



CREVOSHAY

ILLUMINATIONS

EARTH TO JEWEL



GUIDE

of the temporary exhibit
at the Mineralogy Museum MINES ParisTech
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ILLUMINATIONS – EARTH TO JEWEL

EXHIBITION OVERVIEW

"Illuminations – Earth to Jewel" is the temporary exhibit presenting a selection of **extraordinary creations of the jeweler and artist Paula Crevoshay**, put in resonance with **exceptional minerals from the collection of the Mineralogy Museum MINES ParisTech** (Paris School of Mines). While Crevoshay invites the visitor to a contemplative journey through her creations, the Mineralogy Museum proposes to discover the rough materials and the expertise of the artists and creators. The exhibition "Illuminations" is located at the confluence of the foundations of the museum: to present and explain to the public the relationship between minerals and manufactured goods. The museum's collection was built to define resources that can be to the service of industry. Here, we speak of **the luxury industry**, which began in the heart of France, in **Paris, the City of Light**. It is therefore natural that these gems are shown at the Mineralogy Museum, among the most fabulous minerals in the world.



Pink tourmaline in "Maharani Devi" by Paula Crevoshay, as well as in its rough form, coming from California, USA, in the collection of the Mineralogy Museum.



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PAULA CREVOSHAY – AN ARTIST INSPIRED BY NATURE

Paula Crevoshay is a worldwide recognized artist, who **creates opulent and beautiful jewels**. Her creations are inspired by nature and depict flowers, animals from the land, water and air. She uses the **mineral diversity that exists in nature to give life to her jewels**, sometimes created with unusual gems. For example, she knows how to use the intense sparkles of demantoid garnet and sphalerite, the subtle purple and pink colors of kunzite and sapphire, the extreme blues of chrysocolla, turquoise, aquamarine and azurite. She plays with the different ways of cutting stones, such as faceting, carving, or polishing as cabochon, as each method enables light to be reflected, transmitted, sometimes also refracted and diffused into the gemstone in its own way. "Illuminations" is the term that defines how the artist plays with light and gemstones.

The art of Paula Crevoshay is an ode to gems minerals. Its place at the Museum of Mineralogy was therefore obvious.



Artist and jeweler Paula Crevoshay finds her inspiration in nature to create her jewels. Copyright: Crevoshay.



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ABOUT MINERAL MINING: A HUMAN HIST°RY

Historically, man has been fascinated by stones, minerals, and crystals. **Since prehistoric times**, stones are cut to **create tools, first by percussion and polishing**, sometimes with an aesthetic concern. With the need of stones, mining in the form of open pits or even of wells developed since the Neolithic times. **Jewelry is already created and made from shells or teeth**. The use of clay minerals for manufacturing **pottery** develops from 20,000 B.C. in China. Mastering fire will then lead to metallurgy **with the Copper Age and then the Bronze Age**. It is known that the oldest and longest **trade routes** were established for the trade of stones, minerals and gems.

With the **industrial revolution**, the need for raw materials grew exponentially, so that **mining** had to develop just as much. The dissemination of raw and processed products is greatly facilitated with the railway boom of the 1840s. Since then, we are constantly **discovering new technologies** thanks to elements contained in minerals, such as for rare earths elements. These rare earths elements are chemical elements belonging to the metal group, thanks to which high technology has been developed (aerospace, biotechnology, nanotechnology, etc.). The miniaturization of electronic items like computers or mobile phones is now possible thanks to tantalum and niobium elements contained in minerals such as columbite and tantalite, which use has increased tenfold since the very beginning of the 21st century. Mining at the global scale obviously brings **environmental, strategic, economic and political issues**, which our society must address.



Chalcedony in "Earth's song" by Paula Crevoshay, and in the rough coming from the Martinique Island, France, in the collection of the Mineralogy Museum.



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FROM A NATURAL RESOURCE TO A PIECE OF ART

WHAT IS A ROCK, A MINERAL, A GEM?

As several terms are coming back quite frequently in this exhibition, we decided here to clarify some of them.

A rock is generally a consolidated and hard material, consisting of a mineral assemblage.

A mineral is a naturally occurring chemical species, most often in the form of a crystalline solid. It is defined by its chemical composition and an ordered, periodic atomic structure. Diamond is, for example, a mineral whose chemical composition is C (carbon) and crystallizes in the cubic crystal system.

