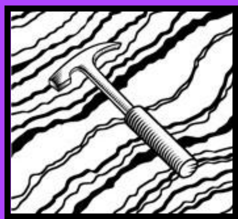
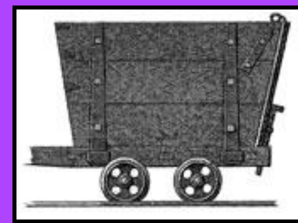
GemHunter – The Prospector's Newsletter





Vol 2, No 11, Nov-Dec. 2010 *Newsletter from the GemHunter*

DIAMONDS

I periodically receive email, photos, or vials of material from people wanting to know if they have diamonds. Over the years, only three out of hundreds of samples actually had raw diamonds. Although I did not see the stones, I was told diamonds were found in anthills in the Butcherknife Draw area of the Greater Green River Basin in southwestern Wyoming. Apparently 5 were found by a rancher from the Rock Springs-Green River area and a few years ago, one of my favorite people, Norma Beers who recently passed away, found a diamond in an anthill in that same region.

Almost the day I showed up for work as a new geologist at the Wyoming Geological Survey, a prospector contacted me about two crystals he had found in his gold concentrates from Cortez Creek. So I drove to Saratoga to see the crystals – they were gem-quality diamonds. These were found by Paul Boden and were beautiful gem diamonds.

The Boden diamonds. The source of these still remain a mystery, although other diamonds were recovered in drill core in this region. Samplers working on one of my grants recovered a few dozen samples containing pyrope garnets (possible diamond indicators). Other anomalies were indentified nearby by prospectors working in Douglas Creek and by companies searching for diamonds in the 1980s.

So how does one tell if they have a rough diamond? In my latest book (Hausel, 2009) I provide information on diamond identification and where these stones have been found in Wyoming. Diamonds have also been found or reported all over the US (Hausel, 1998; Hausel and Sutherland, 2000; Erlich and Hausel, 2002).

In this newsletter, we'll examine details about the mineralogy of diamond and provide a general fact list about identifying rough diamonds. Just remember, if you find a diamond that is worth a few $million, since I shared my knowledge with you, you can share your treasure with me. Just kidding. No I'm not, yes I am, no I'm not, yes I am. Well, you get the idea.

To be honest, I'm not interested in acquiring a percentage of other people's prospects – over the years I found several $billion in gold districts, colored gemstones and gold deposits and that was enough reward for me. I made nothing for any of these discoveries other than a salary or consulting fee. But having the honor of being the first to see these deposits and the honor of friendships I made along the way was enough. And that is more important than money – as soon as a lot of money is involved, greed seems to set in and friendships are lost.

When it comes to identifying diamonds in the rough, it is important to look at as many characteristics as possible. Sending photos is not a good way to identify a mineral or rock as there are no physical properties one can use, and most photos that prospectors send are not good quality. Photos are just two dimensional representations of a 3 dimensional object and retain no physical properties of the specimen - one cannot conduct scratch tests or view inside of these to search for mineral inclusions. So it is best that prospectors learn to identify diamonds themselves.

At one time, I looked forward to teach general prospecting classes and classes in prospecting for gemstones in Arizona and Wyoming. I found there was considerable interest, just a lack of interest by administrators in the various colleges and universities. I was even told by one administrator at the University of Wyoming that a class on *Geology of Gemstones* would be very popular; it was just that it could not be added to their curriculum due to faculty politics. However, I did teach a few classes in *Gold Prospecting* and *Diamond Prospecting Methods* through Extended Studies at the University of Wyoming and at prospecting associations and clubs, and geological associations. And these were always well attended.

When I was working for the Wyoming Geological Survey I often presented talks to various groups on gem and gold recognition and talks on geology which was a lot of fun, although most were given on my own time in the evening (I presented well over 400 talks). Now that I'm a consultant, I still get requests from groups to give talks – but please realize that I have to make a living and can no longer do this for free.

A 620-carat diamond that I photographed at Wiseman's Jewelry in Laramie.

Years ago I was invited by Scott Wiseman to stop by his jewelry store in Laramie to examine the largest uncut diamond in the world (at that time). It was being sent around the country for display by a few select jewelers. But imagine this, a 620-carat, priceless giant diamond was sent through US Mail by first class– it was not insured! Many large diamonds have irregular shapes as did this one.

