Colored Stones

The Big Three

- Emeralds—green like grass
- Rubies—pigeon blood red
- Sapphires—corn flower blue

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Van Cleef & Arpels

Emeralds-Beryl $Be_3Al_2Si_6O_{18}$

- Emeralds are a rare form of Beryl that are colored with either Chromium or Vanadium
- They have a grass green unlike any other stone except for some jade.
- Tourmaline comes close but tends to be a darker green

Natural Crystal AMNH

Emerald is part of the beryl family

Other colors of beryl

- The colorless variety Goshenite.
- The greenish-yellow variety Heliodor.
- The pink variety Morganite.
- red-colored berly is called red beryl
- bright golden-yellow beryl is called gold beryl

Morganite

Emeralds are found in Metamorphosed rocks

- Metamorphosed limestones that are included in Black shales create emeralds.
- Emeralds are in the Beryl family, but most Beryl comes from igneous rocks. The fact that emeralds form in preexisting rocks means that they tend to be included.
- The best emeralds in the world come from Muzo in Colombia.

Mining Emeralds in Muzo

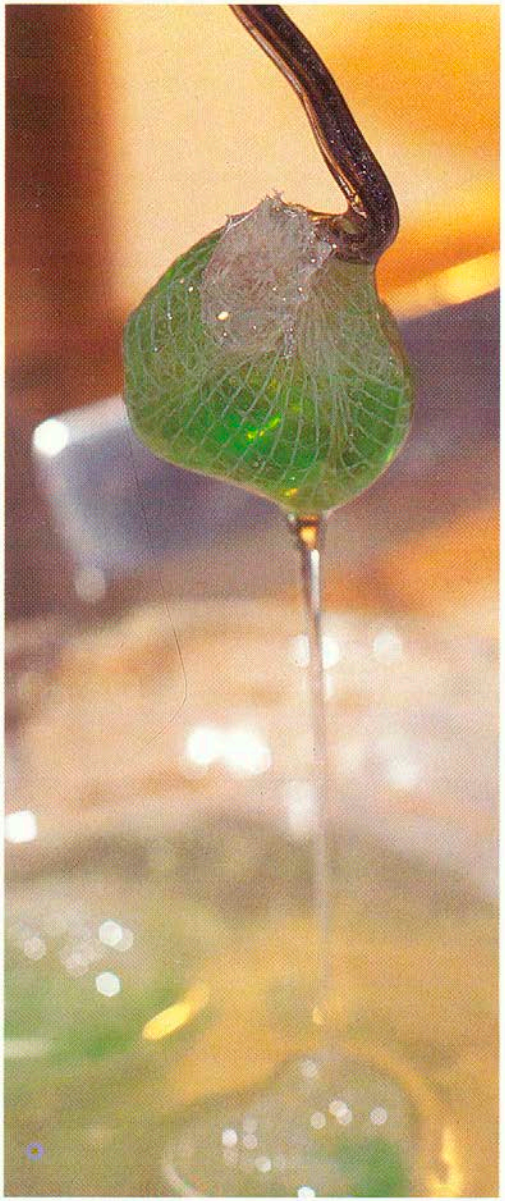
Emeralds always have inclusions and flaws

The color is the key

- Emeralds are typically cut to show the most surface area and color

Emeralds are enhance with Oil

Oiling is an almost universal emerald enhancement, but virtually unknown to the public. Of all the major gems, emeralds are most likely to have inclusions, distinctive relics of the crystals' birth process. Some serve as fingerprints, by which gemologists identify naturals. Too many inclusions diminish a stone's beauty and value. Oiling is not permanent and should be repeated every few years. Only if cracks reach the surface can an emerald benefit from oiling.



A Bogotá laboratory technician washes and dries emeralds (top). Then he soaks them overnight in heated oil, sometimes under pressure, to force oil into inclusions (left). After draining and another cleaning, some emeralds display substantial improvement. Shown above is a 28 ct. gem before and after oiling. Usually, whoever owns a gem at the time it is faceted decides whether to oil.

