Benitoite is a beautiful and unique gemstone that rests in a class of its own, a crystal class that had been predicted seventy-seven years before the gem was actually found. The existence of benitoite provides an important piece to the gemstone crystal system jigsaw puzzle that had been missing.

Benitoite ranks as California’s most unique gemstone among the state’s vast mineral and gemstone wealth unearthed. Benitoite is a blue barium titanium silicate that formed under unusual geologic conditions. Benitoite has a high refractive index of 1.76, a strong birefringence, and a dichroism that shows colorless and blue. The one exception to this is the pink benitoite found at the Mina Numero Uno mine. Benitoite has a dispersion that is higher than diamond, has a hardness of 6 to 6.5, and exhibits a fabulous blue color that is natural and rivals that of fine blue sapphire from Ceylon. Titanium may be the coloring agent for benitoite, however, its hue may result from a charge transfer of electrons.

Inclusions of amphibole shown under magnification as lint-like needles are frequently encountered in benitoite.

Occurrences of benitoite have been confirmed from nine locations around the planet, including Japan, Australia, and Arkansas, but only the historic Benitoite Gem mine and the Junnila claim in the New Idria district in San Benito County, California produce gem quality benitoite material. All of the commercial gem production has been found at the Benitoite Gem mine, as only small non-gem quality crystals have been dug at Mina Numero Uno claim, the Victor claim, and the Santa Rita Peak claim. The Junnila claim has yielded some small benitoite crystals that resulted in faceted gems less than one carat.

Faceted gems of benitoite mostly occur in stones that weigh less than a carat. Benitoite stones over two carats do exist but are extremely rare. Those rare exceptions are the several amazing... continued on page 4
President’s Message

One of the greatest pleasures I get from faceting is the opportunity to meet with other folks who facet. I recently had the very good fortune to stay a couple of days with L. Bruce Jones, our editor, and his wife. I got checked out on my refractometer and polariscope and also saw some amazing equipment in action. My unknown synthetic turned out to be rutile (lucky me!), my tourmalines were copper-less (darn!) and my suspicions that an unknown material was greenish beryl were confirmed. Lots of fun and now it’s time for me to be getting some of it cut.

If you enjoy getting together with fellow faceters and learning new thing then you should keep February 3, 2012 open -- it’s the Friday before the Hobnob and the date of our 2012 seminars in Tucson. Roger Dery has volunteered to stay on as the program chair, many thanks yet again Roger, and is in the process of putting the faceting seminars together. The format has been changed from a 5-day series to an all-day program and we’ll be meeting at the Old Pueblo Lapidary Club’s facilities. The date was chosen to avoid conflicts with any of the major shows opening days and the location will provide us with some level of protection against sub-freezing temperatures or other climate change issues. We’ll be adding additional information as time goes on, but the date and location are set (well, set as much as possible). Hope to see you there and for many of us, Tucson is a welcome break from our normal winter weather in addition to being the location of the greatest gem and mineral show in the world.

You still have time to finish your competition stone. The deadline for the postmark is June 20, 2011. This is also a good time to review the instructions for sending in your stone. They’re on our website here: http://www.usfacetersguild.org/docs/2011SSCAnnounce.pdf.

Good luck and enjoy the sparkle.

Keith Wyman

The Facetron Protractor Scale
by Keith Wyman

Have you ever wished you had a scale on your Facetron to make it easier to set the protractor to 1/100th of a degree like 39.22 (Fig 1)? The following pictures and instructions are for putting a 10-division scale in the window of the Facetron digital protractor. Bob Jones (North Puget Sound Faceting Guild member) made some of these scales a few years ago to make it easier to reproduce the angle settings on his machine. I had acquired one of the scales and have found it to be very useful in setting my angles to the same place in the window. Several folks have seen the scale and wondered where they could get one but unfortunately the file Bob used to make the scales had been lost and he’d moved on to a different angle setup. A bit of measuring and email correspondence with Jeff Ford, engineer, USFG treasurer and list owner, resulted in a PDF that will print 16 scales at a time.

The first thing to do is to get the PDF. It’s in the same location as the newsletters and has the file name FacetroScaleR2.pdf. Make sure your printer is set to 100% or full size or whatever you need to do to reproduce the scales at the same size as on the PDF. You should also set your printer to the highest quality or resolution if it has that feature. You will need to obtain a sheet of transparency material of the proper type for your printer – laser, inkjet or whatever – and then print the file (fig. 2). Cut out several of the scales leaving plenty of room around the edges. Remove the plastic window from the Facetron digital protractor. Cut the left side of the scale so that it fits the window and then locate the screw holes using a couple of pins (fig. 3). Use a sharp knife or razor blade to cut openings around the pin holes that are larger than the screw shaft so you will be able to adjust the scale to the window after you replace it (fig. 4). Don’t tighten the screws completely down until you’ve fit the scale in the window to your satisfaction (fig. 5). Now tighten the screws down, trim the
exposed edges of the film with a sharp knife or razor blade. Don’t worry about messing up one of the scales -- you’ve got lots to play with.

This is a good time to make sure your Facetron is properly aligned with the scale. Use the 45 degree dop and the feeler gage to make sure that you are at 45 degrees when the protractor is set at 45.00 degrees (fig. 6). And as long as you’ve gone this far it’s a good time to check that the zero mark on the cheater is indeed zeroed with the index gear and the dop. If either of these adjustments is a bit of a mystery to you, I’d suggest re-reading the Facetron manual and spend a bit of time on this site and on the web reading about machine alignment. And if it’s still a bit of a mystery, then maybe it’s a future topic to explore. Let me know if you have problems.

Now that you can easily get back to any angle given in the faceting diagrams such as 44.93 degrees (fig. 7), it’s time for a couple more thoughts. First, we all know that we’re just kidding ourselves if we think we are really working at an accuracy of a hundredth of a degree. What we are doing though is getting back to the same spot on the protractor when we go from cutting to prepolish to polish and while it might be 44.87 degrees instead of 44.93 degrees, it is the same setting. This precision in setting the angle will help maintain the meets we so carefully set up during each stage of faceting. Second, make sure you approach the angle from the same direction each time in order to minimize the backlash in the system. I come up on the angle from below and if I overshoot a bit, then I go back a ways and try again. This also helps insure that I’m at 44.93 degrees as shown in fig. 7 and not 45.93 degrees as it is sometimes mistaken for.

