lunar meteorites appear to be of the same general type, whereas Calcalong Creek is somewhat different. Hopefully it will shed new light on lunar petrology as well as on the transfer of impact ejecta from the Moon to the Earth.

To own this specimen is literally a dream come true. It is my ticket to the stars, maybe, someday.

Alan Hills 84001. Micro fossils found inside this Antarctica Mars rock meterorite suggests that life does exist elsewhere.

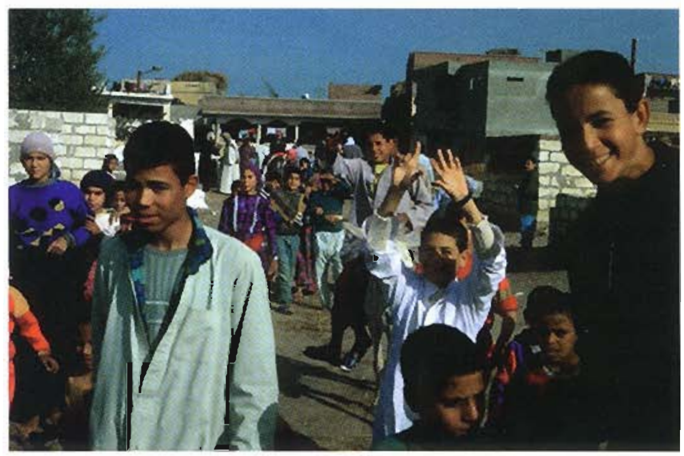
NASA scientists electrified the world in August, 1996 when they announced the discovery of a *fossiliferous* stone meteorite from Mars. The fossils, visible only with a scanning electron microscope, were of microorganisms resembling bacteria or yeast cells, similar to those found on Earth. The Antarctic meteorite, known as Alan Hills 84001, was dated at 3.5 billion years, and was apparently formed during the early stages of Mars' development when the planet had free liquid water on its surface.

As news of this evidence of life on another planet rocketed around the world, phones at Robert Haag Meteorites started ringing off the hook. Scientists and collectors from all over were seeking other kinds of Mars rock, such as Zagami, for investment and study.

Zagami. Stone, 2.78 kg. shergottite Mars rock. This fascinating meteorite fell Oct. 3, 1962.

Alan Hills 84001, obviously one of a kind, so far, is just one of a few Mars rocks that have already been found on Earth. Others belong to the extremely rare group of meteorites classified as belonging to the SNC group (pronounced "snick"). The acronym stands for the initials of the first three known falls of Martian material, namely, Shergotty, India; Nakhla, Egypt; and Chassigny, France.

Analysis of SNC meteorites reveals them to have a very young crystalization age (only about 1.3 billion years ago) relative to Alan Hills and other meteorites. This, along with a chemical make-up similar to volcanic rock found on Earth, indicates that these meteorites came from volcanos, which would have erupted billions of years after any microorganisms on the surface had long turned to dust.



Nakhla, revisited. In December, 1995, I returned to Nakhla to see if more of this fantastic meteorite could be found. After offering the price of gold for additional specimens, I was literally mobbed by crowds of people wanting the flyers we had printed in Arabic describing how to recognize the treasure under their feet. I had to jump into a taxi to avoid being shredded by enthusiastic meteorite hunters.

Nakhla, Abut Hommos, Egypt. Stone. Achondrite: Ca-rich nakhlite. Complete specimen, 120 grams: 57 x 50 x 35 mm. Fell in 1911 in Abut Hommos, Egypt. This type of Mars rock is made up of fine green augite crystals. One stone of Nakhla is said to have hit and killed a dog. (Bow, wow. Ow! ... Gaaack.)

#76 **Pasamonte, New Mexico, USA.** The Pasamonte fireball was one of the largest and most brilliant ever seen in recent times. It was said to have been brighter than the sun. Based on the amount of dust in the air after the event, the original mass was estimated at over a million tons, but all that was recovered were a few small stones. (There must be more out there *somewhere,* but it's a tough place to search.) This is a very fragile meteorite.

#77 **Stannern, Czechoslovakia.** This calcium-rich eucrite achondrite fell on May 22, 1808, following loud detonations. Some 52 kgs were recovered at the time.

#78 **Caldera, Chile.** This beautifully oriented large stone and others were found by a geologist in the vast interior desert of Chile. Note the fine flow-lines.

#79 **Bouvante, Drome, France.** This is a new find from France. It is still very fresh-looking. France is the most meteorite-concious country on Earth and seems to recover the most meteorites, per capita.

#80 **Juvinas, Libonnes, France.** This eucrite has a very coarse texture, with lumps of plagioclase and pyroxene, which grew as the basaltic materials cooled from a liquid state. Paris museum exchange.

#81 **Rancho Blanco, Mexico.** I was in Mexico buying meteorites at the Nuevo Mercurio fall site, when this different specimen was brought in by one of the locals who recognized it by the small amount of fusion crust. Good job, Amigo.

#82 **Kapoeta, Sudan.** This is another type of achondrite called a howardite. Howardites are basically surface substrate or "soil" from a moon or asteroid, and are made up of different types of meteorites that have plowed into the surface and resolidified under pressure. Howardites such as this one are composed mainly of eucrite and diogenite. This fell in WWII in front of an armored column.

#83 **Mundrabilla 018, West Australia, Australia.** We found this by an old water hole. Studies by the University of Arizona confirm this as a howardite.

#84 **Camel Donga, West Australia, Australia.** Eucrite achondrite (metal rich). This very unusual achondrite has big lumps of iron in it. The shiny black fusion crust indicates a calcium-rich specimen. Note rust stains. This is the only metal-rich eucrite I've ever seen.

Palo Blanco Creek, New Mexico, USA. Found in 1954, this Ca-rich eucrite achondrite has a nice, well-preserved fusion crust and the clasts are surrounded and cut by dark, glassy shock veins. Once the crust has weathered away, it's very hard to identify.

ON A RECENT EXPEDITION...

This is another dream come true for me. I found these two new achondrites on a recent expedition. I had a dream about it two nights before the best searching day of my life.

High noon, no shadows, tons of rocks around, but still they let me find them!

P.S. I think they are Howardites!!!

76 PASA MONTE
Eucrite achondrite. Complete stone.
67 gr.: 50 x 35 x 25 mm.

77 STANNERN
Eucrite achondrite. End piece.
396 gr.: 100 x 75 x 50 mm.

78 CALDERA, CHILE
Eucrite achondrite. 90% complete stone. 500 grams total pictured weight.

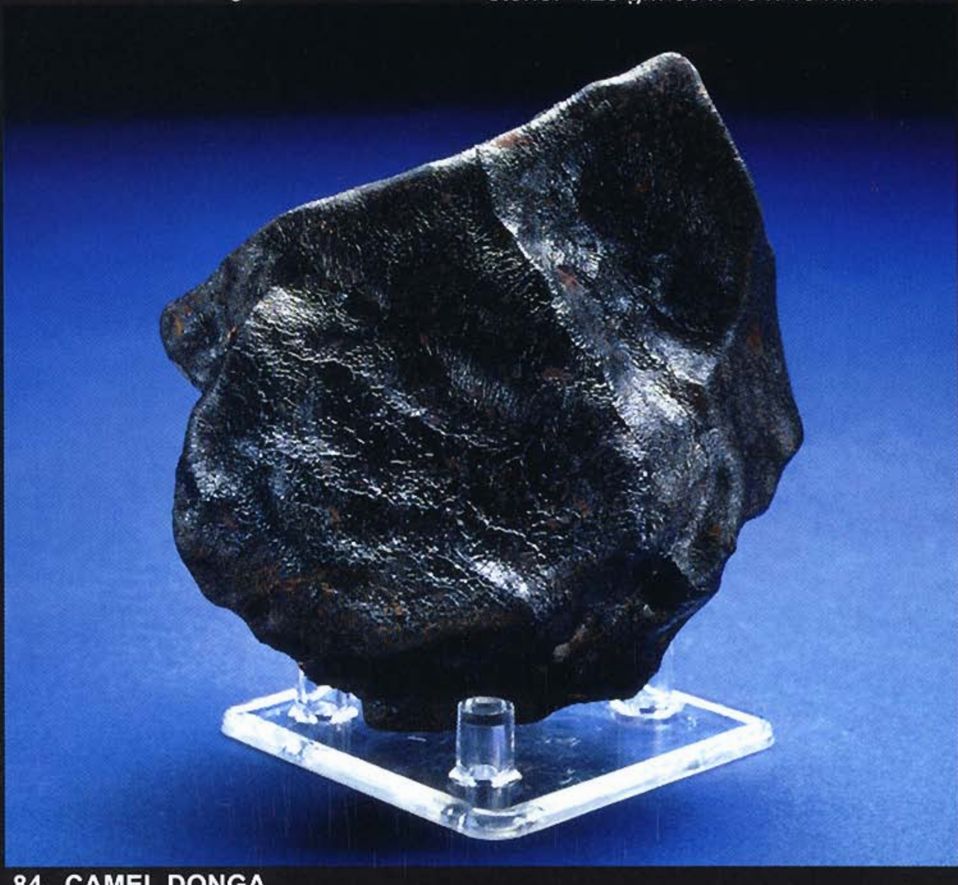
79 BOUVANTE
Stone achondrite. Ca-rich eucrite.
Crusted end piece. 201 gr.: 85 x 65 x 30 mm.

80 JUVINAS
Stone achondrite. Ca-rich. Witnessed fall: 6-15-1821. 367 gr.: 95 x 70 x 50 mm.

81 RANCHO BLANCO
Eucrite achondrite. 80% complete stone. 123 gr.: 60 x 40 x 40 mm.

82 KAPOETA
Howardite achondrite. Fragment.
129 gr.: 50 x 35 x 30 mm.

83 MUNDRABILLA 018
Howardite. Found aug., 1991. 24 gr.: 45 x 37 x 10 mm.



84 CAMEL DONGA
Eucrite achondrite. Complete stone. 1.13 kg.: 110 x 100 x 70 mm.

#85 **Camel Donga, West Australia.** This is a very unusual metal-rich eucrite. The metal iron is mixed with sulfur to form troilite. This is now beginning to rust and stain the matrix material. Look at photo #84 on page 31 and you can see the rust coming through the fusion crust.

#86 **Cat Mountain, Arizona, USA.** This is an absolutely unique meteorite. Classified as an impact-melt breccia, it contains both chondrites and achondrites. Note the flaked metal grains that would have told me this was the real thing, had I been allowed to "peek" into the stone's interior eight years ago. (See story below.)

#87 **Cat Mountain, Arizona, USA.** This amazing little meteorite was found in 1978 by a Tucson gentleman who walked through the desert every day to buy his morning newspaper and coffee. One morning he spotted a small impact crater in the sand, at the bottom of which lay this rock. He swore up and down it had not been there the day before, so he picked it up and put it on his mantle, then called me to take a look. On the exterior it didn't look like any meteorite I'd ever seen, but you never know, so I offered to to take off a tiny sample to look for metal grains or chondrules. Unfortunately, he refused to let me touch it, so it sat on his mantle for another eight years until his death, when his son inherited the stone.

The son took the piece to the University of Arizona mineral museum where Shirley Wetmore finally convinced him to allow a corner to be ground off, confirming that it is in fact an absolutely unique, anomalous, impact-melt breccia, one half chondrite, one half achondrite meteorite! You can see the large clasts of melted H-chondrite surrounded by totally vitrified material.

A footnote: diligent searching of the same area by several different people turned up one more specimen of Cat Mountain, roughly the size of a big pecan, about 1,000 yards from where the first piece was found, some fifteen years before. (Hello? Get that? Go back and research places where meteorites have already been found. You might get very lucky if you know what to look for.)

#88 **Eagle, Nebraska, USA.** This is classified as an EL6, meaning that it is a lower-metal type of enstatite chondrite, with highly metamorphosed chondrules. Enstatite chondrites are quite rare, and consist of crystalline orthopyroxene and magnesium pyroxene.

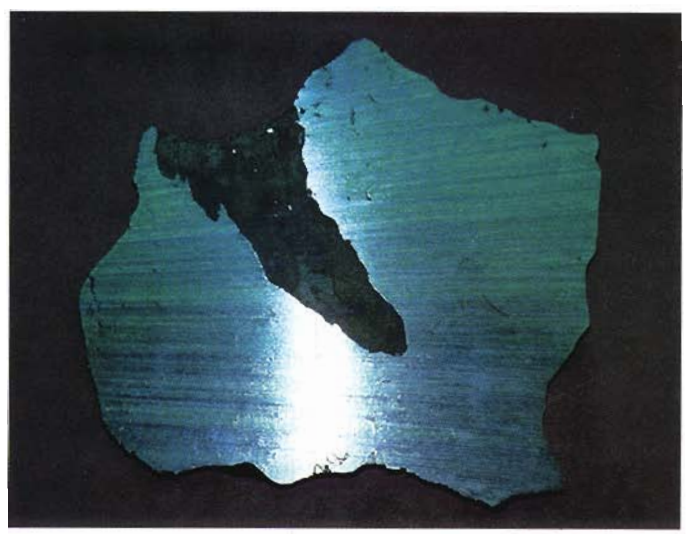
#89 **Abee, Alberta, Canada.** This was a witnessed fall in 1952. A 107 kg stone was recovered from a hole 6 feet deep. It is of a very rare type, EH4, meaning it is an enstatite, high-metal chondrite. Note the way in which the enstatite crystals formed in this unusual specimen.