Synthetic Emerald

- Gilson–flux fusion
- Chatham—flux fusion
- Most synthetic emeralds are made by the hydrothermal method
- They are easily recognized because they are much clearer or even flawless
- They sell for about a 1/3 the price, which is still alot

Annealing emerald after formation

Rubies & Sapphires

- Both Stones are the same mineral
- They are types of Corundum, Al_2O_3
- Chromium Cr makes ruby red
- All other colors are called Sapphire

Both stones have the same physical properties

- Crystal habit: elongate hexagonal prisms and hexagonal plates
- Hardness: 9 on Moh's scale (2nd hardest gemstone)
- Specific gravity: 4.0
- Luster: non-metallic
- Toughness: Excellent
- Cleavage: None; basal parting
- Optics: Biaxial negative, Birefringence: Low (0.008), Dispersion: Low (0.018) Strong pleochroism (color and intensity changes vary with crystallographic direction): strongest color perpendicular to c axis
- Color: red = ruby, all other colors referred to as sapphire, colorless, yellow, orange (Padparadscha), pink, green, blue, brown, and black. Very poor quality corundum is sometime referred to as emery (examples being emery cloth and paper used for sanding).
- Other: Asterism; star rubies and sapphire are highly prized.
- Varieties: ruby, sapphire (many colors), Padparadscha (orange)

Asterism (a star is born)

- star sapphires and ruby are due to oriented rutile needles
- needles of rutile are TiO_2 become oriented in the growing crystal's structure
- stasr can change positions depending on where the light hits
- off-center
- almost centered
- centered

asterism

Ruby

Ruby

- The finest ruby color is a deeply saturated, pure pigeon blood red that is free of other hues. Such a color is very rare and therefore highly valued. Purplish-red or brownish-red colors are more common (and less expensive). The color should be more "deep" than "dark".
- Other factors to considered when shopping for rubies, or any gem for that matter, are clarity and cutting.

Sapphire

- Any Color other than Red
- Colorless, blue, yellow, green, purple, and even pink.
- Less valuable than ruby, but still in high demand.
- Subject to the same treatments as ruby.