Some minerals have **varieties**: they have the same chemical and crystalline characteristics but have different colors. For example, corundum (Al_2O_3 - aluminum oxide that crystallizes in the rhombohedral system) has two varieties: ruby (red variety) and sapphire (blue variety). Beryl ($\text{Be}_3\text{Al}_2(\text{Si}_6\text{O}_{18})$, beryllium aluminum silicate that crystallizes in the hexagonal system) has many varieties, the best known are emerald (green variety) and aquamarine (blue to aqua-blue variety).

A gem is a mineral or rock that is beautiful and rare enough that it may deserve to be cut and eventually be part of a jewelry piece. The weight of a gem is measured in **carats** (1 carat = 0.2 g = 200 mg). Some rocks are also worked by the gem cutter when they have attractive colors and textures. They are known as ornamental rocks.

MINERAL MINING

Metals (gold, silver, copper, etc.) and gem-quality minerals are found in specific deposits. Fairly large minerals with intense colors and exceptional clarity are rare. The common gems used in jewelry like diamond, sapphire or ruby, emerald or aquamarine are found only in very particular geological contexts, unevenly distributed on the surface of the Earth. Here we discuss some examples, which are represented through the exhibition.



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GOLD

Gold is a mineral composed of a single type of atom (Au for gold), which crystallizes in the cubic system. It is found either in primary deposits (in the rock in which it was formed), or in alluvium (in rivers after disintegration of the primary rock), as nuggets or as flakes. In primary deposits, gold generally occurs in rocks rich in quartz. It is common to find small pieces of quartz in gold nuggets found in rivers. The sample of the Mineralogy Museum presented here is a native Australian gold composed of several well-formed crystals. Currently, the largest gold-producing countries are China, Australia, the United States, Russia, Peru and South Africa.

Gold is a malleable metal very rarely used in jewelry in its pure form. This is why it is generally associated with other metals (copper, silver, palladium, platinum or nickel) to form a more resistant alloy. The percentage of gold used in the alloy is measured in karats (not to be confused with the carat for gems): 24 karats is pure gold, 18 karats is 75% gold, 12 karats is 50% gold, etc. (a karat is $1 / 24^{\text{th}}$ of the total mass of an alloy).



The "Flying Fish of Mandalay" by Paula Crevoshay with blue apatite, diamonds and pearls on gold, and a rough gold specimen from Australia in the collection of the Mineralogy Museum.



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EMERALD

Emerald is the green chromium-bearing variety of beryl (beryllium aluminum silicate, crystallizing in the hexagonal system). It has been used for millennia as a precious stone, as mentioned for example by Pliny the Elder and Herodotus. The only known deposit until the 16th century was in Egypt, near the Dead Sea. With the discovery of Latin America by Spanish conquistadors, emerald deposits were (re)discovered in 1555, and Chivor became the first emerald producer in the world. Today, Colombia is still the largest producer of emerald. The mineral specimen from the Mineralogy Museum presented here comes from Muzo, Colombia, which is legendary source of what is often referred to produce the finest emeralds in the world. However, other countries produce emeralds like Russia, Zimbabwe, Brazil, Pakistan or Zambia, which sometimes have nothing to envy to their Colombian counterparts. Gemologists talk about "the emerald garden" to define the impurities visible to the naked eye in emeralds.

The formation of emerald requires very specific geological conditions, and generally differs from one deposit to another. In Colombia, emerald is found in sedimentary rocks. Beryllium and chromium (Cr – the element that gives the green color) were trapped in the sediment basin of the Eastern Cordillera, which is made of black shales rich in carbonaceous materials. It is through a process of alteration and re-deposition in fractures or geodes of calcified schists that the emerald crystallizes. The specimen presented in this exhibition demonstrates the association of calcite and emerald, with, at the back of the specimen, shows the black shale.



Earrings « Versatile » by Paula Crevoshay with emerald pendants and small tsavorite garnet, and a rough emerald specimen on matrix from Muzo, Colombia, in the collection of the Mineralogy Museum.