Well, time to get back to faceting. And while you are, think thoughts of appreciation towards Bob for doing this in the first place and to Jeff for making it possible for you to accomplish this in the privacy of your own home. If you have any questions or problems with the scale, feel free to email me at usfgkw@gmail.com.
Benitoite continued from page 1

Benitoites that weigh five, six, eight, ten, and over fifteen carats that have been seen in private collections and photographed for gem and mineral magazines.

The New Idria district, the location of the benitoite gem deposit, lies in the southern Diablo Range of the California Coast Range geologic province, about 150 miles east of Monterey in San Benito County. The original host rock for benitoite was basalt that had undergone severe metamorphic events, where serpentinite and schist rock plates were faulted, sheared, and folded in such a way that resulted in the gray serpentinite enclosing the blue schist. The minerals mined from the New Idria district include gold, mercury, chromium, asbestos, many different gem varieties. The Benitoite Gem mine lies in close proximity to an active asbestos mine on Santa Rita Peak.

According to Si and Ann Frazier’s report in the November, 1990 issue of Lapidary Journal, the stories that surround the benitoite discovery vary in the telling, and some of the details have been disputed. The tales describing the benitoite discovery all begin in the Diablo Mountains that lie on the western edge of the Joaquin Valley of San Benito County, California, the only gem benitoite deposit ever located. Mineral prospector James Couch in either the autumn of 1906 or the spring of 1907, was prospecting for cinnabar, gold, and mercury in the rugged hills that lie about 25 miles northwest of Coalinga. Couch was working for oilman R.W. Dallas on a mercury venture.

Couch discovered a hillside glittering with thousands of triangular blue crystals that had been weathered out of snowy white natrolite. Thinking he had found a deposit of fine blue sapphires or even blue diamonds, Couch carried a sample to a lapidary shop in Los Angeles owned by L.B. Hawkins. Hawkins, another prospector who had also worked for R.W. Dallas, dismissed the unusual blue gems as being some type of obsidian. Ed Sanders, who had also funded Couch, sent a handful of the blue crystals to his brother in San Francisco, a watchmaker and who may have also run a lapidary shop.

The story includes a jeweler, George Marcher, who was one of the first GIA graduates and who had authored many articles on gemstones and gemology. Later, he was the exclusive benitoite sales agent for R.W. Dallas. Marcher published an account in 1939 that related the benitoite discovery as he remembered it being told by George Eacret.

Eacret was in charge of the gemstone department of Shreve & Company in San Francisco. Eacret told Marcher that a faceted blue stone had been offered for sale by a San Francisco lapidary that represented the gem as a blue spinel. After studying the gem with a dichroscope, Eacret noticed the strong dichroism exhibited by the mysterious blue gem and concluded that it could not be spinel. Spinel is isometric, singly refractive, and exhibits no dichroism. He also noticed that the gem was even too dichroic to be a sapphire. This prompted Eacret to challenge the lapidary that offered the blue stone on the gem’s identification. The lapidary admitted that he had described the gem as a spinel, because he thought the gem too soft to be a sapphire.

Eacret purchased the strange blue gem anyway and then visited the famous geology professor at the University of California at Berkeley, Dr. George Louderback. Intrigued by the mysterious blue gem, Louderback performed enough tests which convinced him that the stone represented a new gem species. Further tests on the blue crystals determined that the gems were new to science.

During this time, R.W. Dallas labeled the deposit a sapphire mine and installed armed guards around the mine to deter any claim-jumpers. Eacret and Louderback were allowed access to the mine if they assured the owners that their studies would not interfere with the mine’s operation. Eacret and Louderback also feared that the famous Dr. George F. Kunz might try to scoop them in naming the new gemstone. However, Louderback was given the honor of naming the new gem, “benitoite” after San Benito County.

In 1830, Johann Friedrich Christian Hessel mathematically predicted the existence of 32 classes and their symmetry characteristics. The possible forms that crystals can assume are the result of precise laws that govern how elements can be combined into compounds, including the proportions and internal geometry of those same combinations. All crystals must fall into one of 32 crystal classes, where each class is defined and characterized by a specific collection of symmetry traits. Those 32 classes are grouped into six crystal systems, where each system refers to a unique axial cross. Missing from the crystal forms found in nature was the ditrigonal dipyramidal class.

Benitoite’s crystal form is the missing ditrigonal dipyramidal (or may also be termed as a dihexagonal dipyramidal) class in the hexagonal system. So far, benitoite is the world’s only known representative of this crystal class. Benitoite crystals form as nearly perfect triangles and occur enclosed in a massive white natrolite, along with black neptunite. Some benitoite crystals have formed as twins, where the C-axis crystal faces of two benitoite crystals merged to assume the flat, tabular shape of a six-sided star.

In 1909, Dr. George Louderback published one of the great classic papers of mineralogy and gemology, “Benitoite: its paragenesis and mode of occurrence”; (Bulletin of the Department of Geology, University of California, Volume 5, Number 23, pages 331 to 380). V.M. Goldschmidt of Heidelberg University considered this paper to be the best description of a new mineral even written. V. M. Goldschmidt was widely acclaimed as one of the world’s greatest mineralogists and crystallographers. The
discovery of benitoite is significant, in that a scientific hole was now filled. The revelation of benitoite provided a real example of a unique crystal species that had never been found until this discovery.

The original mine for benitoite in San Benito County, California comprised a patented mining land tract of 40 acres. The claim remained in the hands of R.W. Dallas until 1987, when William Forrest and Buzz Gray leased the property for 20 years before purchasing the site in 1987. Forrest and Gray sold the mine in 2001 to Bryan Lees of Collective Edge Minerals and the Benitoite Mining, Inc. of Golden, Colorado. Lees is famous for his discovery of the Sweet Home mine near Alma, Colorado, where world-class specimens of rhodochrosite have been extracted. To work the benitoite mine, Lees, President of the Benitoite Mining Company, brought heavy excavating equipment to help rediscover the Level 2 main vein, the extension of the historic deposit. Lees also installed a screening and washing processing plant, including a magnetic separation process. Since benitoite is the only mineral dug from the mine that does not contain any iron, the magnetic separation attracts everything else and allows a 100% recovery of the benitoite unearthed. Although the Benitoite Gem Mine was closed and reclaimed in June 2005, the Benitoite Mining Company has collected a significant stockpile of faceting material.