Diamonds are making a comeback as people are again purchasing the gemstones. In 2008, the diamond market responded to the world economic crisis and took a nose dive. Many diamond companies surrendered to economic woes which included the Jericho mine in northern Canada and several other companies folded around the world, including the diamond exploration company I was consulting for.

But some survived. Today, much of the diamond exploration activity is focused on Canada (Hausel, 2007, 2008). And now that Canada is one of the more important diamond mining countries in the world, one might sit on Santa's lap and request a diamond made in Santa's workshop at the North Pole.

Personally, diamonds don't excite me much – it's their host rocks (kimberlite, lamproite, lamprophyre, eclogite, peridotite) I find fascinating.

Sketch of Santa's Workshop, where many diamonds will be coming from this Christmas.

About Diamonds

Diamonds are extraordinary minerals with extreme hardness sought for personal adornment and industrial use. Because the genesis of this unique mineral requires extreme temperature and pressure, natural diamond is very rare on the earth's surface. So rare that some diamonds are the most valuable commodity on earth when comparing price to weight. Diamonds have sold for >$1 million per carat!

We often hear how valuable gold is – and it is valuable particularly since the 110th and 111th Congresses and associated presidential administrations assumed they were voted into office to spend all of our money, our children's money and our grand-children's money and great grand-children's money. Instead of spending our money, they should spend their own (seems like politicians have more than enough money in their bank accounts; if only they would pay taxes, maybe the budget would balance). Now inflation is starting to jump on the bandwagon and the price of gold is taking off! It seems like it was just in 1971 that gold was selling for $35/ounce. It was! In 1971, the US went off the gold standard when I was just finishing up my BS degree in geology. Just recently, gold rose above $1400/ounce: 40 times higher than it was 40 years ago.

But diamonds put gold to shame. For instance, one diamond recently sold for >190,000 times an equivalent weight of gold! To me that's crazy, but some people have too much money. Wish they would donate it to my special charity (me) instead of paying too much for diamonds.

Today, diamonds are mined on several continents. Natural diamond production averages more than 110,000,000 carats annually and is valued at more than $7 billion for raw stones. Most raw stones are not worth much; it is the cut and fashioned stones that bring extraordinary prices. Diamond values dramatically increase after the stones are faceted and the value again increases by dressing them in jewelry, such that diamond jewelry may sell for >10 to 20 times the value of a raw stone – in other words, the original $7 billion equates to >$100 billion in value for a finished product. Not bad for a little crystal made of carbon. Industrial diamonds, which are considerably lower value, includes synthetic industrial diamonds. Synthetic industrial diamond production has an average annual value of around $1 billion per year.

Due to marketing promotions, many former industrial diamonds are now in great demand as fancy diamonds because of labeling. For instance, chocolate, cognac and champagne diamonds used to be considered industrial diamonds. But now, everyone wants a chocolate diamond. One has to wonder when the industry is going to promote wheat beer or corn whiskey diamonds for us red necks.

Because of extreme value, I had suggested to the Wyoming Geological Survey and Wyoming legislature that they should consider investing in exploration research and marketing (similar to Canada) of diamonds. Most people don't realize, but nearly 50% of kimberlites in Wyoming contain diamonds along with a lamprophyre breccia. Of the kimberlites and lamproites that supposedly do not have diamonds in Wyoming, few have actually been tested, so we do not know if they have diamonds or not. And another interesting fact: of the diamonds recovered from the Wyoming kimberlites, at least 50% were gem quality. Just to the south of Laramie, more than 130,000 diamonds were recovered during exploration, and one commercial mine operated for a very short time but closed due to legal problems rather than a lack of diamonds. This mine, Kelsey Lake, can be found on Google Earth along the Colorado-Wyoming border near Highway 287 (*40°59'38.55"N;105°30'14.52"W*).

Wyoming, Colorado and Montana could lie within a major diamond province, but we'll probably never know in our lifetime. It has been reported that it takes ~ $1.5 million per discovery of a kimberlite pipe (whether it contains diamonds or not) in Canada. In Wyoming, we worked with research budgets of $100 to about $10,000/year for diamond projects similar to Colorado State University. So do the math. The only reason why diamonds were discovered in Wyoming in 1975 was due to accident (McCallum and Mabarak, 1976). And the only reason that anything was done after the discovery, was because of Dr. Dan Miller Jr., who was the director at the Wyoming Geological Survey at the time – and he saw the potential importance, but could not shake much money out of the legislature. But with much less than $1.5 million, about 100 kimberlites were found in Colorado and Wyoming. Imagine how many might be found if these state's invested just 1/50th of what Canada invests.