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TANZANITE

Tanzanite is the blue to blue-violet variety of zoisite, which is a calcium and alumina silicate ($\text{Ca}_2\text{Al}_3(\text{Si}_2\text{O}_7)(\text{SiO}_4)\text{O}(\text{OH})$) crystallizing in the orthorhombic system. If this gem is little known in France, it is very popular in the US and the Asian markets for its unique color, clarity, and sometimes its impressive dimensions. Tanzanite has the particularity of being only found in northern Tanzania, at the foot of the Merelani Mountains (Merelani Hills, Manyara region). Its discovery is fairly recent, going back to 1967, when a member of the Masai tribe, Ali Juuyawatu, picked up the first blue stones from the ground. He then alerted a local prospector, Manuel d'Souza, who bought right away four concessions, thinking he recognized sapphires. It turned out that the gems found were much rarer and that they were blue zoisites. It is Tiffany & Co. which decided in 1968 to rename the stones in a more attractive trade name, after its country of origin: tanzanite.

Note that most stones used in the jewelry market have been treated by heating at low temperature (400-500 °C) to increase the intensity of its blue color. In the process, it loses its famous trichroism that one can see on some rough gemmy stones (3 different colors: blue, purple and red / brown, depending on the orientation of the stone).



Pendant in rutiled quartz and tanzanite by Paula Crevoshay, and tanzanite rough crystal in the collection of the Mineralogy Museum.



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OPAL

Opal is an amorphous (to poorly crystallized) silica containing variable water content ($\text{SiO}_2, n\text{H}_2\text{O}$). Its structure presents usually no arrangement at the atomic scale, however it can have one at the nanometer or micrometer scale. Indeed, silica nano-grains can sometimes arrange to form spheres (or lephispheres) that may be stacked in an orderly manner. In these exceptional cases, the ordered structure serves as a diffraction grating, and opal then shows iridescence, referred as play-of-color. While holding the stone and turning it, one can then see many colors of the rainbow on the surface of the stone, which change according to the orientation. This can be seen on some Australian opals presented in this exhibition.

When opal does not have this perfect arrangement of spheres, it still can be attractive thanks to its intrinsic color, like for example red opal, commonly referred as "fire opal", such as the specimen shown in the exhibit and that comes from the typical deposit for fire opal: Mexico.

