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# PERFECT IMPERFECTIONS

**"Even imperfection itself may have its ideal or perfect state."**

***– Thomas de Quincey***

*Janna Semenova, 2021, Extraterrestrial Patterns in Agat, Multicolour.com*

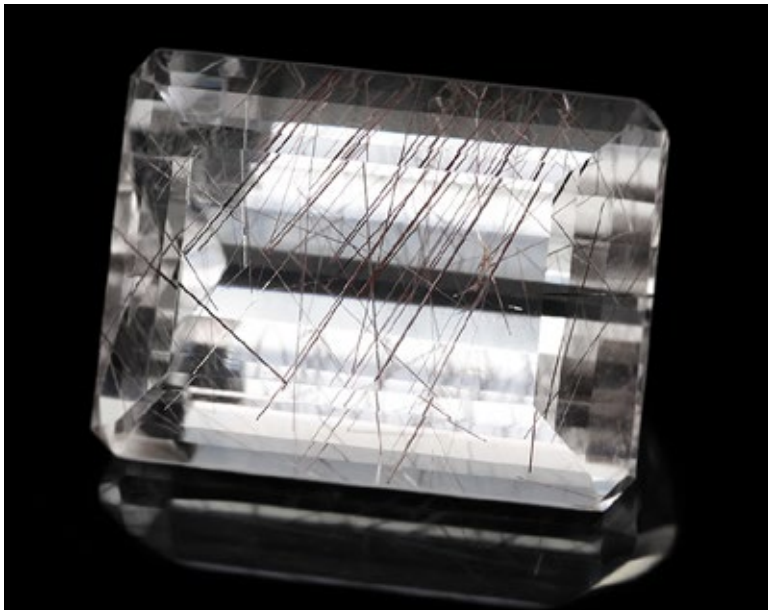
From the advertisers that promoted diamonds for the last 80 years, the public has been taught that gems should be white and clean and that inclusions are flaws. As far more money has gone to popularize diamonds than all other gemstones combined, it is understandable that consumers would follow along. Yet, for other gems, professionals agree the standards should be different. Colored stones are not the same as diamonds and should not be judged by the same criteria.

Colored stones are first of all about color, and preferences should guide purchases. Inclusions are a part of crystal growth processes, and they can add or detract from a gemstone's presentation. Of course, cracks and pits are unwanted, but some inclusions add texture, character, or special effects. Thus, they are critical, not only for identifying treatments and origins but also for their impact on the gems' appearance.

Some gemstones are sought because of their inclusions rather than despite them. As opposed to diamonds, where inclusions decrease value, in colored stones, some inclusions may add value and are essential to the colors and special effects that wonder and amaze us.

Inclusions are also responsible for optical phenomena like asterism, chatoyancy, adularescence, iridescence, color play and labradorescence. Gems with these properties stand out because of the way their inclusions interact with light. In other cases, the inclusions are so distinctive that the colors and patterns become the focal points of the gems they inhabit.

Optical reflections and light interference, along with purely visual effects like color patches, banding, platelets, zoning, spots, specks, needles or filaments, are factors that can give rise to exceptional jewels. When they stand out in their beauty and uniquity, we experience them as fascinating and recognize that they are, in fact, extraordinary.



Rutilated quartz is a variety of quartz which contains needle-like inclusions of rutile.

**GEMOLOGY 101**

**Special Effects Caused by Inclusions**

- Asterism is the phenomenon of gemstones exhibiting stars caused by the light reflecting from needle-like inclusions of rutile aligned perpendicular to the light source
- Aventurescence is the glittery effect of light reflecting from small plate-like inclusions of copper or sometimes hematite in sunstone feldspar or aventurine quartz. These inclusions are visible to the naked eye
- Adularescence (or the schiller effect) is a soft glow of light emanating from a gemstone's interior as a function of interactions between light and layers of microstructures within the mineral. Depending on the gemstone and it's inclusions, the effect varies from a milky murmur to a vivid iridescent play of color. The result is well known in moonstones and rainbow moonstones, but opal, rose quartz and some agates may also display the phenomena
- Chatoyance or the cat's-eye effect is an optical response to light reflected from swaths of parallel needles or hollow tubes. The light appears in a narrow band that moves as the stone or the light source moves. Ideally, the eye should open and close as the stone rotates
- Labradorescence is a peculiar reflection of light derived from variations in planes of crystal growth. The lamellar separations manifest themselves in multitudes of bluish and rainbow colors. Spectrolite feldspar is the most prominent example

**WHAT ARE INCLUSIONS?**

In gemstones, inclusions are a part of the crystal growth process. Similarities in the growth environment tend to correlate with a likeness of inclusions. Although some inclusions are typical or even diagnostic for certain gems, they may also resemble comparable characteristics in others. Gemstones from a given deposit usually show similarities and gemologists study their interiors to determine authenticity and origin.