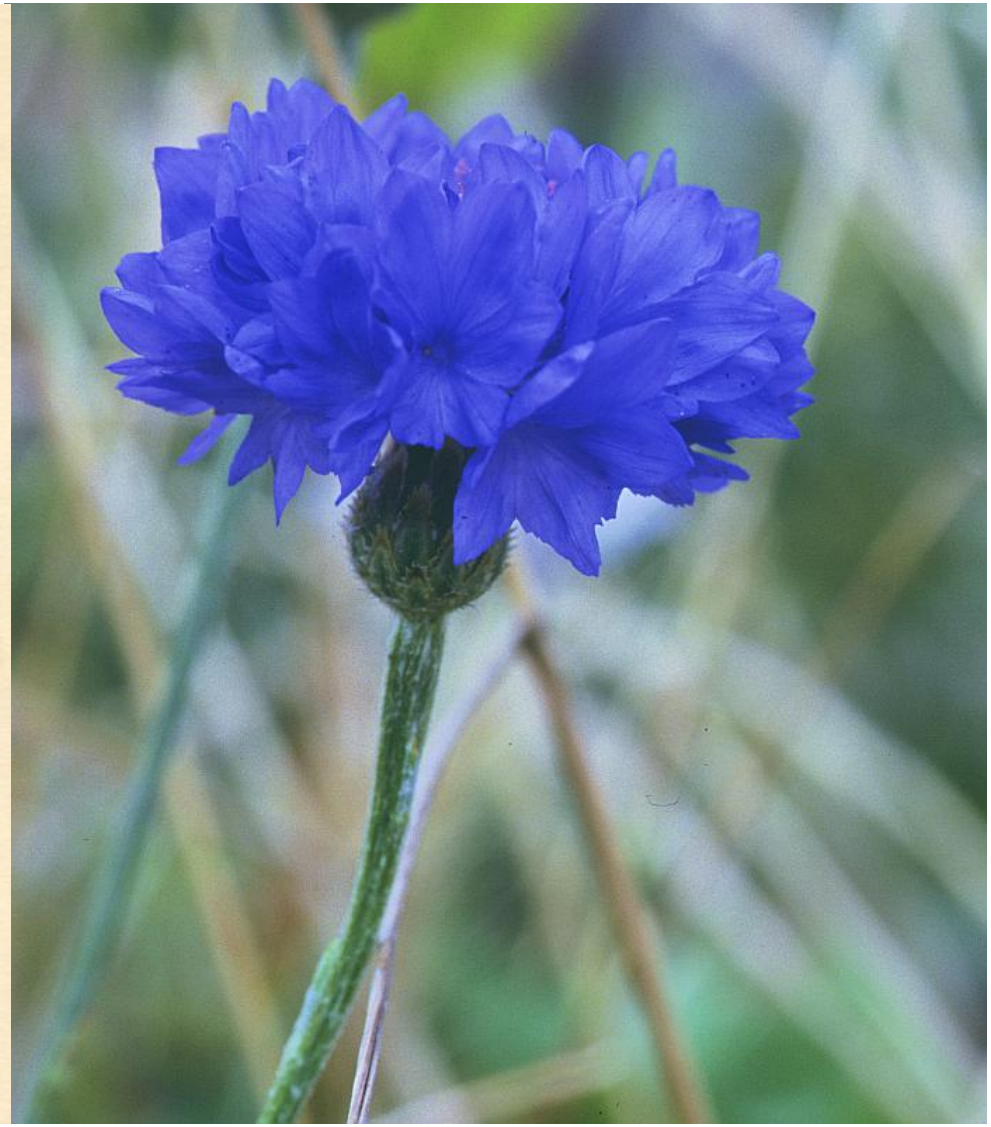
Color

- Cornflower blue is considered the best and most desirable color for sapphire in western culture. Kashmir sapphires are best.

- However, all colors are a matter of taste.

- Thais like Padparadscha, lotus blossom color

Cornflower Blue



Corundum (var. sapphire)

Al_2O_3

Mogok Stone Tract

Shape of Crystals

- Most Corundum is from alluvial (river) deposits and shows some wear.
- Many stones still show a six-sided outline and crystals often taper to a point.
- Crystals often have color zoning

Treatment

- Heat treatment is universal
- Diffusion treatment is very common (heating with extra colorants).
- Some stones are colored with dyes (more so in rubies).