So why should state government invest research funding for diamonds that would one day produce money for a private or public company? This is the concept of research and the concept of how research works at on the university level. Universities and certain government agencies are set up to do ground-breaking research. Few companies have money and time necessary to do initial grassroots geological research – companies focus on areas that already have been shown to have significant potential for commercial diamonds, and no one is going to pry companies away from Canada when thousands of kimberlites are being found. Canada realized how important the mining industry was to its well-being a long time ago, something the US developed amnesia about. Politicians and environmental groups seem to be more interested in importing everything from China, no matter how toxic the materials, or how much damage is caused to the environment. It is the ultimate act of hypocrisy. And we continue to talk about stopping global warming: possibly the greatest scam since the 1872 Diamond Hoax (I'll have to write about the diamond hoax in a future newsletter).

Mines produce a tax base, high paying jobs, research, affiliated industries and more. One of the better swimming facilities in the US was built several years ago in a little town of Gillette, Wyoming. Gillette, one of the driest high deserts in the US produced some of the best swimmers in North America. How could this happen in a town of only 20,000 in the middle of nowhere? Mining! Mining companies built the facility to give back to community of Gillette for the people's support of their operations.

Mineralogy

Diamond is formed of carbon; some of the same stuff you and I are made of. In fact, there is a company that will make us and our pets into diamonds.

In nature, native carbon may occur as one of the following polymorphs: diamond, graphite or lonsdaleite (Erlich and Hausel, 2002). The physical differences between these polymorphs are due to the different bonds between carbon atoms. In diamond, the coordination of the carbon atoms is tetrahedral with each atom held to four others by very strong covalent bonds resulting in a mineral that has extreme hardness.

In contrast, graphite has six-member hexagonal carbon rings which resonate between single- and double-shared electron bonds which produce sheets of graphite that are strong. However, the hexagonal rings are stacked on top of one another, just like mica and these sheets do not share electrons, only a residual electrical charge. Because of a lack of chemical bonds between sheets, this results in graphite being very soft and having sheets that are easily separated.

Frosted cubic raw diamond. Note how greasy this diamond looks (fact #1)– something that is characteristic of raw diamond.

Then there is an extremely rare hexagonal modification of diamond, known as *lonsdaleite*. This mineral has a closer-packed arrangement of atoms than diamond or graphite and also shares very strong bonds between atoms resulting in a rare mineral of extreme hardness (Lonsdale, 1971). Lonsdaleite was initially synthesized at temperatures greater than 1,000°C under static pressures exceeding 130 kbar (Bundy and Kasper, 1967). DuPont deNemours and Co. obtained the same transformation by intense shock compression and thermal quenching. Lonsdaleite has since been identified in meteorites and in rare unconventional host rocks: most notable being the Popigay Depression in Siberia (Erlich and Hausel, 2002). The extreme hardness of lonsdaleite makes it ideal for industrial grinding, but its rarity makes it unattractive for commercial use. It is reported to be at least 30% harder than diamond!

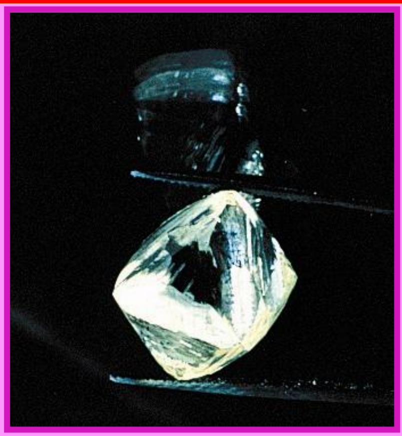
Crystal Habit

Diamonds are isometric (*fact #2*)and have high symmetry with common cubic, octahedral, hexoctohedral, dodecahedral, trisoctahedral and related habits. Twinning along the octahedral {111} plane is common for diamond. Often diamonds are flattened parallel to this plane which results in a diamond with flatten, triangular-shaped habit known as a *macle*.

Left, diamond in the rough – a macle found by diamond hunter Glenn Worthington from Murfreesboro, Arkansas. Photo by Glenn Worthington.