Three kinds of inclusions reflect the three phases of matter: solid, liquid or gas. Single-phase inclusions are inclusions in minerals consisting of only one single-phase – solid, liquid or gaseous. Single-phase inclusions are very common as solid particles or inclusions of other minerals solidified or incorporated into the crystallization. Gaseous single-phase inclusions are common in natural or artificial glasses and synthetic materials formed from a melt.

Two-phase inclusions are cavities inside crystals filled with two different phases. The most common examples are liquid-vapor inclusions, but other combinations are also possible: two immiscible liquids such as water and liquid CO2 or water and liquid hydrocarbons (oil).

Three-phase inclusions typically formed when homogeneous fluids trapped in a cavity separated due to differences in densities or melting points. The most common examples are liquid-solid-vapor inclusions and liquid-liquid-vapor inclusions containing two immiscible liquids. Vapor inclusions are in the form of gas bubbles, always round or nearly round, and obvious to spot with enough magnification. As they remain trapped in a liquid, they sometimes move around as the stone is inverted or turned. Both Quartz and Colombian emeralds are well-known hosts of three-phase inclusions.

For gemological research, it is essential to know when in the course of a gemstone's development, an inclusion originated; before, during or after the completion of growth. Inclusions built and formed before the growth of a host crystal and were absorbed ready-made into the latter are known as protogenic inclusions.

Inclusions that developed simultaneously with the growing host crystal and were enclosed within it are known as syngenetic inclusions. Mineral solids, trapped liquid inclusions, liquids in cavities and tiny gas bubbles are examples. And finally, inclusions that developed after the completion of the host crystals' growth are known as epigenetic inclusions.

Gemstone inclusions bring tidings from the past and help gemologists understand their genesis millions or even billions of years ago. For matters of gemstone origin and treatments, magnification is the best tool available to gemologists.

**MAKERS OF PHENOMENAL GEMS**

Optical phenomena are revealed from light interacting with the crystalline structure or microscopic inclusions within a gemstone. Effects like asterism, chatoyancy, and aventurescence may add beauty as well as value to a jewel.

Star sapphire cabochon weighing 5.55-carat from the Diego area of Northern Madagascar, exhibiting strong and clear asterism as well as the prominent color zoning.

*Vanutsaporn Treemok, 2020, Star Sapphire. Multicolour.com*

## STARGAZING

When microscopic needle-like inclusions inside a gem reflect a streak of light, it is known as a cat's eye. The cat's eye's inclusions should be aligned parallel to each other and fashioned as cabochons with the fibers running across the narrow part of the stone. This phenomenon is also known as chatoyancy, and it becomes most apparent under a spotlight or direct sunlight. A thin bright band of light will appear and open and close as the stone is rotated – hence the eye-like effect. Although many gemstones, including tourmaline, beryl, scapolite, and quartz, may present chatoyancy, these stones are referred to as tourmaline cat's eyes or quartz cat's eyes, and only chrysoberyl is referred to as "cat's eye" with no other designation. In very fine chrysoberyl cat's-eyes, the light divides the cabochon in half and reflects a lighter and a darker color known as the "milk and honey" effect. Chrysoberyl is, in general, the most highly prized of the chatoyant gemstones. The subtle colors are ideal for gent's jewelry, and chrysoberyl cat's eyes are famous among dealers in casinos.