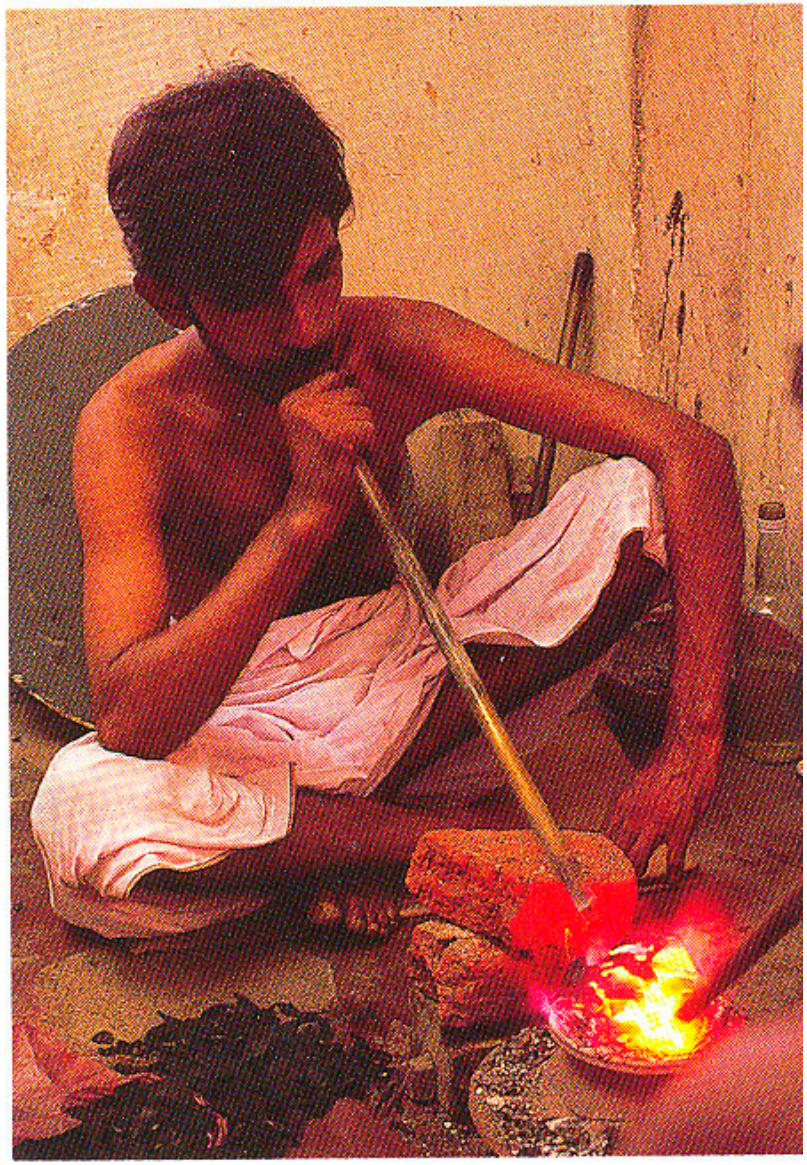
Heat Treatment

- Treatment of corundum is done to remove local color concentrations (patchiness of color) and to improve the depth of color.

- Heating the gemstone redistribute color-causing impurity (Cr, in the case of ruby) evenly through the Stone.

- Detection: inclusions are changed (cracking from uneven expansion).

Heat treatments



Untreated sapphires from Montana's El Dorado Bar eposit (top right) resemble aquarium gravel more than gemstones.

But look what happens when sapphires are taken to high temperatures in controlled atmospheres. After heat treating alters the internal chemistry (center), some stones intensify to brilliant blues and yellows.

Today, heating is used to improve permanently the color and sometimes the clarity of most faceted rubies and sapphires (right).

Diffusion Treatment

- Diffusion treatment is done to deepen the color corundum

- Diffusion treatment is done to faceted stones and is not obvious by inspection under normal viewing conditions!

- SAPPHIRE: blue sapphire is heat treated with Fe and Ti oxide powders placed in contact pre-faceted gems. Fe and Ti diffuse into the surface of the stone only a fraction of a millimeter.