#90 **Hvittis, Abo, Finland.** Total iron: 22%. This fell in 1901. I received it in trade after I stopped at the University of Helsinki on my way back from Moscow and found out that they didn't have any Mars rock. Now they have Mars rock and I have Hvittis. We're all happy.

#91 **Pillistfer, Estonia.** After numerous detonations, the Pillistfer meteorite was seen to fall at noon on August 8, 1868. Only four stones were recovered, the largest weighing 14 kg. One theory of origin for enstatite chondrites is that they formed near the sun, within Mercury's orbit, thus accounting for their low oxygen content. Note bright metal flakes.

#92 **Nuevo Mercurio "B", Zacatecas, Mexico.** A single, 349 gram, fusion-crusted stone was found in May, 1990 by a young girl out hunting meteorites. This is a rare ureilite, with shocked olivine, pigeonite and graphite.

#93 **G'Day, Australia** This new achondrite was just classified as a howardite by Johnson Space center. It closely resembles Rancho Blanco in color and texture (see photo 81, pg. 30). These also can look like eucrites, and for this reason, classification of achondrites by physical properties alone is difficult.



Watson, South Australia, Australia. This is a highly unusual meteorite. Within this otherwise ordinary iron meteorite is a large intrusion of achondritic stone. It is as though the metal flowed around the existing stone, or perhaps the stone was injected in a molten state into a seam in the metal. Interestingly, there doesn't seem to be any heat alteration of either material at their interface. Not much is known about this piece as yet, and it is currently being studied and classified by Dr. Edward Olsen of Chicago's Field Museum. This is a 2 kilogram slice.

85 CAMEL DONGA
Eucrite achondrite. Complete stone w/ polished face. 66 gr.

86 CAT MOUNTAIN
Cut face.

87 CAT MOUNTAIN
Anomalous, impact-melt breccia . One half chondrite, one half achondrite. Phenomenally rare.

88 EAGLE
Enstatite chondrite. EL6. End piece. 396 gr.: 130 x 60 x 30 mm.

89 ABEE
Enstatite chondrite. EH4. Slice w/ crust. 156 gr.: 90 x 50 x 40 mm.

90 HVITTIS
Enstatite chondrite. E6. Witnessed fall, 1901. End piece. 694 gr.: 80 x 75 x 40 mm.

91 PILLISTFER
Enstatite chondrite. E6. End piece. 2.02 kg.: 125 x 125 x 45 mm.

92 NUEVO MERCURIO B
Urelite achondrite. Partial stone. 185 gr.: 55 x 48 x 36 mm.

93 G'DAY
Howardite. Complete stone with crust. 65 gr.: 37 x 35 x 26 mm.

Carbonaceous chondrites, as the name implies, contain both chondrules, and a high carbon content (up to 3.4%) and represent the most primitive of the meteorite types known. *Calcium aluminum inclusions,* or CAI's, for instance, are found in certain carbonaceous chondrites such as the Allende. These enigmatic spherules possibly *pre-date the solar system*, with a crystallization age of approximately 4.6 *billion* years. Spectrographic analysis shows that these CAI's are, in fact, very close in composition to our sun!

The carbonaceous chondrites on this page, such as Orguiel, Murchison, and others having designations of C1 or CM2, are thought to be cometary in origin, and show evidence of liquid water having been present during their crystal formation. C1 types are the most water-altered and the least heat-altered. C1's also contain carbonate and sulfate silicaceous minerals, indicating that they formed in a warm, wet environment. C2's are somewhat altered from their original condition. C3's have been altered very little.

The letter designation after the "C" for carbonaceous, refers to a particular meteorite that acts as a standard reference for others. For instance, the "M" means that it is similar to the Mighei, Russia carbonaceous chondrite. An "O" indicates a similarity to the Ornans, France, meteorite, while a designation of "V" following a C, indicates that the specimen is like the one from Vigarano, Italy. (See #97, facing page.)

Orguiel, France. This 20 gram fragment represents the most primitive of all, a C1. Unless you see it fall, this type of meteorite is nearly impossible to recognize in the field-it looks like a lump of charcoal. Almost 20% carbon, C1's such as Orguiel (pronounced "OR-gay") show no evidence of chondrules or metal grains, even though the metal content is about 19.5%. Furthermore, these meteorites are considered to be of cometary origin because of evidence of alteration by liquid water. This, and other meteorites like it, is highly sought after for scientific study.

#94 **Kainsaz, Tartar Republic, USSR.** C03. This very rare carbonaceous chondrite was a witnessed fall from 1937. It is my prize specimen received in trade when I was invited to Russia by the Moscow Academy of Sciences. I was very honored and hope to return soon.

#95 **Colony, Oklahoma, USA.** CO3. This is a very old carbonaceous chondrite. The chondrules are small but still visible to a trained eye. It was found in the tines of a cotton cultivator. Years of rain and ground water have rusted out the metal in this piece, making it hard to recognize.

#96 **New Discovery, Nullarbor, West Australia.** This specimen looks almost exactly like the specimen from Vigarano, although it has a slightly greener cast. I think it is safe to say that this is another CV3 carbonaceous meteorite. The green color is due to nickel oxides.

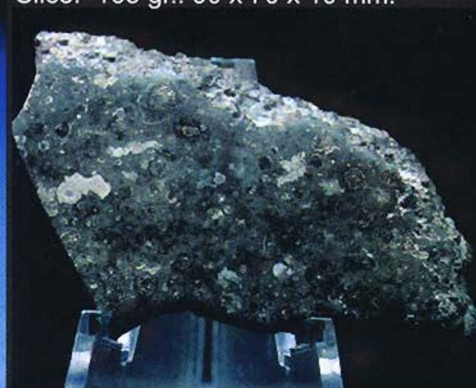
#97 **Vigarano, Italy.** CV3. Vigarano is the classic standard of the "V" designation of carbonaceous chondrites. (Allende is another example of the "V" designation.) The matrix of this piece is a darker grey and is a bit more fragile than Allende. Only 2 stones have been found.

#98 **Maralinga, South Australia, Australia.** C4. The chondrules in this C4 are still intact, but very compacted and weathered. It has had a long Earth exposure, as evidenced by the extreme weathering of the piece.

#99 **Karoonda, South Australia, Australia.** C5. This carbonaceous chondrite is very different from the preceding meteorites, in that the petrologic end number is 5, meaning that it has been subjected to high pressures and temperatures. These influences have changed the structure of the minerals, creating glasses in some crystals, as well as bending, breaking and crushing in others. The chondrules in this piece have been smashed to powder. This was an American Museum of Natural History trade specimen. This fell November 25, 1930.

Nogoya, Entre Rios, Argentina. This 112 gram end piece of a CM2 carbonaceous chondrite was seen to fall following a fireball on June 30, 1879. 18% total iron.

95 COLONY
CO3 Carbonaceous chondrite.
Slice. 165 gr.: 90 x 70 x 10 mm.



94 KAINSAZ
Carbonaceous chondrite. Type III (CO3). Very rare. Witnessed fall, 1937.
Half stone. 943 gr.: 80 x 80 x 80 mm.

96 NULLARBOR CV3.
Small fragment. 30 gr.: 50 x 25 x 10mm.

97 VIGARANO
Carbonaceous chondrite. Type III (CV 3)
Witnessed fall, 1910. Slice. 61 gr.: 90 x 65 x 4 mm.

98 MARALINGA
C4 carbonaceous chondrite. Old Earth age. Fragment. 183 gr.: 125 x 114 x 6 mm.

99 KAROONDA
C5 Carbonaceous chondrite. Rare! Fragment. No crust. 84 gr.: 70 x 50 x 30 mm.

Betty Maslin, a Murchison, Australia resident, displays the smelly rocks that landed on the outskirts of town one Sunday morning in September, 1969. Detonations and "hissing" noises were heard when the fireball exploded and smoke rings were seen hanging in the air. Some 700 kilos of stones rained out of the sky, covering 33 square kilometers, and stinking up the town with the smell of methylated spirits. (Betty and her father found the two largest pieces by the road.) The jar Mrs. Maslin is holding had been sealed for ten years, and when I opened it, the smell of alcohol and ether was still strong enough to nearly put me under.

Murchison, Victoria, Australia. Tiny round chondrules can be seen in this 2x close-up of a polished face of the Murchison meteorite. Learn to identify chondrules!

Murchison is one of the most primitive meteorites known, and is believed to be virtually unchanged since the formation of the solar system, some 4.6 billion years ago. Besides being carbon-rich, the Murchison meteorite contains 12% water, and is considered to be cometary.

Some scientist believe that all water on Earth originally came from the stars, in the form of cometary ice and in meteorites such as the Murchison. Before Earth developed a heavy shielding atmosphere, many times more meteorite impacts would have occurred. Of course, there were more "loose parts" floating around then; now most have hit or have found a stable orbit. The same line of reasoning has been applied to the appearance on Earth of basic pre-life compounds, such as amino acids and polymerized molecules, also present in Murchison. (Perhaps all life on Earth was "seeded" from the stars...)

Murchison, Victoria, Australia. This beautifully oriented specimen of Murchison weighs nearly one kilo and shows classic, text-book quality "thread-lines". This fine new acquisition was purchased from an old geologist who visited the fall site a few years after the event. He said he'd paid "a hundred dollars" for this specimen. I paid him ten thousand dollars for it. And it was still a deal!

Partial List of Organic Molecules Found in Space

Acetaldehyde	CH_3CHO
Acetonitrile	CH_3CN
Acetylene	HC=CH
Ammonia	NH_3
Carbon monosulfide	CS
Carbon monoxide	CO
Carbonyl sulfide	O=C=S
Cyanamide	NH_2CN
Cyanoacetylene	HC=C-C-C-N
Cyanotetra acetylene	HC_9N
*Dimethyl ether	H_3C-0-CH_3
*Ethanol	C_2H_5OH
Ethyl cyanide	CH_3CH_2CN
Formaldehyde	H_2CO

*Possible chemical candidates for the smell in Murchison

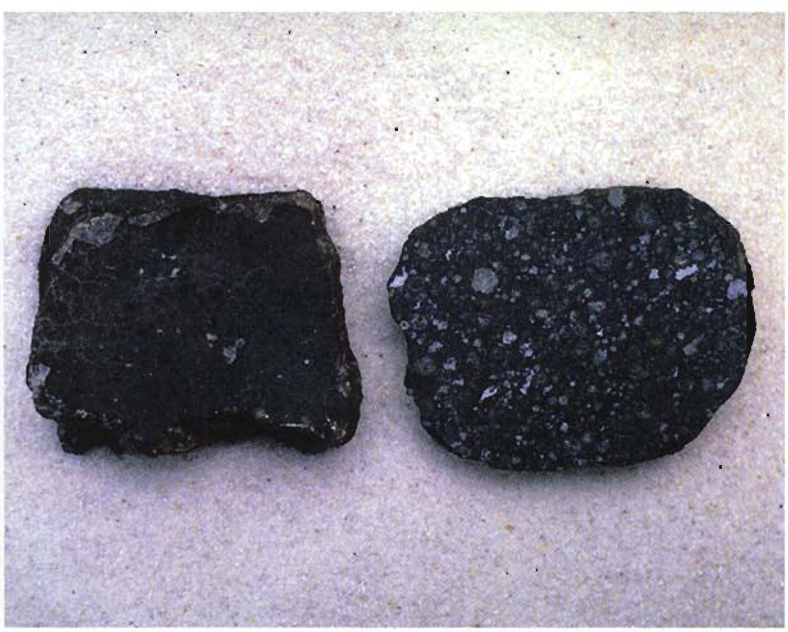
Table 36A. Many of these molecules have shown up in meteorites such as Murchison, Allende and others.

Allende, Chihuahua, Mexico. Several thousand kilograms of this rare type of meteorite fell in 1969. It made one of the largest stone strewnfields in recorded history - 150 square kilometers! This particular specimen was used at a garage to block the wheels of cars when they changed tires. If you look closely, you can see the dent in the right side from the weight of the axles. 23 % total iron. 17 kg.

The Allende carbonaceous chondrite is one of the most important falls from a scientific standpoint, primarily because it contains pristine chondrules and calcium-aluminum inclusions, or CAI's. These inclusions are considered to be some of the oldest matter ever known, possibly dating from before our solar system began to condense into a star and planets, some 4.6 billion years ago. To hold a piece of Allende in your hand is to hold the most ancient thing known in the universe currently available on Earth.

