

Aa.



SHOES

BAGS


JEWELRY

SCIENCE OF STONES: SAPPHIRE



MINERAL: Corundum // CHEMICAL
COMPOSITION: Al_2O_3 // COLORS: Blue,
Yellow, Pink, Green, Purple, Orange,
Brown // REFRACTIVE INDEX: 1.76-1.77
// BIREFRINGENCE: +0.008 // SPECIFIC
GRAVITY: 4.00 // MOHS HARDNESS: 9

This month as part of our Science of Stones we look at Sapphires, the September birthstone. Sapphires have been prized as great gemstones since 4000BC when Chinese armies used the stone in axe blades. The name "sapphire" comes from the Latin sapphirus and Greek sappheiros



OSCAR HEYMAN
PLATINUM CEYLON
SAPPHIRE 21ct &
DIAMOND RING

meaning “blue stone. Rulers of ancient Persia believed the sky was painted blue by the reflection of sapphires. In the middle ages, its celestial blue color symbolized heaven and attracted divine favor and wise judgment whilst

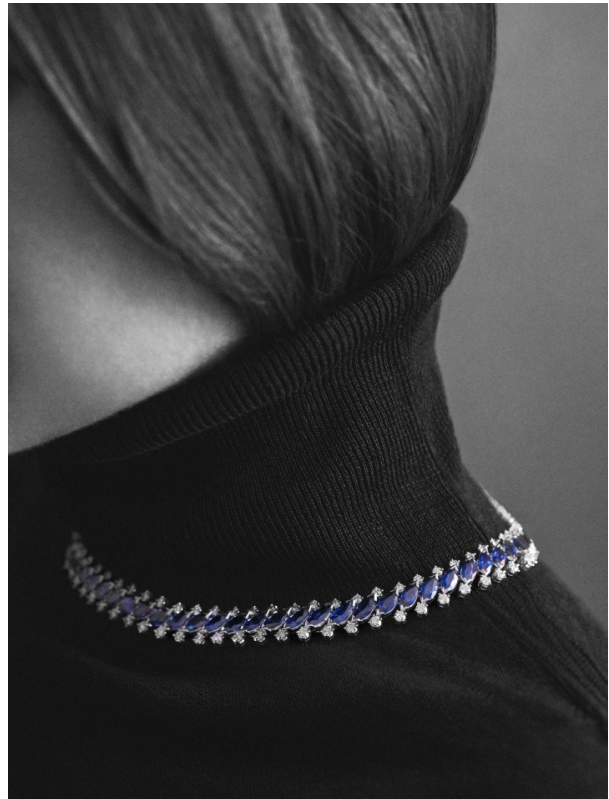
protecting those close to you from harm. The blue sapphire is a precious gem of wisdom and nobility representing the promise of honesty, loyalty, purity and trust through time. To this day, it’s still one of the most beloved engagement stones. We recently honored the 20 year anniversary of Princess Diana’s passing, which served as a reminder that Prince Charles proposed with a sapphire engagement ring. Buddhists believed they brought spiritual enlightenment, and Hindus used it during worship. Greeks wore sapphire for guidance when seeking answers from the oracle and early Christian kings cherished a sapphire’s powers of protection, using them in their ecclesiastical rings. As well as being September’s birthstone, sapphires are given for 45th wedding anniversaries.

Where stones are discovered may influence a buyer’s perception of their value, in the same way that color, cut, clarity and carat size are impactful. Every sapphire mine produces a wide range of quality, and although consumers will often seek stones from certain regions, origin is not a guarantee of quality. Even still, the most prized Sapphires come from Burma, Kashmir and Sri Lanka. Stones from the Mogok valley in Burma have always been very highly regarded. Their blue tone is the closest to true spectral blue with a unique velvety luster and they’re prized for their clarity and quality. Classic violet-blue sapphires traditionally came from the Kashmir region of India between the late 19th and early 20th centuries and despite peak production having taken place during this period (it has tapered off since), its reputation in the gem industry as a region for producing exquisite stones remains to this day. Kashmir-origin contributes significant value to a sapphire with most corundum of Kashmir origin being readily identified by its characteristic silky appearance and exceptional hue. The world record price-per-carat for a sapphire was a gem from Kashmir, which sold at auction for \$242,000 per carat (more than \$6.75 million total) in 2015. Sri Lanka’s sapphires are a less deep shade of blue and you’ll find they appear almost pastel. Famous star sapphires like the 1404.49-carat Star of Adam (the largest blue star sapphire), the 563.4-carat Star of India (the

second largest) and the 182-carat Star of Bombay came from Sri Lankan mines who remain the world's largest producers of sapphires over 100 carats. Australian sapphires are dark blue with a slightly green secondary hue. The presence of green tends to make them less expensive than those from Burma, Kashmir and Sri Lanka as green actually masks blue and devalues the stones. Australia is the largest producer of parti colored sapphires, stones that display two colors simultaneously. Australia was the largest source of sapphires for over 20 years until Madagascar discovered deposits during the early 90s in their Ilakaka mountains. Madagascar remains the leader in sapphire production.