The largest faceted benitoite on record is a 15.42-carat cushion triangle, followed by a 10.87-carat round and a 10.47-carat kiteshape. Since 2002, all benitoite gems have been faceted by Ben Kho of Decatur, Georgia. Before 2002, most of the benitoite gems were cut by Buzz Gray and Michael Gray. The market for benitoite melee was developed by Paul Cory (Iteco, Inc. of Powell, Ohio) and Eric Braunwart (Columbia Gem House, Inc. of Vancouver, Washington). Iteco, Inc. has showcased at the Tucson Show the color variations of benitoite in calibrated sizes of rounds and squares intended for jewelry sets.

In 2005, Bryan Lees sold the benitoite mine to Dave Schreiner, who wanted to open the site to rock hounds and gem hunters. On one particular night, Schreiner was hunting for benitoite with an ultraviolet light at the mine. Benitoite glows bright blue under a black-light, (and so do some scorpions!), and Schreiner spied a gorgeous gemmy crystal that weighed 34.7 carats. Master facetor Ben Kho cut the crystal into a fabulous gemstone that weighs 8.05 carats. Benitoite became the official state gemstone of California in 1985.

I have faceted one benitoite. At a Tucson Show many years ago, Steve found a sizeable crystal on matrix that yielded a cut round gem of 0.42-carat. Although the finished gem contained inclusions of natrolite and neptunite, the color of this dazzling gem appeared like blue velvet. I recently checked the historical prices for benitoite and found that the carat prices for benitoite had not changed much in the last several years. At the 2010 Tucson Show, Iteco, Inc. told me that their availability of benitoite had diminished.

The Benitoite Gem mine is open to the public every weekend. Mine owner Dave Schreiner’s website is: www.calstategemmine.com for fee-dig information. He related to me that they had dedicated a room for using black-lights to locate the benitoite crystals from the mine diggings.

(Sources for this article include: Si & Ann Frazier for the November, 1990 issue of Lapidary Journal, the Fall, 1997 issue of Gems & Gemology, JCK, Bob Jones for Rock & Gem, and Colored Stone.)
Light Return from the Girdle: Part II
by Glenn Klein

Part one of this article was in the March 2011 USFG Newsletter (the last one). The CZ round multicolored stone Starburst picture included here should have been shown along with the STARBURST design that is in the March issue. The P2 facets are floating facets and the P3 as well as CA facets are large. The table is also a large 70%. This was all done so that the facets near the girdle could be more important. The many spectrums of color that are shown in this picture are multiplied. This round STARBURST picture only shows one view, but the flashes are all over the stone as it moves or you move.

Next in my experiments I stretched the round stone into an oval shape and arrived at the design I call STARBURST OVAL, stone picture and design are shown in this Newsletter. To actually see the results in a finished stone, I cut the design in a medium yellow piece of Cubic Zirconia. The results turned out very good. The gem is very flashy, a sparkling beauty from any angle of the crown. On this piece of CZ, I used the angle of thirty-one degrees for the closing culet facets that are at indexes 24 and 72. That is just three degrees above the critical angle of CZ (28 degrees).

To carry the experiment a little further, I cut another piece of CZ that is of a medium to dark pink color, almost looks like Kunzite. This time I used the design I call STARBURST OVAL 10 (included with this article). Here I used closing culet facets at indexes 24 and 72 by using the angle of thirty-four degrees (six degrees away from CZ’s critical angle of 28 degrees). By looking at the pictures of the pink and yellow stones you can see that different results are shown. The Horizontal pink stone picture is being lighted only from the top 12 O’clock position. The Vertical pink stone picture is being lighted only from the top 12 O’clock position, which means most of the light illuminates the top half of the stone. You may notice that there are two dark black facets pointing towards the long sides of the stone. This makes the vertical stone picture look like it has a face looking back at you. I see two eyes, two ears, a nose, and a beard…oh well, I sometimes get carried away so don’t mind me.

I took these pictures about two feet away from my master bedroom window on a sunny morning, when the direct sun rays were at the opposite side of my home. That is the only lighting I used. So, the gems are being illuminated with light from the side nearest the window and at an angle towards the crown. I made a jig that I used to use for taking pictures of gem inclusions through my microscope. Darn it, I sold the microscope. Now I still attach my Nikon D40x camera and 60mm lens to the jig in order to take gem pictures. I can raise or lower the camera. I do have a 4” by 4” white piece of light weight cardboard covering my lens. That cardboard has an approximate ¾” hole in its center. The camera shoots the picture through that small hole while the white cardboard reflects any room light into the crown/table of the gemstone. The gem simply rests in a small round plastic gem container to hold it in position.

Try it. Cut and enjoy.
**STARBURST OVAL**

By Glenn Klein

Angles for R.I. = 2.160

65 + 16 girdles = 81 facets

2-fold, mirror-image symmetry

96 index

L/W = 1.500  T/W = 1.061  U/W = 0.707

P/W = 0.538  C/W = 0.162

Vol./W³ = 0.418

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**PAVILION**

1  42.03°  96-48  Cut to center meet point.

   37.45°  09.0-39.0-  57.0-87.0

   31.00°  24-72

2  43.71°  02.7-45.3-  50.7-93.3

   42.11°  05.6-42.4-  53.6-90.4

   36.65°  13.1-34.9-  61.1-82.9

   34.06°  18.2-29.8-  66.2-77.8

3  52.31°  04.1-43.9-  52.1-91.9

   44.40°  15.5-32.5-  63.5-80.5

4  54.44°  96-48

   49.93°  09.0-39.0-  57.0-87.0

   43.00°  24-72

G1  90.00°  04.1-43.9-  52.1-91.9

   90.00°  15.5-32.5-  63.5-80.5

   90.00°  96-48

G2  90.00°  09.0-39.0-  57.0-87.0

   90.00°  24-72

**CROWN**

A  46.25°  04.1-43.9-  52.1-91.9

   38.32°  15.5-32.5-  63.5-80.5

B  43.03°  04.1-43.9-  52.1-91.9

   35.24°  15.5-32.5-  63.5-80.5

C  50.54°  96-48

   45.91°  09.0-39.0-  57.0-87.0

   39.00°  24-72

T  0.00°  Table

---

Use your good judgement to make stone look like the design

P2 are floating facets. P3 & CA facets are large. Table large 70%

Angles shown are for CZ critical angle of 28 degrees

C:\Documents and Settings\Glenn Klein\My Documents\My Pictures\GEMCAD DESIGNS\STARBURST OVAL.gem
STARBURST OVAL 10
By Glenn Klein
Angles for R.I. = 2.160
65 + 16 girdles = 81 facets
2-fold, mirror-image symmetry
96 index
L/W = 1.500  T/W = 1.061  U/W = 0.707
P/W = 0.604  C/W = 0.162
Vol./W³ = 0.447