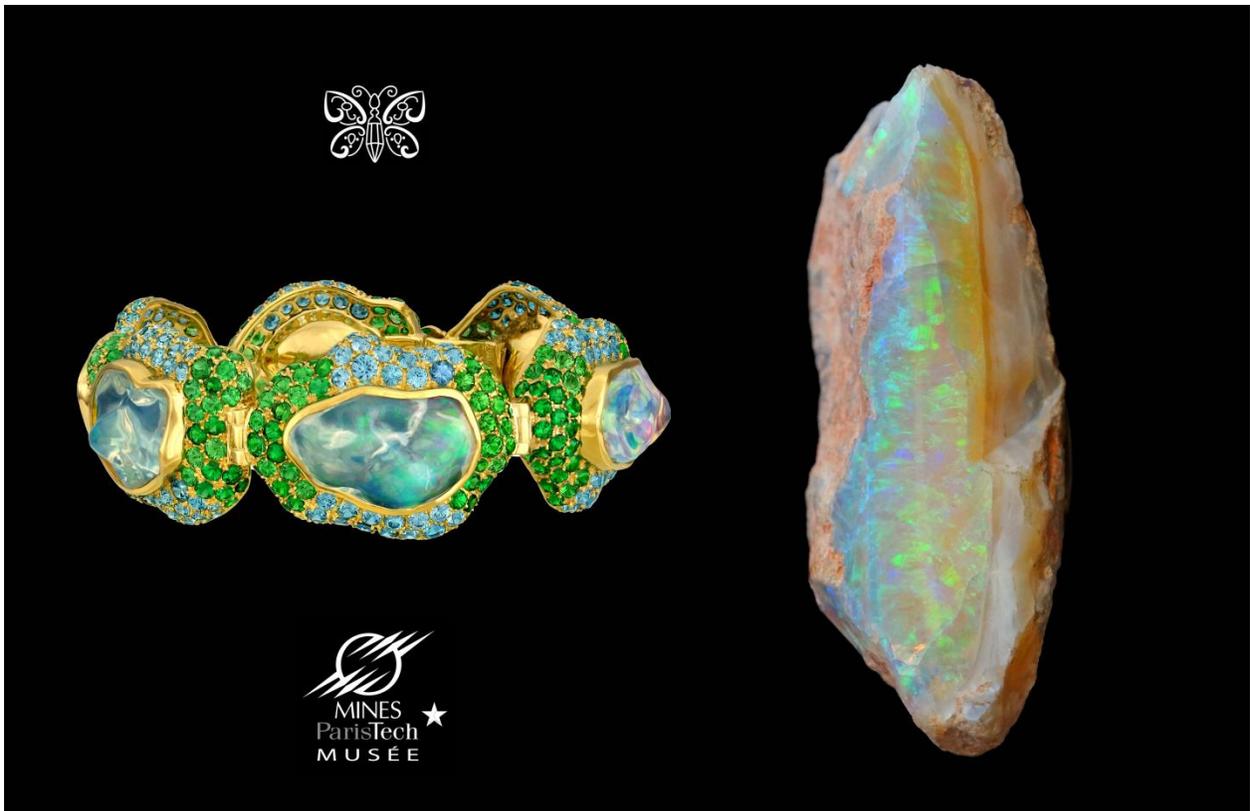


Black opal with play-of-color in the bracelet "Tradewinds" by Paula Crevoshay, and in its rough form coming from Australia, in the collection of the Mineralogy Museum.



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The largest opal deposits are located in Australia. It is where the black opal variety is found, which is certainly the most popular on the market. Mexico is also a major producer, with its varieties of common fire opal and play-of-color fire opal. Since 2012, the Wello deposit in Ethiopia has become another major producer for the market of gem opals, as it produces exceptional play-of-color opals, usually hyaline (colorless) or milky white. There are other smaller deposits, as in Brazil, Honduras, the United States, Hungary, Turkey, and Indonesia, for example. In all cases, the opal is formed by alteration of a silica-rich rock, and re-precipitation in cavities of the rock, either sandstone (sedimentary rock rich in silica) as in Australia, or rhyolite / ignimbrite (volcanic rocks rich in silica) as in Mexico and Ethiopia, for example.



Play-of-color opal in the « Sabrina » bracelet by Paula Crevoshay, and in its rough form coming from Australia, in the collection of the Mineralogy Museum.



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GARNET

The garnet family includes a variety of minerals with very similar properties. All are silicates which crystallize in the cubic system ($X_3Z_2(SiO_4)_3$ is the generic formula, where X may be Ca or Fe and Z may be Cr or Al for example). We can cite the following species commonly used in jewelry: almandine ($Fe_3^{2+}Al_2(SiO_4)_3$), andradite ($Ca_3Fe_2^{3+}(SiO_4)_3$), grossular ($Ca_3Al_2(SiO_4)_3$), pyrope ($Mg_3Al_2(SiO_4)_3$) and spessartite ($Mn_3^{2+}Al_2(SiO_4)_3$). Pyrope and almandine generally come in a range of colors from purple to red to orange-red. Spessartite may present various shades of orange, while andradite usually ranges from yellow (variety called topazolite) to yellow-green (the green variety is called demantoid). Grossular is certainly the species that presents the most variety in colors, from yellow to orange-red to deep green (variety called tsavorite) ... or can even be colorless.

Garnets are minerals that form in metamorphic or magmatic rocks, and are quite widespread worldwide. Gem quality stones are obviously much less frequent. Historically, the red we usually associate with garnet is the pyrope garnet coming from the historic mines in Bohemia (former Czechoslovakia), which were mined since the 13th century.



Spessartite garnet in the « Athena » bracelet by Paula Crevoshay, and in its rough form coming from Brazil from the collection of the Mineralogy Museum.



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SPINEL

Spinel is iron and aluminum oxide ($MgAl_2O_4$) crystallizing in the cubic system. It looks very much like corundum (ruby and sapphire) once cut, and also presents a wide variety of colors. In Latin, "ruby" actually means "red", and under the Ancient Rome, the distinction corundum - spinel was in fact not done. The King of France François the First (early 16th century) had a collection of 3 rough red spinels set in jewelry, including the famous Côte de Bretagne (212 ct), which was recut as dragon under Louis the Fifteenth, and which was set in his Golden Fleece in 1749. The Côte de Bretagne was part of the French Crown Jewels, and is on permanent display at the Louvre.