Sapphire is a variety of the mineral corundum, an aluminium oxide (Al_2O_3) that contains trace elements of titanium, vanadium and iron (usually less than 1%). The crystallization of a sapphire is divided into two phases. A nucleus forms before layers of mineral are added over time. If conditions in the surrounding environment change, the formation of the sapphire will stop and the nucleus may break apart. Every sapphire discovered today began forming its hexagonal bipyramid shape millions of years ago, adding one molecule at a time under the immense heat and pressure found below the earth's crust. Impurities give the corundum its color with the characteristic blue being a combination of Titanium (Ti) and iron (Fe) impurities.

Sapphires are known to occur in a myriad of colors produced by an intervalence charge transfer. The transfer of an electron from one transition-metal ion to another. For example; Iron Fe^{2+} (ferrous)



OSCAR HEYMAN
PLATINUM MARQUIS
SAPPHIRE &
DIAMOND
NECKLACE

or Fe^{3+} (ferric), and titanium Ti^{4+} ions are substituted for the Aluminium (Al^{2+}), creating areas of imbalance in the electrical charge. An electron transfer from Fe^{2+} and Ti^{4+} causes a change in the connective state of both, creating Fe^{3+} and Ti^{3+} . This occurs because there is enough overlap between the outer orbits of Fe^{2+} and Ti^{4+} to allow their electrons to pass from one ion to another. This change absorbs yellow light. White light - yellow light = blue light, hence the blue you see. Sometimes a blue-green harlequin color is created when atomic spacing differs in different directions. Chromium impurities in rubies result in the absorption of all light except the color red, resulting in red rubies. Intervalence charge transfer produces strong color with a low percentage of impurity. Corundum only needs titanium and iron to be present at 0.01% of a stone's weight for the blue of a sapphire to become apparent. This is 100x less than the amount of chromium needed (1%) before the red of a ruby is seen.

As a result of strong and short oxygen and aluminum bonds in Al_2O_3 sapphires are remarkably hard, registering 9 on the Mohs scale. For reference, diamonds register a 10. This hardness makes sapphires very attractive in non-jewelry applications too. They are most commonly used in infrared optical components, high-durability windows, watch crystals and movement bearings.

Sapphires are mostly mined from eroded sediment carried by water and re-deposited in a dry place, today what would amount to ancient creek and river beds where water once ran. These alluvial deposits (as they're known in geological circles) settle and harden, trapping sapphires. Typically, sapphires in the rough are found in a barrel shape. Similar to an elongated football, they're tapered at the ends and wider in the middle, representing their bipyramidal structures. Burmese sapphires are typically found embedded in marble. Geographically, sapphire deposits can be found along the borderline where the Indian sub-continent pushed into Asia forming the Himalayas. The heat and pressure produced by these plate tectonics created the corundum that makes Burma, Kashmir and Sri Lanka origin stones so valuable, be they sapphires, rubies or other colored gemstones. Over time, erosion exposed these deposits, making them accessible to humans in the alluvial deposits.

The process of formation and the surrounding mineral environment means sapphires from different geographic locations have different appearances or chemical-impurity concentrations and contain different types of microscopic inclusions. Sapphires can therefore be divided into four broad categories: The classic metamorphic and non-classic metamorphic stones have undergone transformation by heat pressure as the earth's crusts folds while magmatic and classic magmatic stones form in and are brought to the surface by the lava in volcanic eruptions. Classic metamorphic sapphires from Kashmir, Burma, or Sri Lanka that haven't been heat-treated are for many, the pinnacle of sapphire creation.



OSCAR HEYMAN
PLATINUM NO HEAT
MULTICOLOR
SAPPHIRE BRACELET

Sapphires are assessed by color, clarity, cut and carat, the 4Cs. Color is a sapphire's key price indicator with the most valued being a vivid blue, sometimes with a hint of violet, although darker blues have also been known to command high prices. Similar to other colored stones, the color of a sapphire is broken into three parts: Hue - the color of the gem, saturation - the brightness of the hue, and tone - the lightness or darkness of the hue. Secondary hues of green or gray may detract from a sapphire's value by masking the hue, saturation and/or tone. Blue sapphires are evaluated on the purity of their primary hue with purple, green and violet being the most common secondary hues. Sapphires with 85% blue and 15% purple or violet are of fine quality.