Both the Allende and the Murchison meteorites arrived on our planet in 1969. (This was also the year that the Apollo Moon landings brought back lunar samples.) It wasn't until 1980, however, that I was able to go to Allende to hunt for additional meteorites. Working with some of the ranchers, I scoured the territory, offered rewards, went ranch to ranch, and eventually came up with over 50 kilograms of material that had previously been found, but was never collected.

A tremendous amount -- at least 3 tons! -- of this important, exotic meteorite fell. It has since been widely distributed to universities and other scientific institutions and collectors around the world, and its value continues to appreciate...



Typical Allende stone. (Left.) Note the excellent fusion crust, chondrules and CAI's (calcium-aluminum-like inclusions). Shown lifesize.

Allende is like Brigadoon. It seems far more natural to go about on horseback than in an automobile. The people of Allende are just tremendous; they took me in, fed me and encouraged me. I loved it there. (It seems that if ever a place deserved to "blessed by heaven", Allende is that place.)

Interestingly, this area of Chihuahua, Mexico, mysteriously collects large meteorites. Two of the largest iron meteorites in the world, the Morito and the Chupadero, fell on either side of the enormous Allende strewnfield. This region has been called the "*Zona de Silencio*", or "Zone of Silence", for the unexplained radio silences that occur there, and has even been compared to the "Bermuda Triangle".

The following meteorites are representative of the type of stones known as *ordinary chondrites.* Ordinary chondrites are believed to have crystallized in outer space at fairly low temperatures and pressures relative to other stone meteorites, such as achondrites.

In these meteorites, the relative amounts of oxidized iron and metallic iron are *inversely proportional*; in other words, if the amount of *metallic* iron is high, then the amount of *oxidized* iron will be low. This is the case with H chondrites (H = high metallic iron). The so-called L chondrites (L = low metallic iron) have lower concentrations of metallic iron and higher concentrations of oxidized iron present, while the LL chondrites (LL = low - low metallic iron), have the lowest concentrations of metallic iron and the highest concentrations of oxidized iron. There is no HH designation. (Of the three, the LL's, or amphoterites, are the rarest, especially those with low numbers.)

#100 **Ragland, New Mexico, USA.** This LL3 olivine-hypersthene chondrite was found in 1982 in Quay County, New Mexico. It shows superb chondrules and is in terrific condition. Terrestrial weathering has oxidized out the metal grains and made it an overall rusty color.

#101 **Parnalee, Tamil Nadu, India.** This is an extremely primitive, LL3 stone amphoterite meteorite, full of slightly compacted chondrules. It was a witnessed fall from February 28, 1857. Two stones of approximately 134 pounds and approximately 37 pounds, respectively, were seen to fall after loud detonations were heard. This was a trade with Arizona State University, Tempe, AZ.

Butha Qi, Nei Monggol, China. LL Amphoterite fragment. 203.5 grams: 45 X 45 X 35 mm.

#102 **Greenwell Springs, Louisiana, USA.** This in an LL4 amphoterite, indicating that it has a very low iron content and has been moderately metamorphosed. This meteorite fell on a fireman's lawn in 1988. Since I had an exact location from which to start, I went to Greenwell Springs and passed out flyers, showed similar stones to lots of people, offered a reward and generally hit the pavement. We searched and searched in that small rural town, but no more was to be found. This is somewhat odd, because by looking at this piece, one can see that it is a fragment of a larger mass that blew completely apart. So... where's the rest of it ?

#103 **Ensisheim, France.** This meteorite fell in 1492 and is one of the oldest known falls from which there is recovered material. For hundreds of years, a large stone was kept chained in the local church, to prevent it from wandering off in the same manner in which it arrived! Metal is visible, but there's almost no visible evidence of chondrules. The high petrologic end-number, 6, means it was highly metamorphosed inside of the parent body.

#104 **Naryilco, Queensland, Australia.** This is the best example of a brecciated chondrite I have ever seen. The original material has been broken up and then re-cemented to form a wonderful mosaic pattern, and many different clasts of light and dark stone have been melded together. An LL6 amphoterite, this single stone was found in 1975 by an Australian rabbit trapper.

#105 **Tuxtuac, Zacatecas, Mexico.** This LL5 chondrite amphoterite was a witnessed fall on October 16, 1975, but it took 14 more years before this main mass was found, when it was stumbled upon by ranchers. There were bits of grass growing out of the cracks, but otherwise, it appeared as though it had fallen yesterday. The surface details show the classic " thumbprint", or *regmaglypt* pattern associated with melting during entry.

#106 **Saint Severin, France.** This was a witnessed fall on June 27, 1966. Eight stones totalling 271 kg. were recovered. Are there more? Paris trade.

Butha Qi, Nei Monggol, China. (Left) This highly unusual little meteorite is a 1980 fall from a remote area of China. As far as I know, it is undescribed, but it appears to be an amphoterite. The round, dark inclusion looks highly carbonaceous.(CM2?) Only 3 kgs of this material are known, and reportedly, this is the only fragment to have been released from the country. It was originally received in trade for 300 tons of agate for carving!

100 RAGLAND
Amphoterite. LL3. Partial stone. Acquired in trade with Vienna. 186 gr.: 80 x 60 x 30 mm.

101 PARNALEE
Amphoterite. LL3. Fragment. 260 gr.: 60 x 50 x 33 mm.

102 GREENWELL SPRINGS
Amphoterite. LL4. Slice. 68 gr.: 75 x 55 x 8 mm.

103 ENSISHEIM
Amphoterite. LL6. Slice. 86 gr.: 60 x 60 x 35 mm.

104 NARYILCO
Amphoterite. LL6. End piece. 5 kg.: 230 x 160 x 70 mm.

105 TUXTUAC
Amphoterite. LL5. Half stone. 8 kg.: 270 x 210 x 150 mm.

106 SAINT SEVERIN
Amphoterite. 5 kg.: 200 X 110 X 110 mm.

The most plentiful of all the stone meteorite types are the L's, or olivine hypersthene chondrites. Of these, the most plentiful group is the L6. These are low-iron, highly metamorphosed stone meteorites. Keep in mind that the petrologic numbers at the end refer to the degree of metamorphosis, or change, from the original, round, chondrite crystal structure. An L3 or L4 has a low number and is therefore only slightly changed or metamorphosed, while an L5 or L6 has virtually no undamaged chondrules.

#107 **Bjurböle, Finland.** This *extremely* fragile, chondritic meteorite fell on sea ice and somehow both the ice and the meteorite survived the impact. This is especially surprising because Bjurböle will literally crumble to pieces in your hand. An L4, one can see that these multi-sized chondrules have been only slightly pressure changed. This was a trade piece from Helsinki.

#108 **Peekskill,New York, USA.** Michelle Knapp received a little surprise one rainy, Friday night in October, 1992, while waiting for her boyfriend to call. Instead, what came calling was an 11 kilogram, L6, stoney meteorite, which crashed through the back of her Chevy Malibu, leaving a large hole in the car and a crater in the dirt beneath it. Seconds before the crash, Michelle's cat stood up, hair bristling, back arched, and looked at Michelle in terror before streaking from the room. Police initially confiscated the meteorite as part of their investigation, saying that "someone must have thrown a rock through your car..."

#109 **Peekskille, New York, USA.** The Peekskill Meteorite and car were purchased from the Knapps for $69,000. Here the car is being exhibited in Tokyo, Japan.

#110 **Barratta, New South Wales, Australia.** In this L4 olivine-hypersthene chondrite meteorite, the spheres are tightly compressed and on broken edges this structure can be seen. Note the remnants of old fusion crust.

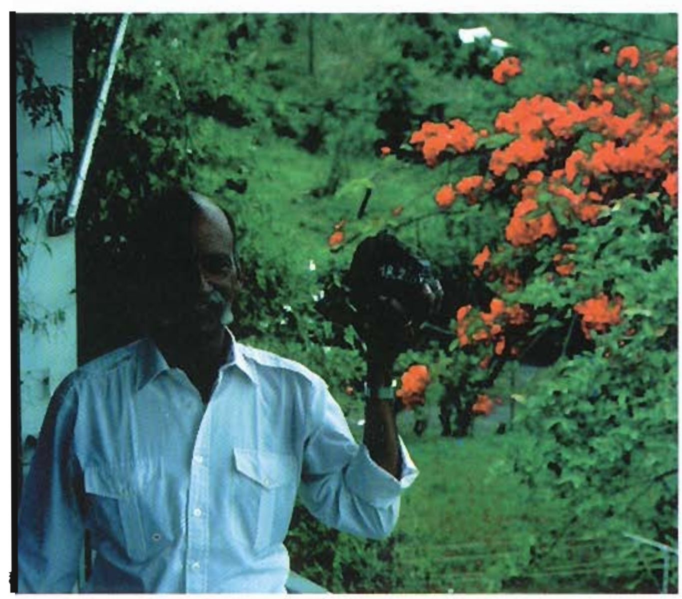
#111 **Moorabie, New South Wales, Australia.** This is an L3 stone and is entirely made up of chondrules of all sizes. L3's are hard to find. They are also more interesting to science than a highly changed stone, such as an L6, for instance. Only a 17 kg. specimen was found.

#112 **Tsarev, Volgograd District, USSR.** This stone was found in 1968 and was saved, for some reason, though it was not recognized as a meteorite until 9 years later, in 1979. An L5, it shows signs of pressure change.

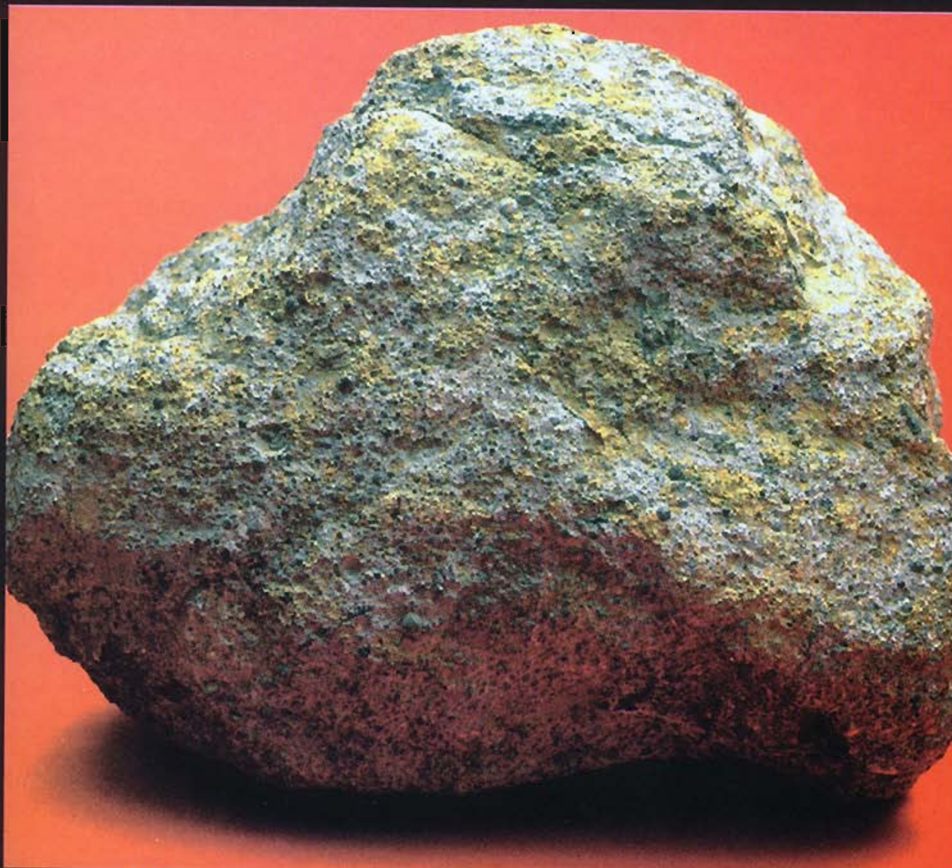
#113 **Beaver, Oklahoma, USA.** This L5 olivine- hypersthene chondrite was used for 40 years as a door stop in the local jail! It was finally recognized in 1981.

#114 **Knyahinya, Ukraine, USSR.** This meteorite fell in June, 1866, amid detonations and a shower of stones, with estimated total weight of 500 kg. Notice the delicate crust on this meteorite.

#115 **Bovedy, Northern Ireland.** This fall of 1969 has classic chondrules typical of L3's.



Djermaia, Chad. Daytime, witnessed fall of February 18, 1961. H-chondrite. The original discoverer of the fall, Serge Caprice, was once a member of the famed French Foreign Legion. By his account, this meteorite did not make impact craters, but rather produced anthill-like cone structures above each impact site. This phenomenon has never been previously recorded. I had to travel to Martinique to recover this specimen. (Dang. I hate it when that happens.)