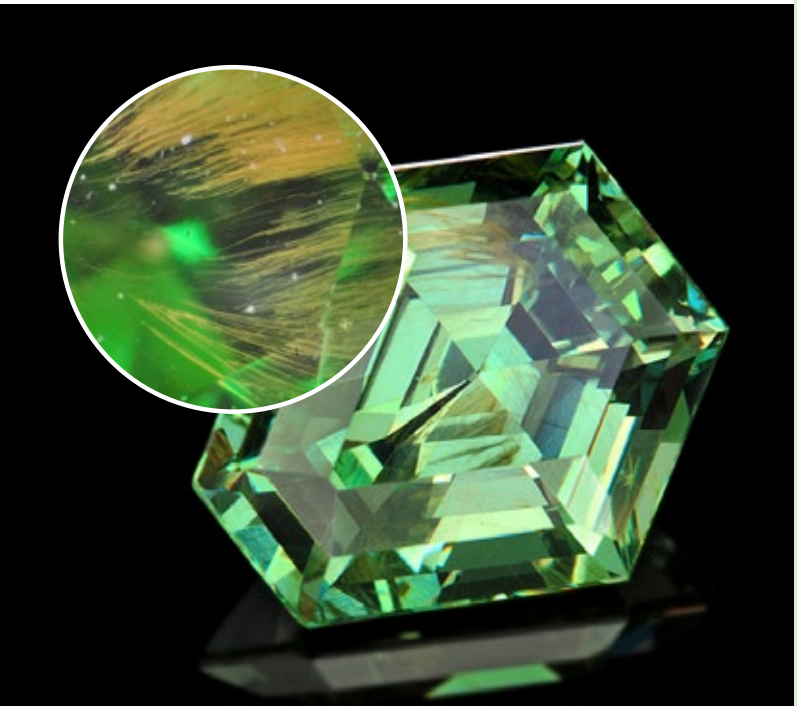
Star stones are similar but different. The most common asteriated stones presenting six-rayed stars result from three groups of needle-like inclusions in a plane perpendicular to the c-axis. Here, the needle-like inclusions intersect each other at 60 degree angles related to the crystallization. When their orientation is correct and the fibers are dense enough, a star can be observed. The most prized examples occur in sapphires and rubies. Corundum stars are usually six rays, as are quartz and spinel stars. Other gemstone varieties like garnets or moonstones will show only four legs. The stars' rays appear to float suspended over the host with an ethereal light that seems to emanate from within.

## ALL THAT GLITTERS

Gem connoisseurs and innovative jewelry designers often seek the subtle beauty of lesser-known but intriguing gemstones with inclusions that create patterns or brilliant flashes and color spots within a stone. This glittery appearance comes from the plate-like inclusions of copper or sometimes hematite that reflect light in a spectral array known as Aventurescence. The most common examples occur in quartz or feldspar (sunstone). Although most sunstones possess a yellow, orange or brown body color, not all sunstones are aventurescent. The appearance of the phenomenon depends upon the size of the inclusions. Slight inclusions create a reddish or golden sheen, while larger inclusions create attractive, glittery reflections. In aventurine quartz, spangles of green mica glitter and may also add to the gem's perceived body color.

## THE ADDED VALUE OF INCLUSIONS

Some inclusions affect color and add character, aesthetics, and value to the gemstones they inhabit.



Dermantoids are among the few gemstones that are prized and valued for their inclusions. The radiating fibrous inclusions of byssolite are know as "horsetails" and are said to be diagnostic for Dermantoid.

## HORSETAILS

Demantoid garnet is considered to be one of the rarest and most valuable of the garnets. Discovered in Russia more than a century ago, demantoid garnets are even more dispersive than diamonds. The distinctive feature of Russian demantoids is the characteristic inclusions of yellow byssolite (asbestos) fibers with radiating arrangements known as horsetails. These yellowish hairs appear to radiate out from crystals inside the stone. A well-formed horsetail will increase the value of the demantoid especially when it is clear and easy to see. Horsetails are also indicators of Russian progeny as they rarely appear in demantoids from other localities.

## SUPERSTARS

An unusual kind of emerald composed of triangular or trapezoidal partitions separated by black lines is known as the Trapiche emerald. Despite its starlike appearance, the spoke-like patterns with rays of darker material remain stable and in position regardless of the light source. When miners first came upon these patterns in their stones, they called them Trapiche, the Spanish word for the six branch gears used to crush sugar cane. Trapiches are characterized by equivalent growth sectors like the pieces of a pie. The boundaries intersect in a central point or extend from the edge of a central core. The effect is also visible in some corundums and tourmalines but quite rare. Trapiche stones attract collectors and investors, and prices for Trapiche emeralds have tripled as well-known designers have incorporated them into their jewelry. A beautiful Trapiche effect will unquestionably add allure to a gemstone.

## NEEDLES

As the predominant mineral in the Earths' crust, quartz is inexpensive and available in large sizes. Its crystalline form is represented by amethyst, citrine, ametrine, rock crystal, prasiolite, smokey quartz and rose quartz. When it contains needle-like inclusions of rutile, it is known as rutilated quartz. Although needles of rutile are well known as inclusions, every needle-like inclusion is not rutile and they may also be composed of actinolite, tourmaline, hornblende or goethite. Rutilated quartz is valued specifically for the pattern and distributions of the needles. An infinite variety of golden and copper-colored rutile can be observed and their appeal is univeral. In the case of rose quartz, the needles may orient to form six-rayed stars in stones that can easily exceed 30 cts in weight. Though such stars occur in rose quartz, they are rarely as well defined as they are in corundum.