When people think of sapphires, they typically think of a blue stone. However, as aforementioned, sapphires come in a rainbow of colors dependent on trace elements within the corundum. Green is produced by magnesium, yellow by iron, orange by copper, violet by chromium and the iconic blue by a titanium/iron blend. Known as 'fancy sapphires' these colors won't often attract a price as high as their more famous blue cousin apart for one exception; Padparadscha, a pinkish orange variety, reminiscent of a sunset which takes its name from the sanskrit "padma ranga" padma = lotus; ranga = color akin to the "Lotus Flower". Padparadscha commands the highest per-carat value for a fancy due to its rarity. It remains one of the most sought after stones in the world.

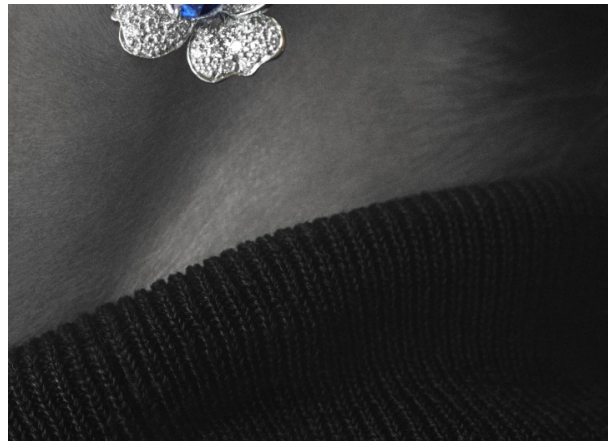
Color-change sapphires exhibit different colors in different light, shifting from blue in fluorescent light to reddish purple under incandescent light. Most commonly mined in Tanzania and Thailand, the color-change results when the intervalence charge transfer of chromium and vanadium interacts with the unique spectral output from a light source.

Blue sapphires typically have better clarity than rubies, though they often have similar long, thin rutile inclusions called "silk." Similar to rubies, silk in sapphires generally makes gems less valuable, but star sapphires may see their value increase. Often cut en cabochon these stones exhibit asterisms formed by inclusions of the mineral rutile that flows along the underlying crystal structure. Inclusions may also form a cat eye if the cutter orientates the 'face up' direction of the cabochon dome perpendicular to the crystal's c-axis rather than parallel to it. The value of a star sapphire depends not only on the weight of the stone, but also the body color, visibility, and intensity of the asterism.

Sapphires may be treated to enhance and improve their clarity and color. Treating is a common practice that assists mother nature in finishing above ground what she had begun below. Instead of heat and pressure being applied from the shifting of tectonic



plates in the earth's crust, a furnace's temperature is set to 500 - 1,800 °C (932 and 3,272 °F) for several hours. Heating may also occur in a nitrogen-deficient atmosphere oven for seven or more days. Heating causes stones to become bluer in color and lose some of their silk. When high temperatures are used, the stone loses all silk and becomes clear under magnification with a jeweler's loupe. Evidence of sapphire and other gemstones being subjected to heating dates back at least to Roman times. Since heating is so ubiquitous, unheated jewelry quality natural stones are rare, extremely valuable and will often be sold accompanied by a certificate from an independent gemological laboratory attesting to "no evidence of heat treatment" similar to the Oscar Heyman bracelet above.



OSCAR HEYMAN
PLATINUM PEAR
SHAPE SAPPHIRE
FLOWER EARRINGS

As with everything in life, there is an exception, Yogo sapphires being the case for sapphires. Mined in Montana, they require no heat treatment because their cornflower blue color is uniform and deep, they are generally free of silk and have highly uniform clarity.

Diffusion treatments are used to add chemical impurities to the sapphire that enhance color. Beryllium, titanium, iron, chromium or nickel, is absorbed into the crystal structure by heating the stone to just below its melting point. This colored layer can be removed when stones chip, are re-polished or re-faceted, depending on the depth of the impurity layer.

According to the United States Federal Trade Commission guidelines, disclosure is required of any mode of enhancement that has a significant effect on the gem's value

Because of their hardness, sapphires can be cleaned in almost any way. Warm, soapy water is best, though you can also try ultrasonic cleaners and steamers. You

can also use water with a touch of ammonia. If you have a fracture in your sapphire or own a star sapphire, do not use mechanical cleaning methods as a sapphire can shatter if hit sharply. This may be especially risky if the stone has inclusions, which weaken the crystal structure. As with most valuable stones, avoid doing heavy work or coming into contact with chemicals while wearing your stone, as they can damage the setting.

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BY AA.