107 BJURBOLE
Fragment. 3.3 kg.: 155 x 110 x 105 mm.

108 OK. LET'S GO OVER THIS
AGAIN... You say a *rock* *just* fell out of the sky *and hit your car... ?*

109 THE CAR
The Peekskill car is as famous as the meteorite and has toured the world.

110 BARRATTA
Olivine-hypersthene chondrite. Crusted fragment. 995 gr.: 130 x 70 x 50 mm.

111 MOORABIE
Olivine-hypersthene chondrite. End piece. 5 kg.: 220 x 190 x 90 mm.

112 TSAREV
Olivine-hypersthene chondrite. L5. Slice. 1.07 kg.: 110 x 90 x 40 mm.

113 BEAVER
Olivine-hypersthene chondrite. L5. Complete slice. 574 gr.: 235 x 180 x 6 mm.

114 KNYAHINYA
Olivine-hypersthene chondrite. L5. Complete stone. 434 gr.: 80 x 80 x 50 mm.

115 BOVEDY
L Olivine-hypersthene chondrite. Complete slice. 83 gr.: 85 x 75 x 5 mm.

#116 **Antarctica 76009.** This specimen was spotted from a helicopter, unlike most of the Antarctic meteorites, which were found by snowmobile. In a blue and white landscape, the dark meteorites are highly visible. While the climate of Antarctica is inclement to humans, it suits meteorites rather well, as there is little weathering from liquid water -- it's almost all bound up in ice crystals. (Ice crystals, carried by strong winds, can cause the same scouring effect as blowing sand, however.)

#117 **Alfianello, Lombardy, Italy.** This fine-grained L6 olivine-hypersthene chondrite was a witnessed fall from February 16, 1883. This piece was buried deeply enough within the parent body to begin altering the integrity of the chondrules and blurring the chondrule boundaries, thus creating a new texture. I acquired it in trade from a museum in East Berlin.

#118 **Holbrook, Arizona, USA.** Thousands of these L6 olivine-hypersthene chondrites showered down into the desert sand dunes near Holbrook, AZ on July 19, 1912. It remains in excellent condition due to the dry climate. Since the sands continually shift, more may surface from time to time. This would be a very good place to search in the future. A "magnet stick" really helps here.

#119 **Etter, Texas, USA.** Note the way the metal flakes in this meteorite were squeezed into long veins. For this reason, it is called an L6 *veined* chondrite. As these meteorites weather, the metal veins rust more quickly than the silicates, and speed up breakage.

#120 **Tenham, Queensland, Australia.** This meteorite fell during the night in the spring of 1879, showering the countryside with stones. Some 150 kilos were recovered. This too is an olivine-hypersthene chondrite. Recently, meteorite hunters camped out in the bush for months and recovered 100 more specimens. (Good job!)

#121 **Bruderheim, Alberta, Canada.** These are all beautiful specimens with intact fusion crusts because they fell in soft snow after the appearance of a wild, midnight fireball. The next day the locals found these shiny black rocks contrasted against the white background. This fall proved to literally be "pennies from heaven", as one farmer discovered, when he sold several meteorites for enough money to almost pay off his farm.

#122 **Pervomaisky, Ivanovo-Vosnesenk, USSR.** This L6 olivine-hypersthene chondrite was a witnessed fall on December 26th, 1933. I received it in trade from the Moscow Academy of Sciences. (Everywhere one goes in Moscow, there are monuments to space exploration and the stars, and their astronauts are heros...)

#123 **Forrest (b), Western Australia, Australia.** This olivine-hypersthene chondrite was found in 1980. Another meteorite, the Forrest (a), an olivine-*bronzite* chondrite, was found in the same area in 1967. When two or more *different* meteorites are found in the same general area, an alphabetical designation is usually added to the locality name, to distinguish between them.

#124 **Nakon Pathom, Thailand.** A highly unusual meteorite, its history can be read in the stone. At some time in its past, the parent body was crushed by intense pressure, and the minerals then re-solidified into a conglomerate rock, called a *breccia*.

Mbale, Uganda. This L6 olivine-hypersthene chondrite fell in Uganda on August 14, 1992 at 3:40 pm. Dozens of pieces were recovered, among them one that fell though a textile mill, leaving a hole not only in the roof, but in the machinery and floor below. Others were recovered from the railway station roof and from the prison. Many stones were ground to powder by the local residents, with the idea that they had been sent by God as a cure for AIDS. Note the large troilite crystals. This is very unusual.

116 ANTARCTICA
L6 stone. Fragment. 200 gr.: 80 x 60 x 20 mm.

117 ALFIANELLO
Olivine-hypersthene chondrite. Slice. 1.42 kg.: 150 x 120 x 33 mm.

118 HOLBROOK
L6 stone. Complete stone. 1.55 kg.: 160 x 100 x 70 mm.

119 ETTER
L6. End piece. 45 kg.

120 TENHAM
L6. Various stones. Largest pictured weighs 1.4 kg.

121 BRUDERHEIM
Nick Hallawate and his lucky stars!

122 PERVOMAISKY
Olivine-hypersthene chondrite. L6. Complete stone. 566 gr.: 70 x 70 x 55 m

123 FORREST (B)
Olivine-hypersthene chondrite. L6. End piece.1.26 kg.: 120 x 115 x 50 mm.

124 NAKHON PATHOM
Olivine-hypersthene chondrite. L6. Slice. 96 gr.: 120 x 60 x 5 mm.

#125 **Macy, New Mexico, USA.** In this extensively weathered meteorite only a few un-oxidized chondrules and metal flakes can be seen.

#126 **Salla, Lappi, Finland.** L6 olivine-hypersthene chondrite. Found in 1963. This was a trade with the University of Helsinki Museum.

#127 **Tulia (a), New Mexico, USA.** H3-4, olivine-bronzite chondrite, brecciated meteorite. This was a 1917 find, when two specimens were plowed up.

#128 **Neenach, California, USA.** This L6 olivine-hypersthene chondrite was plowed up right outside of Los Angeles in 1948. (Try plowing up something there today... other than power lines.)

The Age of Meteorites

Meteorites are considered to have at least three different "ages". The first age has to do with how long ago the elements and minerals of the piece last crystallized. This "actual" age is commonly determined by radiometric dating. This process measures the total amount of one radioactive* particle, or isotope, which stays the same over the course of time, against the amount of another radioactive isotope which changes at a steady rate over time. By measuring the difference between the two, scientists can estimate the age of the specimen to within several million years - a mere snap of the fingers, cosmic time-wise.

The second age is the so-called exposure age. This refers to the amount of time elapsed since the meteorite has been separated from the parent body and out in space. This "age" can be estimated by looking at the amount of isotopes such as neon-21 present in the meteorite's surface, since this isotope only happens when the meteoroid is exposed to high-energy rays (cosmic rays) from the sun.

The third "age" is the Earth age, which is determined by examining the piece for weathering; rust, decomposition of silicates, presence and condition of fusion crust, etc., and usually constitutes an "educated guess" on the part of scientists. (This is especially tricky because meteorites from the same fall can and do, weather differently!)

* *Note: Meteorites themselves are NOT radioactive!*

#129 **Harrisonville, Missouri, USA.** This veined L6 olivine-hypersthene chondrite was found, along with some 12.9 kg. of other stones, by another "meteorite man", the great H. H. Nininger on April 9, 1933. (Dr. Nininger's books about his adventures in the early days of the meteorite biz make fascinating and entertaining reading! Check them out at the library.)

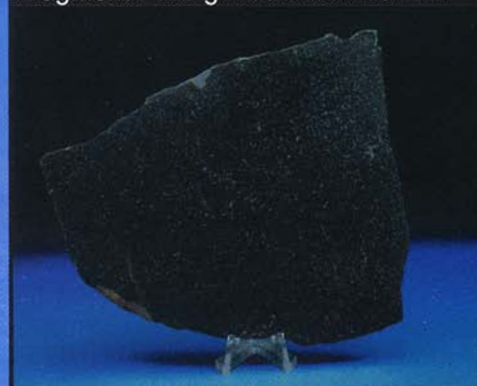
#130 **Valkeala, Kymi, Finland.** This L6 olivine-hypersthene chondrite was found in Finland in May, 1962. Note weathered fusion crust on this complete stone.

Sunsites, Arizona, USA. This fist-sized stone was accidentally recovered while searchers were looking for additional specimens of the Cat Mountain Meteorite. This typical chondrite weighs 590 grams. Love that serendipity!

(Many thanks to my friend Marcel Vanek for this cartoon...)

125 MACY
Stone. L6. Slice. 176 gr.: 50 x 40 x 30 mm.

126 SALLA
Olivine-hypersthene chondrite.
Fragment. 618 gr.: 65 x 65 x 60 mm.



127 TULA (A)
Olivine-hypersthene chondrite
Slice. 305 gr.: 145 x 120 x 6 mm.

128 NEENACH
L6. Slice. 449 gr.: 140 x 110 x 15 mm.

129 HARRISONVILLE
Olivine-hypersthene chondrite. Half stone. 314 gr.: 60 x 60 x 44 mm.

130 VALKEALA
Olivine-hypersthene chondrite. L6. Complete stone. 309 gr.: 70 x 52 x 40 mm.

#131 **Nuevo Mercurio, Zacatecas, Mexico.** Thousands of various-sized, well-oriented stones peppered the desert after the inhabintants were awakened one night in 1978 by noises decribed as being like "dynamite" going off and "freight trains" going through. The whole town turned out to search and some 40 kilos were recovered. This is an H5 olivine-bronzite chondrite.

#132 **Pultusk, Poland.** This shower of stones rained down over Pultusk on January 30, 1868, after a fireball appeared and detonations were heard. It was estimated that more than 100,000 stones must have fallen, yet nowhere near that amount has been recovered, so many more must still be there. (By now they would be rusty-looking.) This brecciated H5 olivine-bronzite chondrite was a trade specimen.

#133 **Chaing Khan, Thailand**. This H6 meteorite fell in 1982 near the so-called "Golden Triangle" region of northern Thailand, making it an interesting place for a meteorite hunt. (...*sure* you're looking for rocks from the sky. Now up against the wall, Yankee...)
Notice how the iron in the crust has started to stain through into the interior of the piece.

#134 **Zhovtnevyi, Ukraine, USSR.** Six large and several small stones were recovered after a witnessed fall on the night of October 10, 1938. This is an H5 olivine-bronzite chondrite.

#135 **Gao, Burkina Faso, Africa.** H5 Gao stones by the gunnysack. I'm stoked! See story on page 53.

#136 **Weston, Connecticut, USA.** This was a witnessed fall from December 14, 1807. The strewnfield for this H4 olivine-bronzite chondrite was 10 miles long. There has been speculation that news of this fall once prompted Thomas Jefferson to make his famous, but probably apocryphal, remark that he'd "rather believe that two Yankee professors would lie, than that stones could fall from heaven."

#137 **Beardsley, Kansas, USA.** This H5 olivine-bronzite chondrite was a witnessed fall in October, 1929. More than 60 stones fell, with not an oriented specimen among them.

#138 **Big Rock Donga, South Australia, Australia.** This H5 olivine-bronzite chondrite was found by an old rabbit trapper who picked it up to stuff into a rabbit burrow to prevent the rabbits from escaping. It remained on a sheep station for years before being recognized.

#139 **Conquista, Minas Gerais, Brazil.** This H4 olivine-bronzite chondrite fell in the early morning hours sometime in December, 1965. Many fragments were collected, but only one main mass remained intact.

Tunguska Blast

On the morning of June 30, 1908, something exploded over a densely forested region of central Siberia. Seismometers as far as Tiblisi, some 3,000 km away, recorded an enormous earthquake and microbarograph readings in England showed simultaneous fluctuations. For weeks afterwards, the night sky over Europe and Asia was strangely luminous, due to suspended vapor and particulates in the upper atmosphere. Whatever violently detonated in Earth's atmosphere that morning created an explosion "brighter than the sun", with a force equivalent to 30 *million* tons of TNT (as opposed to Hiroshima's 20 thousand tons) and an estimated temperature of over 30 million degrees F. "Tongues of flame" shot up thousands of feet in the air, frying everything for 30 miles and leveling 2000 square kilometers of trees in all directions. Nomadic people 45 km away were seared by the hot, hurricane-strength winds, which blew away their tents and killed and injured their animals.

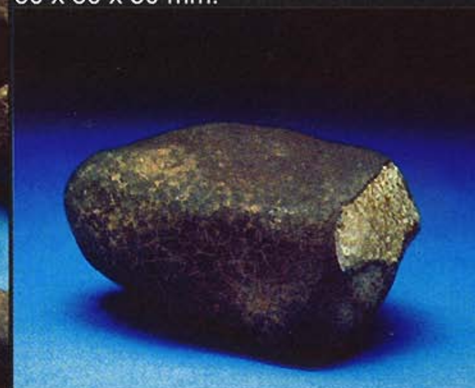
The mysterious entity that caused the destruction is still unidentified; no impact craters or meteorite fragments were ever found. Only one clue was ever unearthed: billions of nearly microscopic, black, metallic and glassy microspherules only 0.10 mm in diameter were later discovered in the soil.

