How Gems are Classified

by Donald Clark CSM

... There is one curious fact that permeates gemology, nothing is ever simple and straight forward. For every principle or example put forward, there is always an exception to be found. When it comes to classifying gems, there are several ways of doing it. Each method has its own purpose, so that is simple, but each method also has its exceptions to pay attention to.

Precious and Semiprecious

... A couple centuries ago the terms "Precious" and "Semiprecious" gems came into common use. There are so many exceptions to this classification, that it no longer has any value. For example diamonds have always been considered precious gems, yet there are diamonds that sell for £100 a carat. You can see them, (with sufficient magnification,) as accent stones on inexpensive jewellery.

... On the other hand there are garnets that sell in excess of £1,000 a carat. Garnets have traditionally been considered semiprecious gems, but some of them are worth more than ten times what a low quality diamond is.

... These terms are still used occasionally, but they are frowned upon. The U.S. Federal Trade Commission, (which sets legal definitions,) has considered making it illegal to use them because they can be deceptive. If you want to appear professional and well educated you should eliminate them from your vocabulary.

Diamonds and Coloured Stones

... Gems can be divided into two categories, "Diamonds" and "Colo**u**red Stones." This is due to the extreme hardness of diamond. It takes special tools to cut diamonds that aren't suitable for cutting colo**u**red stones, and the reverse is also true. (As usual, there are a few exceptions to this.)

... There are also differences in the mining and distribution of diamonds. They are the one of the few gems that has a consistent supply. The marketing is monopoli**s**ed, which is also different from all other gems.

... From this perspective a blue diamond is still a diamond, it is not a colo**u**red stone. A colo**u**rless sapphire or topaz would be classified as a colo**u**red stone. In spite of the wording there are only two categories, diamonds and everything else.

Natural and Man Made

... There are a couple of terms commonly used for gem material that is created in a laboratory. "Synthetic" refers to materials that duplicate their natural counterparts. Emerald, sapphires and spinel are common synthetics.

... "Homocreate" materials have no counterpart in nature. This category includes the synthetic garnets, GGG and YAG. Cubic Zirconium was long thought to be a synthetic, but tiny crystals have now been found in nature. (They were not large enough to be used as gems.)

... While natural and man made materials can share the same physical and optical properties, there are still considerably differences, the main one being rarity. A natural gem takes considerable time to form and is usually millions of years old. Plus, many feel they have aesthetic qualities not found in mass produced materials.

... While natural and man made materials appear nearly identical, their values vary considerably. For this reason it is important to be able to distinguish between the two.

... It is also worth pointing out the definition of an "imitation." Anything that is posing as something else is an imitation. For example, a white topaz posing as a diamond is an imitation. A CZ, described as a Cubic Zirconium, is not an imitation.

Organics and Inorganics

... Another approach is to separate gems into organics and inorganics. Organic gems are those whose creation is associated with living organisms. Amber begins life as tree sap and pearls are created inside an oyster. Hence, they are classified as organic materials.

... Inorganic covers everything else. That "everything else" is primarily the mineral kingdom. Here one notable exception comes from the political arena. In the United States, the definition of a mineral includes the requirement that it is created in the earth. This has the weight of law so there is a certain amount of wisdom in accepting the definition, especially when advertising.

... By requiring a mineral to be created in the earth, that puts lab made materials in a separate category. They may have identical chemical make up, physical and optical properties of their natural counterparts, but they can't legally be described as a mineral in the U.S. For purposes of study though, the properties of minerals are shared by lab grown crystals.

Crystalline and Amorphous Materials

... Not all gem materials are crystalline. There are also amorphous materials that have no regular pattern to their molecules, no crystalline structure. Amber and opal are good examples of amorphous materials. Glass is also an amorphous material. Man made glass is used as an imitation gem, however there are natural glasses as well. They include obsidian and techtites like moldavite.

... It is important to note that amorphous materials can be both organic, as is the case with ivory and amber, or inorganic.

Aggregates

... There are a number of requirements for crystals to form. Among them are the proper chemicals, heat, pressure, time and space. If the material cools off too quickly, or if there isn't space for the crystals to grow, you end up with an aggregate.

... An aggregate will look much like an amorphous material, but internally it is composed of thousands of microscopic crystals. The most common example of this is the chalcedony family, which contains agates and jaspers. These are all members of the quartz family, so they have many characteristics in common. They will have the same density and same refractive index as a whole crystal of quartz, but considerably different appearance.

Rocks

... Rocks are a mixture of minerals, where crystals and amorphous materials have a single ingredient. While not a gem material, granite is one of the most common and best known rocks. If you look at it carefully, you will see black, white and gray bits all bound together in a single material.

... In the gem world lapis lazuli is the best known rock.

Minerals

... Now we are getting into the heart of how gems are classified. The vast majority of gems are minerals. Mineral "species" are defined by a combination of their "chemical makeup" and their "molecular structure."

... "Chemical makeup" refers to the atoms the mineral is composed of. Diamond has the simplest chemical makeup, with carbon being the only element present. Corundum is composed of just two elements, aluminum and oxygen. Its chemistry is expressed as Al_2O_3, meaning there are two aluminum atoms and three oxygen atoms in a molecule of corundum. The chemistry of other gems can get a lot more complicated. For example, tourmaline's chemistry is expressed as $Na(Li,Al)_3Al_6B_3Si_6O_{27}(OH)_3(OH,F)$.