PAVILION
1  45.34°  96-48
   40.69°  09.0-39.0-
        57.0-87.0
   34.00°  24-72
2  47.02°  02.7-45.3-
       50.7-93.3
   45.42°  05.6-42.4-
       53.6-90.4
   39.87°  13.1-14.9-
       61.1-82.9
   37.20°  18.2-29.8-
       66.2-77.8
3  55.47°  04.1-43.9-
       52.1-91.9
   47.71°  15.5-32.5-
       63.5-80.5
4  57.51°  96-48
   53.15°  09.0-39.0-
       57.0-87.0
   46.31°  24-72
G1  90.00°  04.1-43.9-
    90.00°  52.1-91.9
   90.00°  15.5-32.5-
    63.5-80.5
   90.00°  96-48
G2  90.00°  09.0-39.0-
    57.0-87.0
   90.00°  24-72

CROWN
A  46.25°  04.1-43.9-
   52.1-91.9
   38.32°  15.5-32.5-
       63.5-80.5
B  43.03°  04.1-43.9-
    52.1-91.9
   35.24°  15.5-32.5-
    63.5-80.5
C  50.54°  96-48
   45.91°  09.0-39.0-
    57.0-87.0
   39.00°  24-72
T  0.00°  Table

Use your good judgement to make stone look like the design
P2 are floating facets.  P3 & CA facets are large.  Table large 70%
Angles shown are for CZ critical angle of 28 degrees
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How To and What For #30

by Art Kavan

Several fellow faceters and I have been cutting large (50 mm plus) stones for several years now, spiders, bats butterflies and so on. Billy Bob Riley came up with an idea to cut what he called a shadow spider and I cut one the same time he did. The idea was to cut frosted facets with a polished spider on the bottom and another set of polished facets with a frosted spider on top. In other words it would look like a shadow spider. He called me and said he would like to come over and show me his cut spider, he didn’t know I had cut the same thing. When he got to my shop we had a good laugh as we both made the same mistake. Neither one of us took into consideration the magnifier effect of the polished top as it made the bottom spider about 25% larger than the top. They look pretty good but will look a lot better by cutting the bottom spider 25% smaller next time.

I was also obsessed with cutting a Kate Middleton look alike ring. I wrote Gerard’s of England to try and get the size of the blue sapphire with no return answer. I went with what I could see and ended up cutting four of Jeff Fords oval one 14X12 one 13X9 and two 12X10’s. After the experience I believe the correct L/W is either 1.27 or even 1.40. Anyway the only similar ring I could find was a Stuller with 14 three millimeter diamonds around a 12X10 oval and that is what I went with even though it cost around $300 in white 14kt gold. A customer saw the ovals and wanted a red one so I cut that one out of raspberry ruby.

This will be my last article as I have not missed a newsletter in seven and a half years. I have had cancer since 2005 with five years of Chemo and 57 radiation treatments on my head. I will start radiation on the head again next week because of five new tumors and am doing chemo every three days. I am doing OK as most pass away in the first three years and only 20% make it to five. My cancer is called Mantle Cell Lymphoma and is consider non curable.

Editor’s Note

Art, I am sure the entire USFG membership joins me in wishing you continued success with your battle against cancer. We are also most grateful for all of the contributions you have made to the USFG over the years. We certainly hope that you’ll be back in the future with How To and What For #31.

In Deepest Appreciation...

– L. Bruce Jones
A Historical Perspective: Improvised Faceting
by Fred Van Sant, 1981

Until I attended the Tucson Show this year, I called the kind of work I am about to describe "Freehand Faceting." But, at that show I saw the beautiful work done by Gerhard Becker of Idar-Oberstein, which he called "Freehand Faceting." It consisted of holding the stone in the hand without any supporting or positioning device and cutting, and polishing all the facets by eye and hand skills alone. As you might guess, the stones were quite large and cut from quartz. I can conceive of such fine work as displayed by Mr. Becker being done only by a very talented person possessed with infinite patience.

"Improvised Faceting," which is what I now call a way of cutting that makes use of standard faceting machines and all accessories, is done without using any preconceived pattern or design. The design, angles and indexing are improvised as the cutting progresses. It can be done by anyone past the beginners stage.

Improvised Faceting has several advantages and no drawbacks. It may take a little longer sometimes to cut a stone, but the extra time is spent on a more creative and exciting project. Improvising allows you to get the largest sized stone possible from a piece of rough, and the finished gem is unique and totally your own creation. In my own experience thus far, I have not had a bad stone, a spoiled stone, or one that did not stand up well against most gems cut from predetermined designs.

With rare exceptions, I cut the pavilion first. I grind a flat spot where I want the table and attach a dop. With the dop parallel to the lap (90 degrees), I cut away the flaws and thin projections, then look at the general shape. By "shape" is meant the outline of the stone as seen looking directly at the table or culet. If the shape is nearly symmetrical I will round off the stone to a symmetrical shape, and if not, I will round it off to a pleasing baroque shape. The shape may be anything you wish—with flat sides, curved sides, or any combination of the two.

If the stone is for show purposes only, you may omit the girdle, or allow it to vary in thickness. Because I'm often in doubt as to the gem's eventual use, I aim for a standard girdle, the plane of the girdle being parallel to the table and the girdle having uniform thickness. If there are curved sections in the shape, you should mark three girdle lines in the area where the girdle will be. Make these lines very close together, so that if you find you need to cut past one, or even two, you will still have at least one line left as your guide. Never use a pointed metal marker; the marking device described at the end of this article has proven satisfactory, however.