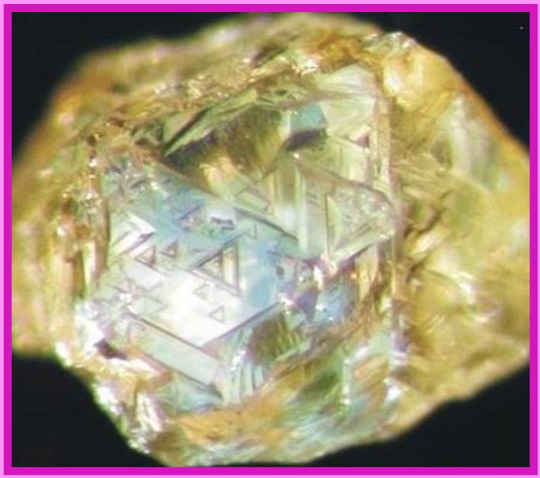
Cube. Cubes are a relatively uncommon habit for diamond. When found, these are primarily frosted industrial stones. Many diamond cubes have been found in placers in Brazil, and a significant percentage of diamonds mined from the Snap Lake diamond mine in Canada have common cubic habit (Pokhilenko and others, 2003). Crystal faces of a cube often exhibit square-shaped pyramidal depressions rotated 45° diagonally to the edge of the crystal face. The cube may also have scattered trigons mixed with pyramidal and other depressions of hexagonal morphology.

Octahedron. The octahedron is an eight-sided crystal that has the appearance of two four-sided pyramids attached at a common base. This is a relatively ***common habit for diamond and seen in just about any diamond parcel (Fact #3).*** Each pyramid will have four equilateral triangles known as octahedral faces. In nature, these octahedral crystal faces will often have positive or negative ***trigons (fact #4)***: small equilateral triangles visible under a 10X hand lens or geologist's loupe. These are growths or etches on the crystal surface that represent a product of disequilibrium during transport to the earth's surface from the initial stable conditions at depth within the mantle.



An extraordinary 14.2 carat octahedral diamond recovered from the Kelsey Lake mine in Colorado (photo by Howard Coopersmith).

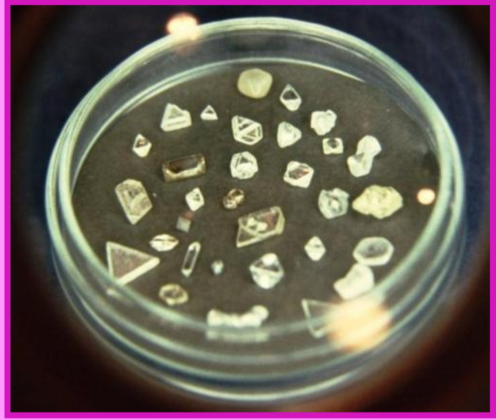
Partial resorption of the octahedron will result in different crystal habits including a rounded dodecahedron (12-sided) with rhombic faces. Further resorption may result in ridges on the rhombic faces yielding a 24-sided crystal known as a trishexahedron. Many diamonds from Argyle, Australia, Murfreesboro, Arkansas, and the Colorado-Wyoming State Line district exhibit resorbed crystal habits. Four-sided tetrahedral diamonds are sometimes encountered that are distorted octahedrons (Bruton 1979; Orlov 1977).



Note the surface of the diamond to the right – this slightly yellow diamond has several trigons on the surface (triangular depressions and plateaus) that are seen on most natural diamonds. As a diamond prospector, you need to become familiar with these and look for them as well as look at the crystal's luster – it should look greasy. Sometimes the trigons are in the shape of hexons (6-sided depressions and sometimes as four-sided depressions, but trigons are more common – see below).

Natural diamonds enclose mineral inclusions along cleavage planes. Such inclusions formed in the mantle at about the same time diamond crystallized. These tiny inclusions provide important data on the origin of diamond and may be used to determine the age of the stone or to identify the unique chemistry associated with the genesis of diamond. In a natural diamond, you should be able to see a couple of these with a 10X hand lens unless you found a really good diamond – then you may need a microscope.

Bort. Bort is poor grade diamond used as an industrial abrasive. It forms rounded grains with rough exterior and has a radiating crystal habit. The term is applied to diamonds of inferior quality as well as small diamond fragments.