Various hypotheses about the object include things such as a collision with a microscopic "black hole", or ball of "anti-matter". It has even been attributed to the explosion of an alien space ship. The most likely answer is that an ice-bearing comet impacted with the atmosphere and it's kinetic and potential energy was instantly converted to heat... and devastation.

As a result of the cosmic enrichment and who-knows-what else, rate and amount of regrowth of plant life at the site has been phenomenal.

131 NUEVO MERCURIO
H5 stone. Various stones. Largest specimen is about 950 grams.

132 PULTUSK
H5 stone. Complete stone. 224 gr.: 60 x 50 x 30 mm.



133 CHIANG KHAN
H6 stone. Complete stone. 683 gr.: 90 x 60 x 80 mm.

134 ZHOVTNEVYI
Olivine-bronzite chondrite. End piece. 241 gr.: 60 x 45 x 45 mm.

135 GAO
Numerous stones. Largest weighs over 8 kgs! Too good to be true!

136 WESTON
Olivine-bronzite chondrite. H4. Fragment w/ crust. 63 gr.: 40 x 30 x 30 mm.

137 BEARDSLEY
Olivine-bronzite chondrite. End piece. 422 gr.: 92 x 70 x 35 mm.

138 BIG ROCK DONGA
Olivine-bronzite chondrite. End piece. 7kg.: 245 x 190 x 60 mm.

139 CONQUISTA
H4 stone. Slice. 408 gr.: 250 x 90 x 80 mm.

#140 **Homestead, Iowa, USA.** This interesting specimen was given to a school teacher after a witnessed fall, (year and location unknown, but possibly Homestead, Iowa, a witnessed fall from1875) and was sent to my office with very little background information. It has a very obvious fusion crust, which, together with the trusty magnet-on-a-string, is one of the strongest clues in identifiying stone meteorites.

#141 **Plainview, Texas, USA.** Over 1000 stones were found on prime Texas farmland otherwise devoid of rocks. When local residents learned that these stones were worth a lot of money, they kept their eyes open for them, and many were recovered in this way. This specimen is beginning to stain on the outside from rust.

#142 **Hammond Downs, Queensland, Australia.** This H4 olivine-bronzite chondrite was found in 1986 by Mr. Joe Geiger, not far from Ingella Station and the Tenham strewnfield, both sites of other meteorite falls.

#143 **Faucett, Missouri, USA.** This H5 olivine-bronzite chondrite was found in 1966 in Buchanan County, Missouri, but may have fallen in the summer of 1907. Over 100 kg. of this material have been found.

#144 **Melvern Lake, Kansas, USA.** Mr. David Baker, a fellow meteorite hunter and friend, was going house-to-house in the area of the Admire pallasite strewnfield, when a farmer brought out this specimen. He had recognized the stone meteorite by its unusual weight and by its distinctive "thumbprint" surface pattern. Go, Dave, go!

#145 **Wellman (c), Texas, USA.** This fine H4 olivine-bronzite chondrite shows beautiful flight markings, even though it has begun to weather slightly. Two previous, different types of stone meteorites have come from this same area, the Wellman (a) and Wellman (b).

Tenham, Queensland, Australia. This 500 gram specimen of Tenham meteorite was photographed where it was found, in the cracked, dry mud of the blacksoil plains in Queensland, Australia. It had lain in this spot since it fell in 1879. Since then, about 250 kilos have been found.

The Twelve Largest Asteroids

Name	Diameter (Kilometers)	Surface Type
Ceres	1000	carbonaceous
Pallas	605	peculiar carbon
Vesta	530	eucritic
Hygeia	450	peculiar carbon
Euphrosyne	370	carbonaceous
Interamnia	345	carbonaceous
Davida	320	carbonaceous
Cybele	305	carbonaceous
Europa	290	carbonaceous
Patientia	275	carbonaceous
Eunomia	275	siliceous
Psyche	250	metallic iron

#146 **Faith, South Dakota, USA.** This is also a very nice stone specimen with good surface features. Recognition of such surface features as "thumbprints", flow lines, obvious orientation, etc.,is one of the best "tools" in a meteorite hunter's "kit". This specimen also is showing signs of contact with terrestrial water by rusting.

#147 **Ransom, Kansas, USA.** This H4 olivine-bronzite chondrite was a 1938 find. Farmers have found dozens.

#148 **Djerj, Algeria.** This specimen was found, along with several others, near an oil drilling rig in Algeria. It is an H5 ordinary chondrite. No doubt many more meteorites will eventually be found in Africa's Sahara Desert.

#149 **Correo, New Mexico, USA.** This small, complete stone was found by the author in a small blow-out on the sand dunes west of Albuquerque, NM. Sand dunes can be excellent places to look for meteorites, both because of high color contrast and excellent preservation conditions. This was my first stone meteorite!

#150 **Lake Machattie, Queensland, Australia.** This weathered H5 chondrite is a relatively new find from Queensland. A single, 2.6 kg stone was recovered from near Lake Machattie in Queensland by an anonymous finder who spotted it from a moving vehicle. No more has been found. No fusion crust remains on this piece.

#151 **Forest City, Iowa, USA.** Beautifully oriented, shield-shaped specimen weighing 5 kg. It has great flight markings.This fell May 2, 1890. Total iron equals 27%.

140 HOMESTEAD
Complete stone. 134 gr.: 60 x 50 x 30 mm.

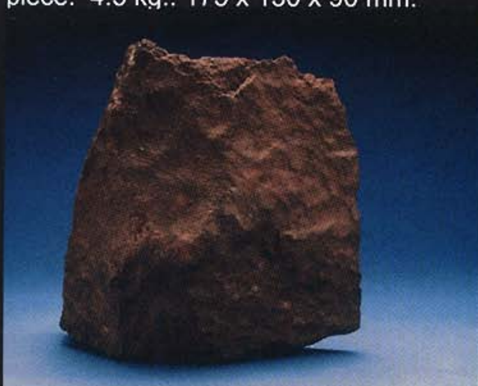
141 PLAINVIEW
Ordinary chondrite. H5. Complete stone. 2.85 grm.: 140 x 70 x 40 mm.

142 HAMMOND DOWNS
Ordinary chondrite. H4. End piece. 211 gr.: 250 x 70 x 70 mm.

143 FAUCETT
Olivine-bronzite chondrite. H5. End piece. 4.5 kg.: 175 x 130 x 90 mm.

144 MELVERN LAKE
Half stone. 4.5 kg.: 200 x 130 x 110 mm.

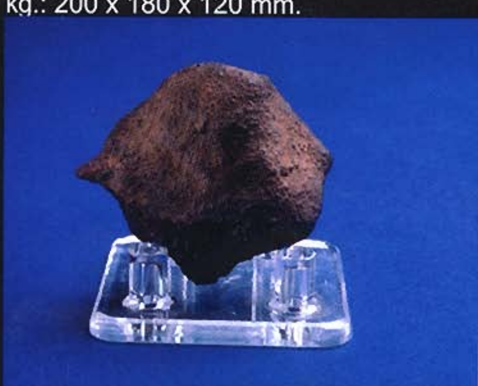
145 WELLMAN (C)
Olivine-bronzite chondrite. Complete stone. 3.38 kg.: 160 x 130 x 110 mm.



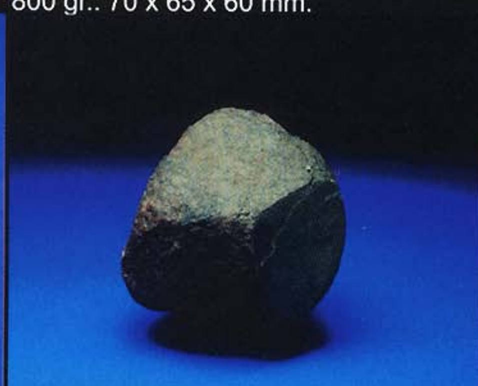
146 FAITH
H5 weathered stone. End pievce. 7 kg.: 200 x 180 x 120 mm.

147 RANSOM
Olivine-bronzite chondrite. Half-stone. 800 gr.: 70 x 65 x 60 mm.

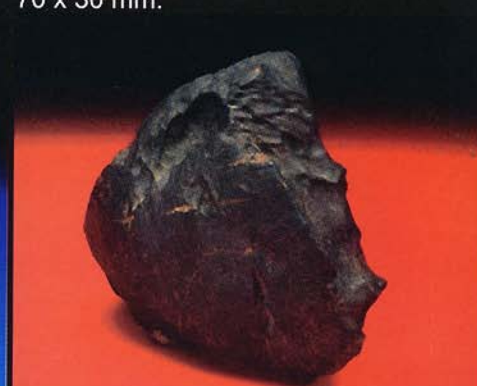
148 DJERJ
H5 chondrite. Stone. 419 gr.: 90 x 70 x 30 mm.



149 CORREO
Ordinary chondrite. H4. Complete stone. 176 gr.: 50 x 40 x 30 mm.



150 LAKE MACHATTIE
Olivine-bronzite chondrite. H5. Complete stone. 2.5 kg.: 110 x 100 x 100 mm.



151 FOREST CITY
Beautiful fresh stone. 5 kg.: 200 x 160 x 85 mm.

#152 **Wiluna, West Australia, Australia.** This H5 olivine-bronzite chondrite fell in front of hundreds of witnesses on September 2, 1967, near the Wiluna Township. An estimated 1000+ stones rained over an elliptical area. Interestingly, the Wiluna strewnfield overlaps that of Millbillillie. (See pg.28)

#153 **Vulcan, Alberta, Canada.** A single stone of this H6 olivine-bronzite chondrite was found in April, 1962. Note all the obvious metal flakes present in this nice, polished slice. Metal flakes are one of the key indicators of meteoritic origins for stones.

#154 **Musiyumovo, USSR.** You can see how the metal is beginning to stain the matrix as it oxidizes. This weakens the crystals and speeds its breakdown.

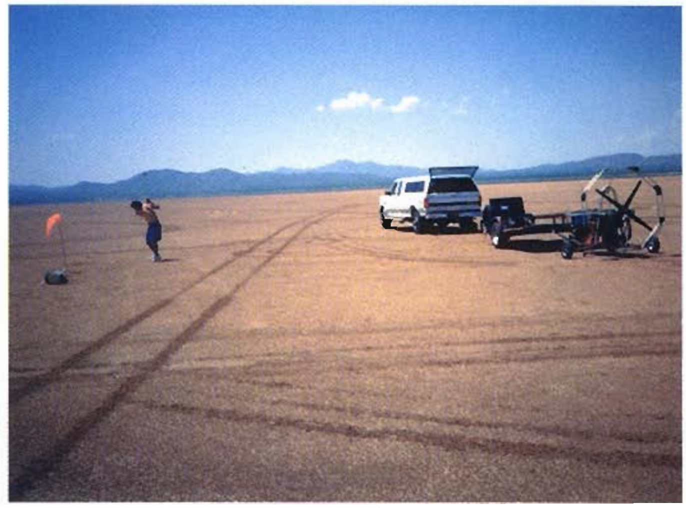
#155 **Selma, Alabama, USA.** This H4 olivine-bronzite chondrite was found in 1906. It is a fairly weathered specimen with a total iron content of over 22%!

#156 **Ybbsitz, Austria.** This meteorite was collected in the field as an "interesting rock" in 1977, but wasn't identified as being a meteorite until 1980.

#157 **New stone, Uruguay.** This ordinary H chondrite unfortunately came to us with very little information.

#158 **Gladstone, New Mexico, USA.** This black-veined H6 olivine-bronzite chondrite was found by Nininger in Union County, New Mexico in 1936. Three more of the same stones were found just over the county line in Colfax County.

Saint Robert, Montreal, Canada. We'd *love* to show you a picture of this 1994 H5 witnessed fall, but the Canadian government wouldn't let me buy or collect any. So I didn't, and here is what happens. Regulations like these defeat their own purposes.



Dry desert lake beds are good places to look for meteorites. Between paraplane flights we hit a black golf ball as far as we can which becomes our search target. Then we scan the ground for meteorites until we reach the ball. Several stone meteorites have been found here at Wilcox, AZ.

#159 **Blue Ice, Greenland.** Meteorite hunters even more adventurous than I am have recovered dozens of meteorites on blue ice in northern Greenland. This is the same way meteorites are found in Antarctica, but closer.