## PICTURESQUE

Agates are primarily formed from volcanic and metamorphic processes. Banded, striped, wavy or concentric, agates occur in a variety of colors worldwide. The bands might be better referred to as zoning lines rather than inclusions, but they are nevertheless both. The shapes and bold colors of the bands and ribbons and the varieties of patterns are incomparable. Moss, Dendritic and Plume agates can be exceptional and are prized for their floral patterns. In contrast, Picture agates can even reveal images with an uncanny resemblance to the desert landscape from which they were unearthed and sometimes exhibit a complete panorama replete with shorelines, trees, shrubs, lakes and mountains.

## GEMSTONE PHOTOMICROGRAPHY

As opposed to macrographic photos of gemstones, which are visible to the naked eye, a micrograph, or photomicrograph is a photograph taken through a microscope to show a magnified image of a gemstone's inclusions. With an infinity of colors and patterns, they resemble masterpieces of modern art.

Edward J Gubelin was a pioneer in gemology and among the first to initiate and publish his comprehensive approach to gemstone photography. He developed into a master photographer of their internal paragenesis and, in the process, acquired a new understanding of inclusions and how they can be studied. In Gubelin's day, there was only film photography, which would have been much slower than today's instant digital results. As an admirer and collector, he cataloged and photographed gemstones for decades before selecting the best images for his book, "The Internal World of Gemstones". The book is still a platform for gemstone studies and is considered a bible and an inspiration for photographers. Most importantly, his work invalidated the association of inclusions as flaws and recognized their ascetic beauty. Photography and magnification have improved a lot since his time, but the inclusions haven't changed, and Gubelin's images remain as relevant as the day he captured them.

There is no doubt that any artist would fail to marvel at the infinite colors and arrangements that appear in the world of gemstones. Inclusion studies reveal their magical world's innermost recesses, and images of them have only served to enhance and glorify their distinction.

# WABI-SABI: THE GEM OF IMPERFECTION

**Finding beauty in every aspect of so-called imperfections in gemstones and recognizing the aesthetics of their asymmetry is an acknowledgment that has redefined gemology and a luxury industry obsessed with perfection.**

## REFLECTIONS
**LABRADORITE**

Labradorite exhibits an effect known as labradorescence – a broad flash of color across the surface. The perceived colors are dependent on the thickness of the alternating layers and their refractive indices.

## TRANSIENCE
**QUARTZ**

Oil-bearing and bituminous inclusions in quartz provide testimony to an organic environment with their iridescent reflections.

## ASYMMETRY
**TOURMALINE**

Variations in trace elements are among the factors that contributed to the prominent sectioning in this bi-colored stone.

## CHAOS OF THINGS
**QUARTZ**

Acicular crystals of rutile are among the most common inclusions in quartz. The elaborate clusters and patterns are a magnet for collectors and designers.

# RELICS & RARITIES

Alexandrite is one of the most admired of all the colored gemstones, and while chatoyancy does occur in some chrysoberyl, finding stones highlighting both a cat's eye and a color change is rather uncommon.

Beautiful stones would be in high demand from any collector and would likely sell immediately. Occasional specimens have been unearthed from the major deposits in Brazil, Africa and India, but most stones are small, and even those are elusive.

*Janna Semenova, 2021, 3.25-carat Alexandrite Cat's Eye from Andrapradesh, India, Multicolour.com*

# PROSPECTOR'S CORNER

Despite the name, chrome tourmalines can be colored by chromium or vanadium, the same elements that color emeralds. As a result, the color range is distinctive and in most cases, easy to recognize with experience. Compared to other green tourmalines, where iron is the chromophore, chrome tourmalines stand out for the high saturation and purity of their colors. The primary sources lie in Kenya and Tanzania although a few stones have also been found in Myanmar.

This half-terminated specimen from Kenya is an excellent example of tourmaline's hexagonal crystallization. Measuring 16.30mm x 10.8mm x 7.9mm and weighing 12.80-carat, the lateral view reveals parti-coloring that could fashion a bi-color. This stone should be faceted as an octagon or a baguette with the table parallel to the long axis to feature the color separation.


*Vanutsaporn Treemok, 2021, 12,80-carat Chrome Tourmaline Crystal, Kenya. Multicolour.com*

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