... "Molecular structure" refers to how the molecules attach to each other. While you can't see the individual atoms, you can see the result of how they attach to each other in whole crystals. Diamonds form crystals that look like two pyramids attached at their bases. Quartz forms elongated crystals with six sides.

... This is a result of the molecular structure. It's as if you had two sets of tiles to work with. Those with four sides will form one kind of design, others with six sides form an entirely different set of designs. The two styles can't be fit together, six sided tiles and four sided tiles are different systems.
... These two elements, chemical make up and molecular structure, must be taken together when defining a mineral. The best example is comparing diamond and graphite. Graphite is used in pencil leads. It is very soft and black. Diamonds are the hardest substance in nature and colorless.
... Both diamonds and graphite have the exact same chemical makeup, being pure carbon. It is only when you add the second element of molecular structure that you can show how they are different. Conversely, you will find that several minerals share the same structure, then it is the chemistry that defines them.

Species and Varieties

... It is important to note that we are discussing pure minerals. In nature it is common for a mineral to have impurities. These are present in very tiny amounts, usually 3% or less of the crystal by weight. They aren't considered to change the primary chemistry, so they don't change the name, or species, of the mineral. However, they do change some of the mineral's characteristics so we come up with a subclassification called a "variety."
... While impurities don't make a significant difference in the chemistry of a mineral, they can make a significant difference in its appearance and this can have a considerable effect on its value.
... A pure mineral is usually colorless and it is the impurities that give it color. An excellent example is corundum. In its pure form it is completely colourless. Add a bit of chromium and we call it a ruby, a bit of titanium and iron and it becomes a blue sapphire. Pure beryl is also colourless. Add a touch of chromium and you have an emerald, a bit of iron and you get an aquamarine. Just a tiny bit of these impurities and a mineral suddenly becomes exceptionally valuable!
... Corundum and beryl are called "mineral species." Their coloured versions are "varieties." Another very common species is quartz, which has the varieties of amethyst, citrine and smoky quartz.
... Now there always has to be an exception or two, so here we go. Not all minerals are colourless in their pure state. Garnet is one of the most obvious examples. Also, there are several species of garnets as well as varieties. Garnets all share the same structure and a lot of similarities in their chemical make up. However, they do have variations in chemistry and, with each variation of chemistry, we have a new species.
... The following example is not up to scientific standards of accuracy, but it will help to illustrate how garnets vary. Look at your hand and consider it to be a model of a garnet molecule. All garnets will have the same structure, the shape of your hand, and pretty much the same chemistry. The last joints of your fingers represent separate atoms. While most of the atoms remain the same, different atoms can reside in those places. If you change the atoms, (the chemistry,) you change the species, that's the rule. However, you can see that the shape of your hand hasn't changed shape, nor have any of the other basic characteristics. Hence they are still garnets.
... Common red garnets are either almandine or pyrope. However, the purest almandine garnet ever found contains 80% almandine and 20% pyrope. The opposite is also true, the purest pyrope contains 20% almandine. (It is actually more complicated than this, with a small percentage of other garnet species involved.)

... When a gemologist needs to put a name on a garnet, they will call it by the component that is in the majority. As you can see, this is not always a clear distinction. If the purest pyrope garnet ever found is only 80% pyrope, then there are a lot more that are closer to being only 50% pyrope. For most garnets, it is best to describe them simply as almandine/pyrope.
... There are some garnet blends that take on a distinct set of characteristics. A good example is a rhodolite garnet. A rhodolite is approximately 70% pyrope and 30% almandine. What makes it distinctive is its purple colouring. (Remember the two major components are red, hence the purple is distinctive.) This quality is distinct enough that rhodolite is considered a variety of garnet. Not necessarily of pyrope, but simply a variety of garnet.

Series and Blends

... As mentioned above, garnets are never found in their pure state, but always in combination with each other. For example, most of our gem grade garnets are in the almandine - pyrope - spessartite series. Almandine, pyrope and spessartite are individual species of garnet and they are always found together. The element that makes up the majority is the one whose name is given to the gem.
... This kind of blend, (always having almandine, pyrope and spessartite together,) is called a solid state series. The feldspar minerals also form in a series like this.

Mineral Groups

... Minerals are also classed as groups. This is more important to the mineralogist than the gemologist, but it helps to know the terminology. The two fields overlap and the terms show up in gemological text books from time to time.
... The garnet group would contain the three species mentioned above, (almandine, pyrope and spessartite,) plus hydrogrossular, kimzeyite, goldmanite, schorlomite, knorringite, yamatoite, andradite and uvarovite. Of these later additions, only the last two are gem material.
... A similar situation exists for the tourmaline and feldspar groups. They have several members, but only a few are used as gems.

Mineral Classes

... Minerals are also categorized by common chemistry. For example, all minerals that contain silica will be grouped as silicates. This kind of grouping isn't important to all gemologists, but you should at least know that it exists.
... It is important to mineralogists, chemical gemologists and occasionally to the gem cutter. For example, if a lapidary is about to cut a gem for the first time, the best polishing compound is a mystery. If he knows what group the gem in question belongs to, it would be reasonable to start with compounds that work for other gems in that group.

The information contained in these FREE sheets has been gathered from many different sources.
While the information contained here is offered freely, this information should only be used for general information.
*Sources.
Barrie & Jackie Wakeford (CrystalConnection) 2009. (Pictures and some text)
The International Gem Society. (Mainly text and characteristics of stones)