If the shape consists of all flat sides, you may establish the girdle by "girdling" the stone. This consists of cutting a set of facets at the same angle setting, using the same indexing as for the girdle facets, end to end all around the stone. If the last facet cut does not meet exactly with the first one cut, adjust the cheater and repeat the entire process until the meet is perfect. In cutting the pavilion, I usually girdle the stone at about 52 degrees, and work from girdle to culet. The reason for doing it this way is that you don't know at this point whether the culet will be a point or a line, where it will be located, or what angles and indices will be used, while an established girdle line is a known area from which to work. I chose 52 degrees to avoid a deep pavilion which traps light.

You have now rounded-off your stone at 90 degrees and brought it to pre-polish stage (or the 1200 grit diamond lap), and marked three girdle lines or girdled the stone. Before proceeding, a few general principles should be kept in mind: Don't get too elaborate. Keep the number of facets appropriate to the size of the gem—fewer for small stones, more for large ones. Long flat sides are more difficult to break up - you may need to cut the girdle facet at 56, 60, or even 65 degrees, depending on how long it is, but if you plan to cut a step pattern you will cut all girdle facets from the same angle setting. Keep A LOG of all facets cut, so you can get back on them for fine grind and polish. Also, make a diagram 3"-4" in diameter, and sketch in the facets after cutting each set. A 120 index gear is best for improvised faceting, as it gives the most options. If the shape is symmetrical, orient the stone to the zero point of the index gear so that when zero is at 12 o'clock or 6 o'clock position, right and left side indexing mirror each other. If the shape is baroque, set the stone so that the index reads zero when the longest side is parallel to the lap. With baroques, after you finish the pavilion and transfer dop, make a new sketch with left and right sides reversed, and mark in new indexing for the crown (see Fig. 1).

Try to avoid index settings and angles which are close together when you cut your first few improvised stones. Keeping them well apart will give you greater leeway in the choice of indexing and angles, and also reduces the problem of overcutting facets or controlling their
shape. In cutting and logging, I find it easiest to key all the facets of a set to the one facet in that set which lies closest to the center of the dop axis; this will be the facet with the longest side if the dop is centered on the stone. However, in cutting baroques it sometimes happens that a side other than the longest one is closer to the center of the dop axis, in which case it should be set to zero on the index gear, as it will be your key facet. When you cut the key facet to an angle, then cut all the other facets of the set by changing the index only, the angles of the other facets may be slightly higher, but never lower, than that of the key facet. By cutting all the facets of a set not at the same angle, but at the same machine angle setting, you save yourself a lot of work and time, and by keying a set to the key facet, you never get culet facets below the critical angle. To get back on any facet of a set, locate the key facet, then re-index. In logging, mark your key facet index and angle, followed by the indexing of the other facets of that set. (Example: Index 120 @ 52 degrees--14-40-51-80-102.)

While improvised faceting is spontaneous, there are basic patterns of facets which you will draw. As shown in Fig. 2, these are:

**The Bar Pattern**—These are parallel bar-shaped facets. When parallel to the girdle, they are called step cuts; the emerald cut is a step cut done on the emerald shape. Bars may also be cut vertically on the pavilion, as in author's Bar-X Cuts, or in any direction on the crown. Bars cut at a slant result in the pinwheel type cuts.

**The Staggered Pattern**—Here the indexing of one set of facets splits the indexing of the set just higher or lower in angle, as in the crown of the Portuguese Cut. (You'll find this cut on page 364 of the December 1952 Lapidary Journal Magazine; on page 137 of the book, Faceting for Amateurs by Glenn and Martha Vargas; and as Cut No. 6 in The Book of Gems Cuts, Volume 2, from M.D.R. Manufacturing Company).

**The Fan Pattern**—Several wedge-shaped facets fan out from a single point, as in the crown ends of The Birdcage Cut (see Page 31, Gems and Minerals, February 1965 or Cut No. 2 in The Book of Gem Cuts, Volume 3); or on the crown of Afton Giacomini's Tri-Fan Cut (see page 27 of Afton's book, Trophy Winning Facet Cuts or her article on page 27 of the September 1968 issue of Gems and Minerals.

**The Angled Pattern**—Two facets angle diagonally across another facet and meet, as in the crown of the Scissors Cut (see page 120 of the June 1949 issue of Lapidary Journal, Page 154 of Faceting for Amateurs by Glenn and Martha Vargas, or Cut No. 16 in the M.D.R. Book of Gem Cuts, Volume 2); the culet facets of the Mitchel Six-Ray Star Cut (see Cut No. 9 in the M.D.R. Book of Gem Cuts Volume 1) or the crown girdle facets on the Standard Round (see page 16 of Facet Cutters Handbook by Edward J. Soukup).

The combination of these four basic patterns in different ways has produced nearly all the designs ever printed. Often the shape of your stone, or its appearance after the girdle facets have been cut, will suggest where to make the next cuts. Continuing now with your pavilion, if you feel too unsure and this is your first try, you may wish to cut a simple step-cut on a baroque shape. If you want more challenge, try a staggered pattern on a baroque shape, as follows: With the rounded-off stone brought to prepolish, and girdled at 52 degrees, cut your second set of facets at about 46 degrees, splitting the indexing of the girdle facets. Then cut a third set of facets at 41 degrees (add 2 degrees all around for quartz), which split the indexing of the 46 degree set, and which may or may not be the same indexing as the girdle facets. Let the culet assume whatever form the 41 degree facets give it. As you get more experienced, you will learn how to adjust the facets during cutting so that their points meet. On the facets that correspond to the pavilion mains, be sure that you do not go below the critical angle. Various books on faceting recommend angles for the various sets of facets, including the pavilion mains, which are based on the refractive indexes and critical angles. Some books, such as Faceting for Amateurs, list the critical angles for various gem materials. Books on gemology also cover these subjects.

For the crown you can also use the staggered pattern. Try the crown girdle facets first at about 48 degrees; if you need to lower the angle later, you can.

Remember, you can always cut away more stone, but you can’t put it back on. Don’t worry about how it will look—almost any stone that has the right number of facets for its size, and that is well polished, will look good when finished, so you should get a nice gem out of this effort.

Don’t let the published designers have all the fun. Most designers avoid shapes which are non-symmetrical or difficult to duplicate, but which are the real meat for the improvisor. So, dop a piece of synthetic rough or quartz and wade right in. You can try improvising on an oval preform, but the perfect round, cut-corner square, and marquis shapes are so worked-over that they don’t offer much chance of coming up with something original. An unusual shape helps get you off the beaten track. Dare to be different, and put a few stones in your showcase that no one has seen before, or make one into a ring that will attract the attention of everyone who sees it.