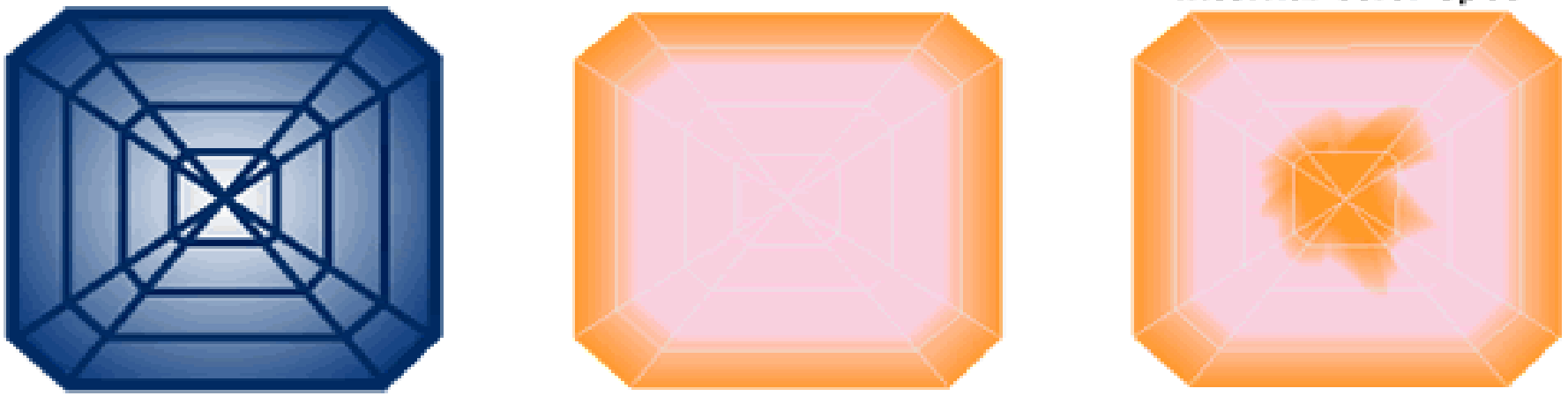
Diffusion treatment

Top View

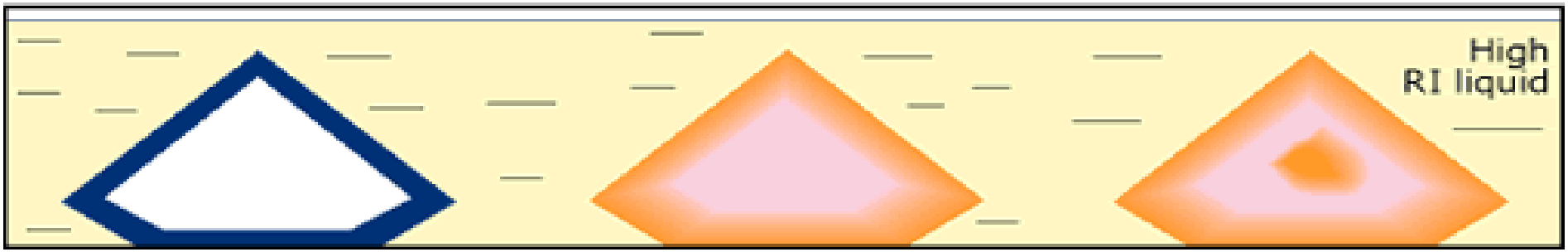
Blue surface-diffusion treated on colorless core

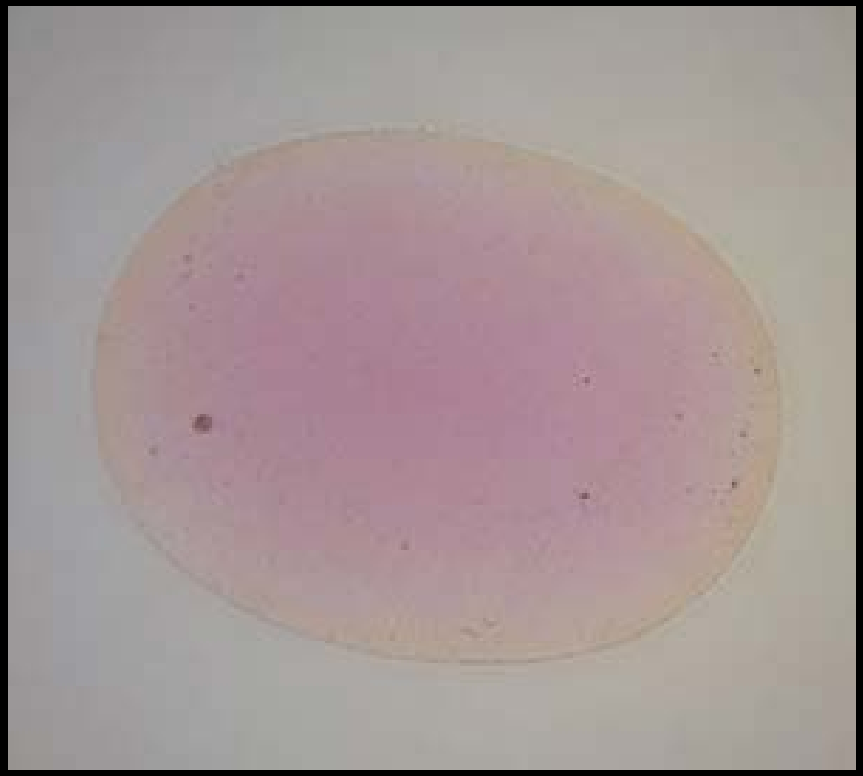
Orange surface-diffusion treated on pink core