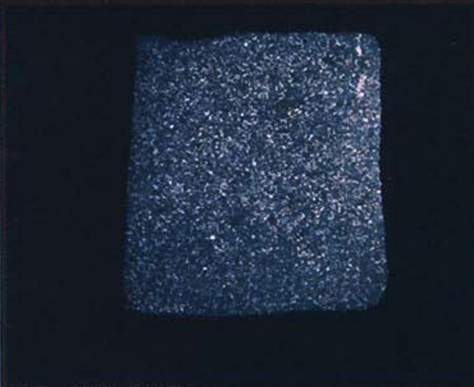
#160 **Owasco, Texas, USA.** Stone meteorite. In this piece, large patches of fresh, unweathered areas with good chondrules are separated by fractures and metal veins from more weathered areas.

#161 **Ozona, Texas, USA.** This H6 olivine-bronzite chondrite was found in Crockett County, Texas in 1929. Notice the extreme degree of weathering in this specimen. All the metal grains have disappeared out of this piece, making it very hard to recognize.

#162 **Pampa (c), Chile.** This is the oldest, most weathered stone meteorite in my collection, with an estimated Earth age of over 1 million years. There is virtually no metal left, the fusion crust is entirely gone and the remaining chondrules are hardly visible. It was found by accident when a friend of mine picked it up by the road to support his car jack, while fixing a flat! This specimen is of more interest as a curiosity than for scientific study.

#163 **Mills, New Mexico, USA.** This H6, olivine-bronzite chondrite stone meteorite was found on a ranch in Harding County, New Mexico in 1970. Although 6 pieces were found in all, none of the fragments could be fitted together. This is very weathered -- a ball of rust.

152 WILUNA
Olivine-bronzite chondrite. Half stone. 79 gr.: 52 x 40 x 20 mm.



153 VULCAN
H chondrite. Slice. 117 gr.: 95 x 80 x 4 mm.

154 MUSIYUMOVO
End piece. 757 gr.: 90 x 80 x 45 mm.

155 SELMA
Weathered slice. 240 gr.: 120 x 90 x 10 mm.

156 YBBSITZ
Fragment. 287 gr.: 80 x 70 x 35 mm.

157 URUGUAY FIND
2 kg.: 150 x 120 x 990 mm.

158 GLADSTONE
Slice. 2.56 kg.: 280 x 250 x 15 mm.

159 BLUE ICE
Stone. 1 kg.: 135 x 65 x 65 mm.

160 OWASCO
Fragment. 682 gr.: 141 x 90 x 35 mm.

161 OZONA
End piece. 1.28 kg.: 170 x 65 x 40 mm.

162 PAMPA (C)
Very old, weathered. Half stone. 3.16 kg.: 160 x 130 x 90 mm.

163 MILLS
Olivine-bronzite chondrite. H6. Fragment. 1.24 kg.: 170 x 110 x 60 mm.

Late in the day on January 6th,1985, Mrs. Rios of La Criolla, Argentina, had just finished supper with her family and was clearing the table, when a 750 gram stone crashed through her roof, destroyed her front door and ricocheted around the small room, terrorizing her and her children. Mrs. Rios grabbed her children and fled. She had heard loud detonations and was convinced that a passing airplane had dropped bombs onto her home. It was a long time before Mrs. Rios would even enter her house again.

Soon a representative of the University of Salta arrived in La Criolla to investigate. He was able to recover a few specimens and not long afterward, a slice made its way to Brian Mason, then curator of the Smithsonian Institute's meteorite collection. He determined that the visitor from space was an L6 olivine-hypersthene chondrite stony meteorite.

Back in Tucson, Arizona, I was reading a report of the new fall at La Criolla in a *Geophysical* newsletter. I was interested, but didn't think much about it until a month later, when I read a second report saying that "tens" of stones had been found in the area. A bulb lit up over my head: if there were "tens" of stones, there were just as probably hundreds of stones, and my chances of finding some were good. I made immediate preparations to go.

In Buenos Aires, I showed a map of the area to someone in a local travel agency and they got me on a flight to a town called Concordia, which was within 10 kilometers of La Criolla. Once in Concordia, I chose the most honest-looking of the town's two taxi drivers, showed him pictures and maps, and asked if he knew anyone who might have some of those stones. Luckily, he had some relatives in La Criolla, and said he'd take me there the next day.

La Criolla. The 6.1 kilogram specimen.Note "thumbprints."

True to his word, my driver showed up and off we went. In La Criolla, we stopped at a small *bodega*, or grocery store and started asking questions. The store keeper remembered the fall in vivid detail. Over big cups of maté, a thick, herbal tea drink, I mentioned purchasing some of the meteorites. She went into her back room and returned with a 50 gram stone. I bought it from her on the spot and asked if she knew where I might find more. She said to try "*El Policia...*"

"*El Policia*" turned out to be the town's only constable, a very friendly man who knew the community well – the perfect contact. When I explained what I wanted, he asked to go along on the quest. But first we stopped at the home of the Mayor, a Mr. Silva. I asked him, too, if he knew where I could find more stones. He too excused himself and came back with the most beautiful, fresh meteorite I had ever seen. It was a 6,100 gram stone with scalloping over two sides and a clean break showing the interior. I was ecstatic. I offered him the equivalent of a year's wages which he accepted. Furthermore, he knew of many others! So we all piled into the taxi; the driver, the long-haired gringo, the policeman and the mayor, and went in search of treasure from heaven. We must have made a funny sight.

Just up the road, we stopped at a small farm house. Over more maté, I asked the woman there all the same questions and she told me that there was a piece in the barn, right beside the oil and tools! It turned out to be a 7,000 gram, complete specimen. Then, as if that weren't enough, her husband brought out another 2,600 gram speciman from his father's house. After I paid them for both stones, they told me they were terrified to have that much cash in the house.

The news of the crazy man buying rocks spread like wildfire, and soon people were coming from all over carrying black stones. After eight days, I had recovered 54 stones with a combined weight of some 30 kg. I promised to return in two months to get more, which I did, buying ten more kilos. Then, six months later, I made a final visit to La Criolla, and on that trip I recovered another 2 kg.

Back home, I distributed most of the meteorites among institutions, museums and collectors, but I will always keep the 6.1 kilogram stone in my personal collection as a remembrance of some wonderful people and a rewarding trip in search of the La Criolla meteorites.

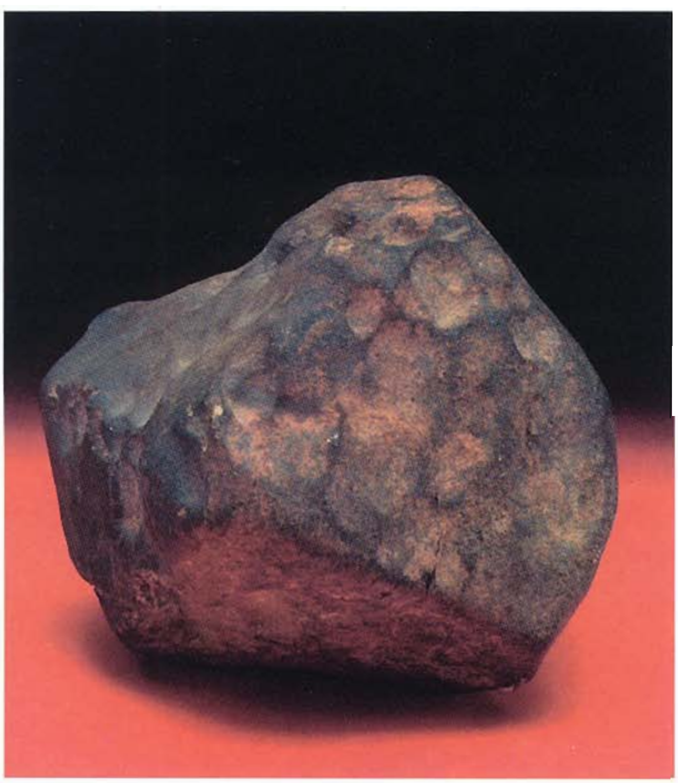
GAO STORY

The Gao stony meteorite was seen to fall on March 5, 1960 in the village of Gao, Burkina Faso, in western Africa. Many of the 16 pieces that were originally recovered actually crashed through the roofs of people's huts.

Several years later, while we were exhibiting at a mineral show in Paris, France, a gentleman contacted me who lived and worked near Gao. We talked, and he went back fired with exploratory zeal, which he imparted to many of his neighbors in the area. Recognizing an excellent opportunity to trade rocks for food and money, local people searched the fields and in this way, many more kilos of stones were recovered.

When all was finished, an astonishing 300 kilograms total weight of stones came to light. The largest to date weighs in at 45 kilos, and who knows how many more might be hiding in the weeds.

Interestingly, it now appears that another, distinct strewnfield has been discovered within the original strewnfield (which actually happens a lot). This second meteorite is called "Guenie" and is an H5.



Gao, Burkina Faso, Africa. 8 kilogram complete stone. This is what I call a "glamour shot". Lights! Camera! Action! We're gonna make you a star!

In situ. This stone meteorite was just sitting there, waiting for someone to pick it up. Might as well be you... .

Heads up! These women are standing at the exact spot where a hut was demolished by falling rocks from space. These local women actually found most of the specimens while doing all the work in the fields *by hand.*

The next generation of Meteorite Men

After several hundred years of scientific study and debate, no one can say with certainty exactly how tektites occur. They have been variously thought to be:

1. *man-made artifacts from primitive cultures*
2. *silica colloids that formed by "electrolytic action" in granite-rich Earth terrain.*
3. *the result of lightning striking the Earth*
4. *terrestrial volcanic ejecta*
5. *impact phenomenon whereby melted, silica-rich, melted Earth rock is thrown into the high upper atmosphere after a meteorite impact. Molten glass then falls back down, acquiring flight markings*
6. *an actual "glass" meteorite composed of pure silica (My theory...)*

Items 1 through 4 above, have been totally discredited, but items 5 and 6 are still hotly debated.

What is known about tektites are the following facts: 1.) tektites contain virtually no water, 2.) they are low in the volatile elements lead, thallium, copper and zinc found in Earth sediment, 3.) they are oxygen-poor compared to Earth rock, and 4.) they don't show any trace of cosmic-ray exposure.

On the *pro* side for the *meteorite-impact-on-Earth* theory are the facts that: 1.) impact craters have been found that account for various tektite strewnfields in terms of chemical composition, age and distance, such as the Ries Valley, Germany impact crater : Moldavite strewnfield, the Lake Bosumtwi crater : Ivory Coast tektite strewnfield, and the Elegygytgyn, Siberia crater : australite and indochinite strewnfields, 2.) the chemical composition of tektites closely matches a type of Earth sediment called "subgraywackes". On the *con* side, however, is the fact that tektites are very dry; they contain virtually *no* water, compared to Earth rock, and the largest meteorite craters have spawned no known associated tektites.

The *silica meteorite* theory is weak because of, again, an absence of cosmic-ray tracks indicating time spent in space and the fact that no one in recorded history has ever witnessed a fall of tektites!

Louis Carion in the Libyan Desert. Louis is holding a freshly discovered stone meteorite from the Libyan Desert Glass strewnfield.

#164 **Indochinites, Thailand.** Indochinites are widely distributed throughout Thailand, where they are often picked up out of rice paddies and fields. Most Indochinites have very distinctive tear-drop, wand or even dumb-bell shapes. These tektites are very popular.

#165 **Moldavites, Czechoslovakia.** These tektites are unusual for their clarity and tourmaline-green color. Moldavites can be faceted into beautiful gem stones from space, and some people believe that they possess metaphysical powers for healing.

#166 **Libyan Desert Glass.** Found in the sand sea on the Libya/Egypt border, this beautiful golden tektite shows clear ablation markings on one side, where it was buried, and is sand-scoured where it was exposed.

#167 **Rizal Province, Luzon Island, Philippines.** This and others from this locality have very unusual surface features, such as these deep grooves.

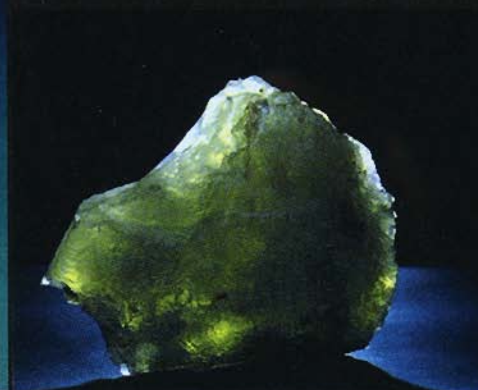
#168 **Columbite, Colombia.** Also called americanite, it's possible that this is not a tektite, but is a terrestrial volcanic glass, similar to obsidian. *In the case of tektites, origin can be difficult to prove.*

#169 **Flanged button tektite (australite), Australia.** It is obvious from the shape of these incredibly perfect button tektites that they re-entered the atmosphere at high speed, causing the leading edge to melt and peel back. These are about 25 mm in diameter.