Happy Improvising.
Firelogo
A Design by Tom Schlegel, Submitted by Lisa Elser

Firelogo
Tom Schlegel, January 2010
Modified Dan Clayton design, Thank You Fred
Angles for R.I. = 1.760
77 + 16 girdles = 93 facets
4-fold, mirror-image symmetry
96 index
L/W = 1.000  T/W = 0.129  U/W = 0.129
P/W = 0.414  C/W = 0.165
Vol./W² = 0.206

PAVILION
1  38.00°  03-09-15-21-  TCP, CAM outline
    27-33-39-45-  51-57-63-69-
    75-81-87-93
2  90.00°  02-22-26-46-  Set stone size, unlevel
    50-70-74-94  girdle
3  90.00°  07-17-31-41-  GMP, set stone shape
    55-65-79-89
4  54.03°  07-17-31-41-  GMP, level girdle
    55-65-79-89
5  54.89°  02-22-26-46-  Level girdle
    50-70-74-94

CROWN
a  38.37°  02-22-26-46-  Establish girdle, level
    50-70-74-94  girdle
b  40.35°  07-17-31-41-  Level girdle
    55-65-79-89
c  30.00°  04-20-28-44-  GMP
    52-68-76-92
d  14.55°  12-36-60-84  Meet c-b-b-c
e  22.70°  02-22-26-46-  Meet apex a
    50-70-74-94
f  13.87°  06-18-30-42-  Meet e-c-d, optionally
    54-66-78-90  FROST
T  0.00°  Table  Meet f-d-f, optional if
don't frost to eliminate dark eye

 Optionally frost the crown maltese cross.
The very small table helps with the apex dark "eye" if you don't frost.
Y:\Gem\Facet_Designs\gemcad\firelogo1.gem
Gemology for Faceters #6

In the March issue we discussed the importance of specific gravity (Gemology for Faceters #5) in identifying gemstones. Previously in the series we have talked about gemological instruments in general (#1), the refractometer (#2), the spectroscope (#3) and the microscope (#4). In this installment (#6), we’ll discuss the polariscope.

The gem instruments have been presented in what I consider to be the general order of their usefulness. For most gemologists, the refractometer is the first step in identifying a gem and with experience, it provides a great deal of information: refractive index, birefringence, optic sign and character and dispersion information can all be obtained as well as information on gem orientation.

The polariscope is a simple and relatively inexpensive instrument and one you could make yourself if you were so inclined. With it you can make some straightforward determinations of the optical character of the material but it also has the advantage, for a faceter, of assisting you in determining the location of the optic axis or optic axes of a stone. (Remember that uniaxial doubly refractive materials have one optic axes while biaxial materials have two).

With a polariscope you can determine whether a material is singly refractive (e.g. glass, garnet, spinel, diamond), doubly refractive (e.g. corundum, beryl, quartz) or a microcrystalline aggregate (e.g. chalcedony). It can also show strain or twinning, known as anomalous double refraction (ADR). The polariscope is only effective on transparent to translucent gems. Light must be able to pass through the gem in order for the polariscope to provide you with any information.

One potential advantage the polariscope does have over the refractometer is that it can be used with a gem of any refractive index. It is not limited to stones with R.I.s typically less than 1.81, like is the refractometer. However, some stones that are over the limit (OTL) do give misleading results so in the case of a doubly refractive material you should confirm by looking for doubling of the back facets through a microscope.

Using the Polariscope

1. First, turn on the unit and cross the polarizers so when you look down through the analyzer the field of view is dark.

2. Place a stone on top of the polarizer and under the analyzer. Generally, just placing the stone on top of the polarizer works best but you can hold the stone in your fingers.

3. Now, rotate the stone through 360 degrees.

4. If the stone remains dark throughout the rotation, the stone is singly refractive (SR). Test it in three orientations to make sure you are not looking down the optic axis of a doubly refractive stone. If it stays dark when you perform the procedure in all orientations, it is SR.

5. If the stone remains uniformly light throughout the rotation, the stone is a

An Eickhorst M4 Polariscope. Two strain-free glass spheres are shown and are used for conoscopic observation.
crystalline aggregate, like microcrystalline quartz (e.g. agate, chalcedony, carnelian, etc.)

6. If the stone clearly and consistently blinks from light to dark (generally four times) throughout the rotation, the stone is doubly refractive (DR).

7. If the stone does not blink consistently, if it shows snake-like bands or crosshatched or patchy patterns as it is rotated, the stone is showing anomalous double refraction (ADR). This means the stone may be strained, like in garnet, spinel, amber, plastic or glass, or it could be twinned (e.g. feldspar, amethyst)

Confirmation Test

If you received a clear SR or AGG indication, you do not need to do a confirmation test. However, if the stone is ADR or DR, you should confirm in the following manner:

1. Cross the polarizers so no light is visible through the analyzer. Place the stone on the polarizer and then block as much extraneous light as possible with your fingers or by placing a black piece of opaque paper under the stone.

2. Rotate the stone so that it, or a given area of the stone, appears as light as possible between the crossed polars.

3. Now, quickly turn the analyzer 90 degrees to the uncrossed position while simultaneously observing the light part of the stone.

4. If the stone looks obviously brighter it is singly refractive (SR).

5. If the stone stays the same or looks darker, it is doubly refractive (DR).

Precautions/Limitations

- You can only test transparent to translucent stones on the polariscope.

- Examine the gem in three different orientations to make sure you are not looking down an optic axis.

- Stones that are heavily fractured or included, along with strained and twinned stones, may give an erroneous reaction. Some culprits are garnets, glass, plastic, amber, synthetic spinel, amethyst and feldspar. If you are not sure, use the microscope, refractometer and dichroscope to confirm.

- Don’t put over the limit (OTL) stones table down as the pavilion facets will reflect back to the polarizer and the stone will appear dark. Place OTL stones on their sides instead.

- Very small stones can sometimes be difficult. Using magnification may sometimes help.

Resolving Optic Figures

When you add a converging lens to a polariscope you get what is called a conoscope, a device used to resolve interference figures and to determine optic character. A small strain free glass sphere on the end of a small handle is generally what is used with a polariscope. It is held just over the stone, between the polarizer and the analyzer. One can also use a 10x loupe over the stone but your eye must be placed 18 inches from the loupe.