Carbonado. Carbonado is a black to grayish, opaque, fine-grained aggregate of microscopic diamond, graphite, and amorphous carbon. The material is hard, occurs mainly as irregular porous concretions and dendritic aggregates of minute octahedra, and sometimes forms regular, globular concretions. Carbonado is characterized by large aggregates (averaging 8 to 12 mm in diameter) that commonly weigh as much as 20 carats. Specimens of several hundred carats are not uncommon. The density for carbonado is less than that for diamond and varies from 3.13 to 3.46 gm/cm^3. Because of it having a carbon or burnt appearance, it was named carbonado by Brazilian prospectors.

Although carbonado had been found in placers in Brazil and Russia, it was not until the 1990s that it was found *in situ*. Twenty-six grains of carbonado ranging in size from 0.1 to 1 mm were recovered from a 330-lb sample taken from avachite (a specific type of basalt from the Avacha volcano of eastern Kamchatka) (Erlich and Hausel, 2002).

Left - Parcel of gem diamonds from the Kelsey Lake mine with variety of resorbed habits (photo courtesy of Howard Coopersmith). And (above) another parcel of resorbed diamonds from Argyle, Australia (photo by the author).

Physical Properties

Diamond exhibits perfect octahedral cleavage with conchoidal fracture. The mineral is brittle and will easily break with a strike from a hammer. Even so, it is the hardest of all naturally occurring minerals (except for the extremely rare hyperdiamonds). Diamond is assigned a hardness of 10 on the Moh scale and 8000 kg/mm^2 on the Knoop scale. Corundum, the next hardest naturally occurring mineral has a Moh's hardness of 9. **Thus, diamond will scratch corundum** ***(fact #5)***. Corundum does not even compare to diamond's hardness. The Moh's hardness scale is a little misleading, as it is a relative hardness scale and the difference in hardness between diamond (H=10) and corundum is much larger than that between corundum (H=9) and talc (H=1). A more exact scale is the Knoop scale, which measures mechanical hardness by measuring the pressure applied from a diamond tip. With the Knoop scale, corundum has a hardness of 1370 kg/mm^2 which is considerably lower than diamond. Because of diamond's extreme hardness as well as excellent transparency, diamond is extensively used in jewelry and has a variety of industrial uses. But do not fall for the old adage that whatever scratches glass, is diamond.

Diamond's hardness varies in different crystallographic directions. This allows for the mineral to be polished with a little less difficulty in specific directions using diamond powder. For example, it is less difficult to grind the octahedral corners off the diamond, whereas grinding parallel to the octahedral face is nearly impossible.

With perfect cleavage in four directions parallel to the octahedral faces, an octahedron can be fashioned from an irregular diamond by cleaving (Orlov 1977). The specific gravity of diamond (3.516 to 3.525) is high enough that it will concentrate in placers with "black sand". So for those gold panners who are reading this, watch for diamonds! A few hundred diamonds were recovered with gold in California during the gold rush in the 1800s. And it is very likely that thousands of diamonds were discarded by the gold prospectors. Diamond's density is surprisingly high given the fact that it is composed only of carbon – a light atom. But compared to graphite, diamond is twice as dense due to the close packing of atoms.

Color. Diamonds occur in a variety of colors including white to colorless and in shades of yellow, red, pink, orange, green, blue, brown, gray and black. Those that are colored are termed *fancies*. Colored diamonds have included some spectacular stones – at a 1989 Christie's auction in New York, a 3.14-carat Argyle pink diamond sold for $1.5 million. A 0.95-carat fancy purplish-red Argyle diamond sold for nearly $1 million (US). More recently, the highest price in history was for a pink diamond that originated from the ancient Golconda mines of India. The Golconda diamonds are thought to have come from olivine lamproite similar to the rock type at Argyle, Australia. This pink diamond was sold at a Sotheby's auction for US$46 million for the 24.78 carat diamond ($1.86 million/carat). The world's largest faceted diamond, a yellow-brown fancy known as the 545.7-carat Golden Jubilee (Harlow, 1998), is considered priceless. Possibly the most famous diamond in the world, the 45-carat Hope, is a blue fancy.

Fancy diamonds from the Argyle mine, Western Australia (photo by the author).

In most other gemstones, color is the result of transition element impurities; however, this is not the case for diamond. Color in many diamonds is related to nitrogen and boron impurities or a result of structural defects. Diamonds with dispersed nitrogen may produce yellow (canary) gems. If the diamond contains some boron it may be blue, such as the Hope diamond. The Hope was found in India; however, many natural blue diamonds have also come from the Premier mine in South Africa. Blue diamonds with traces of boron are referred to as type IIb, and are semiconductors. Natural irradiation may also result in blue coloration in some diamonds (Harlow, 1998).