Orange surface-diffusion treated on pink core with internal color spot



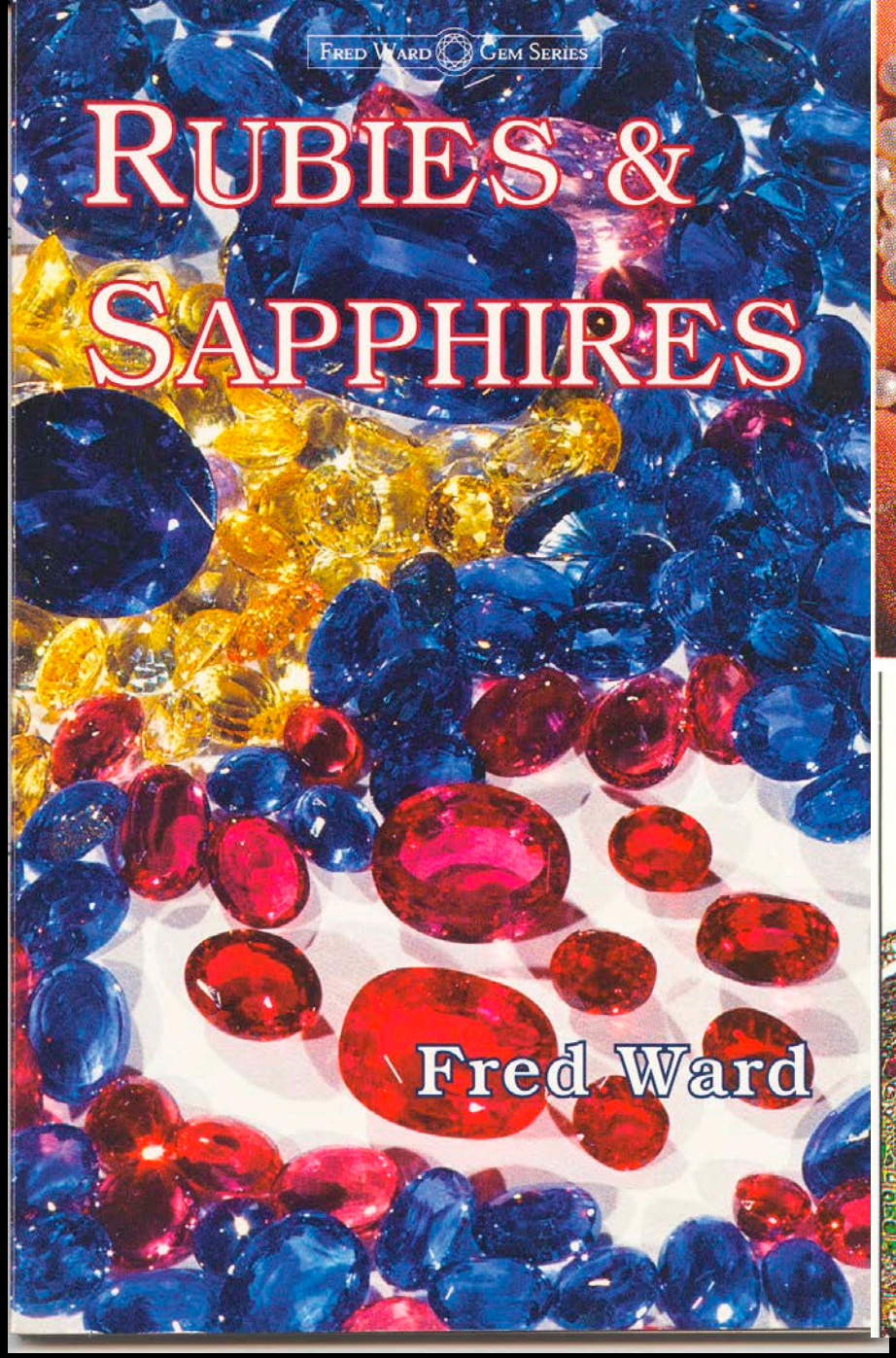
Side View

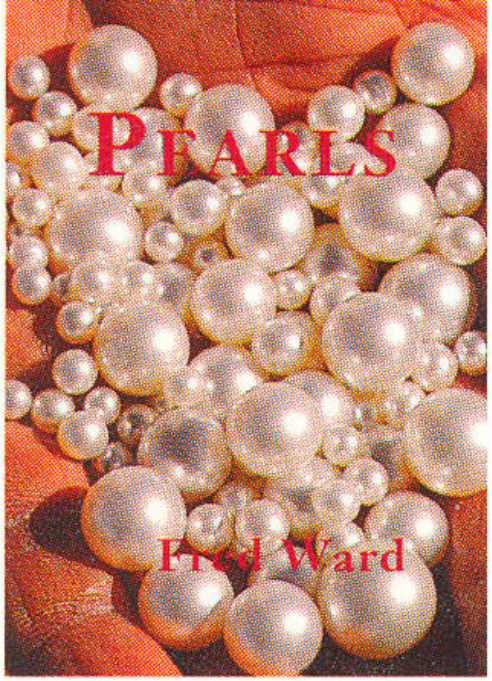




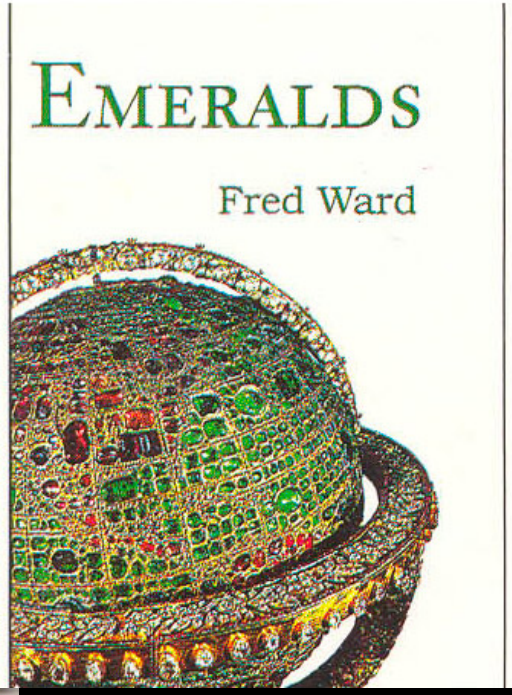
- Orange rim surrounding a pink core in a surface-diffusion treated orange sapphire from Madagascar. The color rim is visible when the gem is immersed in liquid and is evidence of a treatment applied after cutting.
- Recutting such stones will produce a loss of the orange color.

A Sri Lanka sapphire before (top), and after diffusion (below).


Fred Ward Gem Series
Rubies & Sapphires
Fred Ward


Pearls
Fred Ward


Jade
Fred Ward


Emeralds
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Diamonds
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