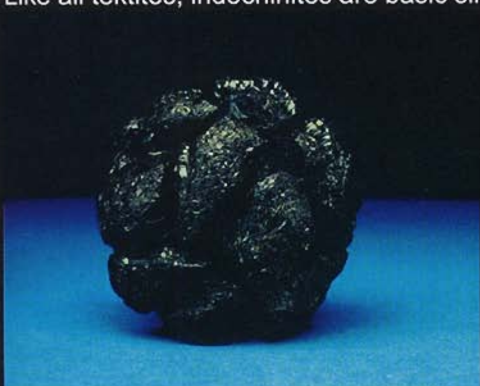
Antarctica. While rich in meteorites, no tektites have yet been found in Antarctica. Why not?

164 INDOCHINITES
These are easy to recognize because of their black color and unusual shapes. Like all tektites, indochinites are basic silicon dioxide with trace elements.

165 MOLDAVITES
Faceted and natural specimens.



166 LIBYAN DESERT GLASS
Complete stone. 2.08 kg.: 155 x 150 x 87 mm.



167 RIZAL PROVINCE
163.5 gr.: 60 mm. diameter.

168 COLUMBITE
Also called americanite.

169 FLANGED BUTTON TEKTITE FROM AUSTRALIA.
SIO_2. Re-entry marks are obvious. Largest is 25 mm. in diameter.

Imagine thousands of square miles of pristine, undulating sand dunes towering 600 feet above the desert floor, dwarfing your Land Rover, threatening your puny human existence. These dunes are 300,000 years old. They have slipped and twisted over the desert for millenia before the first Egyptians built the smallest mud and wattle huts, let alone the pyramids. And for all that time the dunes have hidden secrets and treasures along their sinuous flanks, like precious stones sewn into the hems of twirling, gypsy scarves. Leave it to Robert Haag to lift the veils for a peek beneath.

We flew into Cairo and from there set out by road to Farafra, the last oasis. Beyond Farafra stretched something out of a movie set. We spent 12 days in the desert, 1000 kilometers beyond the last known road, navigating by satellite, like sailors on a great, sand sea. The dunes ran in straight lines for hundreds of miles - wave after wave of snaking lines of sand. In the valleys and troughs between, we found the meteorites.

Meteorites, naturally, were why I was there in the first place, thousands of miles from home and a thousand kilometers from the end of the middle of nowhere. As on many other trips to obscure and remote places of the globe, I was looking for anything forwarded from an outer-space address, but on this trip, we were specifically hunting Libyan desert glass, a particularly lovely variety of tektite.

Libyan desert glass, 29 million years ago was probably formed when an asteroid or comet hit the surface of the earth like a huge atomic bomb, unleashing enough destructive force to not only liquify the rocks, sand and dirt at ground zero, but to splash the molten, mixed material up into the wispy outer atmospheric regions. Perhaps some escaped Earth's gravity altogether; the rest plumeted back in a rain of fire and molten glass. The crater marking the original impact site has not been discovered - no doubt it is under millions of pounds of sand. But wherever the original impact responsible for Libyan Desert Glass occurred, the results came to rest in the wilds of the Western Egyptian desert.

I had been invited on this expedition by my friend and fellow meteorite collector, Alain Carion and his son, Louis, who are French. Other members of the group included Michelle and Olivier, two free-lance writers, and Didier, a noted mineralogist and adventurer. Sam and Walli were our drivers and guides. Between them they've logged over a million miles of treacherous sand dune driving. And I mean treacherous. You've never seen anything like it. Out there, death sits on your shoulder like a vulture - one insignificant little accident and you're just ... dead.

I found out quickly that surviving the desert is in the details. We were riding in two, 4-wheel drive turbo diesel trucks. All the fuel, all the water, all the food, all the spare parts we were possibly going to need, all had to come along with us, because if we got into trouble, we couldn't just call AAA to come and tow us into town. In fact, if you get in trouble out there, you're probably in the worst trouble of your life. We were carrying 150 gallons of fuel per vehicle, and 150 gallons of water, and I didn't think it would be enough.

The one indispensable item was a really superb pair of sunglasses. Unfortunately, I went without mine for one hour once and suffered for days. The reflected radiation off the white talc desert and the light sand is incredibly intense. You would literally go blind in a few hours without eye protection.

Besides good sunglasses, I brought what I figured were the perfect shoes for sand dunes - light-weight hiking boots with high-relief, Vibram soles. Good traction on the sand, and all that. *Wrong*. The best possible shoes turned out to be either plain tennis shoes or cowboy boots with really smooth leather bottoms - anything that didn't break the crust of the sand. Once you broke through the surface crust, you floundered around like a cow on roller skates. Naturally our mountain bikes were completely useless, since there was no sand hard enough to bike on and you exhausted all your energy in about a minute and a half trying.

As it was, we got the vehicles stuck every day. Somethimes we got stuck three or four *times* a day. We carried big sheets of aluminum poked full of holes to put under the tires to get out. Sometimes, when it was really bad, we might only go a few feet before we'd get stuck again. It all depended on the orientation of the sand grains. Sand going one way - hard as a parking lot. Sand going the other way? Wooff! Down you went to the axles. Again. Dig, push, all together.

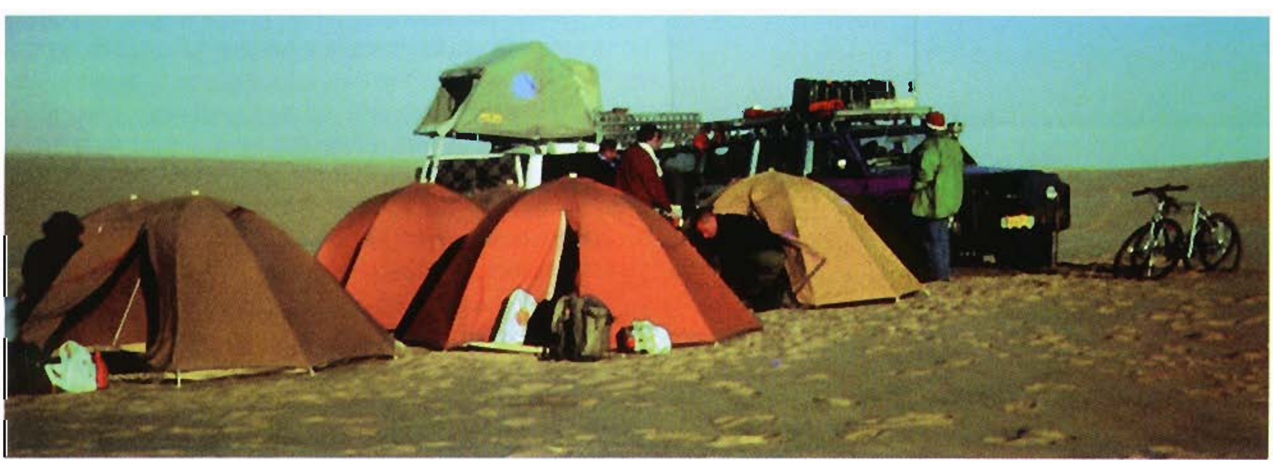
Another interesting aspect of driving in almost white sand is that you can't drive at noon. There are no shadows. Therefore there is no relief, no contrast and no depth perception. Everything is the same color. You might drive right off an eight-foot drop and never even see it. And that would be a *bad* thing.

There were plenty of non-cosmic surprises in the desert. One day we were zooming along when someone yelled stop. We had just driven past multiple caches of ancient terra cota jars, arranged in circles, about eight to ten pots per cache. All that could be seen of them without excavation was a series of black and rust-colored circles in the hard packed sand. Everything above the sand line has been eroded away by the endless sand-blasting of the desert. It was a tremendously exciting discovery, but we had neither the time nor the expertise to investigate further, so we took pictures, made notes and shot the exact location of the caches using a GPS unit (ground positioning satellite) that measured latitude and longitude, for a report to Egyptian archeologists upon our return to civilization.

Another fun discovery was desert fulgerites. These bizarre artifacts are like "fossilized" lightning. Lightening, which is hotter than the surface of the sun, actually strikes the ground quite often and the desert is no exception. When this happens, a perfect record of the shape of the lightning is preserved in the melted sand or dirt, then it can be lifted or dug out. Generally these fulgerites look like petrified roots or perhaps the burrows of snakes, but of course are neither. We were able to collect several wonderful, branched specimens to bring home. Some are hollow, like flutes.

When we finally spotted the first specimen of Libyan desert glass we were somewhat unprepared. It was nearing sunset and the sunlight was streaming across the white sand at a low, oblique angle. Suddenly someone shouted and pointed. On the sand ahead of us was an eerie, glowing green light. It looked almost radioactive. When we got there, we found a big beautiful chunk of desert glass glowing in the sunset. We found many more in that fashion and also in the mornings when the sun was still low in the sky.

In all, even with the dangerous extremes of the desert to contend with, it was one of my favorite adventures. Not only did we actually find what we were looking for, but we found lots of things we weren't looking for, and sometimes, that's the best part. Friendship, excitement, the blood pounding in your ears as you scream down a sand embankment sideways, wondering if the Land Rover is finally going to roll over, the fabulous panorama of the night heavens, like mirrored image - sparkling sand dunes in the sky - these are the things that make life as the Meteorite Man the best adventure imaginable!



As every meteorite afficionado knows, besides Antarctica, Australia's Nullarbor Plain is the granddaddy meteorite hunting ground of them all; an area of some of the oldest undisturbed ground on Earth, site of the great Mundrabilla strewnfield and a bunch of others. Unfortunately, or fortunately, it's also at the ends of the Earth, in the middle of the tremendous interior desert known as the outback. They also speak English.

I had been planning an expedition there for years, and with the help of my good Australian friends, it was coming together. We discussed buying a paraplane, a small, gasoline powered parachute; something like a soapbox derby with a giant fan on the back and a billowy parachute above. I found one in Phoenix, and after some "entertaining" test flights, I boxed it up and sent it off to Australia. Otherwise, I didn't need much - warm clothes and a sleeping bag. It would be the end of winter, and cold in Australia.

We made final preparations in Perth, buying everything we intended to eat, drink, read or otherwise use for the next few weeks. (There aren't any convenience marts on the Nullarbor.) Finally, we headed out, saying goodbye to civilization. And I mean goodbye not only to civilization, but to the world as most of us know it. Entering the Nullarbor Plain was like leaving planet Earth entirely. There is NOTHING on the Nullarbor Plain: no mountains, no trees, no rivers, no man-made structures, no nothing. It is as featureless as the ocean. We literally had to "navigate" our way with compasses and the odometer. It's an odd place, where every mile traveled looks identical to the last. It feels like some kind of time and space warp.

Ancient Aboriginal burial grounds as seen from the paraplane.

After some expert tracking by my friends, we lurched across the Mundrabilla railway "station". (This consisted of some tracks and a radio tower.) It was only another fifty kilometers from there that we finally found the site where the three- and eleven-ton Mundrabilla irons had been recovered.

That first night was incredible - the air clean and cold, no city lights and the whole Southern sky ablaze with stars. A mere 4 light years away, Alpha Centauri was so beautiful that we named our camp Alpha Centauri Base. It was an inspiring way to begin, under the Southern Cross with the Comet Levy making a command appearance overhead.

The next day was less poetic: the Nullarbor has some of the most vicious rocks on the planet. It was once an ancient sea bottom and the sharp limestone shards left behind are called "razorbacks" for good reason. They can slice a tire to shreds. Maneuvering slowly and carefully, we went the whole 30 days without a blow-out. Good driving!

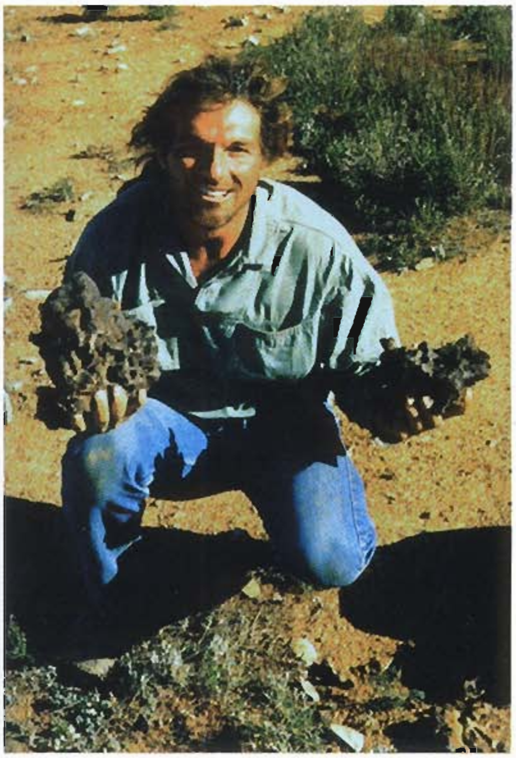
This far into the Nullarbor, the horizon seems to recede from you in every direction. It's sky, sky, sky and miles of absolutely flat desert floor, covered with white limestone. After awhile, your eyes adjust, and begin to cancel out the limestone, focusing instantly on a black fusion crust or the weathered brown of a Mundrabilla. (I found one the first day, while looking for firewood!)