Spinel is an alternative for ruby. It can be found in many catalogs like those of the French or English Crown jewels. Today it is very popular again, not only for its red variety that has nothing to envy to ruby, but also for its other colors: blue, pink, purple. The cobalt-rich variety is certainly the rarest and most sought after by collectors, thanks to its electric blue color ("cobalt blue").



Red spinel and moonstone composing the "Octopus" by Paula Crevoshay, and a rough red spinel from Burma, in the collection of the Mineralogy Museum.



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PERIDOT

Peridot is the variety of the gem-quality mineral called forsterite (magnesium silicate, Mg_2SiO_4) which crystallizes in the orthorhombic system. It belongs to the olivine group, which ranges in composition from forsterite, the magnesium end-member, to fayalite (Fe_2SiO_4), the iron end-member.

Olivine is the most common mineral in the Earth's mantle. It can occur at the surface of the Earth in very specific tectonic settings, such as rifts (extension areas of the crust). The Egyptian rift, at the Red Sea, offers a historical and mythical deposit of peridot. It has been mined since the ancient Egypt, and still was until 1958. That is why it is found in Tutankhamun jewels and in many Christian religious artifacts from the Middle Ages, for example. Certainly one of the finest examples of a rough crystal coming from this place (St John's Island in the Red Sea) is presented in this exhibition, and is part of the collection of the Mineralogy Museum.



The « Cleopatra » ring by Paula Crevoshay made with peridot, and the exceptional peridot from St John's Island, Egypt, in the collection of the Mineralogy Museum.



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DIAMOND

Diamond belongs to the class of native elements, as it is only made of one kind of element: carbon (C). It crystallizes into the cubic system. It is the hardest natural material. However diamond is quite fragile as it has planes of weakness following its octahedral faces. Diamond is probably now considered as the ultimate gemstone, most likely thanks to its extraordinary fire and luster. It symbolizes eternity since a successful marketing campaign in the 1940s. Diamond comes in all kinds of colors (including the highly valued pinks and blues), which are due to natural defects in its structure.

Diamond is more than just a pretty gemstone. For geologists, it tells the story of the deep Earth: it forms at least at 90 miles deep, in the rock making the Earth's mantle, known as peridotite (and in the less common eclogite). Most diamonds are formed from 1 to 3.5 billion years ago, so diamonds also gives clues about the evolution of the Earth's mantle through time. Reaching the surface of the Earth is not an easy task for a diamond: by regular exhumation processes, it is transformed into graphite (C, crystallizing into the hexagonal system). To avoid that transformation, diamond has to travel fast. It happens thanks to a very special kind of volcanism, first found in Kimberley, South Africa: the kimberlitic volcanism. The kimberlitic magma has a very peculiar chemical composition, rich in alkaline and volatiles. This magma travels at fast rates to the surface, bringing back pieces of the Earth's mantle, sometimes including diamonds that are kept intact. Diamond-bearing kimberlitic magmas are found in the oldest parts of continents, called cratons, such as in South Africa, Brazil, Russia, or Canada. In Argyle, Australia, diamonds are found in another rare diamond-bearing magmatic rock, called lamproite.



Black diamonds in "Magie Noire" by Paula Crevoshay, and a natural white octahedral diamond in the collection of the Mineralogy Museum.



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THE ART OF METALLURGY

Behind the empirical blacksmith art lays a true science: understanding metals, their properties and their treatments. The most advanced alloys have nowadays been developed. The first metal used by man in his early history was copper. It can be found in nature in its native and pure form, and easily worked to be transformed in a useful tool. Then came the human-engineered alloy of copper and tin: bronze, stronger and more resistant than copper by itself. Millennium after millennium, discoveries using metals and their alloys have multiplied. Since the 19th century with the industrial revolution, the art of metallurgy evolved with the discovery of steel and of advanced alloys used for the high technology industries of aerospace, electronics, construction and automotive for example.