The most common color for diamond is brown. Prior to the development of the Argyle mine in Australia in 1986, brown diamonds were considered industrial stones. But due to Australian marketing, brown diamonds are now highly prized gems. The lighter brown stones are labeled *champagne* and the darker brown referred to as *cognac*. Yellow is the second most common color and such stones are referred to as *"Cape"* diamonds in reference to the Cape Province of South Africa. When the yellow color is intense, the stone is referred to as *"canary"*.

Pink, red and purple diamonds are rare. The color in these is concentrated in tiny lamellae (referred to as pink graining) in an otherwise colorless diamond. The color lamellae are thought to be the result of deformation of the diamond structure.

Green diamonds are different. Even though there are many green diamonds, few are faceted, primarily because most have a thin green surface covering clear diamond such that if the stone is faceted, the green layer is removed. Faceted green diamonds are so rare that only one is relatively well known (the 41-carat Dresden Green) that is thought to have originated in India or Brazil. The color in most green diamonds is the result of natural irradiation. Other green diamonds may result from hydrogen impurities. Another variety, known as a green transmitter produces strong fluorescence that tends to mask the yellow color of the stone. Other colors include rare orange and violet diamonds (Harlow, 1998).

A green modified octahedral diamond from undisclosed location (photo by the author)

One of the better-known black diamonds is the 67.5-carat Orlov. Black diamonds are colored by numerous graphite inclusions, which also make the diamond an electrical conductor. These are difficult to polish due to abundant soft graphite, thus black gem diamonds are uncommon. Opalescent, or fancy milky white diamond, is the result of numerous mineral inclusions and possibly nitrogen defects in the crystal (Harlow, 1998).

Dispersion, transparency, conductivity, wet-ability. Diamond has high coefficient of dispersion (0.044): the coefficient being the difference in refractive index of two visible light wavelengths at the opposite ends of the spectrum (one blue-violet and the other red). This produces the distinct fire seen in faceted diamond. Diamond is completely transparent to a broad segment of the electromagnetic spectrum making it useful in a variety of industrial, electrical and scientific applications. It is also transparent to radio and microwaves. Colorless diamonds are transparent to visible light wavelengths extending into the ultraviolet, and a few rare diamonds (Type II) are transparent over much of the ultraviolet spectrum.

Diamond has a luster described as **greasy to adamantine** that is related to its high refractive index (IR=2.4195) and density. Such high density greatly diminishes the speed of light. For example, the speed of light in a vacuum is 186,000 mi/sec, but in diamond, it is only 77,000 mi/sec (Harlow, 1998).

Many diamonds are luminescent: approximately one-third luminance blue when placed in ultraviolet light. In most cases, luminescence will stop when the ultraviolet light is turned off (known as fluorescence). Diamonds fluoresce in both long- and short-wave ultraviolet light. The fluorescence is usually greater in long wave and diamond may appear blue, green, yellow or occasionally red. However, fluorescence is weak, and it may not be readily apparent to the naked eye. In some cases, light emission is still visible for a brief second after the ultraviolet light source is turned off (known as phosphorescence). Some diamonds may also show brilliant phosphorescence when rubbed or exposed to the electric charge in a vacuum tube; or when exposed to ultraviolet light (Dana and Ford, 1951).

At room temperature, ***diamond is four times as thermally conductive as copper (fact #6)***, even though it is not electrically conductive. Because of the ability to conduct heat, diamond has a tendency to feel cool to the lips when touched, since the gemstone conducts heat away from the lips. This is why diamonds have been referred to as *"ice"*. GEM (also referred to as Diamond Detectors, Diamond Detectives) testers (about the size of a pen) are designed to identify the unique thermal conductivity of diamond and distinguish it from other gems and imitations. This one tool can be very useful to a prospector due to the fact that it sells for a reasonable price – and if you think you have raw diamonds, get one of these.

Grease table. We used a 10:1 mixture of Vaseline to paraffin to extract diamonds from concentrates (photo by the author).

Diamonds are hydrophobic (non-wetable). Even though diamond is 3.5 times heavier than water, it can be induced to float on water. Because it is hydrophobic, diamond will attract grease, thus providing an efficient method for extracting diamond from ore concentrates (i.e., grease table). Oil, grease, and other hydrocarbons have an affinity for materials that do not contain oxygen (such as diamond).