During the next few days we found another achondrite, some chondrite fragments, several australites and Mundrabillas. One of our party had some extravagant luck when she saw a small brown spot on the ground, no bigger than a quarter. It turned out to be a tiny tip of a buried,1 kilo, new stone meteorite! Overall, however, it was uneven pickings; we might find several pieces within a few feet of each other, then go the rest of the week without finding a scrap. But such is the nature of the meteorite hunt - it just keeps you tantalized!

We really had to train our eyes. The rocks seemed to come in waves, and after hours of scanning, just the eye strain caused problems. If you tried too hard, you saw nothing, but just about the time you gave up and relaxed your gaze, bingo, something brown would just seem to leap out. Zen and the art of meteorite hunting, I guess. We all carried magnets on strings for testing our specimens, and sometimes a small, nondescript "rock" would cause the magnet to practically jump out of our hands.

One had to be very careful while searching on foot away from the caravan, because there are no landmarks whatsoever. One day, I donned my Walkman, dropped in some raging rock 'n roll and went out, searching for the "big one". I was really rocking out, not paying much attention to where I was, when suddenly realized that I'd *no* idea where I was. After 4 hours of wandering alone in the outback, I figured I was in a bit of a mess. Once I sat down and figured out how the sun moved in relation to me, I oriented myself. The only way out of it, I decided, was to walk straight towards the sun. As it turned out, my calculations were correct, and I found camp again. Whew.

We had a sort of crows-nest arrangement on top of one of the Land Rovers. We'd take turns spotting with binoculars from up there while going slowly. If you saw something, you banged on the roof and someone would get out and investigate, while you



shouted directions from above - "a little more to the left.. now forward. No, -more left! Right by your foot!". This is how someone spotted a magnificent, 55 kg. Mundrabilla sitting regally in a patch of grass.

In addition to foot prospecting and riding on top of the Land Rovers, we used the parasail for aerial reconnaissance. We flew mostly in the mornings, when there was little or no wind (the only real hazard to these flying go-carts) and endured some bitter cold. I wore two pairs of pants, two shirts, a coat, ear muffs, gloves, and a helmet, and I *still* froze my, er, nose off. Once airborne, though, the machine was incredible.

I'd be cruising along with the engine howling in my ears and look over to see eagles flying along beside me! I could see everything for miles, including rabbits scurrying into their holes and kangaroos hopping below me. Once I flew low over a mob of 'roos, ("herd" of kangaroos to non-Aussies...) and a big male tried to jump up and bite me! Twice I came upon circles in the desert piled about a meter high with white rocks - these were 10 to 12 thousand year old Aboriginal burial mounds. It was a very spiritual experience - at times I almost felt that the ancient Aborigine spirits were there with me...

Occasionally, a "willie-willie", (what we call a "dust devil") would blow up from the desert floor, tossing me violently around and threatening to collapse my chute. These scared the daylights out of me, but luckily I was never downed by one.

I did, however, go down once. I had to make an emergency landing when my fuel line clogged. I just drifted down into some bushes, unscathed. The real problem at that point was being found. My friends knew to come looking if I didn't appear within the hour and a half fuel running time, and they knew my general direction, but without some way to signal, it would be like looking for the proverbial needle in the haystack. While I waited, I fixed the clogged line enough to send the chute billowing up into the air every half hour. Finally, after several tense hours, they spotted my chute, and arrived to collect me. I was glad to see them. Again.

Occasionally we came across "blow holes" - a peculiar phenomena where variations in pressure cause wind to roar into or out of the mouth of a small hole in the ground. They are the vent holes for extensive limestone caves, and often the volume of air escaping was so huge that large rocks thrown down the hole would come sailing back at you like they were made of styrofoam. At other times, the air would be turbulently gushing *into* the ground. Talk about a rush! Naturally I had to investigate.

I enlarged the opening of one and by fastening a chain to the jeep, I was able to lower myself down into one of the monsters, with the understanding that if I wasn't back in an hour, the crew would come looking for me. It was a steep climb in and I had no idea of what to expect. The only thing I'd ever heard about a blow-hole was that a man had found an entire fossilized fish in one a few years earlier. But not just fossilized: it had *opalized* as well! Incredible. All I found were spiders and adventure.

After a hard day of flying and meteorite hunting, we'd relax around the fire and have dinner. Luckily, we had a great cook who knew 50 ways to prepare kangaroo meat. We had kangaroo stew, kangaroo chops, and a great apricot kangaroo dish. We even tried boxtail lizard, Aborigine style. Some Aborigines had told us how to cook it. (It's awful: not a bit like chicken!)

Sometimes, we had the luxury of a hot shower - a billy can full of heated water that ran out fast. Then, a bit of time for tea and battening down the hatches, because every evening, about two hours after sundown, the wind came lashing over the plains from the south at about thirty miles an hour. We could hear it roaring as it came. It was a solid front of extremely cold, moving air, and if you didn't have everything already stowed or tied down, it would go off in a northerly direction without you. It was a good time to be snug in your bag and swag. (A swag is a kind of mini-tent for your sleeping bag.)

I had brought a couple of harmonicas, so we'd sing and play music under that fabulous sky, while we looked out the windshield of Spaceship Earth... in all, an incredible experience.

In the final analysis, we found adventure and some great meteorites. At least one was a complete puzzler that needed further study. This rock, later turned out to be a real earth rock! Wow, my favorite planet.

Bob

GLOSSARY

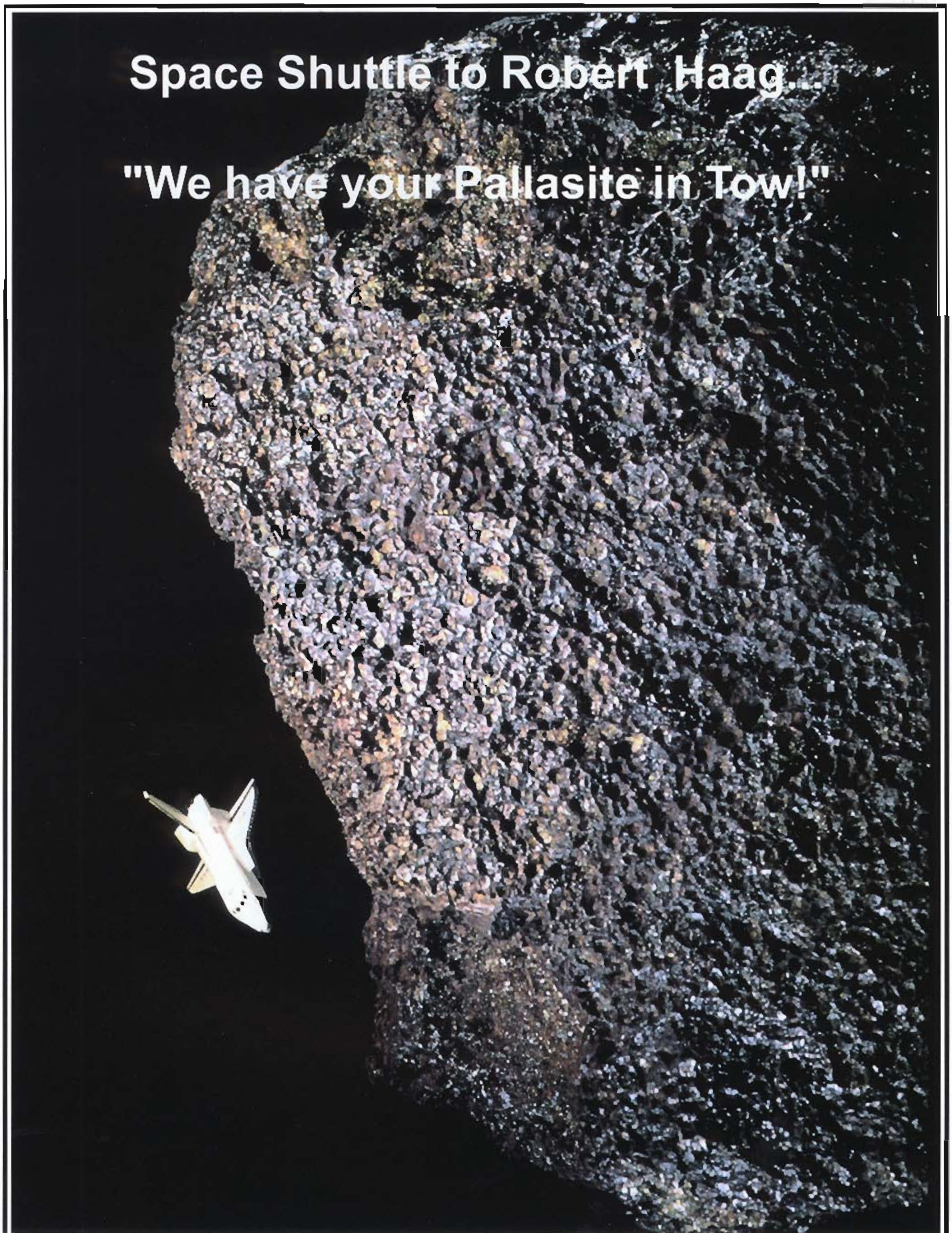
Achondrites	Stone meteorites that do not contain visible chondrules
Amino acid	Large organic molecule; building block of protein
Amphoterite	Obsolete name for LL (low-low iron content) chondrites
Anomalous	Highly unusual, unique, uncategorized
Asteroid	An interplanetary body, of varying size not associated with a fixed orbit
Ataxite	High-nickel content iron meteorite showing no Widmanstatten pattern when etched
Bronzite	A silicate mineral with associated iron content of between 10% and 20% - $(Mg,Fe)_2Si_20_6$
Carbonado	Carbon that has metamorphosed into its diamond phase but remains black
Chondrites	Stone meteorites that contain chondrules
Chondrules	Small spheres of silicaceous minerals associated with early formation of solar system
Enstatite	Silicate mineral with an associated iron content of 10% or less. $Mg_2Si_20_6$
Eucrite	Class of stone meteorite consisting of Ca-pyroxene and plagioclase
Fall	Witnessed event of meteorite-dropping fireball
Find	A found piece without associated witnessing of event
Hematite	Oxidized iron ore
Hexahedrite	Six-sided crystal structure found in nickel-iron meteorites
Hypersthene	A silica mineral with associated iron content of between 20% and 30% $(Mg,Fe)Si0_3$
Inclusions	Mineral grains that once existed separately but now form an aggregate
Kamacite	Nickel-iron alloy (7wt %) phase with body-centered cubic structure
Limonite	Oxidized iron; rust
Lodranite	Refers to only the silicated portions of silicated irons - archaic term
Matrix	Base material, surrounding material
Mesosiderite	A class of meteorite; partly stone, partly nickel iron in a melded mixture
Meteor	A meteoroid that has entered Earth's atmosphere
Meteorite	The remnants of a meteor after it has actually impacted the Earth
Meteoroid	An object in space; similar to but smaller than an asteroid
Newman lines	Fine striations seen in some high-nickel iron meteorites
Octahedrite	Eight-sided crystal structure found in nickel-iron meteorites
Olivine	A silicate mineral with the general formula $(Mg,Fe)_2Si0_4$
Pallasite	Class of stony-iron meteorite containing crystals of olivine
Plagioclase	A triclinic mineral with the general chemical composition of $Al_2Si_2O_8$
Pyroxene	One of a number of $Si0_4$ silicate minerals common in meteorites
Schreibersite	A phosphide mineral with the formula $(Fe,Ni)_3P$
Silicate	Glassy or stony component made up primarily of the element silicon
Strewnfield	The area over which a meteorite has fallen
Sulfide	Sulfur-containing, as in sulfur-oxide
Taenite	Iron alloy with a face-centered crystalline orientation
Troilite	Stoichiometric iron sulphide, FeS
Ureilite	Carbon-rich achondrite meteorites with olivine and pigeonite
Widmanstätten	A crystalline pattern seen in iron meteorites after acid etching

IF YOU THINK YOU HAVE FOUND A METEORITE, please send a small, *quarter-sized* piece for me to examine along with a description and photograph of the entire specimen. **If you wish to have the sample returned to you, you must enclose return postage.** All non-meteorite samples without return postage are added to the pile outside the back door. If I suspect that your sample *is* a meteorite, I will contact you by letter and phone, so **be sure to enclose your name, address and phone number with all samples.**

WRITING & EDITING BY TERRI HAAG, TUCSON, AZ

GRAPHICS BY LIZ LEWIS, RLC & ASSOCIATES, TUCSON, AZ

PHOTOGRAPHY BY FOTOSMITH, TUCSON, AZ



Esquel, Patagonia, Argentina pallasite. This is 388 kilograms of the most beautiful pallasite in the world. I am extremely fortunate to have acquired this specimen. If things like this fall in our back yards, imagine what treasures we will find in space!