It must be said at the outset that this is a bit of a difficult technique to learn and requires practice. Familiarity with the technical details of optical mineralogy is of significant help.

1. Cross the polarizers to obtain the dark position.

2. Holding the stone in your fingers look for an optic axis direction which can be found by looking for interference colors.

3. Use your sphere at the position where there is the highest concentration of interference colors.

4. The colors indicate that the optic axis is approximately parallel to the light path which is the ideal condition. If you cannot see the figure, flip the stone 180 degrees and look for the optic figure again.

5. You can also follow the brush by finding the blinking extinction pattern and then placing the sphere on the narrow end of the brush.

6. If you still can’t find an optic figure, try touching the sphere to all parts of the stone while you turn it.

7. Place a drop of water or oil on the sphere or you can also immerse the stone in a liquid that approaches its refractive index.
A normal uniaxial interference figure appears like a black cross with concentric circles of interference colors.

Because of the enantiomorphous nature of quartz, quartz has a unique bullseye uniaxial optic figure.

When you see the center of the cross, you are looking straight down the optic axis. This could be helpful if you are looking to orient a piece of rough for faceting.

Remember that while uniaxial stones have one optic axis, biaxial stones have two.

A biaxial optic figure that looks like a cross will show two areas where there are concentric isochromes (colored circles). The dark brushes are called isogyres and where the concentric circles and the isogyres meet is the melatope. There are two melatopes in biaxial minerals that correspond to the centers of the optical axes.

Turning the interference figure will cause the melatopes to separate. the amount of separation being dependent upon the mineral’s 2V.

Optic Sign

It is also possible to determine whether the uniaxial or biaxial mineral is positive or negative in sign. This can be done with a retardation plate. That determination is most often best made with a refractometer instead, but it can be done with the polariscope in conoscopic mode and using an appropriate retardation plate.

Pleochroism

While a dichroscope is a better choice for detecting pleochroism because two colors can be seen simultaneously and compared, pleochroism can be observed with the polariscope by setting the filters to their uncrossed “light” position and then rotating the stone and observing the color differences. The colors will change to their maximum difference in 90 degree increments of rotation.

Conclusion

The polariscope represents a significant tool for the gemologist and can be quite helpful to the faceter as well.
Quantification of Optical Data: Geology vs. Gemology

As gemologists, our ability to use a critical angle refractometer to determine the optical characteristics of a gem are quick and painless compared to what a geologist must endure to determine the same qualities in a sample. I thought that I would take a brief moment to explain the process.

A geologist takes a hand sample and first grinds it and then sieves it to prepare a sample of the appropriate size grains, typically about .01 mm. If the sample is not mono-mineralic then density and or magnetic separation techniques are employed, as is washing, to eradicate dust and contaminates.

The prepared sample grains are sprinkled on a slide, immersed in RI oil and placed on the stage of a petrographic microscope (complex and expensive) where they are examined, typically with objectives designed for oil immersion and minimum working distances. In the case of an isotropic substance the grains will have a given relief based on the difference between the RI of the oil and the RI of the sample. The relationship between the two can be determined by the becke line technique, in conjunction with relative relief, and new samples on a slide are immersed in a new oil to approach a match in RI. Oils cover the range from 1.4 to 1.8 in RI in increments of between .002 and .005.

When the sample is anisotropic, the situation gets interesting. Given a sufficient number of grains in random orientation the two definitive RIs for uniaxial, and the three for biaxial, samples can be measured. Using the microscope with conoscopic configuration and crossed polarizers and rotating the stage to achieve extinction positions one can use interference colors and interference figures in conjunction with an accessory plate to determine the optic sign and 2V. Once grains representing the 2 or 3 indices are discovered, using the above techniques, then the immersion oil-grain matching process continues to identify the requisite RIs to describe the sample. The procedure is time consuming and complex and the equipment is expensive - but you do come away with a complete knowledge of optical mineralogy and such things as the Bxa, Bxo, isogyres, melatopes, 2V, 2e, and six different types of dispersion.

Ironically, using the powder method with an x-ray diffractometer and sample grains of slightly smaller size will produce identification data when compared to a database in about 20 minutes - far quicker than the optical procedure described above. In addition, the sample need not be mono-mineralic as constituents of a mixed sample can be identified just as quickly. Single crystal methods are better used for determining the details of crystal structure but for identification, powder diffraction rules.

Structural crystallographic date will not suffice in describing a gem species when there are solid solution series issues (e.g. feldspar, garnet, olivine, etc.) complex compositions (toumaline) or where other trace element determination data are required for geologic provinance (origin) studies or transition metal cation data as chromophore constituents. Non destructive testing methodologies include my favorite, electron microprobe analysis, where samples down to just a few microns in size can be quantitatively analyzed (including gemstone inclusions exposed by grinding and polishing and then carbon coated) as well as a host of more destructive techniques, (mass spectrometry, neutron activation analysis, etc.) albeit many with small sample size requirements. Results are typically shown in terms of the metal elements in weight percent of oxide form including water and other anions.

All this is only to say that there is a whole analytical world beyond gemology from which one can learn much and fully indulge one’s self in more elaborate forms of exotic equipment, detailed determinations and the satisfaction of taking understanding to the next level.

– L. Bruce Jones
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<td>Faceting accessories at discount prices and select faceting rough. Also slabs, cabbing and carving rough, cabochons, beads and more! Visit our new warehouse at the Tucson Show. Web: <a href="http://www.color-wright.com">http://www.color-wright.com</a> E-Mail: <a href="mailto:rk2@color-wright.com">rk2@color-wright.com</a> Tel: (toll-free) 877-548-1439</td>
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<td>Author, Historian, Competition Faceter. To learn about Faceting History, what equipment was used and what methods were used through the centuries in fashioning diamonds and faceting colored stones, check my website to get information for ordering my new book: <em>Faceting History: Cutting Diamonds &amp; Colored Stones</em>. Web: <a href="http://www.glennklein.com">www.glennklein.com</a> E-Mail: <a href="mailto:glennklein@yahoo.com">glennklein@yahoo.com</a></td>
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<td>Jonathan L. Rolfe: Gearloose</td>
<td>Online articles illustrate how to build your own laps, faceting machines, digital angle readouts for existing production machines. Some examples of Jon's gem cutting appear &amp; information re his BATL Lap. There are links to other gem cutting sites and organizations. Web: <a href="http://www.gearloose.com">http://www.gearloose.com</a> E-Mail: <a href="mailto:USFG@gearloose.com">USFG@gearloose.com</a></td>
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<td>John Kilian: The Kilian Collection</td>
<td>“We sell faceted gemstones, gem rough, mineral specimens, jewelry and decorator pieces. The site features specimen picture galleries and a picture chronology of my faceting activity.” Web: <a href="http://www.kiliancollection.com">http://www.kiliancollection.com</a> E-Mail: <a href="mailto:info@kiliancollection.com">info@kiliancollection.com</a> Tel: 206-963-9065 or 520-229-3209</td>
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<td>Paul Head: GemCadWin Tutorial</td>
<td>The file is in PDF format, consisting of 116 pages and 240 figures. If sent as an email attachment the price is $50.00. If sent as a CD by surface mail the price is $55.00. Pay by check, cash, or money order. Free on line assistance will be available for registered buyers. E-Mail: <a href="mailto:dnhpah@cox.net">dnhpah@cox.net</a></td>
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Dues and Newsletter Policy