Diamonds are unaffected by heat except at high temperatures. When heated in oxygen, diamond will burn to CO_2. Without oxygen, diamond will transform to graphite at much higher temperatures (1900°C). Several years ago, I tried to burn a diamond using a Bunsen burner with added oxygen, and burned a diamond to graphite plus plant food (CO_2). Diamonds are unaffected by acids.

More on diamonds later.

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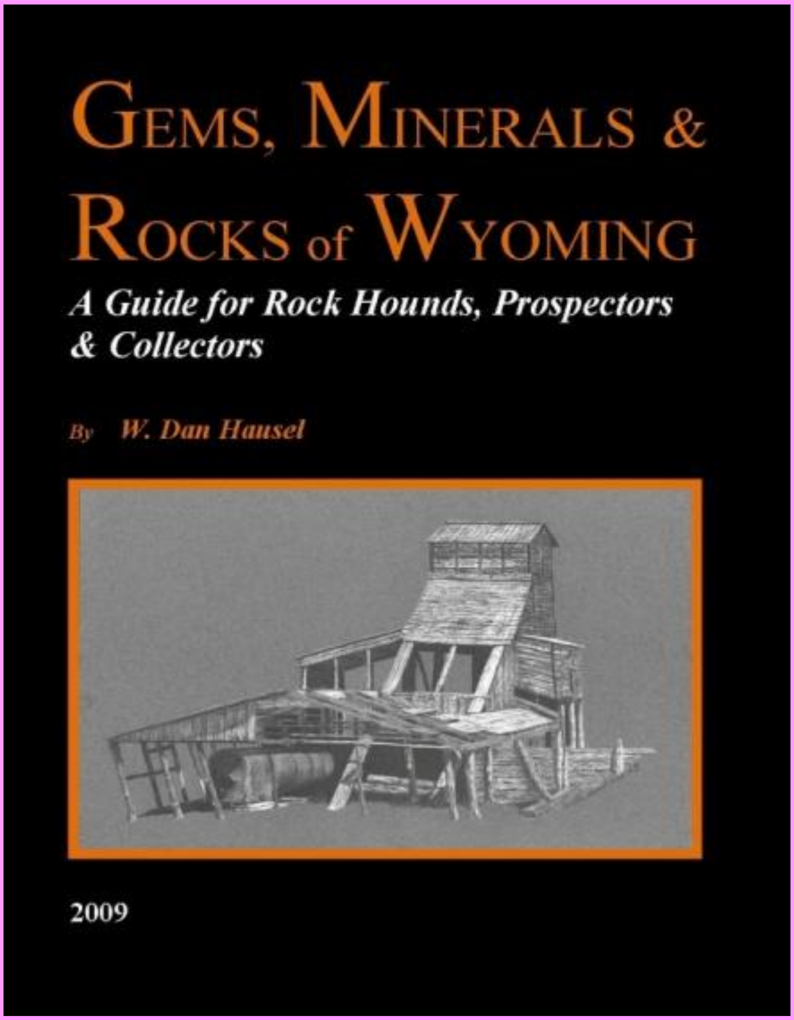
MOST VALUEABLE GEM

Nov. 2010: A rare pink diamond sold for the highest price in history at an auction in Switzerland. The 24.78 fancy pink diamond was sold at a Sotheby's auction for a record US$46 million (or $1.86 million/ct). This beat the old record for the 35.56-carat Wittelsbach blue diamond that sold for more than $24 million in 2008. The emerald cut pink diamond was apparently last seen on the market 60 years ago. Another diamond that is up for auction is also expected to bring a high price - a pear-shaped 26.17 carat flawless diamond from the ancient Golconda mines of India. *Photo - EPA (European Press Association).*

BOOKS

Gems, Minerals and Rocks of Wyoming – A Guide for Rock Hounds, Prospectors and Collectors is available from Amazon: or order it from your local bookseller.



The GemHunter Newsletter

Because I'm trying to put together a group of books, I've decided to cut back on the GemHunter newsletter. Instead of sending it out each month, I will be going to a format of 6 newsletters each year.

See you next year – http://GemHunter.webs.com

The GemHunter Newsletter
W. Dan Hausel (GemHunter@live.com)
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