Metallurgy is also the basic foundation of jewelry. Strictly speaking, metals come in only four colors: yellow, copper red, silver hite and all the other metals are varying shades of grey. In jewelery, gold is primarily used in alloys mixed with copper, silver and palladium to give white gold. Typically, gold is present in 75% (i.e. 18k) mixed with these other metals. Silver is also widely used in jewelry. To increase the hardness (like for gold), silver is alloyed with a little copper (92.5% silver). Platinum is the purest metal used in jewelry, accounting for 95% of the alloy (the remaining elements are usually copper or iridium). Both ductile and malleable, platinum is a transition metal highly resistant to corrosion and abrasion, with a brilliant white luster, and is highly prized in jewelry. A cheaper alternative sometimes employed is palladium, used in the same purity (palladium is a metal belonging to the platinum group and have similar characteristics to platinum). Rhodium plating can be used to make platinum alloys appear more “white” and to make silver tarnish resistant.

THE ART OF THE LAPIDARY

The job of the lapidary is to shape a rough mineral into a cut gemstone, whether as a cabochon, a faceted gem or a carving. The first lapidary art can be traced back to the Stone Age, when men cut their first tools by using the hardness of different rocks, about 2.3 million years ago! Artifacts using drilled stones to make necklaces date back from about 1 million years ago. With the Egyptians, lapidary art truly developed since 4800 B.C., with carved stones cut in the shape of beetles, using turquoise, lapis-lazuli or amethyst. Between the 10th and 11th century in Europe, the art of faceting gemstones developed over the polishing of cabochon. In 1290, the lapidary guild was created in Paris; techniques of faceting gemstones, including diamonds, were taught. The French Revolution marked the end to the development of the art of lapidary in France. Gem cutters fled France to go to Lisbon and diamond cutters to Amsterdam, where they continue to refine their techniques. After World War 2, the survivors reestablished the trade in Antwerp (as well as New York and Tel Aviv). These cities are still major diamond cutting centers.



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In the meantime, gemstone and ornamental carvers as well as colored gem cutters settled in Idar-Oberstein, Germany. This city already had a long history in agate mining and gem-cutting for over 500 years. After World War 2, gem artists developed new concepts and techniques using stones from important new deposits such as Brazil and Africa. The city still brings together the best lapidary artists and carvers.

Faceting a gem always begins with studying it first. The gem cutter must identify possible inclusions and fractures, and have to determine the crystallographic orientation of the mineral. From this analysis, the best shape will be chosen to maintain the maximum material while removing most, if not all, inclusions. From the rough to the faceted stone, there may be a weight loss of up to 75%, depending on the quality of the starting gem material! Once the shape is chosen, the lapidary will pre-form the stone, removing the unwanted parts revealed by the preliminary examination. Sawing is usually done using a circular saw incrustated with diamond powder (diamond is the hardest material). The preform shape is generally obtained with a diamond or carborundum wheel and is then polished with an aluminum oxide covered wheel (synthetic corundum). There are several standard shapes for a gemstone, such as the brilliant cut (typical for diamond), the emerald cut (rectangular), pear cut, oval cut, marquise cut, cushion cut, heart cut, princess cut and more. The cut chosen generally depends on the shape of the rough crystal. An elongated cut generally corresponds to a rough mineral crystallizing in elongated prism, such emerald. Much more complex and unique cuts exist, with different shape and extra facets and carving. This art is the specialty of lapidary artists in Idar-Oberstein.