Membership cards are no longer being issued. Need to know when your membership expires? Your membership expiration date will be within the email containing your newsletter notification.

All members receiving a DUES DUE issue will receive one more complimentary issue bearing a FINAL REMINDER notation.

For ALL members who elect not to renew their membership (and death is really the only acceptable excuse), the FINAL REMINDER will be your final issue.

The USFG Newsletter is a quarterly publication of the United States Faceters Guild, published in March, June, September and December. It is delivered by email only, to all paid members of the Guild. Membership dues are an incredibly reasonable $18 per year (USD) and are payable to the USFG Treasurer.

Please help us grow the organization by recommending membership in the USFG to fellow faceters.

Opinions expressed are those of the editor, contributing members, or quoted authors, and do not necessarily represent the United States Faceter’s Guild or its membership.

The newsletter is for the express purpose of sharing information with the members and other faceting guilds, and has no intent to show preference to, or cause damage to, any person, group, product, manufacturer or commercial company.

Newsletter Submissions

Correspondence concerning the content of the newsletter, exchange bulletins and newsletters should be sent to the editor. Items submitted for publication in the newsletter should be sent to the editor as well. The e-mail address for the editor is: bruce@gemscientist.com

We’re always looking for new ideas and contributions to the content of the newsletter, so if you would like to make a suggestion or a submission, please e-mail the editor.

Please try to submit newsletter items no later than the 20th of the month preceding the publication date.

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A warm welcome to our latest members:

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Robert Padgett
Mike Heini
Eric Hoffman
Bob Carrier

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USFG Website

http://www.usfacetersguild.org/
UNITED STATES FACETER’S GUILD
Application for Membership

Membership to the USFG is open to faceters or people interested in faceting everywhere. Our primary goal is to improve the art and science of faceting through our newsletter and correspondence. Our secondary goal is to improve competitions and competition rules both in the US and internationally. Officers are elected every two years for 2 year terms, taking place in even years. Members will receive our Quarterly Newsletter - usually about 20 pages each, and the right to participate in the USFG activities. The By-Laws of the USFG may be reviewed at our website.
http://www.usfacetersguild.org/docs/USFGbylaws.pdf

Name ________________________________________________________ Date _________________________
Street Address _________________________________________________ Telephone ____________________
City, State, Zip ________________________________________________ E-mail _______________________

I am interested in becoming a faceter ______ I have been faceting for_________ yrs
I have a display case ____ 12 stones ____ 20+ stones ____ Educational ______ Other _______________
Competition experience/ Certifications: Junior_____ Novice _____ Intermediate/PreMaster _____ Master ______
Which machine(s) do you cut with? _________________________________________________________
Do you cut commercially? ____________________________ Are you a dealer? ______________________
Have you given talks or written articles on faceting? _____________________________________________
Special talents or interests to share? __________________________________________________________

Membership (all locations) is $18 USD for one (1) year - please remit US funds only. As a convenience members may choose to renew for multiple years at $18 per year.

Please make checks payable to the “USFG”
Mail this form with payment to:

USFG Treasurer
c/o Jeff Ford
2410 N 2nd St
Kalamazoo, MI 49009

Please feel free to copy or use the back of this form for additional information or special instructions.

Membership questions may be sent to  Jeff Ford or membership@usfacetersguild.org

Please circle one

New Membership
Renewal
Returning Member
USFG Single Stone Competition – Cutter Entry Form

Please include a signed copy of this form with your stone, return packaging and return postage. A 6” x 9” bubble padded envelope or box is recommended for return.
Please use a 1-1/8” clear stone cup if possible.

Mail entries to:
Jeff Ford / USFG
2410 N 2nd St
Kalamazoo, MI 49009

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The most common questions about the USFG Single Stone Competition:

1. This is a closed competition; cutters MUST be current members of the USFG. Membership application/fees/renewals may be submitted with the cutters entry.
2. This is a single stone event; one cutter, one class, one stone. Cutters may not enter multiple stones and/or classes.
3. Cutters may not enter stones in classes below prior certifications levels.
4. Cutters may challenge higher classes, BUT it is highly recommended that they have another cutter honestly evaluate their cutting skills before doing so.
5. The complete rules may be found at: [http://www.usfacetersguild.org/docs/CurrentSSCRules.pdf](http://www.usfacetersguild.org/docs/CurrentSSCRules.pdf)

<table>
<thead>
<tr>
<th>Entry Class (circle one)</th>
<th>Novice</th>
<th>Pre-Master</th>
<th>Master</th>
<th>Grand Master</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stone Data (if known)</td>
<td>Stone Size, mm</td>
<td>Stone Color</td>
<td>Stone Weight</td>
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<tr>
<td></td>
<td>Stone Species</td>
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| Entry (circle one)       | Anonymous Entry: Yes, I wish to enter as "Anonymous" Note: Scores still may be reported, but only identified as "Anonymous Entry" |
| Public Entry : Yes, I wish to have my name & score “Public” and reported as such. |

Note: All cutters (Anonymous or Public) will be entitled to receive awards and/or certification for qualifying scores. If NO selection is made above, it will be assumed that the cutter wishes to enter their stone as “Public”

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<th>Signature / Date</th>
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Your signature indicates that you accept the Rules & Conditions of USFG competition.