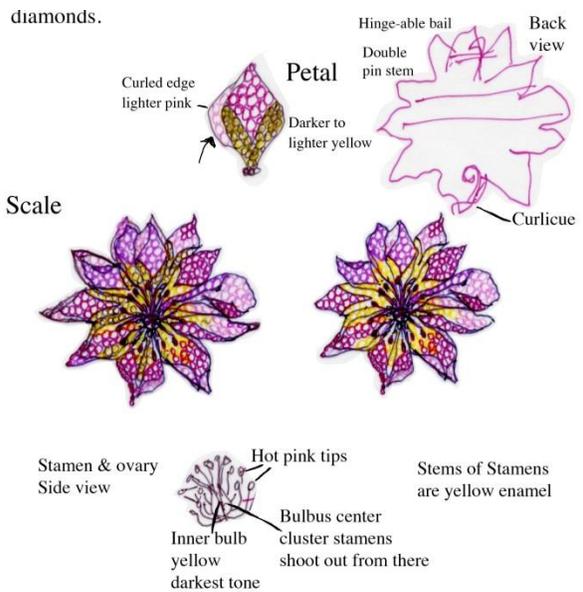
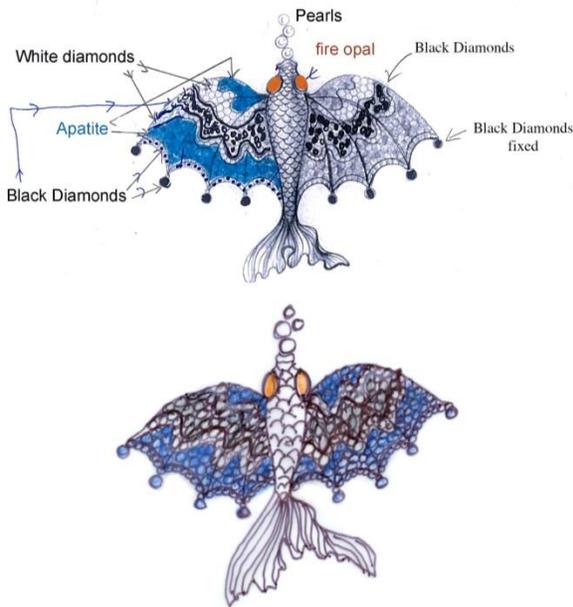
*Gem cutter and carver Glenn Lehrer during his work: carving an opal on the left, and faceting a gemstone on the right.
Copyright: Glenn Lehrer.*



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THE ART THE JEWELER

The art of the jeweler is to make jewels from gems or pearls mounted on precious metals (gold, silver, platinum, palladium). There are different kinds of ways to make jewelry. In the world high-end jewelry, each piece is unique and crafted from exceptional gems. In regular jewelry, the artist manufactures unique pieces on demand from less exceptional gems. The retail jewelry uses standardized stones and a design easily reproducible.



Preparing Paula Crevoshay's creations: "Flying Fish of Mandalay" and "Bitterroot". Copyright : Crevoshay.



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Preparing "Portuguese Man of War" by Paula Crevoshay. Copyright: Crevoshay.



The "Portuguese Man of War" jellyfish by Paula Crevoshay is made with play-of-color opal, chrysocolla, sapphire and coral. On the right, a specimen of chrysocolla from the Democratic Republic of Congo in the collection of the Mineralogy Museum.





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Many experts consider King Louis the Fifteenth's Golden Fleece as the first piece of high-end jewelry. Made by Pierre-André Jacquemin in 1749, this emblem of knighthood is constituted with many unique gems, like the French Blue diamond (69 ct; the 45.52 ct recut is now known as the Hope Diamond), the bluish diamond called "Bazu" (32.64 ct) and the red spinel shaped into a dragon called "Côte de Bretagne" (107.88 ct). These exceptional gems are accompanied by nearly 500 diamonds and 3 beautiful yellow sapphires.

In France, high-end jewelers can be a long tradition of family business. We can cite the Mellerio jeweler family, still in business today, dating back to 1613. Coming from Italy, the Mellerios receive the privilege from Marie de' Medici to freely exercise the jewelry trade business. The name of "joaillier" (jeweler) will be formalized by a legal act in 1755. It truly is with Marie-Antoinette as early as 1777 that the Mellerio family became renowned. In 1796, the "Maison Mellerio" is officially created and prospers under the First Empire, under which the family works, among others, for Napoleon the First. The company is now known as "Mellerio dit Meller" and is located rue de la Paix in Paris since 1815.

Finally, let us mention some names of great French jewelers: Chaumet (founded in 1780 with the famous jeweler of the king: Marie-Etienne Nitot), Cartier (founded in 1847), Boucheron (created in 1858), René Lalique (founded in 1888), or Van Cleef and Arpels (founded in 1896). Overseas, major jewelers also signed exceptional creations such as Tiffany & Co (USA, founded in 1837), Bulgari (Italy, founded in 1884) and Fabergé (founded in 1842). These are only a few representatives of the luxury industry, which thrives throughout the world.



"Bitterroot" by Paula Crevoshay is made with pink and yellow sapphires from Montana (USA). On the right a specimen of pink and blue sapphire on its matrix from Madagascar, in the collection of the Mineralogy Museum.